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# NewScientist

WEEKLY January 3 - 9, 2015

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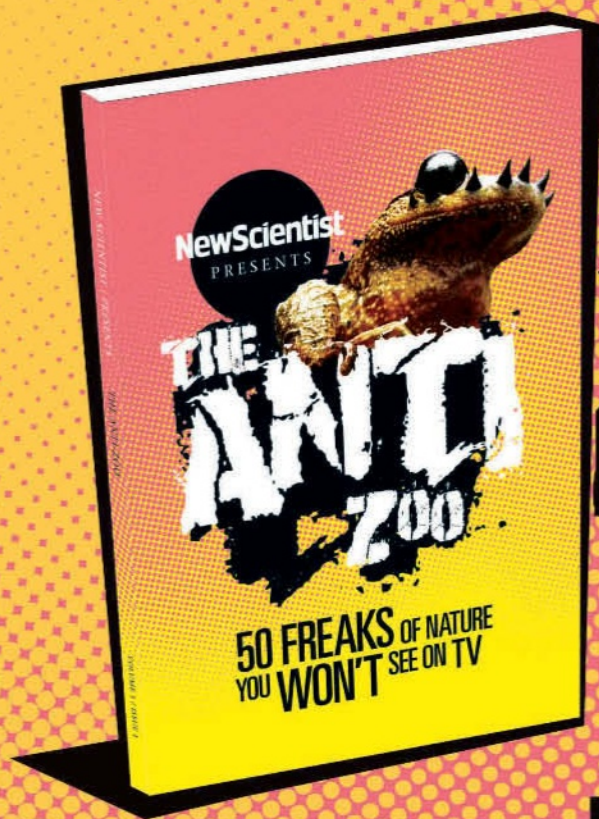
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TOM ROBERTSON/GETTY



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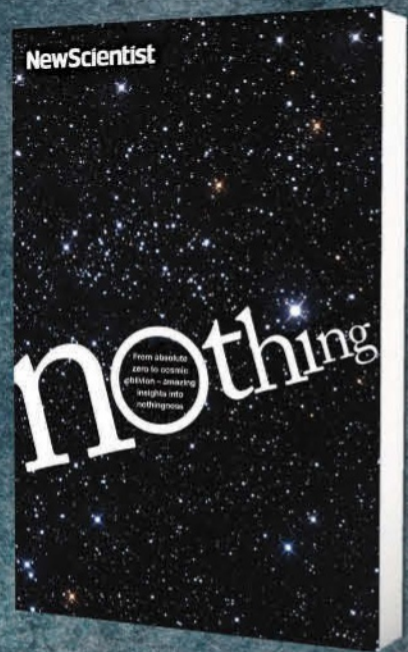
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## A twist on dry January

We should raise a toast to drugs that can be substitutes for alcohol

'TIS the season to be sober. At this time of year, many people decide to stop drinking alcohol for a while, often to atone for an overindulgent festive season.

As we reported this time last year, a dry January seems to pay dividends for both physical and mental health (*New Scientist*, 4 January 2014, p 6). But perhaps in new years to come there will be another option for the penitent overindulger: drugs that are taken as a substitute for alcohol, or which reduce the urge to drink it.

The prospect of such drugs has long been discussed (*New Scientist*, 15 July 2006, p 30). Now they are becoming a reality (see page 8).

Not coincidentally, January is also traditionally the time of

year that smokers try to quit. Doubtless many are relying on a safer substitute either as a crutch or a permanent replacement – e-cigarettes.

The parallels between the two products are not entirely coincidental: the success of e-cigarettes as a smoking substitute has shown advocates of alcohol replacements that even the most deeply ingrained habits can be altered.

But there are some big differences. Vaping delivers nicotine – the largely harmless drug that people crave – while eliminating most of the dangerous chemicals that arise as a by-product of burning tobacco. The act of vaping also closely

mimics smoking and allows nicotine addicts to puff away, circumventing indoor bans and other restrictions on their habit.

When it comes to alcohol, the drug itself is the hazard. And popping a pill is no substitute for the social ritual of drinking or the pleasurable taste of a fine wine or cold beer. So to emulate the success of e-cigarettes, alcohol substitutes will probably have to mimic booze and boozing as closely as vaping mimics smoking.

There is another important parallel: just like e-cigarettes, alcohol mimics will raise moral hackles. To this there is a very straightforward response. If they reduce harm, they must be allowed. To your good health. ■

## A century of relativity

ONE of the defining anniversaries in 2015 will be the centenary of general relativity. In 1915, Einstein published a set of equations that changed our understanding of the universe. Out went the Newtonian notion of gravity as a force between massive objects; in came the counter-intuitive idea that gravity is a property of the universe, with massive objects curving space-time.

A century on, gravity continues to challenge us. The equations predict that cataclysmic cosmic events should send ripples through space-time, but we have yet to observe any. This year will see two projects aimed at sorting this out: the resumption of a gravitational-wave experiment called LIGO and the launch of a spacecraft called LISA Pathfinder that will test technology for

catching the waves in space.

We may even see progress on the biggest unresolved issue of all – the incompatibility of relativity and quantum theory. At the atomic scale, gravity is so weak we routinely ignore it. Now it seems we are wrong to do so (see page 26). Gravity might play a crucial role in the quantum world. It might be the secret ingredient of reality. We won't get full answers this year, but relativity's greatest remaining puzzle looks to be on its way to being solved, at last. ■

## Tourist hell for penguins

FOR those who go, it's the trip of a lifetime – and it wouldn't be complete without a selfie with penguins. But growing tourism to Antarctica could be putting penguins at risk of disease.

Antarctic species are believed to have weaker immune systems due to their long isolation from the world's common pathogens. But Antarctica is opening up: more than 37,000 people visited the continent in the 2013-14 season as part of a growing tourist industry, compared with 8000 just 20 years earlier. An additional 4400 researchers can be accommodated simultaneously during peak months.

"The effects of both a growing tourism industry and research presence will not be without consequences," says Wray Grimaldi

of the University of Otago in Dunedin, New Zealand. "Penguins are highly susceptible to infectious diseases."

She bases that on her team's survey of penguin diseases. It found reports of salmonella, *E. coli*, West Nile virus and avian pox virus infections in captive penguins, and a number of mass penguin deaths across the Antarctic since 1969 (*Polar Biology*, doi.org/xvp). A number of infectious agents are implicated, including avian pox, which killed more than 400 wild gentoo penguins in 2006.

Grimaldi says some pathogens may have been introduced to Antarctica by humans – but direct evidence for that is still slim. "A coordinated monitoring system needs to be in place," she says. "That way, responses can be directed by science."



Say cheese, then run

KEVIN SCHAEFER/MINDEN PICTURES

## EU votes on GM ban

NOT in my backyard! European Union member states may soon be allowed to ban cultivation of genetically modified crops on their soil even if the crops have EU approval. The European

### "The biotechnology industry has a serious problem with arbitrary bans on safe products"

Parliament is expected to vote on the matter on 13 January.

If voted through as expected, the legislation will mean countries will no longer be obliged to provide scientific evidence to the European Food Safety Authority that GM crops will harm human health or the environment. Instead, they will be able to exclude GM crops for reasons such as fear of adulteration of organic produce, or simply that their presence may cause public unrest.

Anti-GM campaigners are broadly pleased. "The list of concerns is not only based on scientific considerations and environmental harm, but also

risks for small farmers, such as contamination," says Mute Schimpf of Friends of the Earth.

But she points out that the provision will also allow biotech companies to lobby governments over possible bans.

Meanwhile, backers of GM say the rules would set a dangerous precedent for free trade and innovation, by allowing products scientifically judged to be safe to be banned by individual nations. "Our industry has a serious problem with arbitrary bans on safe products," says Beat Spaeth of industry association EuropaBio.

## Mercury melter

THE first spacecraft to orbit Mercury is almost out of gas. After discovering water ice, organic compounds and an iron core on the innermost planet, NASA's Messenger orbiter will make one last thruster boost on 21 January.

Engineers expect the 120-second engine burn to give the craft an 80-kilometre lift that will keep it aloft until March. But before then, as Messenger swoops low over the planet, it will heat up to 185°C and the metal solder holding some instruments together could melt.

In that time, the craft will get an unprecedented view of Mercury's pockmarked surface, capturing data on its gravity field, crater contents and surface make-up.

Because of the planet's uneven gravity, the site of Messenger's eventual crash landing is uncertain. But it will likely land on the far side, where it will be out of view until 2024, when the European Space Agency's BepiColombo mission arrives.

To mark its impending demise, the Messenger team is running a public contest to name five of Mercury's craters.

## Stem cell epic fail

"I CAN'T find the words to apologise," said Haruko Obokata at the Riken Institute in Kobe, Japan, as she admitted failing in an attempt to reproduce her much-vaunted "STAP" cell experiments.

An eight-month investigation by a team of Riken researchers, performed under the guidance of Obokata, attempted to reproduce findings first published in two papers in January last year. The papers claimed that almost any



Amazing discovery... undone

THE ASAHI SHIMBUN VIA GETTY IMAGES

adult cell could be coaxing into becoming a stem cell just by dipping it in a bath of acid for 30 minutes – a potentially huge scientific discovery. Obokata's team called the technique stimulus-triggered acquisition of pluripotency, or STAP.

In a report released on 26 December, the Riken committee concluded that so-called STAP cells originated from contamination by embryonic stem cells, "a fact that refutes all of the main conclusions of the two papers". The committee says that the contamination is unlikely to have occurred accidentally.

## Bearable lightness?

SPACE isn't the best place to have a malfunction. The European Space Agency's Gaia telescope has loose fibres that are letting too much light into its giant camera. This will double the errors on most of its measurements of stars.

Gaia was launched in December 2013 to map the Milky Way in unprecedented detail using a 1.5 gigapixel camera to take pictures of a billion stars. But in July last year, ESA revealed that too much light was entering the telescope. This will delay the release of scientific data, so ESA set about diagnosing the problem.

Now ground tests have determined that the most likely cause of the surfeit of light is loose fibres around the edge of Gaia's 10-metre-wide sunshield, which is designed to protect the spacecraft's delicate instruments from the sun's heat.

The stray light shouldn't affect measurements of the galaxy's brightest stars, says Anthony Brown at the Leiden Observatory in the Netherlands, but it will double the expected errors on most of the stars in the Milky Way, which are much fainter. In particular, this will make it harder to measure their velocity through space. "It's a shame, but not a showstopper," says Brown.

## Mega minds clash

BEING good at mind games can be something to brag about. Russia has come up trumps in the 2014 World Mind Games, which saw 150 memory athletes competing in 14 variations of five intellectual games, including chess, go and bridge.

The championships ended in Beijing on 17 December, with Russia topping the medal table with six golds, five silver and one bronze. The Chinese team came in a close second. China's Hou Yifan topped the female leader board, winning medals in three

disciplines of chess, including gold in the "Basque system" event, in which competitors play on two boards simultaneously for only 20 minutes. England rose from tenth place in 2013 to seventh, while the

**"Hou Yifan won medals in three chess disciplines, including one played on two boards in 20 minutes"**

US fell from sixth to thirteenth.

All athletes had to prove they were not using cognitive-enhancing drugs, and spot checks were conducted throughout the event.

## Wake up, Philae

#ROSETTAWATCH

IF THE Philae lander wakes up and continues studying comet 67P/Churyumov-Gerasimenko, it will be a happy new year for the European Space Agency.

As *New Scientist* went to press, researchers were awaiting the latest pictures of the lander snapped by the orbiting Rosetta spacecraft. These should reveal the probe's exact location, which has been a mystery since its rough landing in November. It came to rest in the shadow of a cliff, keeping its solar panels out of full sunlight and leaving ESA uncertain as to whether the probe would be able to continue its mission once its initial power supplies ran out.

The team are planning a review

to figure out what went wrong on landing. But the latest analysis of data gathered by Philae during its brief waking time on the comet suggests it is receiving just enough sunlight to survive the cold and is very likely to switch on again by the spring.

If Philae does wake up, its awkward landing could actually be a boon for science. Analysis of the images already received has revealed a number of accessible icy surfaces – more than the probe would have been able to see from a flat landing spot. Nearly all of its instruments should get a second chance.

"It's a better spot than we could have wished, in terms of science," says Rosetta scientist Matt Taylor.

ESA/ROSETTA/PHILAE/CIVA



## 60 SECONDS

### Touchy feely brain

Addicted to swiping? Your brain knows it. People who use their smartphone a lot show greater brain activity in their cortex when their thumbs and fingers are touched (*Current Biology*, DOI: 10.1016/j.cub.2014.11.026). Researchers say such technology may be shaping the way our brain processes touch.

### Oz gets science

Australia has a minister for science again. When Tony Abbott became prime minister in 2013, he abolished the title, leaving the post unfilled for the first time since 1931. In his first cabinet reshuffle, Abbott has given the portfolio to Ian Macfarlane, who is now minister for science and industry.

### Mitochondrial move

IVF techniques that let women with faulty mitochondria have a healthy baby by using a mitochondrial donor have moved a step closer with the announcement of the regulations to be voted on by UK MPs. These include the stipulation that children conceived this way will not be able to learn the identity of the donor.

### Blind as a sloth

Turn down the lights. It seems sloths, and other xenarthrans like armadillos, lack colour-detecting cells in their eyes, making them completely blind in bright light. The condition arose early in this group's evolution, maybe because early xenarthrans lived underground (*Proceedings of the Royal Society B*, DOI: 10.1098/rspb.2014.2192).

### Ebola booster

An Ebola vaccine has shown potential. Of 30 Ugandan adults who received the vaccine – a segment of DNA that makes a protein unique to Ebola – 17 produced antibodies to the protein. A more potent version of the vaccine is now being developed (*The Lancet*, DOI: 10.1016/S0140-6736(14)62445-4).

# A not-so-bitter pill

Can a drug designed to limit alcohol consumption really work?

Michael Slezak

THINKING of taking a break from the booze? Many of us drink more than we probably should and wish we were better able to control our intake. Several drugs now in development could help us do just that.

In 2012, alcohol played a part in 3.3 million deaths worldwide. Awareness campaigns and prevention services have done little to reduce the amount that people drink overall, and consumption has remained steady or increased around the world. The scale of the problem has led people, including David Nutt, a psychopharmacologist at Imperial College London, to want to try a different approach.

Last month, a patent application was filed for a drug that is supposed to give people a pleasant intoxication as well as limit the amount they drink.

In an unlikely marriage, the

compound was created by the drug designer behind mephedrone, a now widely banned substance that has caused at least one death and been implicated in 13 others in the UK. The man, who has asked to be referred to by his pseudonym, Dr Z, initially intended his creation to be sold as a legal high. But after having discussions with Nutt and trying it on himself, he now plans to gift the patent to Nutt's charitable research group DrugScience, in the hope it will be used as a "binge mitigation agent".

How it might finally be used will depend on the results of detailed testing – including how quickly it is absorbed and how it mixes with alcohol. But it might become something you'd take at the start of a night out, or perhaps even add to each drink.

Nutt and Dr Z have called the new drug "chaperon". Its less catchy name is MEAI or 5-methoxy-2-aminoindane.

Structurally, it is closely related to two drugs you can buy as a legal high in some places – MDAI and MMAI. Both were invented by David Nichols from Purdue University in West Lafayette, Indiana, and have some of ecstasy's euphoric effects.

## Unpredictable effects

Nichols says chaperon also looks a bit like another drug, PMA, which is known to be highly toxic. And therein lies the risk: "There really is no good way to predict biological activity in a completely novel structure," he says. What it does to the brain is also hard to predict because small tweaks to a molecule can result in big changes to the neurotransmitters and pathways it acts on.

So far no lab tests have been done on the substance, but Dr Z and about 40 other people have tried it. One of those people was me (see "A night on chaperon", opposite). According to Dr Z, there have been no serious problems, although one person didn't enjoy the experience. Several others said it made them feel euphoric.

The effects varied, but some of the experimenters reportedly lost the desire to drink. The effect didn't kick in immediately. The longest delay was 2 hours, and it took 5 hours before I felt like holding back on the booze – although this may have been because I took a very small dose to start with. This isn't necessarily a problem, says Dr Z, as long as people know that in advance so they don't keep taking it while waiting for it to work. However, he is concerned that the effect is so much like ecstasy: "Maybe the drug is too good?"

Nutt doesn't think chaperon's ability to induce euphoria is

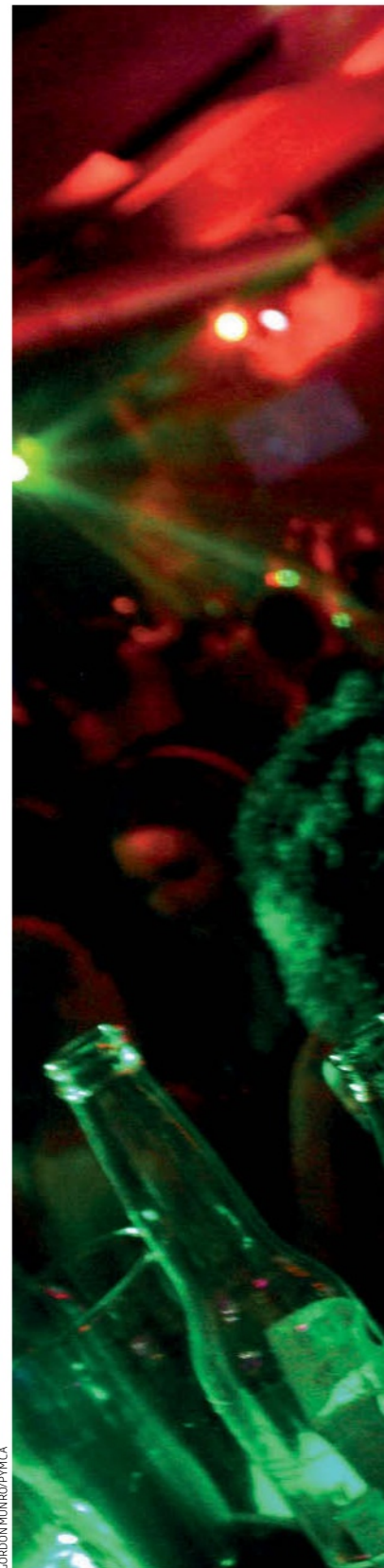
## THE ALCOHOL FIGHTERS

Many drugs already exist that are intended to limit or replace alcohol use.

David Nutt from Imperial College London has been working on alcohol substitutes for years and says he now has five at various stages of development. While chaperon might limit the amount that people want to drink (see main article), the other drugs mimic the neurological effects of alcohol by tinkering with receptors that bind to GABA, the neurotransmitter that alcohol acts on in the brain. Nutt won't reveal what the drugs are, but he has tried some of them himself and finds them enjoyable. What's more, for some, there's an antidote so you can drive home after a night out.

In the 1980s, after seeing the way the mildly intoxicating drug kava was used in Fiji without the kind of violence associated with alcohol, some Indigenous Australian communities introduced it in the hope of replacing alcohol. Whether it reduced overall harm is a matter of debate, but it came with downsides including skin irritation and liver toxicity. In 2007, Australia banned imports of kava.

Drugs like naltrexone and nalmefene block dopamine receptors in the brain, which alcohol acts on to make you feel good. Alcoholics are prescribed naltrexone and those who drink half a bottle of wine a night were recently advised to take nalmefene by the UK health advisory body.



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What's your poison?

necessarily an obstacle. There are other drugs that help people with alcohol problems to drink less or that act as a less harmful substitute – including some that Nutt is involved with (see “The alcohol fighters”, below left). But most cultures around the world use drugs for pleasure, so a drug like chaperon could be a “win-win” situation, he says, acting both as a binge mitigator and providing some of its desirable effects.

But “you need scientific tests”, says Nutt. “Anecdotal evidence isn’t enough.” These would involve finding out what receptors it binds to, how it affects rats and working out a safe dosage profile, before raising funding to conduct clinical trials to see whether it really does reduce alcohol intake.

David Caldicott from the Australian National University College of Medicine says the safety bar for new medicines is high – and even higher for recreational products.

Caldicott is enthusiastic about the potential of a substance like chaperon, that has some of alcohol’s desirable qualities, but he is worried about mixing drugs and alcohol: “From a harm minimisation perspective, mixing

**“It might be something you’d take at the start of a night out, or perhaps even add to each drink”**

drugs and alcohol is never a good idea. It’s one of the basic premises.”

Alex Wodak of the Australian Drug Law Reform Foundation says it is hard to predict what a drug will do when widely released. Its success will depend on whether it lowers people’s intake of alcohol or simply adds another dimension to a night out.

Of course, there’s every chance the drug will simply be banned, like so many of Dr Z’s creations. Nutt is philosophical. “Let’s just hope they don’t,” he says. “We have to see this as an opportunity to reduce harms rather than a new drug that has hit the market.” ■

## A TEST OF CHAPERON

How do you safely try a brand new drug? The bottom line is, you can’t. But I still wanted to put chaperon, the “binge-drinking mitigation agent”, to the test. So to reassure myself that I wasn’t taking an excessive health risk I asked some scientists working in the field to carry out a few tests.

