

BBC



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Knowledge

SCIENCE • HISTORY • NATURE • FOR THE CURIOUS MIND



INCORPORATING
BBC
SCIENCE
WORLD



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THE VIRUSES
THAT MADE
US HUMAN

MARS IN
THE MOVIES



HOW TO
KEEP YOUR
BRAIN
SHARP

WHAT THE EARTH WILL LOOK LIKE WHEN WE'RE GONE

LIFE
AFTER MAN

From the editor



What if you were the last person alive?

Movie makers and authors continue to spend a lot of time and money on imagining a world when mankind has left the building, but we have the scientific version this issue. And it's fascinating...

To push the scenario along, but in a more fun way, we also have an engaging feature on **Mars**, and how the portrayal of the Red Planet over the years has mirrored the state of the world

Away from gloom and doom, we're loving our portfolio of cool photographs of **flamingos**; they make such a dramatic contrast to almost-colourless landscapes. Viruses come in for rare approbation too, with an analysis of how they play a part in keeping us alive.

On our history menu is a captivating profile of **BT Barnum**, aptly nicknamed the Great Pretender, while our Great Indian Authors series serves up the powerhouse that was **Mahasweta Devi**.

But, if the thought of life as we know it ending freaks you out, despite all our attempts to distract you, here are two happy thoughts: One, there are seven new exoplanets to plan trips to, a la Elon Musk, and two, if you don't sharpen your brain with our easy tips, you may not even realise when the world is ending.

Happy planning either way!

Primrose Monteiro-D'Souza
Editor & Chief Community Officer,
BBC Knowledge

EXPERTS THIS ISSUE



Kat Arney is a freelance science writer, speaker and broadcaster. She co-hosts BBC's podcast and radio programme *The Naked Science Show*, and hosts the BBC Radio 5 Live *Science Show*. In this issue, she explains how infection-causing viruses have played a pivotal role in the evolution of humans.



Eric Rabkin is a teacher with the University of Michigan's Department of English and has authored several books on science fiction and writing. In this issue, he shows how depictions of Mars in literature and film often reflect the political scenario on Earth.



Duncan Geere is a Sweden-based science, technology, and culture journalist, and is currently the editor of *How We Get To Next*. In this issue, he ponders upon life after our species cease to exist.



Padma Shri Urvashi Bhutalia is a prominent Indian author and publisher. In this issue, she profiles feminist powerhouse Mahasweta Devi.



SEND US YOUR LETTERS

Has something you've read in *BBC Knowledge* intrigued or excited you? Write in and share it with us. We'd love to hear from you and we'll publish a selection of your comments in the forthcoming issues.

Email us at: edit.bbcknowledge@wwm.co.in

We welcome your letters, while reserving the right to edit them for length and clarity. By sending us your letter, you permit us to publish it in the magazine. We regret that we cannot always reply personally to letters.

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BBC Knowledge

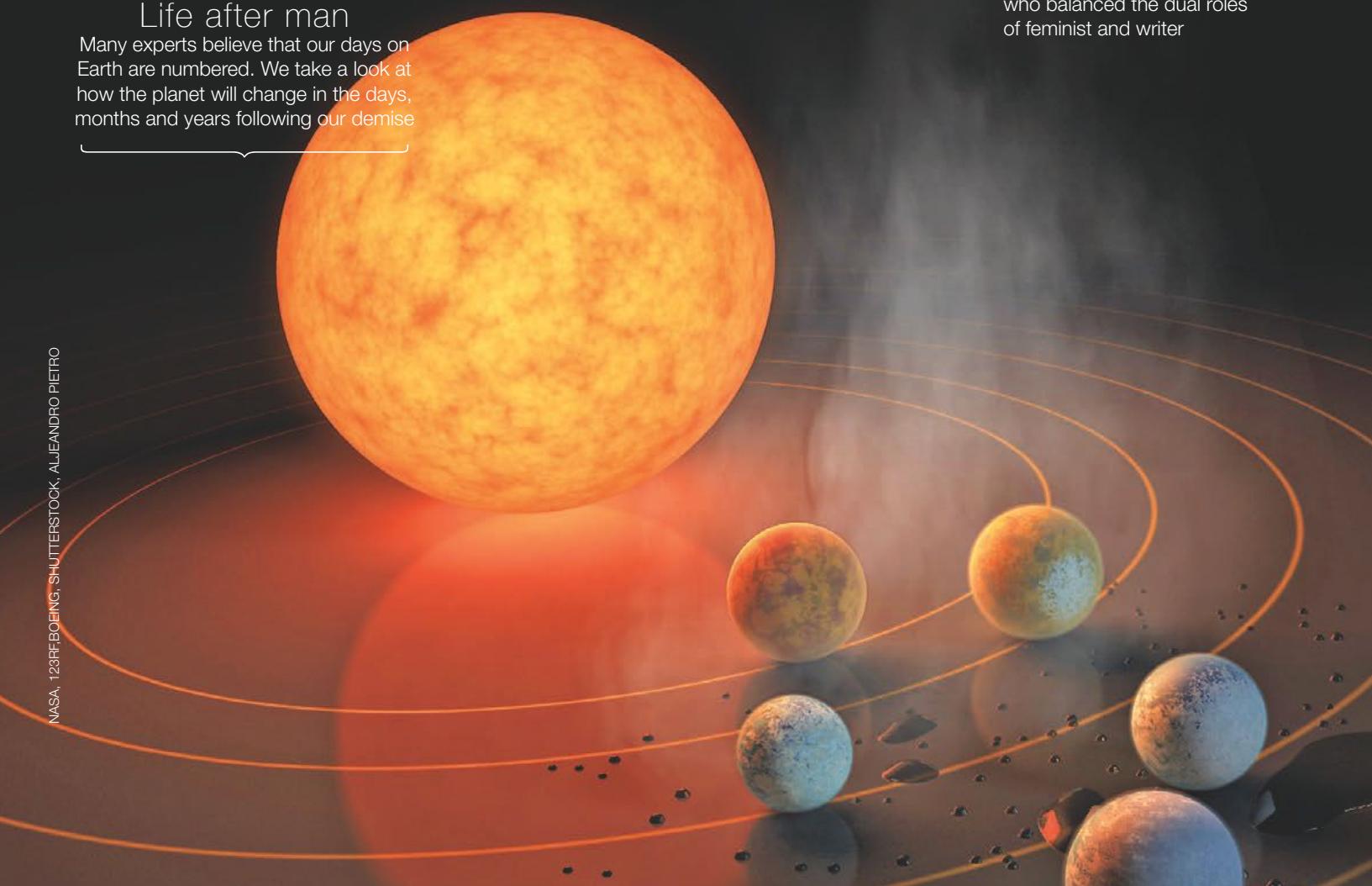
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Life after man