Their investigation was far from comprehensive, but it found that the drug doesn’t seem to be toxic to kidney cells or to a type of neuron. NMR spectroscopy showed that the sample was pure chaperon, scientifically known as 5-methoxy-2-aminointhane or MEAI.

Having decided that the risk is acceptable, I try it on a night out drinking with friends. The first dose brings on a feeling of, well, nothing. After waiting 2 hours, I start to drink, slowly upping my dose of chaperon. Four hours after my first dose, I begin to feel a focused, relaxed high. But this feeling doesn’t make me want to moderate my drinking. And more chaperon seems like a fun idea too.

By about midnight, more than 5 hours after the first dose, I feel intense but controlled euphoria. Now the idea of drinking alcohol seems repulsive – as does eating bar food. My friends are still ordering drinks and if I hadn’t taken chaperon, I’m sure I would be too.

My friends later described my behaviour as rational, if a little tense. The drug didn’t stop me from sleeping and I had no anxiety or depression in the following days. So it seems like a party drug without some of the side effects.

My experience is not a scientific study. It’s a sample of one, and not even a carefully monitored and measured one. But for what it’s worth, it took a lot of the drug to make me want to stop drinking and by then I felt both drunk and high. I enjoyed it, and I did not suffer any acute health problems, though the long term risks are unknown. My verdict? Much more research and development needed.

# Flying high on the wild side

Spying on animals from above helps human and beast, finds **Aviva Rutkin**

ABOVE the Wilibadi II river in the Democratic Republic of the Congo, a drone hovered in the air. It was there to stealthily snap a camera-shy subject: a family of hippos out for a swim.

The moment was captured in October by Julie Linchant, a graduate student at the University of Liège in Belgium. Though she was stationed on a grassy hill several kilometres away, the drone gave her a crisp bird's-eye view (see main image, right). The shot is part of a larger effort to monitor hippos, elephants, antelopes and other big animals in Garamba National Park, whose populations have been threatened by poachers.

"Drones are very silent, so you don't disturb animals and you can find poachers discreetly," says Linchant. "I think we could get great results."

The remote-controlled aircraft has become the new favourite tool for biologists and ecologists around the world looking to sneak up on unsuspecting wildlife. In the past, aeroplanes and helicopters were used to study wildlife spread over a large area. But many scientists now say drones are the better choice as they cost less, cause less damage to the environment and make less noise. That means they can run more flights and get closer to the animals.

Drones are also safer. According to the *Wildlife Society Bulletin*, 60 US biologists died between 1937 and 2000 from aircraft accidents, far and away the most common cause of death while in the field. Any such accident is

a tragedy. If a drone goes down, by contrast, it's merely annoying.

Researchers mainly use drones to estimate the number of individuals in a given animal population. These counts indicate how well a species is doing, and can help focus future research. Jarrod Hodgson at Monash University in Melbourne flies drones around remote Australian islands to tally native birds, like greater crested terns (see image, bottom middle). His group is comparing the drone counts with those done on foot, which tend to be tough work for scientists and disrupting to the birds.

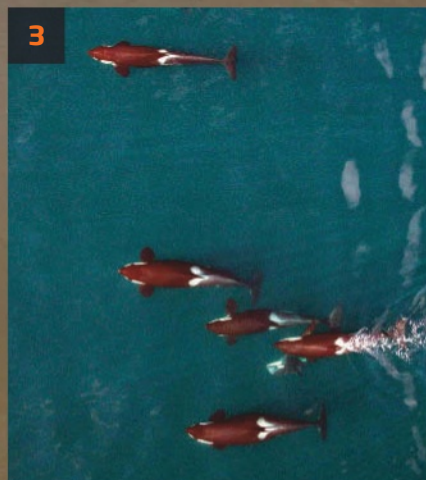
"It's a very exciting time for science," says Hodgson. "Drones might allow us to gain lots of data in a cost-effective way."

In addition, some conservationists are starting to use drones to scout out potential threats to wildlife. The non-profit organisation Conservation Drones – which partnered with Hodgson's team for his research – is dedicated to spotting poachers and illegal activity in protected areas, and training other researchers to do the same. In an expedition to a national park in Indonesia last year, their drone squad counted orang-utan nests in the forests and captured evidence of illegal logging.

At the moment, drones remain mired in a legal grey area in many countries. But researchers hope that it will become easier to get permits to fly drones for science as their benefits become more and more evident. ■

**"Drones are very silent, so you don't disturb animals and you can find poachers discreetly"**





### VIEW FROM ABOVE

As well as counting animals (see main story), drones can be used to help implement wildlife management strategies. In one project in 2013, David Bird, a wildlife biologist at McGill University in Montreal, Canada, and his team experimented with using drones to pick up radio signals from tagged woodland caribou on a military compound in Labrador. In another, data collected by drones helped the Canadian Wildlife Service plan a recovery strategy for threatened waterbirds in the wetlands. Bird has also flown drones around farmland to drive off nuisance birds like European starlings and snow geese, which can quickly devastate crops. "They certainly have a lot of potential as a tool for biologists," he says.

### 1 Swamp monsters

Drones let us assess the health of dangerous animals from a safe distance, like this 1.7-metre-long alligator spotted in Florida.

### 2 Birds on the beach

At the Ashmore Reef in Australia, counting a greater crested tern colony from the air doesn't bother the birds.

### 3 Pod-spotting

Monitoring orcas in British Columbia can show if they are undernourished (thin whale at top), healthy (middle) or pregnant (bottom).

CLOCKWISE FROM MAIN PHOTO: WILUAS / FCC PROJECT / ULG-CEMBLOUX AGRO-BIO TECH FOREST RESOURCES MANAGEMENT TEAM / CIPOR; TIM CALVER; NOAA VANCOUVER AQUARIUM; HODGSON & CLARKE; MONASH UNIVERSITY; MATTHEW A. BURGESS / UNIVERSITY OF FLORIDA

## Super-powered oven pulls back Venus's veil

VENUS is Earth's bad-tempered and secretive twin. Despite being similar to Earth in size and mass, Venus is a noxious pressure cooker with surface temperatures that can melt lead. What's more, it hides its surface in perpetual clouds of sulphuric acid – despite decades of spacecraft visits, no one really knows what Venus's surface rocks are made of.

That's beginning to change, thanks to a powerful oven in a lab in Germany. Jörn Helbert at the DLR Institute for Planetary Research in Berlin and colleagues have used it to make the first analogue studies of Venus's surface. The results could help explain how Earth's twin went bad.

"We want to go back in time and say, what are the evolutionary steps of Venus? Where did it diverge and become Venus instead of Earth?" Helbert says. He presented his research at the American Geophysical Union in San Francisco on 16 December.

There are a few ways to peek beneath Venus's veil. Orbital maps made with radar, which can cut through the cloud layer, show that our planetary neighbour mainly consists of volcanic plains where lava once flowed and then cooled.

On Earth, such flows generally leave behind basaltic rocks. Samples from the Soviet-era Venera landers, which detected basalt in the ground around their landing sites, suggest the same is true on Venus. But they could not tell what exists further away.

More recently, an atmosphere-sensing instrument on the European Space Agency's Venus Express spacecraft – called the visible and infrared thermal imaging spectrometer (VIRTIS) – created a rough map of the southern hemisphere. The blistered rocks of Venus glow with infrared light, emitting spectra according to their composition. Helbert wanted to use that data to tease out which

minerals make up the surface.

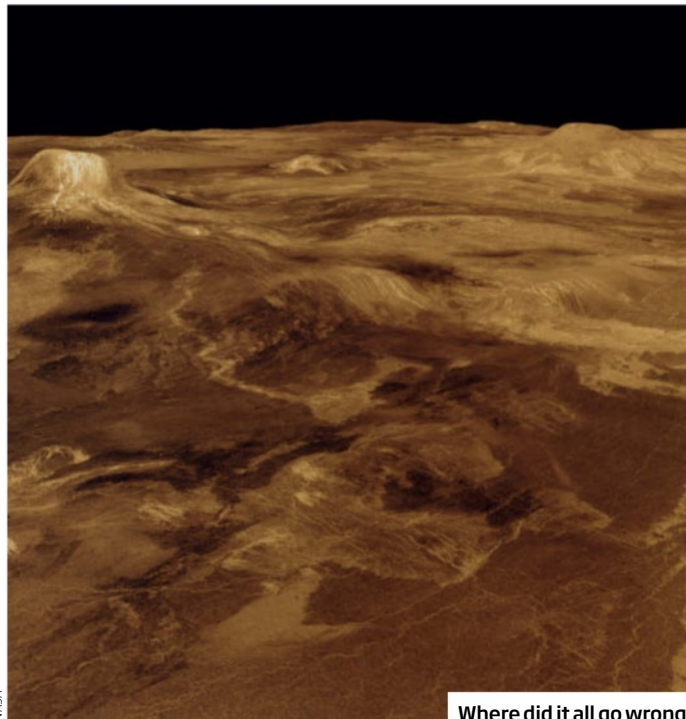
But there was a problem. Scientists know the spectra of rocks at earthly temperatures – but Venus is a scorching 460 °C. So the researchers built a special electric heating chamber to interpret the Venus Express data.

"It's a bit like an electric stovetop in your kitchen, just super-powered," Helbert says. The team cooked a wide range of rocks, including basalt, anorthosite and haematite and matched the resulting spectra with VIRTIS data.

The results suggest that the oldest surfaces on Venus could be made of granite, which on Earth forms through tectonic activity. That might mean Venus once had continents. Many geologists think tectonic activity requires the presence of water, which could mean Venus once had oceans and, perhaps, could have hosted life.

"This kind of data... provides a fantastic way to peek to the surface from orbit, so we can do actual mineralogy from orbit like a real geologist," says Thomas Widemann at the Paris Observatory in France.

Widemann is now working with Helbert to build an instrument specifically for orbital composition scans. It could fly on a future Venus mission, such as ESA's planned EnVision mission or the NASA proposal known as VERITAS. **Adam Mann ■**



Where did it all go wrong?

## Booming voices are no boon for male lawyers

IN THE often macho environment of the courtroom, a booming voice might seem like a good trait for a lawyer to cultivate. Not so – men who sound very masculine are actually less likely to win a US Supreme Court case than their effeminate-sounding peers.

It's well known that our voice shapes how people perceive us, which in turn may affect how successful we are. Men, for example, are more likely

to vote for other men with deeper, masculine voices, and CEOs with deeper voices earn more money.

To explore whether the vocal characteristics of male lawyers affect trial outcomes, a team led by linguist Alan Yu of the University of Chicago collected 60 recordings of lawyers in the Supreme Court making the traditional opening statement: "Mister Chief Justice, may it please the court". Then 200 volunteers rated these clips according to how masculine they thought the speaker was, as well as how attractive, confident, intelligent, trustworthy and educated they perceived the voice to be.

After accounting for the age and experience of the lawyers, statistical analysis showed that only one of the traits could predict the court outcome. Lawyers rated as speaking with less-masculine voices were more likely to win. "It was a surprise to all of us," says Yu, whose results will be presented at the annual meeting of the Linguistic Society of America in Portland, Oregon next week.

Although legal systems are based

**"To get around the bias in the courtroom, you'd need to have legal writings without oral arguments"**

on the principle of objective trials, we know that obscure factors, such as whether the judge has eaten recently, can bias a case. Yu's results suggest that the masculinity of the voice is another source of bias. In future work, Yu wants to explore whether the perceived likelihood of winning may affect lawyers' speech.

If there is a genuine bias, it could be hard to overcome. "You could have legal writings without oral arguments, but that's not a feasible change," says Casey Klofstad of the University of Miami. Rather, you could make people aware of the bias, and hope they bear it in mind, he suggests. **Dan Jones ■**



A hovercraft you can call home

# Explorers adrift on an Arctic ice floe

Catherine Brahic

DESPITE his situation, Yngve Kristoffersen is calm. The 73-year-old Norwegian geoscientist is camping in a hovercraft, parked on the ice deep within the Arctic circle. He last saw the sun in late October, and won't see it again until spring.

"People have asked me how I was going to kill the time," he says, his voice occasionally crackling over the satellite phone. "There is no time to kill. We are working our butts off. And entertainment? As a scientist my entertainment is to see the data come in. This is plenty for me."

Expeditions to the Arctic Ocean are relatively few and far between. Only a handful of countries have icebreakers and only a handful of those are kitted out for research. So we don't know much about the ocean on the roof of our planet. One of the least-explored areas of all lies between the North Pole, Canada and Greenland. Here, Greenland's northern coastline and the thousands of islands that make up the Canadian Arctic Archipelago conspire to trap the

oldest and thickest sea ice. That makes it largely inaccessible, a no-go zone for icebreakers.

What scientists do know of the region makes them want to find out more. Remnants of an asteroid that smashed into the North Pole millions of years ago are thought to be hidden beneath the ice, on Alpha ridge. Just to the east of this, also concealed under the ice, sits one of the most distinctive features of the Arctic seabed: a huge, steep deep-sea ridge that draws a straight line from Ellesmere Island to the North Pole. Despite ripping right through the Arctic Ocean, the Lomonosov ridge is poorly studied.

Both ridges date back more than 50 million years, when the Arctic was a balmy sea, 12°C warmer than today and home to turtles and crocodiles. Data from this period may hold clues to what the Arctic will look in a warmer future world.

These mysteries were part of the allure for Kristoffersen, who is normally based at the University of Bergen in Norway. On 30 August, he and fellow explorer Audun

Tholfsen climbed off the Polarstern – a German research icebreaker – on to a 1.1-metre-thick floe. They took with them over 30 tonnes of equipment, including a hovercraft and fuel and food for 18 months. The Fram 2014/2015 expedition was under way.

Kristoffersen compares life on constantly moving sea ice to living on an active tectonic zone. Where floes collide, pressure ridges of crunched-up ice form, rising up above the flat, white surface. Rivers of open water suddenly appear when the ice breaks up and pulls apart.

Moving ice and snowstorms mean things disappear. So far, the team has lost some food, fuel and a wind turbine. None of this seems to faze Kristoffersen. "We have plenty of food. We are so remote, you have to have several

layers of backup." The real danger, he says, are the pressure ridges that take everything in their way.

On 13 October, Tholfsen discovered a 10-centimetre-wide crack running right through the middle of their camp, which grew to 7 metres wide in days. Thankfully, the pair had already moved on.

Despite such challenges, research is going well. By chance, the drifting ice has taken them in a perfect zigzag right down the Lomonosov ridge. "We are in an area now where nobody has been," says Kristoffersen. "If I had my own icebreaker I couldn't do this better."

Seismic monitoring has picked up deformations on the slope of the Lomonosov ridge that faces Alaska. The signal could be the first confirmation of a long-suspected tectonic fault line in

**"Where floes collide, pressure ridges of crunched-up ice form. They are the real danger"**

the Arctic and could give clues to how the ocean basin was born. He says the structure suggests it is a strike-slip boundary, similar to the San Andreas fault.

There have been some bonus observations. In October they spotted a Russian submarine, and in November their camera photographed a large eel-like fish slithering across the muddy sea floor (see inset). Antje Boetius of the Alfred Wegener Institute for Polar and Marine Research in Germany says this is the first time a deep-sea fish has been documented in the Arctic.

Sometime in the spring, another explorer who will be dropped off by plane to swap places with Tholfsen. Kristoffersen will stick around until the natural drift of the ice takes him closer to Fram Strait, where the Norwegian coastguard will pick him up. He's not expecting a ride home before the summer. ■



Eel alert



## Giant clams are multitasking coral-reef support systems

IT'S time they came out of their shells. It seems the world's largest molluscs, the giant clams of the Indo-Pacific coral reefs, have been doing a huge amount of good work we knew little about. These sea creatures turn out to be multitasking ecosystem engineers. They are reef builders and shapers, food factories, shelters, reservoirs of algae and water filters - all in one.

Giant clams have been around for about 38 million years. The largest ones can grow to 1.2 metres long and weigh more than 200 kilograms. But their role in the ecosystem is poorly understood, says Peter Todd, a

marine ecologist at the National University of Singapore. Todd's team investigated the role the molluscs play in their surroundings to try and shed some light.

They found that the 13 giant clam species are food factories for coral reef inhabitants, nurseries and refuges for young fish, and sites for adults laying eggs (*Biological Conservation*, doi.org/xrc). They also make carbonate shell material, which helps build the reef structure.

"They are a vital indicator species of coral reef health and their ecological contributions are innumerable," says Deepak Apte of the Bombay Natural History Society in India. But these benefits are likely to continue only if giant clam populations are healthy. The team hopes their work will reinforce the case for conserving the molluscs, which are currently vulnerable.

## Wi-Fi lets robots roam around the ISS

ROBOTS could soon move freely around the International Space Station, thanks to a new guidance system powered by the orbiting outpost's own Wi-Fi network.

Astronauts have shared the ISS with three small robots called SPHERES since 2006. They are there to test whether menial tasks on the station can be automated, freeing up humans to do more interesting things. At the

moment, the bots are confined to a 2-metre-wide cube marked out by five ultrasound beacons, which transmit a locating signal that works like GPS does on Earth.

It would be much more useful if the SPHERES could travel round the whole station, so Terry Fong at the NASA Ames Research Center in California and colleagues are trying to guide them using the ISS's existing Wi-Fi.

An astronaut floated around the US section of the station with a smartphone, measuring the varying signal intensity from two Wi-Fi routers at different points. The team turned this data into a map capable of locating a SPHERE robot to within 1.59 metres, accurate enough to identify which ISS module it is in. The work was presented at the SSCI conference in Orlando, Florida, in December. The next stage is to test the map with a real robot on the station.

## Tree extract helps smokers to quit

WANT to give up smoking in 2015? We might have just the thing. Cytisine, a plant extract, seems to be better at helping people quit than nicotine replacement patches and gums.

Cytisine, an alkaloid extract from the laburnum tree, has been used as a quitting aid in Eastern Europe since the 1960s but is largely unknown elsewhere. This is partly because clinical trials in the 1960s and 1970s in Eastern Europe do not meet current US and European standards.

A team at the University of Auckland in New Zealand has carried out a fresh trial. In it 1310 smokers were given either pills of cytisine, taken daily in decreasing doses for 25 days, or nicotine replacement therapy (NRT) for two months. After six months, 143 of the 655 cytisine recipients were not smoking compared with 100 in the NRT group (*The New England Journal of Medicine*, doi.org/xtz).

## Titan lakes could be fed from below

THE lakes of Titan, Saturn's largest moon, may fill up from below.

Titan's lakes contain a mixture of liquid ethane and methane. But remote readings can't distinguish between the atmosphere and surface liquids, so no one knows how much of each is present, which could affect how long it takes for the lakes to evaporate.

Adrienn Luspai-Kuti of the Southwest Research Institute in Texas and her colleagues simulated Titan's frigid surface conditions in the lab, and found evaporation rates for methane and ethane that were so high they should have emptied the lakes. That could mean they are being replenished from a subsurface liquid reservoir (*Earth and Planetary Science Letters*, doi.org/xtj).

## Lobsters surf on jellyfish

TALK about first-class travel. Young smooth fan lobsters spend their first weeks floating on a pillow of jelly. They latch on to a jellyfish and then kick back and relax while it does all the hard work. And as if free transport wasn't enough, the work-shy youths treat the hapless animal as their own private buffet.

"By using jellyfish as food and a vehicle they can eat and rest at the same time," says Michiya Kamio at the Tokyo University of Marine Science and Technology in Japan. "It may be lazy but it's also very smart."

The jellyfish fights back by secreting a thick mucus that covers the hitch-hiker from head to toe, cutting its oxygen supply and attracting microbes. With their lives at stake, the lobster larvae (*Ibacus novemdentatus*) spend half their time grooming themselves. They do this with an elongated appendage specialised for use as a sort of windscreen wiper (*Journal of Experimental Marine Biology and Ecology*, [doi.org/10.1016/j.jembe.2014.06.001](https://doi.org/10.1016/j.jembe.2014.06.001)).

Without this unique device, which is long enough to clean its entire body, jellyfish surfing would be almost impossible, says Kamio. With it, lobster larvae can dine at their leisure, taking anywhere from a few hours to several days to polish off their ride - at which point, the youngsters head off in search of their next mobile meal.



## Sunshine hormone keeps our internal clocks on track

ARE you spending enough time in the sun? As well as keeping our bones strong, vitamin D - the hormone our skin makes when exposed to ultraviolet rays - may also help regulate our body clocks.

We all have a small group of "clock genes" which switch on and off during the day. As a result, the levels of the proteins they code for rise and fall over a 24-hour period. Enforced routines such as night shift work can play havoc with our health - increasing our risk of a stroke, for example.

To find out whether a lack of

vitamin D might be responsible, Sean-Patrick Scott and his colleagues at the Monterrey Institute of Technology and Higher Education in Mexico looked at the behaviour of two clock genes in human fat cells. When the cells were immersed in blood serum, they acted as they would in the body: the clock genes' activity oscillated over a 24-hour period.

Dosing the cells with vitamin D instead produced the same effect. No such effect was seen in cells placed inside a nutrient broth.

"Vitamin D synchronises the cells," says Scott. "Our results explain some of the benefits of sunlight," he says. "Vitamin D is one of the ways we might be able to maintain circadian rhythms in the body."

Julia Pakpoor of the University of Oxford says clinical trials are needed to confirm the effect in people, but she adds, "We should all make sure we are vitamin D replete regardless." The work was presented at the World Stem Cell Summit in San Antonio, Texas, last month.

## Nanowires make self-heating cloth

MUCH of your winter heating bill is spent warming up empty air rather than people - but a new form of cloth designed to directly heat your skin could help.

Almost half of global energy use goes towards indoor heating, according to a recent report by the International Energy Agency. So Yi Cui of Stanford University in California and his colleagues have developed a technique for coating textiles in a network of silver nanowires by dipping cloth in nanowire "ink". "The process of making the nanowire cloth is as simple as dyeing," says Cui.

The cloth acts as a reflective surface for heat, preventing heat loss to the surrounding air and keeping you warm. It is porous enough to let water through so you don't feel sweaty. What's more, because the cloth conducts electricity, running a voltage through it heats it up to provide extra warmth (*Nano Letters*, [doi.org/10.1021/nl40248a001](https://doi.org/10.1021/nl40248a001)).

George Havenith of Loughborough University, UK, thinks the nanowire cloth is a good idea, but it might be tough to convince people to use it. After all, some prefer to crank the heat up rather than put a sweater on.



## White wines might not really exist

THAT Chardonnay you're drinking is more of a red wine than it looks. It turns out that white grapes also contain the pigments that give red wine its colour - anthocyanins.

Most sources say that "what distinguishes red from white is that white wine grapes don't have anthocyanins," says Panagiotis Arapitsas of Italy's Edmund Mach Foundation. His team used mass spectrometry to analyse the skins of grapes from Chardonnay, Sauvignon Blanc and Riesling grapes, which are used in the production of white wine. They found these white grapes did

contain anthocyanins, although in concentrations several thousand times smaller than in red grape varieties such as Merlot (*Food Research International*, [doi.org/10.1016/j.foodres.2014.06.001](https://doi.org/10.1016/j.foodres.2014.06.001)).

Arapitsas says this shines light on one of wine-making's oldest curiosities - why white-wine producers occasionally end up with a wine that is a bit pink. "Sometimes there were producers of white wines who collected white grapes and ended up with a slightly rosé wine," he says. "Now they have some information about why that happened."

RODRIGO GOMEZ ROVIRA / AGENCY VUCCAMERAPRESS

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Wearing your alibi

# It's a Fitbit, Your Honour

Wearables are the latest source of data about our lives that could be used in court, says **Aviva Rutkin**

IN LATE November, a court case in Calgary, Canada, set an unusual record. Lawyers representing a personal trainer injured in an accident were the first to wield data from a wearable device in the courtroom. They planned to use the sluggish activity levels recorded by their client's Fitbit fitness tracker to prove the lasting effect of her accident.

Evidence gleaned from sources like email, social media and GPS trackers has already become common in trials. Newer tech like wearables and smartphone apps exude an even richer exhaust of information concerning our whereabouts, activities and close contacts. Cases like the one heard in Calgary raise questions about what it means to have this data in the courtroom – and how people could use it to protect themselves in the eyes of the law.

An Android app called Alibi, released a few weeks ago, is designed to help citizens protect

themselves in this way. Like a civilian version of the body cameras now worn by many police officers, a smartphone running Alibi discreetly records an hour of location data and audio, as well as photographs of a person's surroundings. This data is constantly overwritten until a user elects to store the past hour's cache secretly on their device.

It joins a class of several similar apps like Cop Recorder and Police Tape, which send covert records of interactions with authority figures to a central server. Such records could buoy legal claims of workplace harassment, vehicle accidents, or problematic police interactions, writes developer Jeff Myers on the Alibi website: "It gives users the confidence to stand up for themselves in the face of misguided authority or misplaced aggression."

In fact, a wide variety of cases could benefit from digital

evidence garnered by wearables or apps, suggests Tyler Newby, an attorney in San Francisco. "Lawyers, especially plaintiff lawyers, are always creative," says Newby. "I think the possibilities are limitless."

For example, activity levels recorded by trackers like Jawbone might be able to show if you were injured at work and how that injury has affected your daily routine. Location data could help establish where you were at the

## "Location data from a fitness tracker could help establish where you were at the time of a crime"

time of a crime, or a sleep tracker could show you were unconscious while it happened. A fast heart rate might support claims that you felt afraid during an assault. Or someone accused of distracted driving – such as the California woman pulled over in 2013 for

driving while wearing Google Glass – could go back through their data to show that the device was safely turned off.

"The control of personal data is going to become increasingly important," says Yves-Alexandre de Montjoye at the Massachusetts Institute of Technology. He works on OpenPDS, a tool that allows people to sift through data from their devices and control how it is accessed by outside programs. OpenPDS isn't specifically intended for legal use: it helps ordinary people better understand what personal information is on the record.

For the most part data is treated equally in court, whether it comes from a computer, a Fitbit or an app. Lawyers must prove that the information is authentic and relevant to the case – a relatively low bar to clear. An expert may be called to demonstrate that the device was working and that the data does show what it claims to. In the Fitbit case, the client's data is being crunched by a third party, the Calgary analytics firm Vivametrica.

This kind of data is not infallible, of course. A smartphone could be handed off to another person – just because the device was at home doesn't mean that's where you were – or a fitness tracker could be jostled to fabricate movement.

There's also the potential problem of software glitches. Take Scott Peterson's high-profile murder trial in 2004. Police GPS trackers were used as evidence despite some glitches in the data, including one that indicated Peterson had been driving at thousands of miles an hour.

"In English and US jurisprudence, the members of the judiciary accept that the cost of proving everything is prohibitive," says Stephen Mason, a barrister in Bedfordshire, UK. The outcome is instead left to a combination of expert testimony and supporting low-tech evidence. After that, it's up to the jury to decide. ■

# Turn on, tune in, don't drop out

US schools are turning to online learning to let children progress at the right speed for them

Hal Hodson

THE teachers at Summit Public Schools in California don't stand in front of the class and deliver the same lesson. In fact, they don't teach lessons at all. Instead, semi-autonomous software guides children through the syllabus, with a teacher on hand to answer questions and explain more complicated concepts.

The idea is that children work best when setting their own goals and moving at a pace that suits them. Evidence from early pilot studies shows that pupils learn

tracks goals and keeps learners motivated.

SPS students use an e-reading system called Curriculet. This lets teachers add notes and thoughts to the texts students are working through. It also feeds student progress back into a Personalised Learning Plan, an online dashboard that tracks the pupils' entire educational life. Based on data gathered on their school performance, the dashboard tailors the lessons and content it serves to each student. For example, a student might set a goal to read the next 10 pages of an e-book this week. The system would monitor her progress, giving regular feedback, to keep her on track. If she falls behind, a teacher can step in and tweak her program.

While teachers can motivate their students, they don't have the time to closely monitor each child's progress in their class. For a cloud-based computer, with full access to learning materials and ways of measuring their progress, this is simple. "The key change is



that there's technology to leverage to allow for a far greater degree of personalisation that we really couldn't do before," Tavenner says.

Summit's scheme fulfils some of the fundamental tenets of goal-setting theory, says Chris Hulleman, an educational

psychologist at the University of Virginia. This is the idea that people perform better when they set their own goals and receive specific feedback on their progress. No teacher could keep track of and give feedback on the goals of a classroom of individuals, the way that software can.

"Differentiation is vital to setting effective goals," says Hulleman. "You can't just do one thing and every child is going to learn. Kids come with background knowledge and different skill levels."

The scheme also asks students to think about their long-term goals – such as where they want to go to college and what they want to study. "The platform allows kids to set their college goals and relate that back to their daily

**"People perform better when they set their own goals and receive specific feedback on progress"**

more effectively this way than with traditional teaching.

"We've automated the activity that teachers in normal settings spend the bulk of their time on – grading things and delivering lectures," says Diane Tavenner, CEO of Summit. "Things that are not of high direct value to students, we are trying to remove or eliminate."

Summit is one of a group of US schools that are using technology to completely change the way students are taught. The overhaul for Summit's four schools began three years ago. Today 2000 students, aged between 11 and 18, use Google Chromebooks, which are cheaper and easier to set up than a conventional laptop because most of the software runs in the cloud. A web platform

## MASSIVE FAILURE?

Do we need classrooms at all? Why not educate students entirely through computers, letting people learn anywhere with net access?

This was the promise of the Massively Open Online Course, or MOOC. But so far, completion rates are appallingly low. Even Sebastian Thrun, who launched Udacity in 2012 and amassed more than 1.6 million students, described it as a

"lousy product" in an interview when he realised how few students were finishing his courses. The idea was that MOOCs would encourage diversity, but so far most students are rich men who have no trouble accessing education. So online courses like Coursera and edX are making lessons more accessible via mobile devices that are standard for net access in poorer countries.



SUMMIT PUBLIC SCHOOLS

that it frees up human teachers to do other, more important things than grading papers and ensuring pupils are following lectures.

Instead, teachers lead group discussions or manage group projects, devoting their time to things that automated systems

**"The most dramatic impact is in maths for children aged 7 or 8, who doubled their ranking nationally"**

can't easily do. "We think the teachers' time is very high value and should be used as such," Tavenner says.

This kind of personalised education is cutting-edge, but it seems to be delivering results. Think-tank the RAND Corporation, in partnership with the Bill and Melinda Gates Foundation, studied 23 new charter schools around the US that were experimenting with personalisation techniques for student learning. RAND found that student achievement in maths and reading had improved faster than the national average since these programs began. The most dramatic impact is in maths for children aged 7 or 8, where personalised learning almost doubled their ranking nationally, on average raising them from the 33rd percentile into the 64th.

Many of these programs are not as technologically advanced as those at SPS and Achievement First, but the techniques are the same. Educational feedback through technology, rather than from human teachers, seems to make it easier for students to go at their own pace.

Matt Keller, director of the Global Learning XPRIZE, says learning based on laptops means an end to missed lessons and falling behind. "You can have a world where every child learns at her own pace, which I think is the future of learning," he says. "A world-class education in the palm of your hand." ■

Your pace or mine?

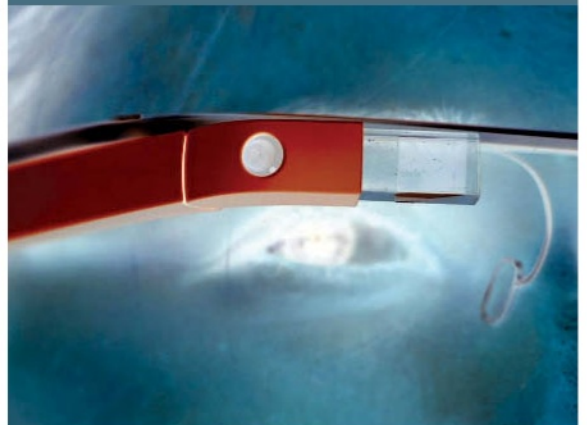
behaviours," Tavenner says.

Schools around the US are making similar moves away from teacher-led lectures and towards systems that use technology to give students control over their own learning.

East coast public school network Achievement First, which runs 29 schools between New York and Rhode Island, is launching its own personalised learning program called Greenfields in 2015. And in the second half of the year, SPS will roll out its learning platform to 20 schools across the country, giving away the technology they have developed to thousands of students.

Although this kind of education clearly has a big future, one of the biggest benefits of tech-driven learning at a school like Summit is

## ONE PER CENT



### Glass helps blind people see the world

"OK Glass, recognise this." That's all a visually impaired user of new software running on Google Glass has to say to find out the worth of the banknote they're holding, or the brand of the bottled water they've picked up in a shop. The system was developed by Rajat Bhageria, at the University of Pennsylvania, with two fellow students at a hackathon.

**"Dear Sony Hackers: now that u run Hollywood, I'd also like less romantic comedies, fewer Michael Bay movies and no more Transformers."**

Film-maker Michael Moore tweets in the wake of Sony's decision to pull its new movie *The Interview*, a comedy about a plot to assassinate North Korean leader Kim Jong-un. Sony had already had executive emails and financial documents leaked by hackers

### Tweets lift the lid on diet and health

Meal-inspired messages on Twitter can give a geographical insight into obesity and diabetes rates. Sofiane Abbar and colleagues at the Qatar Computing Research Institute scoured the tweets of 210,000 Americans for mentions of fast food chains, food and cooking and calculated an approximate calorie intake for each US state. The team found that their calorie counts were strongly correlated with local obesity levels, and quite closely related to the prevalence of diabetes ([arxiv.org/abs/1412.4361](http://arxiv.org/abs/1412.4361)).

### China's Google understands you better

Watch out, Google. Awni Hannun and team at a Silicon Valley research centre owned by internet search firm Baidu - nicknamed "China's Google" - have come up with a new approach to speech recognition that they claim beats their rivals' best efforts. The method uses a unique combination of neural networking techniques that is unexpectedly efficient, says Steve Renals at the University of Edinburgh, UK, who was not involved in the study ([arxiv.org/abs/1412.5567](http://arxiv.org/abs/1412.5567)).





## Russia's Galapagos

OLGA KAMENSKAYA says she lost her heart to Lake Baikal. It's easy to see why. At 1642 metres deep and 25 million years old, the lake is the world's deepest and oldest. It's basically an inland sea.

Baikal is also a paradise of biodiversity, "the Galapagos of Russia". Thousands of species of plants and animals live there, and some 60 per cent of them, including the photogenic Baikal seal, are found nowhere else. This little beauty is also unique to the lake.

I say little, it's actually a giant. It looks to be the giant spiny amphipod, *Acanthogammarus victorii*, which is about 70 millimetres long. The typical freshwater shrimps found in Europe (*Gammarus pulex*) grow only to about 20 mm. Gigantism in the lake is thought to be fuelled by high levels of dissolved oxygen.

Baikal has more than 350 species of amphipod, occupying the full range of lake habitats. This one feeds on the organic matter, like dead insects and fish, that drifts down through the water. Amphipods are the trash collectors of Baikal, and help maintain its exceptional purity.

Kamenskaya has been photographing the lake's wonders for years but can't see her love waning. "One can never end the dialogue with Lake Baikal. The feeling of satisfaction will never come." Despite having walked hundreds of kilometres on the lake's frozen surface and taken thousands of shots, she says she has only touched upon its mystery. Rowan Hooper



### Photographer

Olga Kamenskaya [Naturepl.com](http://Naturepl.com)

# Gifts that keep on giving

Science and technology are the key to prosperity for poor nations. Time to unleash their full potential, says **Curtis Abraham**

THIS is the year that the world stands at a crossroads in its attempts to tackle world poverty. At the turn of the century the United Nations ushered in its eight millennium goals to try to dramatically improve the lot of poorer nations by 2015, for example, by halving the number of people in extreme poverty and hunger and getting all children into school. Progress has been made, but it's not enough. Now comes the chance to set the agenda for the next 15 years.

Science and technology broadly underpin the arguments about what should be part of that agenda, and are also explicit in the 17 goals and 169 targets proposed for 2030. Few would argue that they have not been important in the preceding years. Campaigners are fighting hard to make sure this doesn't change when the goals clear the last hurdle from draft to reality in September. Between now and then, UN member states will be hammering out the final wording.

There are many examples of science and technology's impact in poorer countries, not least the major scaling-up of disease control. HIV, tuberculosis and malaria have all been targeted. Many lives have been saved with low-cost antiretroviral drugs. Mother-to-child transmission of HIV has declined with the development of several drug and treatment protocols, while new medicines have been developed to treat multidrug-resistant TB.

Considerable progress has been made in controlling malaria in sub-Saharan Africa, India and



elsewhere, especially through the rapid global uptake of potent artemisinin-based combination therapies. Then there is the development of bed nets treated with long-lasting insecticides, and very rapid diagnostic tests for malaria, particularly in children, to ensure they get the right drugs. Around the world malaria deaths have halved since 2001.

The mobile communications revolution in Africa made a great contribution towards some of the outgoing development goals. Africa now has nearly 300 million cellphone users, and wireless internet access via such devices has opened up isolated villages and rural areas in general, not

only to banking but also to medical care and public health information via telemedicine services. In agriculture, farmers now use cellphones to access market information and sell their produce directly at better prices.

Bio-fortification, the breeding of crops with better nutritional value, has been crucial to combating illness. In Uganda, for example, traditional plant breeding has produced an orange-fleshed sweet potato suitable for growing there that can help

alleviate hunger and malnutrition. It is rich in beta-carotene, the precursor to vitamin A, which helps prevent blindness and other conditions. There has also been the development of golden rice, genetically modified to be rich in the same nutrient. High-yielding, drought, flood and heat-resistant rice varieties have also emerged.

We have seen innovation in the design of efficient and cleaner-burning cooking stoves, which cut indoor pollution and reduce respiratory infections, saving lives, particularly among the young. These stoves are more efficient and mostly use renewable fuels such as wood, charcoal and animal dung. Equally important is that, unlike the burning of coal, there are no net greenhouse gas emissions.

All this happened without tech and science being explicit in the millennium goals. Why change that? One key reason is that despite progress, poorer nations are still struggling to create their own science base. To address this the new goals set a 2017 target for the creation of the Technology Bank, a UN initiative for transferring technology and building scientific capacity in Africa and elsewhere. Latin American, Asian and African researchers would become major recipients of Western technology.

The bank would do this by establishing a depository for research that could give scientists from the developing world better access to literature. It will also create networks to widen researchers' horizons beyond those of their own country's often

**"At no other time has technological progress offered such hope to lift millions out of poverty"**

underdeveloped research community. And it will help poorer countries negotiate access to appropriate intellectual property rights.

Such technology transfer should help address some key outstanding problems. They include the estimated 1.3 billion people (equivalent to China's population) in the developing world without electricity. Electrification of urban and rural communities is crucial for socio-economic development. Some new technologies such as Shared Solar, have been developed to provide reliable, modular, cost-effective, off-grid power in remote rural areas. More will be needed.

Communication technology has yet to fulfil its vast potential for providing education to the disadvantaged. A new approach for remote teaching of children in underprivileged regions of the globe is being tested. Though in its infancy, expanding this type of approach could have a big impact.

As UN secretary-general Ban Ki-moon said in his report last month on the new goals: "We live in a period of unprecedented technological innovation and change. New technologies are unlocking possibilities for sustainable development. The solutions that they can generate, and the levels of access that they can enable, will be crucial to our vision for the world beyond 2015."

While poverty still hinders many nations, at no other time have key scientific breakthroughs and technological progress offered such hope to lift millions more out of poverty. They are not a panacea but they thoroughly deserve to be explicit in the new targets. That is why, as leaders battle over the wording, amid growing demands for a slimmed-down set of goals, their potential must not be diluted by politics. ■

Curtis Abraham is a journalist based in East Africa

## ONE MINUTE INTERVIEW

# The seeds of the future

Climate change will cut a swathe through the crops we rely on, but seed banks alone won't save us, warns **Cary Fowler**



### PROFILE

Cary Fowler helped create the world's largest seed bank, the Svalbard Global Seed Vault, which stores more than 780,000 crop varieties in a mountain in the Norwegian Arctic. He is a senior adviser to the Global Crop Diversity Fund

### Why are seed banks important?

I call them an insurance policy for the globe. Without crop diversity, farming isn't going to adapt to climate change, and neither are we. It's the biggest challenge that agriculture has faced since the Neolithic days when it began. We're going to see a change in seasonality, growing seasons that no longer align with rainfall – everything will be out of whack. If you think the recent droughts in the US Midwest and California were bad, we've got more of this coming, and it's going to get worse.

### How will these changes affect the global food supply?

Climate change is going to impact people in Africa and south Asia worst. If you fast-forward 20 years, the climate they will have doesn't even overlap with their current climate. In some places the coldest temperatures will be hotter than the hottest in the past. So you ask yourself, how adapted are today's crops to a completely different climate? If we have the same crop

varieties in the fields 20 years from now, we will see dramatic decreases in plant production, leading to famines and higher food prices for us all.

### Is it enough just to save seeds in seed banks?

No, you also need to know what you have there. To use an analogy, it may be in the library, but we don't yet have it card-catalogued for the kinds of traits that we will need in the future. At the moment, virtually no seed bank is geared up for screening seeds and providing good answers to farmers who need new crop varieties in order to adapt to climate change. If a new disease comes along and you need resistance, and that resistance isn't found in the crops that are already in your field, you'll go out of business or starve.

### What's needed to increase our preparedness?

National seed banks around the world should figure out which traits will be needed and distribute the relevant seeds. They have to get these seeds into the hands of farmers and empower them to be the breeders and developers of new traits. Underdeveloped countries especially need this because they lack big, viable commercial research sectors. The farmers will do it: they love to experiment, to try something new.

### You advocate gaining knowledge about wild relatives of food crops. Why is that?

Take Queen Anne's lace. If you pull it up, you will see and smell a carrot. Well, Queen Anne's lace is one tough weed – just look around the roadsides, you can't get rid of it. Think about the traits that plant has and how valuable those will be in a climate-changing world. There are many hundreds of wild relatives of domesticated crops and we want to bring that into the gene pool, that's really important. But we're not there yet.

### Are you pessimistic?

It is clear we're not prepared. But we could be. We know the disaster is coming. It is within our capacity to avert the worse effects, if we mobilise now.

Interview by Richard Schiffman

# How pets got their spots (and floppy ears)

Why do domesticated animals share certain physical traits?

**Tecumseh Fitch** unpicks the puzzle that mystified Darwin

CHARLES DARWIN was fascinated by the many breeds of domesticated birds and mammals. His cataloguing of the unusual and sometimes bizarre varieties of pigeon was more than a hobby: he was an avid pigeon breeder, and devoted many pages of *On The Origin of Species* to documenting how readily the birds change their form when selected for unusual traits such as webbed or feathered feet.

The study of domesticated animals was a key pillar in Darwin's argument for natural selection. The changes he observed in pets and farm animals showed that artificial selection by humans – whether for webbed feet in pigeons or more milk in dairy cows – can quickly produce heritable changes from the “wild type” state. This provided a compelling argument that analogous “natural selection” by Mother Nature could produce similar changes and eventually lead to new species.

## “Pigmentation and other visible traits are side effects of selection for tameness”

Darwin didn't limit himself to pigeons. Through correspondence with hundreds of breeders, he compiled information about virtually every domesticated species of the time, from chickens and ducks to dogs, cats, pigs, cows and horses. He published his research in 1868 in the massive two-volume *Variation in Animals and Plants Under Domestication*, which even today remains the most comprehensive work on the subject.

Darwin's detailed research uncovered a remarkable regularity, which has recently been dubbed the domestication syndrome. In all domesticated mammals, a bizarre collection of traits shows up time and again. Besides a general docility, Darwin noticed that coloration is modified (for example, black and

white coats appear), teeth and brains get smaller, and snouts shorter. In many species, the tail may become curly or reduced, or ears flop over. Why should this unusual set of features appear together in different species that were domesticated at different places and times? Although Darwin speculated that some traits might have been specifically selected for (black-and-white coloration, for instance, might make lost livestock easier to find), he never came up with a convincing solution for the whole set of traits.

Recently, together with biologists Adam Wilkins and Richard Wrangham, I proposed a novel solution to Darwin's mystery (*Genetics*, vol 197, p 795). Our hypothesis hinges on the fact that virtually all of the traits involved in the domestication syndrome are derived from the same source: an unusual type of cell called the neural crest.

Neural crest cells arise during early embryonic development, when the brain and spinal cord are forming. These cells originate on the embryo's back and migrate to form the adrenal glands and parts of the nervous system, along with pigmentation cells and major portions of the skull, teeth and ears.

Our hypothesis suggests that selection in any newly domesticated species is focused on tameness. Animals that become fearful and agitated when encountering humans are unlikely to breed in captivity. Fearful animals are also more likely to bite, kick or otherwise injure their human caretakers. Thus docility and a lack of fearfulness are among the most important traits to appear when a wild species is first domesticated.

How does tameness arise, physiologically? A key change is that the adrenal glands and sympathetic nervous system, which are jointly responsible for the “fight-or-flight” response to scary events, mature late. When young animals are first exposed to their

### PROFILE

W. Tecumseh Fitch is professor of cognitive biology at the University of Vienna, Austria. He studies the evolution of speech, language and music

The appearance of these foxes hints at what really underlies domestication



human custodians, they do not have a full-blown physiological capacity to feel afraid. Thus they remain relatively calm during these encounters, and by the time their fear response matures they have already been habituated to humans. This is precisely what it means to be “tame”.

Wolves, for example, have a brief window of time after their eyes and ears start working before they are capable of mounting a mature fight-or-flight response. Anyone wishing to tame a wolf must expose it repeatedly to humans during this period, which lasts until the age of about 1½ months. In contrast, many experiments have shown that this “socialisation window” lasts until the age of 4 to 10 months in dogs, depending on the breed, after which time dogs exposed to people for the first time will remain fearful regardless of how much they interact with humans.

Now comes the interesting part. We



VINCENT J. MUSI/NATIONAL GEOGRAPHIC CREATIVE

hypothesise that the late maturation and general under-functioning of the adrenal glands and sympathetic nervous system – leading to docility – derives from reduced numbers and delayed migration of neural crest cells in the embryo. Because the cells are the precursors of teeth, pigmented skin, snouts, ears etc, these are also smaller or develop late. Rather than humans selecting for black-and-white coloration, we suggest that pigmentation changes and other traits of the domestication syndrome are just unintended side effects of selection for tameness.

Strong evidence in favour of our hypothesis comes from experimental studies of domestication. The most famous were carried out with foxes in Siberia over many decades, beginning in the late 1950s. The researchers attempted to create a new domesticated species by selecting only for tameness. They started with unselected, fearful foxes, and

carefully tested their young for fearfulness and friendliness. Only the friendliest offspring were chosen to breed.

After a surprisingly short time – less than 10 generations – the Siberian team bred a strain of foxes that is amazingly tame and unafraid of humans (see photo above). What's more, these foxes showed most of the other traits of the domestication syndrome, such as reduced and delayed adrenal function and a longer socialisation window (as required by our hypothesis), plus pigmentation changes, floppy ears and shortened snouts. These experiments have been repeated in rats and mink, with similar results.

Tameness is the only attribute selected for in this work. Nonetheless, the traits of the domestication syndrome pop up much more frequently than expected if they were random.

There is other evidence. We predicted that neural crest development changes should be

pervasive in domesticated species compared to wild counterparts. A study published just last month confirms this for multiple neural crest genes in domesticated cats (*PNAS*, vol 111, p 17230).

Our hypothesis leaves several questions open. The most obvious concerns the brain: the neural crest cells make no direct contribution to the central nervous system, so it is unclear whether cognitive changes in domesticated species can be fully explained by the same mechanism, or whether interactions between the neural crest and the developing brain are important in brain reduction as well.

Further research is needed, but our hypothesis is consistent with available data. We think it finally provides a coherent explanation for the characteristics of domestication that have puzzled biologists since Darwin. ■

# The SECRET LIFE of REALITY

Why is quantum reality so different from our everyday experiences? The answer could be right under our feet, says **Michael Brooks**

**T**HE quantum realm has always seemed worlds apart from general relativity, Einstein's theory of gravity. One rules at the atomic scale and smaller; the other reigns supreme across the cosmos. This is one reason why physicists are wrestling in their efforts to meld quantum theory and relativity into a theory of everything that shows how the universe works at a fundamental level.

So far, all the attention has focused on schemes that come into play under the high-energy conditions that existed just after the big bang. The trouble is, experimenting with such theories is incredibly difficult. "The tests for it are way off," says Roger Penrose at the University of Oxford. "You have to build an accelerator the size of the solar system – that's not on the cards at all."

Perhaps, though, the quantum world has more in common with relativity than we think. According to Penrose, we've actually been doing experiments for decades that combine quantum theory and gravity. With a few tweaks, they might offer a different way to the revelations we seek. "It looks a much more promising route to the truth about how the universe actually works."

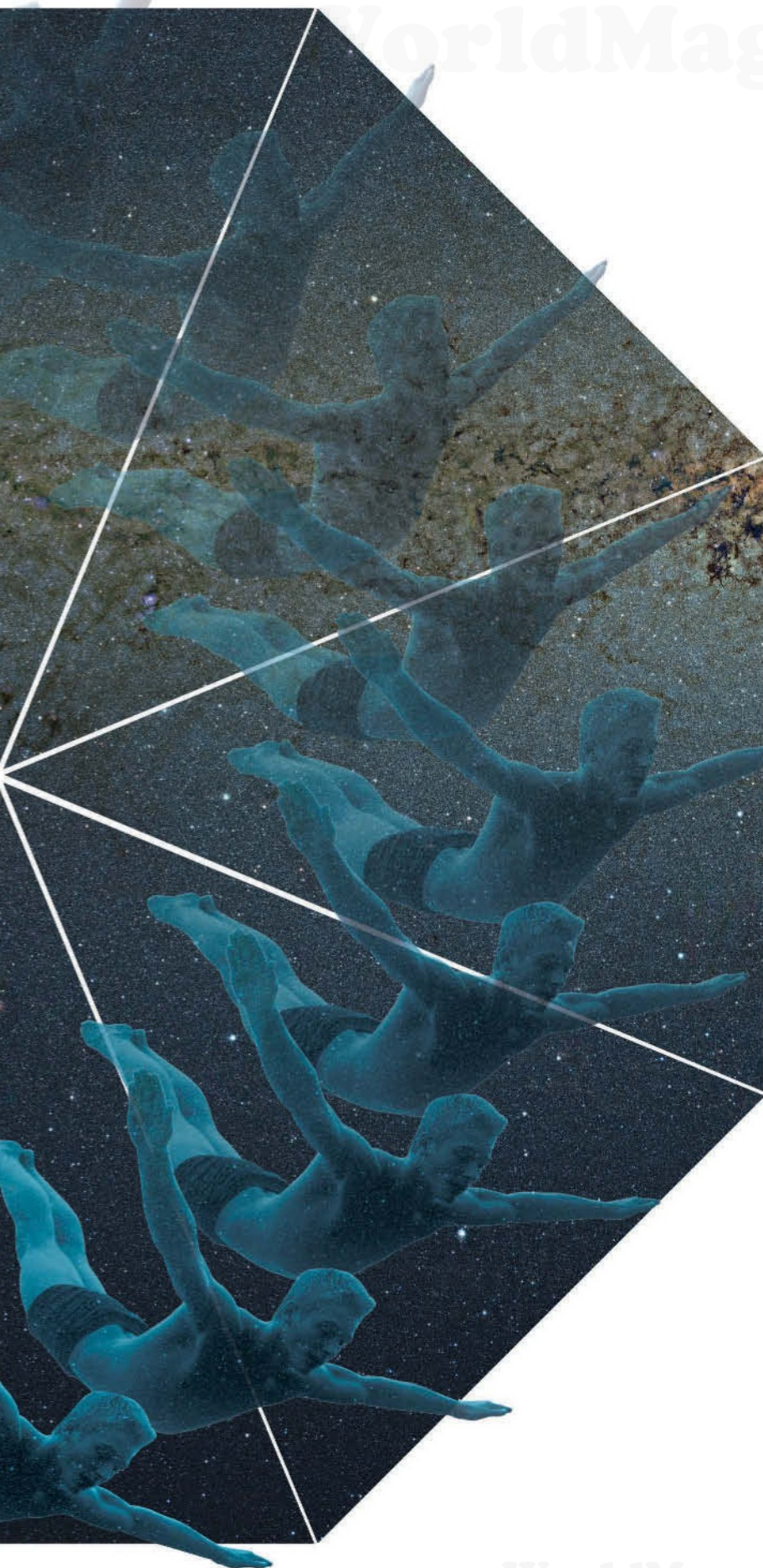
How can this be? Well, until now the

interplay between some of the best known oddities of physics has largely been ignored. Take the fact that atoms and small molecules can exist in two places at once, a phenomenon known as superposition. This famous ability is a key feature of quantum reality and has been demonstrated in countless experiments. Yet it turns out that some fundamental questions about the role of gravity in superposition have never been asked, let alone answered.

Asking those questions, and finding out the answers, would enable us to open the door on an understanding of the universe in its entirety. They might also shed light on one of the biggest mysteries of science: what causes the transition between the weird quantum world and the everyday "classical" reality we experience. What were once impossible-looking puzzles might not be too far from a solution. "We're way closer than we've ever been," says Cisco Gooding of the University of British Columbia (UBC) in Vancouver.

The enigma is, in many ways, quite simple to lay out. Here's a starter: general relativity says that mass distorts space and time in a way that causes things around it to feel the attractive force we know as gravity (see diagram, page 28). So, in superposition,





is an atom's mass creating two distinct distortions in space-time – and thus exerting a gravitational pull on itself?

Here's another: special relativity says that an atom moving through space will have a unique experience of the flow of time. This phenomenon is known as time dilation. But if a moving atom is in superposition, the time dilation must occur along two different paths at once, and will be different on each path. So when the superposition ends and the two become one again, have they aged differently?

More fundamentally, it is questionable whether general relativity even allows superposition. "There's a conflict here," says Penrose. "You can't have a superposition of two gravitational fields: that's illegal."

It is worth pointing out that we have seen nothing wrong with general and special relativity so far: experimental tests show they are correct.

## Quantum collapse

Quantum theory works similarly well, even though its ideas are odder. Superposition, for example, works because of a phenomenon called quantum coherence. This is what allows quantum objects to split their existence, characteristics and properties between spatial locations, different kinds of movement or even between different particles entirely.

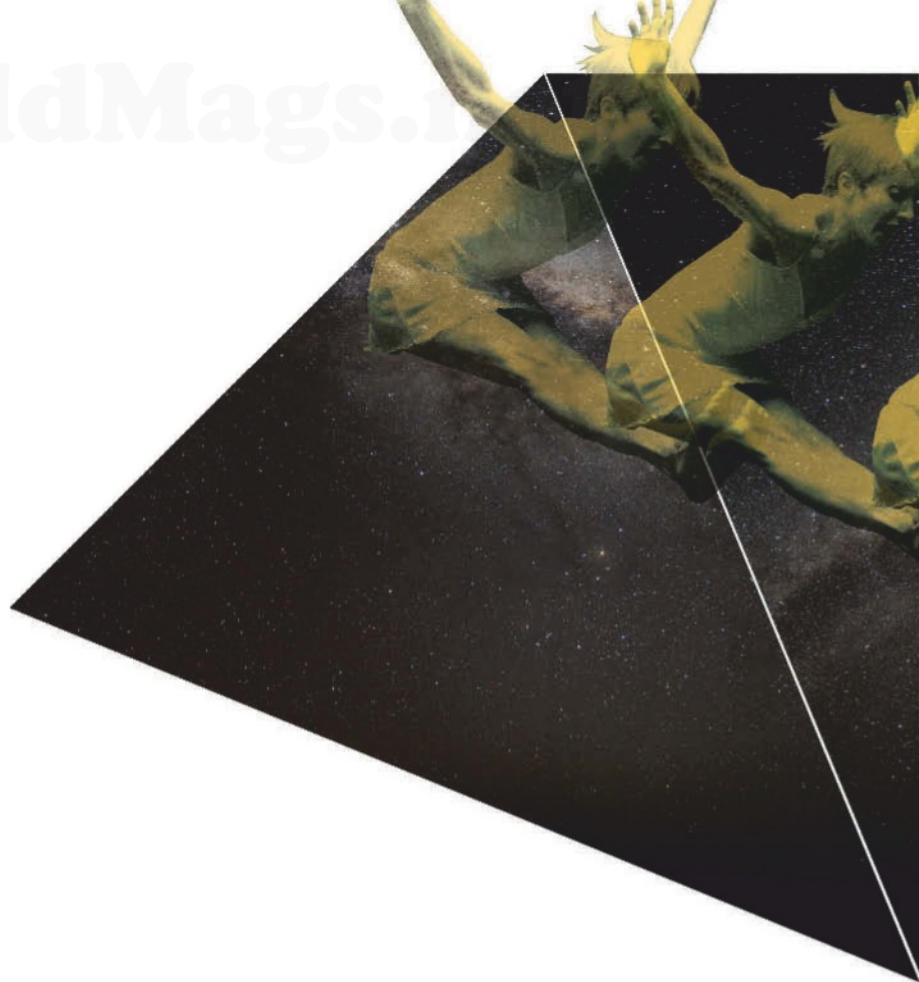
The real problem is that these two theories only work separately. Quantum theory has nothing to say about the properties of the space and time its particles pass through. And relativity says nothing about the properties of those particles. When you try to combine them, they simply butt up against one another. "How do you go from one to the other?" says Miles Blencowe of Dartmouth College in Hanover, New Hampshire. "We don't have a quantum theory of gravity."

And that is why the new generation of experiments in "gravitationally induced decoherence" can't come soon enough for Penrose and others.

Decoherence is the name quantum researchers give to the falling apart of quantum coherence. You can put an atom – even a lot of atoms – in a spatial superposition, for instance, but it doesn't last. Eventually, the superposition "collapses", and the atom is suddenly in only one place.

The classic way to investigate quantum superposition is to fire an atom at a screen with two slits, also known as an interferometer. The atom can go through either, but experiments show that if no one

DREAM PICTURES/GETTY; BACKGROUND: ESO



is measuring which slit it passes through, it will actually go through both. The result is an “interference pattern” that forms in a detector placed behind the slits. This reveals a series of well-defined patches where the atoms appear to hit the detector, alternated with blank spaces where no atom seems to land. The only explanation for such a pattern is that each atom splits in two, with one part going through each slit, then interfering before it reaches the detector.

Even weirder things happen if you equip this interferometer with another detector sited so that it can tell which slit the atom went through. The mere presence of this detector causes decoherence and destroys the interference pattern. It seems that the atom only behaves oddly when no one – or nothing – is looking.

## Ticking atoms

There are many ideas for why such a thing might happen. Most are to do with information loss: reading the atom’s path forces the atom to choose one path or the other and prevents it taking both. Experiments have shown that there doesn’t even have to be a detector: heating the atom up, so that it emits thermal photons that could be used to infer its position, seems to be enough to weaken the interference pattern.

No one really knows what to make of this. It is made even worse by the discovery that large collections of atoms seem to be unable to exist in superposition. We have made interference patterns with molecules composed of 800 atoms, but the more massive they get, the shorter-lived the superposition. This has led some to suspect that gravity might be the real reason why massive collections of atoms – including us – are not quantum.

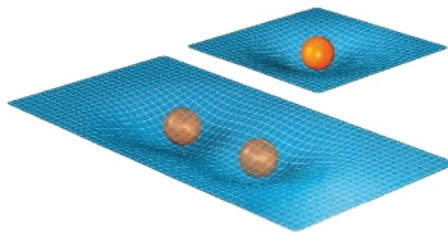
Testing this idea is far from easy because superpositions of atoms are such delicate things. But our ability to protect them from heat, vibrations and other disturbances has come on leaps and bounds, meaning we can start to get to grips with gravity’s role.

For instance, Gooding and Bill Unruh, also at UBC, are planning to look at how an atom in a superposition experiences time as it flies through different paths in an interferometer and then recombines to produce an interference pattern. An atom can be thought of as a tiny oscillator, a bit like a clock’s pendulum. Send an atom into an interferometer and “it’s a little clock that is ticking differently, and when it comes back together, those two clocks don’t necessarily

## Weighty matters

All objects leave their mark in space-time, but how would a particle that can be in more than one place at the same time affect it?

Classical object deforms space-time to create a gravitational field



Would a quantum particle existing in two places at once create two gravitational fields? If so, where would they be?

agree with each other,” says Gooding. “We should see some sort of clash between each of their individual notions of time evolution.” That should be enough to degrade the interference pattern in predictable and detectable ways.

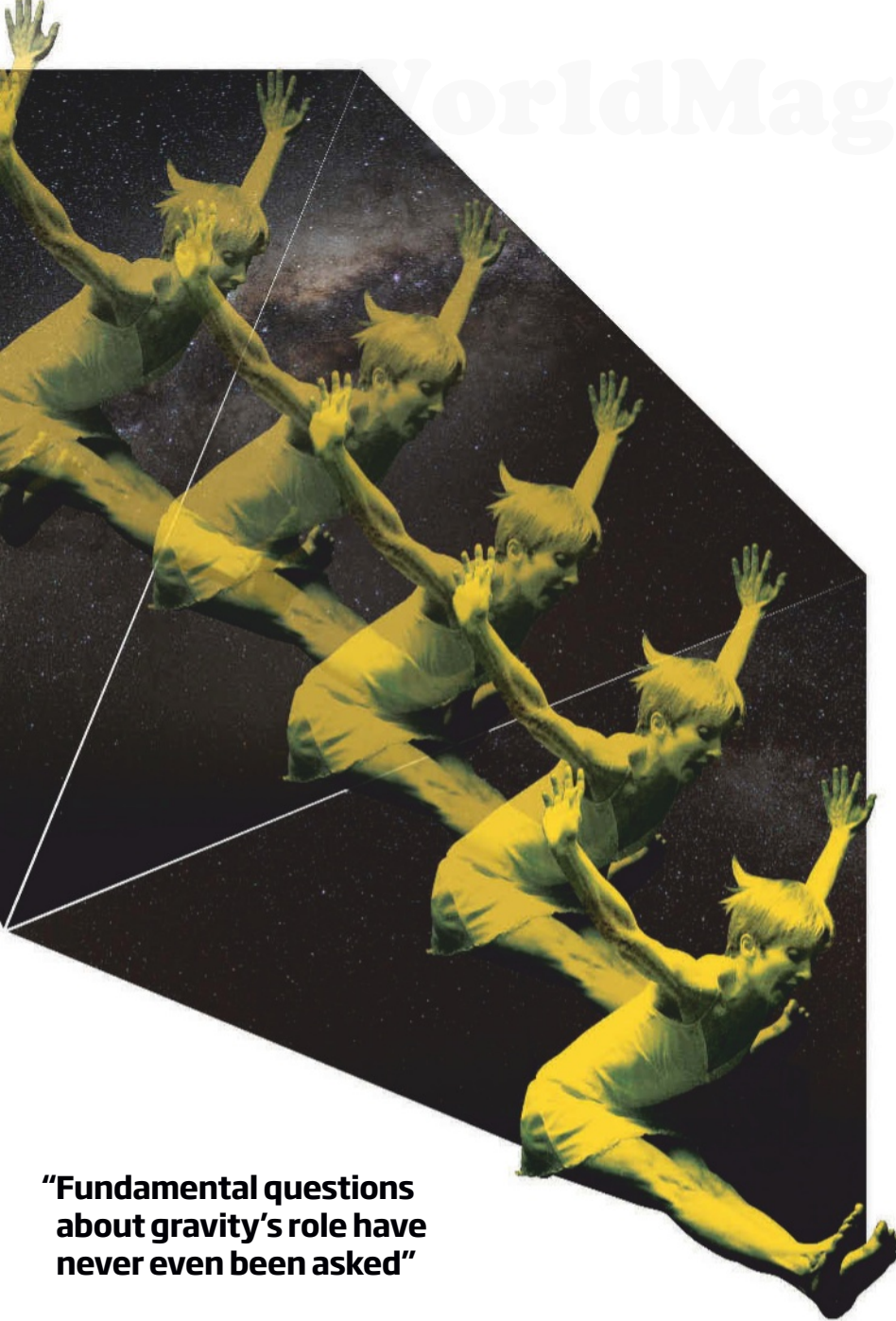
Igor Pikovski at Harvard University has another plan based on time anomalies. Working with Caslav Brukner’s group at the University of Vienna in Austria, they think we could put a clock in a superposition of two different heights from the ground.

That would mean the two parts of the superposition exist in different parts of the Earth’s gravitational field.

According to general relativity, clocks run faster in a weaker gravitational field. That’s why, over your lifetime, your head ages 300 nanoseconds more than your feet. For a one-atom clock in a superposition, this creates a problem – as the two times diverge, the atom will be forced back to being at one height or the other. “The fact that the atom records different time in different places gives away information on the atom’s position,” Pikovski says. “This destroys the coherence.” In other words, time dilation due to gravity can explain why we do not see quantum superpositions in our everyday world.

This can be tested using “atomic fountain” techniques that push atoms upwards through microwave fields to create ultra-accurate interferometers. It will involve some tweaks to existing experiments, but not too many. “It’s not something that can be done now, but it’s possible soon,” Pikovski says.

Other experiments under development involve a different kind of superposition. Dirk Bouwmeester at Leiden University in the Netherlands, and Markus Aspelmeyer at the University of Vienna are independently making mirrored cantilevers. These structures look rather like springboards that exist in two configurations at once. When a photon in superposition hits the mirror, it can put the



## "Fundamental questions about gravity's role have never even been asked"

cantilever into a superposition of being both vibrating (as if a diver had just left the springboard) and undisturbed.

This was first achieved a few years ago. Now Penrose believes that each part of the superposed springboard should create so much gravity for the other that they collapse back into one. "It's hand-waving to a degree," he says, "but something certainly goes wrong."

The challenge now for Bouwmeester and Aspelmeyer's teams is to make the superpositions last long enough to investigate the decohering effects of gravity. One of the problems with the diving boards is that it is hard to disconnect them from their environment. This results in superpositions collapsing because of vibrations transmitted through the apparatus, rather than gravity.

Making and studying superpositions of large objects – large in quantum terms anyway – is new territory for researchers. And not surprisingly, there are other ideas for why reality ceases to be quantum at larger scales. One suggestion is that we need to revise quantum theory itself. A souped-up version of it says that superpositions are impossible for objects composed of more than a certain number of particles because of a phenomenon called spontaneous localisation, which suggests that the distribution of mass – its density – is what matters.

We may find out that particular answer fairly soon. Markus Arndt's group at the University of Vienna has been repeating the double-slit interferometer experiment with ever larger objects. Arndt believes that

spontaneous localisation would kick in with particles of a mass of somewhere between 100,000 and 100 million atomic mass units in his apparatus (one amu is equivalent to 1/12th the mass of a carbon-12 atom).

We need to rule out spontaneous localisation before pointing the finger at gravity. "It's difficult to promise when this will be, but hopefully before the end of the year," he says. They are currently superposing objects of 10,000 amu, and working towards 100,000 – the lower limit of where spontaneous localisation is thought to happen. We will then have a nail-biting passage through to 100 million amu, when we would be able to rule it out.

## Theory of everything

Of course, experiments will be the final arbiter of this. And in the end, all these techniques have their own challenges. "Nobody on the planet can actually do any of this yet," Arndt says. It's still a good time for theorists in this field, he quips. "We can't constrain them."

So, really, all the pressure is on the experimenters. Not that they are guaranteeing any quick solutions. Aspelmeyer reckons there is a long road ahead – and that's just the bit he can see. "It could be long, very long or impossible," he says.

And people disagree about how much such work will illuminate the search for a theory of everything. Many believe that such a theory is as distant a prospect as ever. But Gooding is an optimist. One of the good things about these experiments, he says, is that they don't involve making anything up. We've tested general relativity and quantum mechanics under these conditions, and they work. "If we can demonstrate something from just those theories then we have a good reason to believe that effect is real," he says. "If we demonstrated it from string theory there would always be a nagging thought in your mind that maybe it's something to do with the assumptions of string theory."

He thinks that we could have answers within 10 years. And that is very good progress. Until fairly recently, it didn't look as if we'd ever be able to test gravity's quantum interactions. "It's now looking like something that's actually doable, not something that has absolutely no chance of ever being observed," Gooding says. ■

Michael Brooks is a consultant for *New Scientist* and author of *At the Edge of Uncertainty: 11 discoveries taking science by surprise* (Profile)

# Swipe and burn

Dating apps that connect people in the here and now are being linked to a surge in sexually transmitted infections. **Shaoni Bhattacharya** reports

**S**OME people do it in bed. Others slope off to the bathrooms at work. Look carefully and you'll probably spot someone at it on the train. You might even be one of them.

Whether or not you have joined the millions regularly logging on to hook-up apps such as Tinder and Grindr, it is clear that over the past few years they have become an accepted part of today's dating scene. With touchscreen interfaces that allow users to swipe through profiles of available matches, they make finding a date as quick and easy as flicking through the pages of a magazine.

Tinder, used by men and women, generates 15 million mutual matches a day. Grindr, a similar app for men seeking men, has 6 million users, with 10,000 joining daily. And because these apps rely on GPS to recommend potential matches within a given radius, they make meeting people in the flesh easier than ever.

But for all the fun and spontaneity, a darker side is emerging. The rise of such apps has coincided with a surge in outbreaks of sexually transmitted infections (STIs) that had long been under control, and an increase in other rare diseases. Public health officials are now pointing the finger of blame at a combination of relaxed attitudes towards safe sex and the easy access to partners provided by these apps.

"What it comes down to is mobile convenience leading to more efficient STI transmission," says epidemiologist Matthew Beymer at the Los Angeles LGBT Center. That's not all. Research is starting to explore the idea that this technology makes you more likely to change your behaviour, causing you to leave your common sense at the bedroom door.

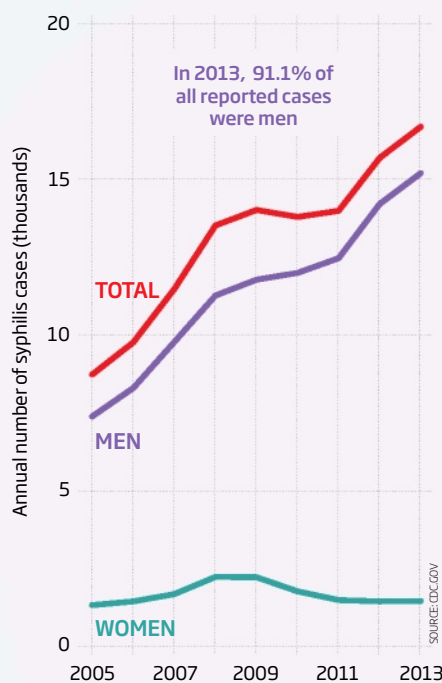
Syphilis was once one of the most feared STIs, but was almost confined to the history

books after it became treatable with penicillin in the 1940s. By 2000, it was on the brink of elimination in both the US and the UK.

But cases of syphilis have rocketed over the past few years in many Western countries, including the US, Canada, UK, Germany, Sweden and Australia. Now the UK sees more than 3000 cases a year and the US more than 16,500 (see graph, below).

## On the up

There has been a sharp rise in syphilis cases in the US in the past decade. Are location-based apps behind it?



Australia had its highest-ever recorded levels last September.

It's not just syphilis. Infection rates for other STIs that had plummeted during the AIDS epidemic in the 1980s are also on the rise. In Australia, gonorrhoea cases rose by 70 per cent between 2009 and 2013. Chlamydia and multidrug-resistant gonorrhoea are on the increase in numerous countries.

In their public responses to these outbreaks, health officials have repeatedly blamed hook-up apps. "You've suddenly invented a way of discovering where the nearest sexually available person is to the nearest metre – it's not difficult for you to get with them," says Peter Greenhouse at the British Association for Sexual Health and HIV.

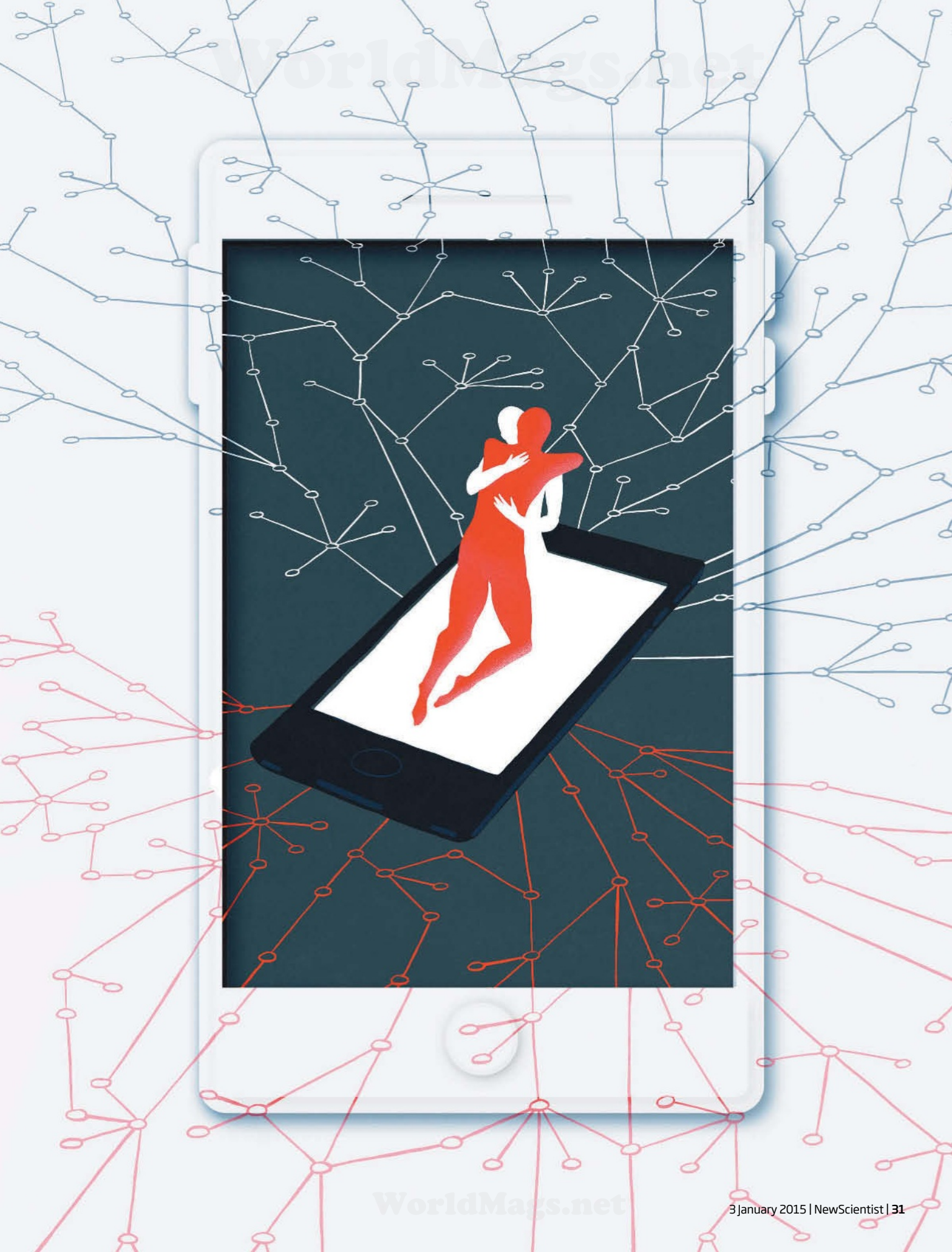
## Rash behaviour

Research into the cause of the STI increase is still in the early stages, but evidence is starting to stack up in support of this idea.

An investigation of six regional outbreaks of syphilis across the UK since 2012 found that location-based networking apps played an important part in how patients had met their sexual partners, especially for men who have sex with men.

The team behind the research, led by Ian Simms at Public Health England in Colindale, UK, says that as well as making it quicker and easier to find new partners, the technology joins together isolated sexual networks in which disease would previously have been contained. This results in "hyper-efficient transmission" of infections, Simms says, so epidemics spread faster and further.

Further evidence that links app use with STIs comes from a small study of men who



## FAST LOVE

### TINDER

Linked to Facebook, it finds potential matches in the local area. Swipe left for no, right for yes

### GRINDR

Location-based social network for men, it provides users with a grid of potential matches in the vicinity

### GROWLR

The social network for gay "bears" – heavier, hairier men. More than 4 million users

### JACK'D

Location-based gay social app. Launched in 2010, it now has 5 million users

### MANHUNT

Launched as an online site and also a mobile network for "guys looking for fun, dates, or friends"

### RECON

Fetish hook-up site for gay men

### SCRUFF

Dating and social networking app for men. Fifty million messages are exchanged each week

have sex with men. This found that those who met up through smartphone apps had significantly more past sexual partners and were more likely to have ever been diagnosed with an STI than those who didn't use the apps (*PLoS One*, DOI: 10.1371/journal.pone.0086603).

That finding was backed up by Beymer and his colleagues, who conducted the first major study to compare STI rates in people who use apps and those who don't. The clinic had noticed that increasingly, men who came in for testing were using apps such as Grindr, Jack'd, Recon and Scruff (see "Fast Love", above).

The team looked at disease incidence in 7000 men who came in for screening and found that those who used phone apps to meet sexual partners were 40 per cent more likely to test positive for gonorrhoea than those who

met sexual partners online. They were 25 per cent more likely to have the disease than men who had met partners socially.

What was "startling", Beymer says, is that even when they controlled for other factors that are known to influence STI risk, such as age, ethnicity and drug use, the link to phone app use remained.

STIs are the core concern, but in the past two years Simms and others have been surprised to find that infections that weren't traditionally

Grindr  
has over  
**6 million**  
users since 2009

thought to spread through sexual contact also now seem to be spreading this way. Two infections that had hitherto been known as travel-related stomach bugs, the gastroenteric bacterium *Shigella flexneri* and the rare verocytotoxin-producing *Escherichia coli* (VTEC), were reported in clusters of gay and bisexual men in the UK. Many cases weren't linked to travel to countries where the disease is endemic, and later interviews with the men revealed factors such as the use of the internet and apps to meet partners.

"Essentially we are saying all these overlapping epidemics are all sides of the same dice," Simms says. "They are sustained by very closely related sexual networks facilitated by geospatial networking apps which allow all these previously un-joined networks to be linked up."

These studies suggest a link, but it could be that the results aren't about the apps but the users, says Ian Holloway at the Luskin School of Public Affairs at the University of California, Los Angeles. "We don't yet know if there's something inherent about these apps or the individuals choosing to use them," he says.

Anecdotal, the spontaneity involved seems to make people more relaxed. "You are more likely to throw caution to the wind," says

Kate (not her real name), who started using Tinder after a breakup. She didn't originally sign up to Tinder for casual sex, but ended up sleeping with three of the five men she met. "Sometimes we'd been chatting for ages so you feel more advanced in your flirtation when you meet them for the first time than with someone you meet in a bar, so it's more likely that things will happen," she says.

But what's the evidence? Working out why and how people behave the way they do when it comes to sex is delicate and complicated. Yet studies suggest that the way people meet their sexual partners might influence what happens when they end up in bed – translating into health consequences.

"We have done work to show that the actual process of interaction online can increase risk-taking," says John de Wit at the University of New South Wales, Australia. With colleague Philippe Adam, he conducted a survey of 2000 men who have sex with men to see if their online experiences affected their actions.

"We found out that 70 per cent of gay men who use these online chat sites or apps fantasise around unprotected sex with their partner as a way of getting aroused – without the intention to actually do that. But in fact all these fantasies modify their sexual script," says Adam, and some men act on them regardless of their initial intentions.

## Safer swiping

Much of the research has so far focused on men having sex with men, but the surge of STIs is far from confined to this community, with outbreaks also occurring in heterosexual adults. Similar research on Tinder would be interesting, says Holloway.

One of the reasons some officials believe that apps are helping to drive the problem is a result of contact tracing, one of the first things they do when trying to address an outbreak. Those who test positive in the clinic are asked for the contact details of recent sexual partners so that they can be alerted of the risk. And it's this process, they say, which often reveals the role of hook-up apps: in the Canadian city of Winnipeg, for example, 50 per cent of people being treated for syphilis said they had met sexual partners through them.

Apps may also make contact tracing harder than if people meet through social connections as there is no need for users to reveal their real name or contact details, making halting an outbreak more difficult.

But although apps have been implicated in the STI surge, they are far from the only factor.

Cases of syphilis have been rising for around a decade, and this coincides with a reduction in sexual health campaigns and a change in attitudes towards HIV. As the perception of AIDS has changed from it being seen as a death sentence to a chronic condition that can be managed with drugs, a so-called “safe-sex fatigue” has ensued. The same generation that is now connecting more easily using mobile devices is also less concerned about safe sex than the generation before.

The success of preventative pre- and post-exposure pills for HIV, which protect against HIV but don't stop other STIs, may add to the issue, officials say, as well as the popularity of “serosorting” websites. These connect people on the basis of their HIV status. Without the HIV risk, people may be less likely to practice safe sex.

With such a complex issue, Holloway cautions against vilifying networking apps. Instead, he thinks they could be harnessed as valuable prevention tools.

That's why he and his colleagues have teamed up with Online Buddies, which owns internet sites and mobile apps such as Manhunt and Jack'd, to conduct a study into how HIV prevention advice through mobile apps might be received by at-risk groups.

Online Buddies has a research arm, OLB Research Institute in Cambridge, Massachusetts, which is focused on gathering evidence on the best way to get sexual health messages across on their platforms. It also acts as a consultancy to health agencies to help them design mobile campaigns that users are more likely to engage with. The institute is headed by David Novak, who was previously National Syphilis Elimination Coordinator at the US Centers for Disease Control but felt that he could do more by working in the industry.

The approach can work. During a deadly meningitis outbreak in New York City in 2012, Novak says they worked with local public health authorities and directed one-third of local Manhunt users to get vaccinated using an advert on the site.

Other app companies are also getting on board. In October last year, Grindr and six other app makers formed a collaboration with the San Francisco AIDS Foundation and the Foundation for AIDS Research with the aim of finding new ways to encourage testing, raise awareness and reduce stigma.

Getting the message right is crucial, however. “Once you make a change to a site of millions of users, if you don't do it properly it can have a bad health outcome,” says Novak.

Online Buddies will turn down paid public

Meeting up has never been easier



JESSE UNTRACHT/OKAPIER/PLAINPICTURE

health advertising or campaigns it feels aren't right for their mobile platforms. For example, it recently refused a syphilis campaign that it felt stigmatised people who had the disease.

And a barrage of criticism fell on the public health department of San Mateo County in northern California recently for its use of fake Grindr accounts to send users sexual health advice. The accounts use stock photos as avatars and are operated by trained STI counsellors, says Darryl Lampkin, Community Program Supervisor at the department. Once they get chatting to users, the counsellors find

the first opportune moment to reveal that they are actually healthcare providers, and use the chat to supply health information. But critics have slammed this as patronising and unethical, and have likened it to entrapment.

“We recognise how this strategy can be perceived as being deceptive,” says Lampkin. But he says it works, with 80 per cent of men remaining online after the counsellors they are chatting to have come clean. They have also seen a rise in the number of men coming in to be tested.

Encouraging testing is crucial, but sending people their results quickly and in a shareable, electronic format can also help to increase dialogue about STIs, says Ramin Bastani, CEO of health platform Healthvana, which works with public health bodies in the US to develop electronic test results. Bastani envisages a day when app users will expect to see some kind of verified sexual health tick or “badge” on people's profiles – noting that many men in the gay community already post their HIV status on their online profiles.

Quite how this technology will evolve remains to be seen. Holloway points out that the possible re-sharing of test results raises privacy issues that have yet to be resolved.

But what is clear is that there is a real drive to change the way sexual health messages are presented. “Young people don't want boring messages about public health,” says Adam. “They want to know about relationships. Sexual health messages need to be embedded in this.” As Basani puts it, “the healthcare of the 21st century will not look like healthcare – it will look like your iPhone, your computer. The things you use every day.” ■

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Tinder has an  
estimated  
50 million  
users since 2012  
15 million Tinder  
matches per day



## Trans-Atlantic aqueduct

Unfeasibility ●●●●○  
 Benefits ●●●●○  
 Downsides ●○○○○

## Flood the depressions

Unfeasibility ●○○○○  
 Benefits ●●○○○  
 Downsides ●○○○○

*We've joined oceans and tunnelled under the sea. But some engineers have much grander plans, as Michael Marshall reports*

# WORLD CHANGING

THEY said it would never happen. Yet by the time you read this, work should have begun on a massive new canal to link the Atlantic and Pacific oceans. Building the 278-kilometre-long canal through Nicaragua will require moving billions of tonnes of earth and cost at least \$50 billion. If it is eventually completed, it will be wider, deeper and three times as long as the Panama Canal. Its backers claim it will be the biggest engineering project in history. But it is certainly not the biggest ever suggested. "All of us live in places that are

engineered and designed," says mega-engineering expert Stanley Brunn of the University of Kentucky in Lexington. So it's natural to dream even bigger, he says.

That may be true. But some of the schemes sound like the plans of Bond villains, such as flooding California's Death Valley or nuking the isthmus of Panama. Others, like damming entire seas to generate hydroelectricity, are on a mind-boggling scale. Here are seven of the world's biggest schemes. Could we really go ahead with any of them? And should we?

5

## Dam the Indian Ocean

Unfeasibility ●●●●○  
Benefits ●●●●○  
Downsides ●●●●●

## Join Asia and North America

Unfeasibility ●○○○○  
Benefits ●●○○○  
Downsides ○○○○○

4

1

## Relink the Pacific and Atlantic oceans

Unfeasibility ●●●●●  
Benefits ○○○○○  
Downsides ●●●●●

## Damming the Atlantic

Unfeasibility ●●●●○  
Benefits ●●●●●  
Downsides ●●●●●

6

## Creating land

Unfeasibility ●●●○○  
Benefits ●●○○○  
Downsides ●○○○○

# 1

## Damming the Atlantic

It doesn't get much bigger than this. We could build a barrier across the Strait of Gibraltar (below), effectively turning the Atlantic into a huge dam reservoir. This was first proposed in the 1920s by German architect Herman Sörgel. With the flow of water into the Mediterranean reduced, the sea would begin to evaporate. Allowing it to fall by 200 metres would create 600,000 square kilometres of new land.

The environmental impacts of Atlantropa, as this plan is known, would of course be gargantuan. Perhaps most, er, damning of all, lowering the Med by 200 metres would raise sea level in the rest of the world by 1.35 metres. "It's impossible in terms of the politics," says Richard Cathcart, a real-estate adviser in Burbank, California, and a mega-projects enthusiast who has written several articles and books. "Academics are actually afraid to talk about big ideas," Cathcart says.

With sea level set to rise tens of metres over the coming centuries because of global warming, Cathcart thinks the idea of a dam across the Strait of Gibraltar is worth revisiting. Instead of lowering the Med, a dam could maintain it at its current level, saving low-lying farmland from the sea as well as cities such as Venice and Alexandria. Egypt in particular would benefit. As things stand, rising waters will swamp large parts of the Nile delta and displace millions of people by 2100.



# 2

## Trans-Atlantic Aqueduct

Northern Africa could do with some more fresh water. The nearest potential source is the world's second largest river, the Congo, but it flows through a volatile, dangerous region. So why not tap the world's largest river, the Amazon, instead? All you'd need is a pipe. A very long pipe.

The idea of piping water all the way across the Atlantic has been around since at least 1993, when Heinrich Hemmer put it forward in a journal devoted to flights of fancy (*Speculations in Science and Technology*, vol 16, p 65). He envisaged a pipe 4300 kilometres long, carrying 10,000 cubic metres of water per second, enough to irrigate 315,000 square kilometres.

There the matter rested until 2010, when Viorel Badescu, a physicist at the Polytechnic University of Bucharest in Romania, revisited the idea with

### "Underground nuclear explosions would do the trick"

Cathcart. They proposed to submerge a pipeline 100 metres below the surface, and anchor it to the seabed at regular intervals (*Water Resources Management*, vol 24, p 1645). The pipe would have to be at least 30 metres wide, and have up to 20 pumping stations to keep the water flowing. It would start offshore in the plume of fresh water from the Amazon - "water that has been discarded by the continent of South America", as Cathcart puts it. All in all, he estimates that the pipeline would cost about \$20 trillion. Residents of the Sahara, start saving now.

It might be wise to start a bit smaller - perhaps by piping fresh water 2000 kilometres from lush Papua New Guinea to Queensland in Australia. In 2010, businessman Fred Ariel announced plans for a feasibility study into a \$30 billion pipeline. This year, the PNG government approved the idea in principle, but Queensland has said the plan is not under "active consideration".

# 3

## Flood the depressions

In 1905, irrigation engineers in California accidentally flooded a depression that lay below sea level. The result was the Salton Sea, the largest lake in the state. There have been many proposals over the decades for flooding other low-lying areas.

The prime candidate is the Qattara depression in north-west Egypt, which lies as deep as 130 metres below sea level. It consists of 19,000 square kilometres of sand dunes, salt marshes and salt pans. The idea is to flood it with seawater from the Mediterranean, just 50 kilometres to the north. Generating electricity is the main motive: if water flows in at the same rate as it evaporates, generation could continue indefinitely. The "Qattara Sea" would become ever more saline, but surrounding areas might benefit from cooler, wetter weather (*Climatic Change*, vol 5, p 73).

The idea has been around since at least 1912, and the Egyptian government looked into it in the 1960s and 1970s. Few people live in the Qattara, so politically it is doable. The biggest problem is the sheer scale of the construction, which would require tunnels to go under a range of hills between the Mediterranean and the depression. One construction plan involved nuclear bombs. You may not be surprised that Egypt abandoned the idea.

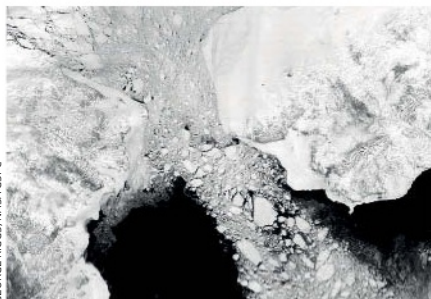
Interest in the idea has revived recently thanks to Desertec - a plan to build a vast solar power plant in North Africa. Magdi Ragheb, a nuclear engineer at the University of Illinois at Urbana-Champaign, has proposed storing energy from Desertec by pumping seawater through a pipeline to storage facilities on top of the hills. When more electricity is needed, this water would be allowed to run down into the depression, turning turbines as it went. There would be no need for tunnels.

Flooding areas like California's Death Valley would also help offset sea level rise caused by climate change. But it is not worth doing for this reason alone: even if we flooded all of the world's major depressions, it would barely make a difference.

The Salton Sea, meanwhile, is not a great advert. It did thrive for decades, but it is now drying out and dying. Most fish can no longer survive in the ever-saltier water, and frequent foul smells and toxic dust are driving human residents away.

Join Asia and  
North America

4



GEORGE RIGGS, NASA GSFC

The obvious place to link Asia and North America is at the Bering Strait (above), in between Russia's north-east corner and Alaska. At its narrowest point, the strait is just 82 kilometres across, and never more than 50 metres deep.

The idea of a bridge has been around since the 1890s. It would be the longest bridge over water, but not by a silly amount: the current record holder is the Qingdao-Haiwan bridge in China, which spans a 26-kilometre-wide stretch of water. But the Arctic conditions, especially the sea ice, pose a huge challenge. Oil drilling companies like Shell have struggled to even explore in the area.

That may be why Russia is more interested in a tunnel. In 2007, its government announced the TKD-World Link, a railway that would link Siberia to Alaska by way of a tunnel. Seven years later, there is still no sign of the tunnel being dug, and relations between Russia and the US have soured. But perhaps China will take the lead: this year the *Beijing Times* reported that engineers there are hatching plans for a high-speed railway that would run from China to the contiguous US, via Russia, the Bering Strait, Alaska and Canada.

It may not be a recipe for more harmonious relationships, however. Twenty years after the Channel Tunnel physically linked it to the continent, the UK is considering breaking its political union with Europe.

Dam the  
Indian Ocean

5

Wherever there's a narrow bit of sea, someone has suggested installing concrete. The idea is usually to build a dam in a place where the water level on one side will drop because of evaporation. The resulting difference in height could be used to generate electricity.

There have been various proposals over the years but two stand out. In 2005, mega-engineering enthusiast Roelof Schuiling, a retired geochemist at Utrecht University in the Netherlands, suggested damming the Gulf in the Middle East where it opens into the Indian Ocean. At one point, the Strait of Hormuz, it narrows to just 39 kilometres across.

The idea is not to do this anytime soon, because it is an important shipping route for oil tankers. But when this trade declines, Schuiling says, damming the Indian Ocean and allowing the level of the Gulf to fall up to 35 metres could generate 2500 megawatts of electricity (*Marine Georesources & Geotechnology*, vol 23, p 25).

There is an even bigger proposal out there: a dam across the Red Sea just before it joins the Indian Ocean, across the Bab-el-Mandeb Strait (below). That would require a dam wall 100 kilometres long, from Yemen in the north to either Eritrea or Djibouti in the south. Even Cathcart calls this "a little more wild". In 2007, he, Schuiling and their colleagues estimated it could generate around 50,000 megawatts of electricity (*International Journal of Global Environmental Issues*, vol 7, p 341).

These projects would lower local sea level and create more land. However, as with Atlantropa, they would cause sea level to rise even faster elsewhere. What's more, without any exchange with the Indian Ocean the water in the seas would become steadily saltier, eventually destroying their entire ecosystems.



EOSMAP/CHELYS

6

## Creating land

Building artificial islands or peninsulas has become routine, with some astounding ones being made in Dubai, for example. But existing methods require deep quarries and deep pockets. Schuiling thinks there is a cheaper way to create land. He has shown that injecting sulphuric acid into limestone turns it into gypsum, causing it to swell to up to twice its original size. So where there is limestone close to the surface of the sea, new land could be created.

One such place is Adam's bridge, a narrow and shallow strip of shoals stretching for 35 kilometres between India and Sri Lanka. Schuiling thinks a land bridge could be created using his method for far less than the cost of a conventional bridge (*Current Science*, vol 86, p 1351).

Relink the Pacific  
and Atlantic oceans

7

Destroying the Isthmus of Panama, the slender strip of land that joins North and South America, would reunite the Pacific and Atlantic oceans. Underground nuclear explosions would do the trick. With the land gone, the ocean current that once flowed around the equator would restart and, allegedly, stabilise the climate (*i-manager's Journal on Future Engineering & Technology*, vol 5, p 74).

This idea is unlikely to be popular in Panama. What's more, some climate scientists think the closure of the gap 3 million years ago forced warm water in the tropical Atlantic to flow north, increasing humidity and snowfall in the Arctic and leading to the formation of the great northern ice sheets. If so, nuking the isthmus would hasten the loss of the Greenland ice sheet. ■

Michael Marshall is deputy editor of BBC Earth

# Easy rider

The incredible flying skills of the albatross can teach us how to harness energy from the atmosphere. **David Hambling** reports

**P**HILIP RICHARDSON'S eureka moment came in 1997, on the pitching deck of a ship in the South Atlantic. The vessel was steaming at more than 20 kilometres per hour into a strong headwind, yet without flapping its wings a lone albatross swooping elegantly just above the waves was easily keeping pace.

These large birds remain on the wing for years at a time and thrive in blustery environments, especially in the powerful winds of the Southern Ocean. Clearly, these aren't the conditions to create thermal updrafts – rising pockets of hot air that hawks and vultures ride like elevators. So what gives the albatross its lift?

This isn't just an academic question. Richardson, an oceanographer at Woods Hole Oceanographic Institute in Massachusetts, realised that if he could unravel the bird's flying secrets, they could lead to a new generation of uncrewed gliders capable of surveying vast areas of ocean without using a drop of fuel. Such gliders could also work over land, harnessing energy from the wind to extend flight durations from hours to days, months or even years.

Over the past 15 years, Richardson has investigated a variety of possible mechanisms for the albatross's flight. Initially, he believed the birds were using "wave lift" to get a boost – capitalising on gusts of wind forced upwards by the sloping edges of waves to create updrafts like those found along cliffs or mountain ridges. However, calculations showed the effect isn't strong enough to account for the bird's remarkable flight.

Another possibility is that the bird uses the "wing-in-ground" effect: as it flies low over the waves, a pocket of smooth air is trapped between its wings and the water and this increases lift. Alternatively, the birds could be making use of sudden gusts. By emerging from low behind a wave into

faster moving air above, they could utilise sudden changes in wind speed to gain energy.

But the most complex theory involves an idea developed by Lord Rayleigh in 1883 to explain how pelicans fly long distances. The "Rayleigh cycle" is based on the fact that friction slows the winds closer to the waves compared with winds 10 metres up, creating a vertical gradient of wind speeds. As the albatross flies into the wind just above the sea surface, it can use this gradient to gain altitude like a kite, riding the increasingly faster winds as it rises. Then it turns away from the wind and descends, gaining speed by diving. Finally, when the bird reaches its starting altitude it turns back into the wind in its original direction, only moving significantly faster.

Over the years, researchers have refined this "dynamic soaring" idea, suggesting that if the bird rolls slightly as it rises into the stronger winds, it can gain even more energy, thanks to the aerodynamic performance of its wings. This magnifies the air speed effect by a factor of 10 or more, says Colin Pennycuik, who researches bird flight at the University of Bristol. "It is just a matter of putting an efficient wing in the air in the right way."

## Dynamic soaring

To many researchers, including Richardson, this theory seems the most promising to explain an albatross's abilities. But is it right? To find out, GPS tracking devices were attached to albatrosses by Gottfried Sachs and his colleagues at Munich University of Technology's Institute of Flight System Dynamics working alongside French researchers. Smaller and more precise than conventional trackers, the devices record the bird's position to within a few centimetres by taking measurements 10 times every second.

In 2013, the team published results gathered from tracking 16 wandering

albatrosses in the Indian Ocean. Their data reveals a four stage flight pattern: a windward climb, an upper turn, a leeward descent and a lower turn – precisely the pattern you would expect for Rayleigh's model. This is repeated over and over, with most energy being gained during the upper curve. According to Sachs, other mechanisms like gust soaring, wave lift and the ground effect aren't significant – it's all dynamic soaring, he says.

This technique is surprisingly flexible. Richardson has calculated that an albatross can use dynamic soaring to fly in any direction, upwind or down (*Progress in Oceanography*, DOI: 10.1016/j.pocan.2014.11.002). When travelling upwind, this generates a zigzag flight – like a tacking sailing ship – at a speed of about two-thirds that of its cruising speed. The model matches closely what Richardson observed in the South Atlantic.

This soaring technique could be incorporated into an ocean-surveillance drone on missions that last for days or weeks, says Richardson – and may even lead to gliders that can outperform an albatross. Current glider designs can withstand accelerations of 100g or more, and Richardson suggests that by copying the albatross they would be able to



fly at speeds of 150 kilometres per hour for extended periods. "Gliders could soar much faster than an albatross because of stronger wings and air frames," he says.

Nor is this limited to ocean-going drones. Anywhere with a strong wind gradient has the potential for dynamic soaring. And drones flying over land can make use of ridge lift provided by hills and mountains, as well as thermal updrafts.

It turns out that some radio-controlled glider enthusiasts already use wind gradients to help their craft go faster. Gathering in the hills of southern California on the lee of ridges, they loop their craft round and round, dipping in and out of the wind to build up greater and greater speeds. The record for this type of flight stands at an astonishing 800 kph, typically driven by winds gusting at around 95 kph. "I was totally blown away by how fast they were flying," says Richardson.

Autonomous drones are already getting in on the action. In 2008, an autonomous glider built by a team at North Carolina State University in Raleigh came third in the Montague Cross-Country Challenge – the first autonomous machine to enter this

US-based competition for remote-controlled gliders. It involved a series of challenges, including distance and speed competitions. Called ALOFT, the glider can both spot and use thermal updrafts to gain altitude and the craft has managed flights of more than 100 kilometres on its own.

## "Lift generated from winds around buildings could power engineless drones"

Could this design be improved by incorporating the amazing abilities of an albatross? Salah Sukkarieh and his team at the University of Sydney in Australia believe so. They have developed sensors and software that can measure wind strength in real time. This allows us to estimate the energy available to a glider, whether it comes from updrafts or wind gradients, says Sukkarieh. And so far it seems to work: the team has added a flight planner and successfully tested the complete system in a glider on short missions.

Add solar panels and batteries and it is

possible to imagine long-distance drones that mimic the capability of satellites at a fraction of the cost. They could be used as flying cellphone towers that shift capacity around as required, for everything from music festivals to disaster relief. Perhaps the biggest market is in farming, to record the state of crops, measure growth, detect weeds and pest infestations and allow the application of water, fertiliser and pesticides only where needed.

Even city-based drone delivery services could be wind-powered, says Caleb White and his colleagues at RMIT University in Melbourne, Australia. They studied the feasibility of using lift generated from wind patterns around buildings in urban areas to power small, engineless drones. Their simulations show that it is possible. However, designing craft capable of flying near buildings without crashing will be a huge challenge. "Albatross have really good collision avoidance," says autonomous-flight expert Jack Langelaan at Penn State University in University Park. "For us it's a bit more difficult." ■

David Hambling is a journalist based in London

# Nice to meet you, Stephen...

A new film about **Stephen Hawking** tries to squeeze an incredible life into a mere 2 hours. How does it do, asks **Rowan Hooper**

IT IS 1963, and we're at a student party in Oxford. A young man approaches a young woman.

"I'm a cosmologist," he says.

"What's that?"

"It's religion for intelligent atheists."

You will have seen him on *The Simpsons* and *Star Trek* but you've never seen him like this. Stephen Hawking, the world's most famous living scientist, as a young, able-bodied, ambitious student, chatting someone up.

This is the beginning of *The Theory of Everything*, the story of Hawking's exceptional life framed by the blossoming – and eventual withering – of romance with his first wife, then Jane Wilde.

Straight away we are tipped off to the broad tone that the movie will take on their relationship: one of his godless cosmology, and of her more conventional Christianity. But how true to life is it? And if it isn't, how much does that matter?

Eddie Redmayne and Felicity Jones are outstanding in the roles of Stephen and Jane. Redmayne especially is extraordinary in his portrayal of how Hawking is affected by motor neuron disease. By the end, when he is almost completely paralysed and unable to speak naturally, everything must be conveyed visually. Redmayne accomplishes this task brilliantly.

Jones plays the indomitable Jane with quiet restraint and

subtlety. This is fitting since her performance, and the role Jane played in his life, are always at risk of being overlooked.

The film skimps on the science, but nit-picking over the accuracy of science in movies is rarely worthwhile. It's too much to hope that a biopic can convey the depth of what Hawking did. It's technical stuff, after all – and even Hawking's bestselling pop science book, *A Brief History of Time*, tops lists of books we don't finish.

But no one had used quantum physics to examine what happens in black holes before Hawking. He discovered that contrary to the belief that nothing can escape the gravity of black holes, a small amount of radiation can in fact get out.

In the movie, that discovery – of what would come to be known as Hawking radiation – is conveyed as a eureka moment that happens when Hawking is staring into a fire. The reality – the proof coming only after months of intense calculation – shows that this stuff is difficult, even for the world's smartest man.

The film's director, James Marsh, has experience in making films based on scientific experiments. His 2011 documentary film *Project Nim* was the story of a baby chimp reared as a human child; it was

**Jane and Stephen Hawking with the actors who portray their early years**



FOCUS FEATURES/PHOTOSHOT

a compelling story of science, but science gone very wrong.

Despite the immense richness of the subject matter here, his telling of Hawking's work doesn't

communicate the same complexity. *The Theory of Everything* splashes around on the shore, but doesn't go deep into what Hawking actually did.

In some ways, another new movie, *Interstellar*, does better. This may be because it has Kip Thorne, one of Hawking's longest-standing physicist friends, as executive producer and science adviser. For a mainstream movie, it manages a far more thorough exploration of the science of black holes.

So does Marsh succeed in telling the story of the central relationship in Hawking's life? To find out, we spoke exclusively to Jane Hawking (see opposite), who was divorced from Stephen in 1995 and whose book, *Travelling to Infinity: My life with Stephen* was adapted by Anthony McCarten to form the core of the movie. ■



IAN WEST/PA WIRE/PRESS ASSOCIATION IMAGES



## My life with a science icon

Married, divorced, then professionally reconciled, **Jane Hawking** tells her own story

**Stephen has said he found the film “broadly true”. What do you think?**

The parts of the film that were true to life were particularly moving, some of them quite overwhelming, but I did not relate to the fictitious episodes or anything outside my own experience.

**How was that first meeting with Stephen?**

There was no exchange about cosmology or religion, except that Stephen explained that he had

just begun research in cosmology in Cambridge. Instead, he gave a lively account of his encounter with the Oxford examiners who called him for a viva after Finals.

**There’s a scene in the film about the May Ball, where Stephen explains that the men’s shirts are fluorescing under UV light because of Tide washing powder. The next day, there’s a packet of Tide on your doorstep. Did that happen?** It isn’t really the sort of thing that anyone would make up!

**That vital first conversation was all about Stephen Hawking’s Finals viva**

**Has your role as a conduit in explaining Stephen’s work been overlooked?**

Although a linguist, I was always interested in, and fascinated by, Stephen’s explanations of his work, and proud of his discoveries and achievements. There was a time when I could explain gravitational collapse and subsequently black holes to an amateur audience, but only in practical not mathematical terms.

I did the first proofreading of *A Brief History of Time*, and when it came to writing my memoir, I consulted many scientific friends, so that contrary to what many critics supposed and were churlish enough to voice, I did actually write the scientific sections myself.

**How much did you feel a tension between the religious implications of Stephen’s work and your own Christian beliefs?**

I had to be steadfast in my Christian beliefs, seeking strength from them. I believed that what I was doing was right and that this role gave my life a purpose, otherwise I should have collapsed under the strain. The tension between Stephen’s atheistic stance and my faith always existed but neither of us tried to convert the other. I am not evangelical.

**Did that tension ever come into the open? In the film there is an exchange between you around the line in *A Brief History* where he says that if a theory of everything is found “we would know the mind of God”...**

Some experiences proved to be rather more disturbing, particularly the trip to Israel with a party of physicists in 1988, where Stephen proudly proclaimed – in the holiest, most ancient city in the world – that he

did not believe in God and there was no room for God in his universe, while I looked on, feeling hurt and bewildered.

**The film’s portrayal of the science and of your life together has been criticised. What did you make of it?** If the film – as well as my daughter Lucy’s books – encourages a [new] generation of scientists, that can only be a good thing. I insisted to the producers and director how important scientific accuracy was in this instance.

The reply from the film industry was that they were trying to squeeze 25 years into 2 hours so

**“In the holiest, most ancient city in the world, Stephen proudly proclaimed that he did not believe in God”**

had to concertina events, warp timescales and conflate characters. In terms of their remit that is just about understandable – I think. After all, *The Theory of Everything* is not a scientific documentary. There have been plenty of those.

**And what of the relationship?**

My reaction is similar to my reaction to the physics. Again, I have had to try to understand the restraints imposed on the film industry by the need to depict a quarter of a century in 2 hours. However, I would certainly like to have seen a better balance between the glittering successes and the exhausting struggles for survival, and at least some reference to the many arduous travels we undertook – removing the whole family to California for a year is but one instance.

Nevertheless it is a great privilege to have a feature film made about us in our lifetimes, and I comfort myself with the thought that if people are interested to know more, they can read *Travelling to Infinity*. ■

Interview by Rowan Hooper

# Looking forward to 2015

A sneak preview of forthcoming books suggests a promising crop

**1 Relativity: The Special and the General Theory 100th Anniversary edition** edited by *Hanoch Gutfreund and Jürgen Renn*, Princeton University Press, \$26.95/£18.95

Get your brain on: 2015 is Einstein Year. Strictly speaking his general theory of relativity wasn't published until 1916, but it was complete by 1915 so let's party. After all, it not only explains planetary motion but also describes the history and expansion of the universe, physics of black holes and the bending of light from distant stars and galaxies. This new edition of Einstein's book features an English translation with an intro and a reading companion by heavyweight academics Hanoch Gutfreund and Jürgen Renn, who delve into Einstein's thinking and reframe his ideas for today. Watch out for a deluge.

**2 Future Crimes: Everything is connected, everyone is vulnerable and what we can do about it**

by *Marc Goodman*, Doubleday, \$27.95  
Former FBI futurist-in-residence, Marc Goodman is a go-to guide for all who want a good scaring about the dark side of technology. From burglars hacking baby monitors to plan their robberies to stalkers using GPS to track people, Goodman shows how easily our tech can be turned against us. But that's not all, factor in the Internet of Things, much greater connectivity, synthetic biology, artificial intelligence, nanotech, virtual reality and augmented reality. Luckily, Goodman says there are ways to take back control. For now.

**3 The Age of Sustainable Development** by *Jeffrey Sachs*, Columbia University Press, \$34.95  
Jeffrey Sachs has been (and still is) special adviser to UN secretary-generals and is head of the UN Sustainable Development Solutions Network. So if anyone knows how

societies can develop economically, equitably and without screwing the planet, it should be him. Let's hope so.

**4 The Man Who Wasn't There: Investigations into the strange new science of the self** by *Anil Ananthaswamy*, Dutton Adult, \$26.95  
You may think you know who you are but research into Alzheimer's, ecstatic epilepsy, Cotard's syndrome (the delusion that you are dead) et al is unpicking old certainties. In an age of neuroscience, what is the self? *New Scientist* writer Anil Ananthaswamy finds researchers think this elusive sense of self is everywhere and nowhere in the brain. Are publishers looking for a new Oliver Sacks, perhaps?

**5 Birth of a Theorem: The story of a mathematical adventure** by *Cédric Villani*, Bodley Head, £18.99

Cédric Villani is a genuine eccentric who dresses like a latter-day Liszt. No surprises, he is a mathematician and a Fields Medal winner (Landau damping and the Boltzmann equation, since you ask). This is a delightful foray into an esoteric world, full of insights and necessary digressions.

**6 Junk DNA: A journey through the dark matter of the genome** by *Nessa Carey*, Columbia University Press, \$29.95

The term "junk DNA" is fast becoming a misnomer as researchers highlight the strange and unexpected roles it can

play in everything from hard-to-treat diseases to gene expression. Some are even asking if this genomic "nonsense" could be the source of human biological complexity. Nessa Carey will deserve plaudits if she does as good a job in helping to explain the controversies in this field as she did about the equally hot topic of epigenetics.

**7 Conscience: A biography** by *Martin van Creveld*, University of Chicago Press, \$29.95

This seems like a new framing for a centuries-old discussion of conscience, a quality many consider as the defining human attribute. So is it down to biology or society? Martin van Creveld ranges from the Old Testament through Cicero, Seneca, Aquinas, Kant and Nietzsche to robotics and neuroscience. Conscience, however, remains stubbornly elusive.

**8 The Nudge Unit: Inside the government department that changed our minds and saved us billions** by *David Halpern*, WH Allen, £20

Benevolent persuasion or a form of coercion? The jury's still out on the Nudge Unit, a behavioural economics body set up by the UK government with a remit to help us make healthier, more responsible choices - thereby saving government cash. Psychologist David Halpern heads the unit, giving us an insider take on an intriguing debate.

**9 The Fish Ladder: A journey upstream** by *Katharine Norbury*, Bloomsbury, £16.99

This may be another *H is for Hawk*, a book with a very personal narrative, beautiful writing and nature at its heart - this time with fish and a river. *H* won the Samuel Johnson prize for non-fiction. But can you step twice into the same stream? ■



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# Earth, wind and data

To understand our planet, data scientists must collect, store and make sense of vast amounts of information about it, finds **Laura Dattaro**



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**W**HAT does a rocket launch from Vandenberg Air Force Base in California have to do with climate change? On the face of it, not much. But rockets armed with satellites designed to collect information on the planet's weather, atmosphere and ice cover can provide Earth scientists with terabytes of valuable data. With each terabyte the equivalent of 1,000 copies of the Encyclopaedia Britannica, making sense of it all is a huge task. Step forward data scientists, the people who hold the "sexiest job of the 21st century".

This year has proved NASA's busiest in over a decade. Since January, the

organization has launched five space-based missions designed to study Earth. These include three satellites for studying rainfall, snowfall, carbon dioxide and soil moisture, and two International Space Station experiments collecting data on ocean winds and atmospheric aerosols.

Missions like these – along with global weather stations and high-tech ocean buoys – help Earth scientists and climatologists understand global weather patterns and warn of dangerous environmental shifts such as rising sea levels. But these important insights can only be made if someone can

join the dots between the masses of data coming in from many sources.

Data scientists collect, catalog and analyze the resulting "big data" sets to spot trends. Data scientists have already proved their mettle in Silicon Valley, having played a vital role in assessing data collected from users of sites such as Facebook and Google to create bespoke advertising opportunities worth billions of dollars. The huge value of data scientists across a range of industries, and the high demand for them, has led some, including Steven Kempler, who manages one of NASA's Earth science data centers, to give the job its "sexy" moniker.

Within the field of Earth science, data scientists help to solve some of the planet's biggest problems, including climate change. When satellites first began collecting data on sea ice in the early 1970s, before climate change was widely recognized, only a small number of specialists were interested in studying it. That was until data scientists noticed that ice levels appeared to be declining over time. "After a few decades, it started to look like there might be a trend [toward a changing climate]," says Ruth Duerr, a data scientist at the National Snow and Ice Data Center in Boulder, Colorado.

## A mixed-up medley

Duerr leads a team of researchers who develop new methods and products for storing and sharing vast amounts of Earth data. For example, she and her colleagues recently developed an archive for polar data – the Polar Information Commons – that aims to provide easy access to scientific data collected from the Arctic and Antarctic.

Often, data is collected in various formats by different researchers using different equipment, which can make them difficult

to compare and study. The way data is formatted can also affect its suitability for specific software or algorithms. Kempler and his team work to standardize Earth data, ensuring that what is gathered from a variety of sources is stored in an accessible format for future researchers to use. As more sophisticated satellites and experiments on Earth collect ever more data, Kempler feels his task is growing.

At his data center alone, eight terabytes – nearly enough to hold the Library of Congress's entire printed collection – come in every day from satellite-based instruments studying Earth's precipitation, hydrology and atmospheric composition.

Once the information has been standardized, it has to be stored. To meet the need for cataloging Earth science's growing quantities of data, there is increasing demand for the expertise found in old-school library science. "When it comes to making information available and searchable, that's what libraries have been doing for centuries," says Nancy Ritchey, the archive branch chief for the National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center.

Ritchey, who initially set out to be a weather forecaster, helps the federal center

archive data from satellites, ocean buoys, and other sources. She researches different, complementary disciplines for better data management, such as using library scientists' ability to organize information accessibly alongside Earth scientists'

## "Having more data enables scientists to better understand our planet"

expertise in specific research areas and statistical analysis. "You're there to ensure that the data remain accessible for the scientists today, and their grandchildren," she says.

## Crunch time

When it comes to crunching the data, students interested in Earth science should know their chosen field well, be it sea ice, atmospheric CO<sub>2</sub> or permafrost, Kempler says. But it is also worth choosing a program with a solid curriculum in data analytics to equip you with the skills to branch out. Two examples Kempler suggests fledgling Earth scientists could consider are those offered by the California Institute of Technology in Pasadena or the Rensselaer Polytechnic Institute in Troy, New York. Data analytics technologies like Hadoop and MapReduce, which help store files and process information, are also useful to know and can be learned from online courses or instruction books.

Ritchey's department at NOAA offers internships and scholarships to students in the environmental, computer, and library sciences, while Duerr says another good starting point for an Earth science career is in a government lab, with NASA, NOAA, or the US Geological Survey the three largest employers.

With a push from the White House and groups like the non-governmental organization the International Council for Science to make all data freely available to scientists and laypeople alike, the demand for data scientists is only going to increase. That's great news for those already in the field, says Ritchey. "Our ability to use multiple data sets has increased," she says. "Having more data, over longer periods of time, enables scientists today and in the future to better understand our planet." ■

Laura Dattaro is a writer based in New York City

## CASE STUDY OCEANS OF DATA



Ryan Abernathy isn't a computer scientist. But as an oceanographer at Columbia

University's Lamont-Doherty Earth Observatory in Palisades, New York, he needs to manage terabytes of data about the ocean's salinity, temperature and current speeds, which often means writing code. Recognising how it would help his career, he largely taught himself through advice he found online. "The ability to work with data is something that people are expected to pick up along the way," Abernathy says.

"But, culturally, we're recognizing more that data skills are critical for success in this field."

Abernathy studied physics as an undergraduate, but he wanted to move into a more interdisciplinary area of science, where he could apply his physics knowledge while studying the Earth's environment. Following a doctoral degree in climate physics and chemistry from the Massachusetts Institute of Technology in 2012, his research now focuses on what he calls "the weather of the ocean": how the density of water drives the currents, how the ocean stores heat and how salinity is related to

the cycle of rainfall and evaporation. Much of his data comes from satellites and from ARGO, an array of thousands of floating ocean sensors, which together can help scientists such as Abernathy tease out the difference between natural ocean variation and the effects of human-driven climate change.

Increasing the amount of data is crucial to spotting potentially dangerous environmental shifts sooner rather than later, Abernathy says. "It's the only way we're going to be able to refine our understanding of these processes that are so important for our climate."

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We are pleased to announce Phase 2 of this effort with recruitment for an anticipated 30+ additional tenure-line faculty positions. The focus for Phase 2 will be to strengthen the six strategic impact areas in Phase 1, with an additional focus area – Drivers of Economic Vitality for Nebraska.

We invite you to view brief explanations of the positions currently being released and those to be released soon at <http://ianr.unl.edu> to explore whether your skills and experience make you a good fit for our team.

The positions will be advertised and posted beginning December 1, 2014. We invite you to visit the UNL employment web site at <http://employment.unl.edu> to learn which positions are posted.

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**Fellowships for Postdoctoral Scholars**

Woods Hole Oceanographic Institution



New or recent doctoral recipients with research interests associated with the following are encouraged to submit scholarship applications prior to January 5, 2015.

**Departments** - Awards related to the following areas are anticipated: Applied Ocean Physics & Engineering; Biology; Geology & Geophysics; Marine Chemistry & Geochemistry; Physical Oceanography; and in cooperation with the USGS laboratory located on the WHOI campus.

**Institutes** - Each Institute fosters interdisciplinary research addressing critical issues, and we will award a scholarship to support related research: Ocean and Climate Change Institute; Coastal Ocean Institute; Ocean Exploration Institute; Ocean Life Institute.

**The Center for Marine and Environmental Radioactivity (CMER)** will award a fellowship for research on natural and human-made radioactive substances in the environment including the study of their sources and fate or use as tracers of ocean processes.

Awards are competitive, with primary emphasis placed on research promise. Scholarships are 18-months with an annual stipend of \$58,000, a research budget and eligibility for health and dental insurance. Recipients are encouraged to pursue their own research interest in association with resident staff. Communication with potential WHOI advisors prior to submitting an application is encouraged.

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## Director, CalCOFI Program and Professor University of California San Diego

Scripps Institution of Oceanography (SIO) at UC San Diego (<http://scripps.ucsd.edu>) is a world renowned center of marine research with approximately 200 principal investigators leading research programs on all aspects of earth, ocean and atmospheric sciences. SIO is committed to academic excellence and diversity within the faculty, staff, and student body. The department is interested in candidates who have demonstrated commitment to excellence by providing leadership in teaching, research or service towards building an equitable and diverse scholarly environment.

SIO seeks a faculty Director of the Scripps component of the CalCOFI (California Cooperative Oceanic Fisheries Investigations) program. CalCOFI is among the preeminent time series programs in the world ocean (<http://www.calcofi.org/>). Established in 1949, it remains a unique partnership among the NOAA National Marine Fisheries Service, the California Department of Fish and Wildlife, and SIO. We seek a leader for the SIO component of CalCOFI who can provide strategic leadership, effectively manage the program, connect the program even more closely to our academic and research activities at SIO and partner institutions, promote understanding and use of the results nationally and internationally, initiate creative scientific research, and seek ways to enhance the program. For the academic part of the appointment, we seek someone who will participate actively in teaching and mentoring, secure support for graduate students, and sustain an innovative, extramurally supported program of research.

Applicants must have a Ph.D. in ocean sciences or related fields, and research interests and distinguished accomplishments in multidisciplinary research that intersects the ocean biosciences. They should have a commitment to teaching and supporting graduate students. The appointment will entail full time salary support as a Director/Professor. Candidates at the Associate or Full Professor level are encouraged to apply. Rank and level of appointment (Associate, Acting Associate, Full, Acting Full) and salary will be consistent with the applicant's qualifications and experience and with University of California pay scales.

All applications and related materials must be submitted electronically via Academic Personnel On-Line RECRUIT <http://apptrkr.com/549307> before 16 January 2015, including: a curriculum vitae and list of publications (separating peer-reviewed from other works); statements summarizing the candidate's research interests and contributions to date, including how their research may enhance the CalCOFI program; teaching and mentoring interests; a separate statement describing past experience in activities that promote diversity and inclusion and/or plans to make future contributions (see <http://facultyequity.ucsd.edu/Faculty-Applicant-C2D-Info.asp> for further information). Candidates should submit .pdf copies of 4-5 of their publications that best exemplify their scientific interests. A list of 3 professional references is required, including names, addresses, phone numbers, and email contacts.

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In 2017, the Fischell Department of Bioengineering will move into A. James Clark Hall. This 184,000-square-foot building will house world-class research and educational facilities and the Robert E. Fischell Institute for Biomedical Devices <http://www.eng.umd.edu/clarkhall/>. The Fischell Department of Bioengineering

currently has 20 regular faculty (with plans to expand), 17 affiliate faculty members and 9 staff members, 400+ undergraduate students, 75 graduate students and more than \$8 million in annual research expenditures. More information at: <http://www.bioe.umd.edu>. Questions can be addressed to: Chair-SearchComm-BIOE@umd.edu.

For best consideration, applications should be submitted to <http://ejobs.umd.edu/postings/30410> (Position number 105571) by 1/30/2015. Applications should include a cover letter, complete curriculum vitae (resume), and contact information for five references.

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## 2015 The Louisa Gross Horwitz Prize for Biology or Biochemistry

The Louisa Gross Horwitz Prize was established under the will of the late S. Gross Horwitz through a bequest to Columbia University and is named to honor the donor's mother. Louisa Gross Horwitz was the daughter of Dr. Samuel David Gross (1805-1889), a prominent surgeon of Philadelphia and author of the outstanding *Systems of Surgery* who served as President of the American Medical Association.

Each year since its inception in 1967, the Louisa Gross Horwitz Prize has been awarded by Columbia University for outstanding basic research in the fields of biology or biochemistry. The purpose of this award is to honor a scientific investigator or group of investigators whose contributions to knowledge in either of these fields are deemed worthy of special recognition.

The Prize consists of an honorarium and a citation which are awarded at a special presentation event. Unless otherwise recommended by the Prize Committee, the Prize is awarded annually. Dr. James P. Allison, University of Texas MD Anderson Cancer Center was the 2014 awardee.

### Qualifications for the award

The Prize Committee recognizes no geographical limitations. The Prize may be awarded to an individual or a group. When the Prize is awarded to a group, the honorarium will be divided among the recipients, but each member will receive a citation. Preference will be given to work done in the recent past.

**Nominations must be submitted electronically at: <http://www.cumc.columbia.edu/research/horwitz-prize>**

All communications and materials must be written in the English language.

**Deadline date: January 30, 2015**

Re-nomination(s) are by invitation only. Self-nominations are not permitted.

### Nominations should include:

- 1) A summary, no more than 500 words long, of the research on which this nomination is based.
- 2) A summary, no more than 500 words long, of the significance of this research in the fields of biology or biochemistry.
- 3) A brief biographical sketch of the nominee, including positions held and awards received by the nominee.
- 4) A listing of up to ten of the nominee's most significant publications relating to the research noted under item 1.
- 5) A copy of the nominee's curriculum vitae.

# Grant Programs

## BIOMEDICAL SCIENCES

### Career Awards for Medical Scientists:

Five-year awards for physician scientists provide \$700,000 to bridge advanced postdoctoral/fellowship training and the early years of faculty service. This award addresses the on-going problem of increasing the number of physician scientists and will help facilitate the transition to a career in research.

### Collaborative Research Travel Grants:

Provide up to \$15,000 in support for interdisciplinary biomedical researchers from degree-granting institutions to travel to a laboratory to acquire a new research technique or to facilitate collaboration.

## DIVERSITY IN SCIENCE

**Postdoctoral Enrichment Program:** Provides \$50,000 over three years to support the development of underrepresented minority postdoctoral fellows in biomedical research.

## INFECTIOUS DISEASES

### Investigators in the Pathogenesis of

**Infectious Disease:** Five-year awards provide \$500,000 for opportunities for accomplished investigators at the assistant professor level to study infectious disease pathogenesis, with a focus on the intersection of human and microbial biology. The program is intended to shed light on the overarching issues of how human hosts handle infectious challenge.

## INTERFACES IN SCIENCE

### Career Awards at the Scientific Interface:

Five-year awards provide \$500,000 to bridge advanced postdoctoral training and the early years of faculty service. These awards are intended to foster the early career development of researchers with backgrounds in the physical/mathematical/computational/engineering sciences whose work addresses biological questions. BWF has moved to a self-nomination format for this award.

## POPULATION AND LABORATORY BASED SCIENCES

### Institutional Program Unifying Population and Laboratory Based Sciences:

Five-year awards provide \$2.5 million to unite population-level and laboratory-based biological sciences. The award supports the training of researchers working between existing research concentrations in population approaches to health and in basic biological sciences. The goal is to establish interdisciplinary training programs by partnering researchers working in disparate environments and intellectual frameworks.

## REGULATORY SCIENCE

### Innovation in Regulatory Science Awards:

Provides up to \$500,000 over five years to academic investigators who are addressing research questions that will lead to innovation in regulatory science, with ultimate translation of those results into improving the regulatory process. These awards are intended to provide support for academic researchers developing new methodologies or innovative approaches in regulatory science that will ultimately inform the regulatory decisions the Food and Drug Administration (FDA) and others make.

## REPRODUCTIVE SCIENCE

**Preterm Birth Initiative:** Provides \$600,000 over a four-year period to bring together a diverse interdisciplinary group with the more traditional areas of parturition research to address the scientific issues related to preterm birth.



## SCIENCE EDUCATION

### Career Awards for Science and Mathematics

**Teachers:** Five-year awards provide \$175,000 to eligible science or mathematics teachers in the North Carolina public primary and secondary schools. The purpose of this award is to recognize teachers who have demonstrated solid knowledge of science or mathematics content and have outstanding performance records in educating children. The award is a partnership between the North Carolina State Board of Education and BWF.

### Student Science Enrichment Program:

Three-year awards provide up to \$180,000 to North Carolina nonprofit organizations, including public/private schools, universities, colleges, and museums. This program supports creative inquiry-based science enrichment activities that occur outside the typical school day for K-12 students. The program's goals are to nurture students' enthusiasm about science, expose them to the excitement of scientific discovery, and interest them in pursuing careers in research or a variety of other careers in science.

### Promoting Innovation in Science and

**Mathematics:** Awards provide teachers with funding for materials, equipment, and training to conduct hands-on, inquiry-based science and mathematics projects in North Carolina public schools.

The Burroughs Wellcome Fund is a private foundation  
located in Research Triangle Park, North Carolina.  
Find out more at [bwfund.org](http://bwfund.org)

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## All work and no pay

From Bryn Glover

Your thoughtful and thought-provoking editorial on the place of robotic workers in society left me wondering about the precise motivations of roboticists (6 December 2014, p 5).



Is it a simple desire to make a lot of money, irrespective of consequences? If so, a simple and direct opposition to their development can be mounted.

Or do these engineers still nurture that once widely quoted mantra about releasing humanity from the drudge of everyday tasks to permit greater leisure and cultural activities?

If it is the latter, roboticists need to clarify how such activities will be paid for, and how to ensure that the low-wage workers their robots displace will still be able to earn money in our society.

Unless something is done radically to reverse the increasing gulf between rich and poor – wider in the UK now than in Victorian times – the sort of robotic developments to which you and Mark Harris refer (p 21) can only add to the problem. Glasshouses, North Yorkshire, UK

## Packing for Europa

From Roger Calvert

You report that the only way for your proposed Europa CubeSat probe to send data home is to await the arrival of the larger

Europa Clipper spacecraft (6 December 2014, p 42).

But how powerful a transmitter could be packed into a CubeSat if nothing else was there? Perhaps a second CubeSat could follow the first to act as a relay. So long as it could still tune into signals from the first one, it could follow quite a long way behind. This trailing CubeSat could relay data direct to Earth, or perhaps to the nearest NASA or ESA spacecraft. Blawith, Cumbria, UK

From Tim Sassoon

I agree that searching for life on Europa should be an urgent priority, but I wonder why we don't try to investigate the inner workings of a body covered in unstable ice by listening to it.

We might do this from very far away using lasers, similar to the way that one can eavesdrop on a conversation by measuring the deviation of a laser reflected off a minutely vibrating surface in the room, such as the window.

Who knows what we might find? Perhaps Europa is alive with a cacophony of whale-like megafauna calling to one another across a dark 100-kilometre-deep ocean. It would be a real achievement to hear them without setting foot on Europa. Venice, California, US

## Laser treatment

From Howard Medhurst

Douglas Heingartner writes about the development of a laser for blasting leaves off railway tracks (6 December 2014, p 23). But where does the reflected light go?

A piece of litter on the rail, say the reflective foil from a chocolate bar, could send it anywhere, and a laser beam powerful enough to destroy a leaf could cause permanent blindness if it hits someone in the eye. Presumably LaserThor, the company that built it, has thought of this. How does the company ensure safety? Crawley Down, West Sussex, UK

The editor writes:

■ The laser is housed in a box underneath the train that safely contains the light. Details are available in this online report: [bit.ly/LaserThor](http://bit.ly/LaserThor).

## American work

From David Flint

John Davnall asks whether 200 million people would be sufficient to produce all the products and services needed for a North American lifestyle (6 December 2014, p 32).

It does, of course, depend which North Americans he has in mind. Mexican farm workers and Texan oil barons have very different lifestyles but let's suppose he means an average American.

I think it's clear that given mechanised mining, automated factories and computerised services, an adequate production of goods and services would be entirely possible. It wasn't so long ago that the US produced the majority of its own goods.

But there's a big uncertainty. Today a large proportion of the work done in developed economies is not about delivering goods and services to people but about competition. The market provides a constant flow of "different not better" products, and marketing and sales work to persuade people to buy them. How much of this should figure in answering Davnall's question?

An orthodox economist would declare this question off limits. But a green economist, or anyone who has read the latest Intergovernmental Panel on Climate Change report, will know that the correct answer is "as little as possible".

With a less frenetic economy would come less frenetic lives and less environmental impact per head. Who knows, we might even provide decent lives for the 7 billion people currently inhabiting the planet. London, UK

## Pluto has airs

From Jay Pasachoff

Your article about the birth of habitable moons in astronomic collisions states that "previous studies suggest that a world must be at least a fifth of Earth's mass to sustain an atmosphere" (22 November 2014, p 19).

But I and my students and colleagues at Williams College and the Massachusetts Institute of Technology, as well as other scientific groups from Boulder and Paris, have long been studying Pluto's atmosphere.

Pluto has only 1/500th the mass of Earth – which played a big role in promoting it to its own class, the first plutoid and one of only half a dozen named dwarf planets designated so far.

Williamstown, Massachusetts, US

The editor replies:

■ Our anthropocentrism got the better of us. We should have said "a breathable atmosphere".

## Basic science

From Donald Haarmann

Erwin Vermeij discusses criminal attempts to dissolve bodies in acid (5 November 2014, p 44).

It's worth noting that Santiago Meza Lopez, also known as "El Pozolero" (the soup maker), is believed to have disposed of 300 bodies for Mexican drug cartels by placing them in barrels and adding a strong solution of sodium hydroxide (caustic soda,



or lye). After two days he poured out the “soup” and then disposed of the teeth.

A biologist would have used trypsin in a sodium tetraborate (borax) solution. It leaves the bones and ligaments intact, making for a nice mount. I have “kitchen tested” this with great success.

*East Meredith, New York, US*

## Walk first, then run

*From Michael Guppy*

Christine Duffill questions whether running and walking at the same speed burn the same number of calories (6 December 2014, p 32).

On flat ground, the oxygen consumption of someone running at 8 kilometres an hour is the same as someone walking at the same speed. I’d suggest the situation would be similar at 6 km/h. Since it is difficult to walk much faster than this on the flat, and difficult to actually run more slowly, comparisons at other speeds are not really feasible. *Moruya, New South Wales, Australia*

## Beaver fever

*From Colin Bargery*

Further to your article on the reintroduction of the European beaver (6 December 2014, p 26), for some years there has been a colony of beavers living and seemingly breeding on the river Otter in Devon.

This has delighted local people, but the Department for Environment, Food and Rural Affairs (Defra) has raised concerns that the animals might carry a tapeworm which could under very unlikely circumstances be transferred to humans via pet dogs. Defra has expressed an intention to capture the beavers and move them elsewhere.

However, experts from the Scottish Beaver Trial, in which

16 animals were recently introduced to rivers in Argyll, have told us it will be extremely difficult to catch the beavers and will be so stressful for them that it is likely to prove fatal.

It seems that as a nation we are happy to ask disadvantaged citizens in less-developed countries to adjust their way of life in order to accommodate the presence of tigers and other dangerous predators, but we are not prepared to accept a harmless vegetarian which is likely to benefit the ecology of the Otter Valley and which is welcomed by the local people.

*Ottery St Mary, Devon, UK*

## Guardians of the net



*From Gwydion Williams*

When it comes to abuse online, it seems the problem is that the police have too few people to cover it, while internet companies have little desire to police their own customers (13 December 2014, p 20).

So why not call for volunteers? People already volunteer to be special constables in the UK; they might be able to do it. Maybe some name like Internet Guardians would be suitable?

Candidates would be vetted and protected against any “trolls” that might try to get at them, and their work as guardians would be recorded, so that they could not easily abuse their power.

I think many people might be

willing to do this, including some who would not normally think of helping the police.

*Coventry, West Midlands, UK*

## The third degree

*From John King*

I read Alice Bows-Larkin’s defence of the 2 °C global climate target with interest, and with dismay (6 December 2014, p 28).

Dismay because it totally fails to understand the nature of politicians. Australia’s current prime minister, a Rhodes scholar at the University of Oxford, came to power saying on record that he thinks human-induced climate change is “crap”.

How are we to get politicians’ hearts and minds to follow Bows-Larkin, especially when doing so will deprive them of votes? Might they be swayed by having to answer to their grandchildren?

More generally, it might help if people’s fear for their jobs, and their children’s jobs and standard of living in the future, can be clearly linked to climate change. *Pacific Palms, New South Wales, Australia*

## Safe fusion

*From John Evans*

Any discussion of the radiological dangers or otherwise of tritium (20/27 December 2014, p 43) must involve context and quantity. The remark “not to be treated lightly” is the key, and one only has to look at the environmental concerns about tritium emissions from the Canadian Candu reactors to see that potential dangers exist.

Although some years in the future, similar or greater concerns might arise when fusion reactors come on stream. While fusion is often claimed to be a safe source of energy, a large reactor could accumulate some tens of kilograms of tritium.

One problem with this is how we can guarantee its complete

containment. Any escape and accumulation within the reactor space could be absolutely disastrous, since tritium is as explosive as hydrogen.

*Abingdon, Oxfordshire, UK*

## Imagine that

*From John Knutson*

I thoroughly enjoyed Anil Ananthaswamy’s article on how to think about higher dimensions (13 December 2014, p 32).

I’m not a mathematician, but maybe extra dimensions are like imaginary numbers – not real, but necessary for things to work. *Winchester, Hampshire, UK*

## Radical oxygen

*From Peter Urben*

It is certainly true that iron is the commonest mediator of free-radical production (6 December 2014, p 38). But we should bear in mind iron is only the catalyst, the ultimate driver is oxygen.

The potentially carcinogenic properties of this element have hitherto been sorely overlooked, although you can be sure that, should you breathe oxygen-stripped air, you certainly will not die of cancer.

*Kenilworth, Warwickshire, UK*

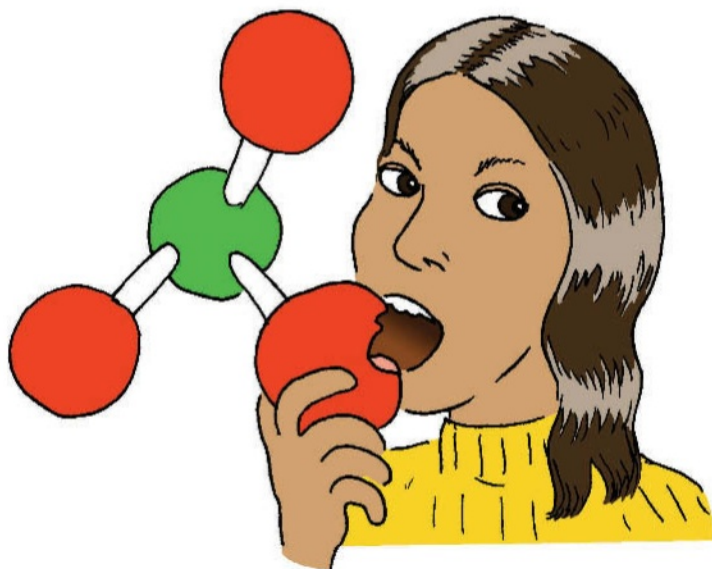
## For the record

■ We should have mentioned that Fred Pearce’s trip to the mangrove forests of Aceh was funded by Wetlands International (20/27 December 2014, p 9).

Letters should be sent to:

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RESOLUTIONS to change one's life are traditional in some cultures at this time of year. You could do worse than pledging to eat more fruit. But what fruit in particular? And how to decide, without spending days sitting down (bad) reading research papers (good)?

Tim Dodd sends a novel shortcut, helpfully supplied on a card with his regular delivery of fruit and vegetables. "SweetTango apples," it explains, "are new apples to the New Zealand market. An interesting fact is that their molecules are twice the size of other apples."

Chemists may rejoice at this – at last, two-apple-sized molecules instead of the small, fiddly ones.

ARE the above-mentioned SweetTango apples real? Taking a shortcut around the vexed philosophical questions of "reality", Feedback headed to the European register of trademarks, where we find that they are legally declared to exist. Their molecular properties will be news to the

University of Minnesota, which holds the trademark. Then we discovered that they have their own website – [sweetango.com](http://sweetango.com), oddly enough. This reports that their cells are much larger than other apples'. That apostrophe is also rather important here. We're vaguely pleased to see greengrocers upholding their apostrophic tradition in the card that Tim Dodd received.

TRADEMARKS... that reminds us. When we checked before the winter break, no one had objected to the Twitter corporation's application to restrict the use of the word "Tweet" in more than 750 contexts, including branding of cremation, pencils and escorts (22 November). We discover at bit.ly/TweetPencils3 that the fee to do so is €350, which may explain the silence. A whip-round?

A NEW numerical era dawns in this issue of *New Scientist*. What other weekly publications have passed our liminal number of 3000 issues, a colleague asked. A famous web

search engine knows: no sooner do we type "issue 3000" than it suggests *The Beano* – which, Your Honour, is a weekly illustrated magazine for children based in Scotland, UK.

The *New Statesman*, probably the inspiration for *New Scientist*'s title, was founded by Sidney and Beatrice Webb with the support of George Bernard Shaw and other progressives on 12 April 1913 – so it has now racked up 5308 weeks.

In a different corner of the political spectrum, *The Spectator* was first published on 6 July 1828. Yes, the dangerously modern Gregorian calendar was in force then. And no, Microsoft's Excel spreadsheet program will not recognise that as a date. It insists they have –89,406 weeks under their belt, which is appropriate for a backward-looking publication.

*Time* magazine was founded on 3 March 1923. Its current issue when we wrote this, dated 22 Dec 2014, was given the charmingly old-fashioned designator "Volume 184 No. 24". What is the base of this arithmetic? We estimate 4792 instances of *Time*.

BUT we are celebrating the above-mentioned threshold in issue 3002 of *New Scientist*. Why?

We glide past the argument that all numbers are interesting (1 November). The dawn of our third numerical millennium should of course be celebrated at the point appropriate to purveyors of practical precision (called "pedants" by some).

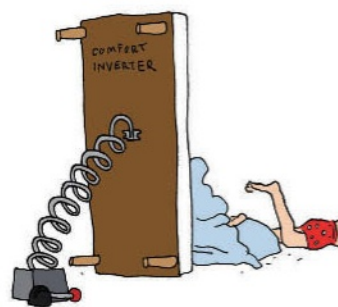
Feedback, for one, questions the thinking that led to fireworks on 31 December 1999: as discussed here on 18 December that year, the start of the Gregorian millennium was 1 January 2001. Hence, we aimed for issue 3001. But the holiday issue was a bumper issue, encompassing numbers 3000 and 3001. In a sense this makes 3001 an imaginary issue number. Cheers, anyway!

RETURNING now to the question of whether all numbers are interesting, we find a report from Graham Andrews that 39 is not. It's a WikiFact, in an article on the 1986 *Penguin*

*Dictionary of Curious and Interesting Numbers*, which states that 39 "appears to be the first uninteresting number". Douglas Woodall argued that this in itself makes it interesting, and so on for any larger boring number (1 November).

However, according to Graham, the 1997 edition of the book notes that 39, like all 2-digit numbers ending in 9, equals the product of its digits plus their sum. Further, it has another property that will lead us to look up the word "hexiamond". Later. The revised edition nominates, Graham reports, 51. We await readers' reasons why this number is interesting, other than for the reason Douglas gave...

All this leads us to suspect that there is a distinct set of formerly uninteresting numbers. Is their distribution as frustratingly irregular as that of the primes? Could there be applications in cryptography?



FINALLY, we return to the world of trademarks. We noted Jeroen Gildemacher's discovery in his employer's basement of a machine labelled "Comfort Inverter" (17 May). Now we find that "Comfort Inverter" exists in law and is registered to Daikin, purveyors of air conditioning. The company's website confirms that we need to invert the meaning, as it were, to describe an "inverter" that controls current to maximise comfort. Glad that's sorted.

You can send stories to Feedback by email at [feedback@newscientist.com](mailto:feedback@newscientist.com). Please include your home address. This week's and past Feedbacks can be seen on our website.

Andrew Doble noticed a useful safety tip on the dashboard of a ParCar golf cart: "stop vehicle before reversing". He has tried to disobey it. And failed

## Beach balls

What could have caused these soft little balls of beach sand (see photo, right) to form? There were huge numbers of them stretched along about 700 metres of this beach about 100 kilometres north of Auckland.

■ The prime suspect would be what are commonly called sand bubbler crabs, a name that covers animals which can belong to the genera *Scopimera* or *Dotilla*. After these crabs have sifted through a batch of sand for microscopic food, they discard it as balls about half a centimetre across.

That said, I would expect the balls to be more densely packed around the crabs' burrow, but the photo suggests a fairly even distribution.

Moreover, although the crabs are widespread in the Indo-Pacific region, New Zealand may be just beyond their range.

*Mike Follows*  
Sutton Coldfield, West Midlands, UK

■ These could be the casts of the lugworm or sandworm, *Arenicola marina*. The small sandy heaps, typically looking like miniature coils of cable, are usually between 1 and 3 centimetres tall. The casts often cover large areas of sandy beach at low tide.

The worms make excellent bait for all sorts of fish and crabs. Fishers looking for them find their casts to be useful indicators, because the worms themselves lurk between 10 and 30 centimetres beneath.



As a child I lived on the Isle of Wight, off the south coast of the UK, and I used to accompany my father on digging trips to the area on the east side of the pier at Ryde, an excellent spot for finding lugworms.

In certain tidal conditions, when constant currents are moving slowly over shallow areas, some of the mounds of coiled sand cast off

by the burrowing lugworms can become dislodged from the seabed. Then, rather than simply disintegrating, they form into small balls or beads of sand which are left behind when the tide recedes.

This happens particularly where the sand is slightly oily, such as when the beach is contaminated with pollutant-



covered debris that has washed up on or near the shoreline.

*Anthony Wilkins*  
Sowerby Bridge, West Yorkshire, UK

## This week's questions

### OFF COLOUR

I spotted this blackbird in the garden (see photo, bottom). It is not black but light grey, and it did not have pink eyes so I guess it is not an albino. It spread its wings and lay in the sun; in due course it flew off. I've never seen a blackbird with this colouring before. Can anyone tell me more about it?

*Eric Bignell*  
Southwell, Nottinghamshire, UK

### TREE TIME

It is generally accepted that the increase in day length in the spring is what prompts deciduous trees to begin growing their leaves. But how does a tree know that the days are getting longer?

*Ray Sheldon*  
Bridgetown, Nova Scotia, Canada

### FEELING THE PRESSURE

When we took a flight recently, we noticed an unopened packet of potato chips inflate because the cabin air pressure fell with altitude. At the same time, a member of my family commented that they felt bloated and uncomfortable. Is it possible that a similar effect was taking place in their gut?

*Duncan Guthrie*  
Edinburgh, UK

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