Many experts believe that our days on Earth are numbered. We take a look at how the planet will change in the days, months and years following our demise



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HIV, flu, and chicken pox. Viruses are horrible, right? Not necessarily – in fact, many may have shaped our genes and evolution

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Find out how our depiction of Mars as a planet was and is often influenced by our current political climate

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HERE'S HOW TO GET IN TOUCH

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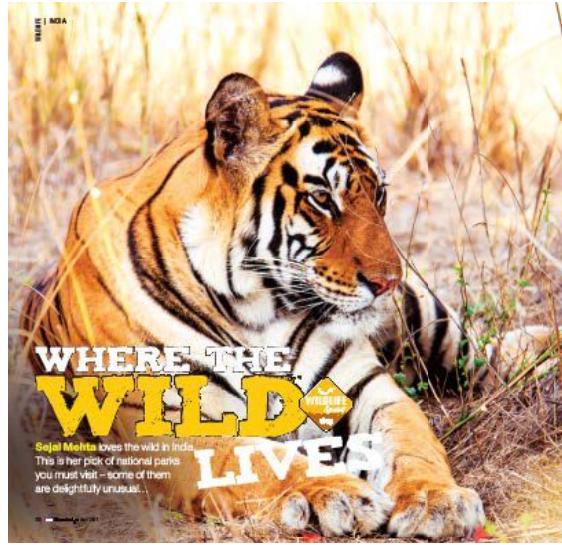
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letters



WILDLIFE the last decade. I've travelled extensively to India and overseas, from the Arunachal Pradesh Pobitora Wildlife Sanctuary to the Gir Forest. The environments are so different and the animals are so diverse, too, with so many different habitats, especially in the different seasons, with or without monsoons, making it so interesting. And in Bengal, I've started to explore places not as 'wild areas', but as 'areas with animals' - like the Sunderbans, which is a place for which there are more people than tigers. So there's a lot to explore, especially when you're trying to explore different environments and different species.

THE COUNTRY'S BIGGEST WILDLIFE PARKS

- **Corbett National Park, Uttarakhand**
- **Tadoba Andhari Tiger Project, Maharashtra**
- **Jim Corbett National Park, Uttarakhand**
- **Yala National Park, Sri Lanka**
- **Keoladeo National Park, Rajasthan**
- **Manas National Park, Assam**
- **Periyar National Park, Kerala**
- **Sundarbans National Park, West Bengal**
- **Sanjay Gandhi National Park, Mumbai**
- **Yercaud Wildlife Sanctuary, Tamil Nadu**

GETTING THERE

BY AIR: The best way to get to most of these parks is by flight. There are direct flights to Corbett, Jim Corbett, Yala, Keoladeo, Periyar, Sanjay Gandhi and Yercaud. There are also flights to Manas and Sundarbans.

GETTING THERE

BY ROAD: Most of these parks are accessible by road. Corbett, Jim Corbett, Yala, Keoladeo, Periyar, Sanjay Gandhi and Yercaud are accessible by road. Manas and Sundarbans are accessible by road.



Like you, dear Editor, I, too, have never seen a tiger in the wild, though I have undertaken tiger safaris in some of India's best wildlife parks. I once went through this ritual every day for five consecutive days at Corbett, but without success except for the occasional roar of the tiger. I personally feel we are over-obsessed with tigers when there are many other wonderful animals and birds in the wild, like the gharial and the wild boar. That's why I thoroughly enjoyed reading the wildlife issue of *BBC Knowledge* that gave me valuable information about other creatures of the wild, besides the tiger.

Om Prakash Pareek,
via email



BBC Knowledge is my favourite magazine. The content is unique and new, and that makes this magazine special. I hunt through the pages for 'knowledge'; every nook and corner of the pages is filled with information that I did not know previously. The magazine, with its 'lighting up new ideas' content, is carving a new path towards a brighter future.

The wildlife special issue was very informative, especially for a young wildlife enthusiast like me.

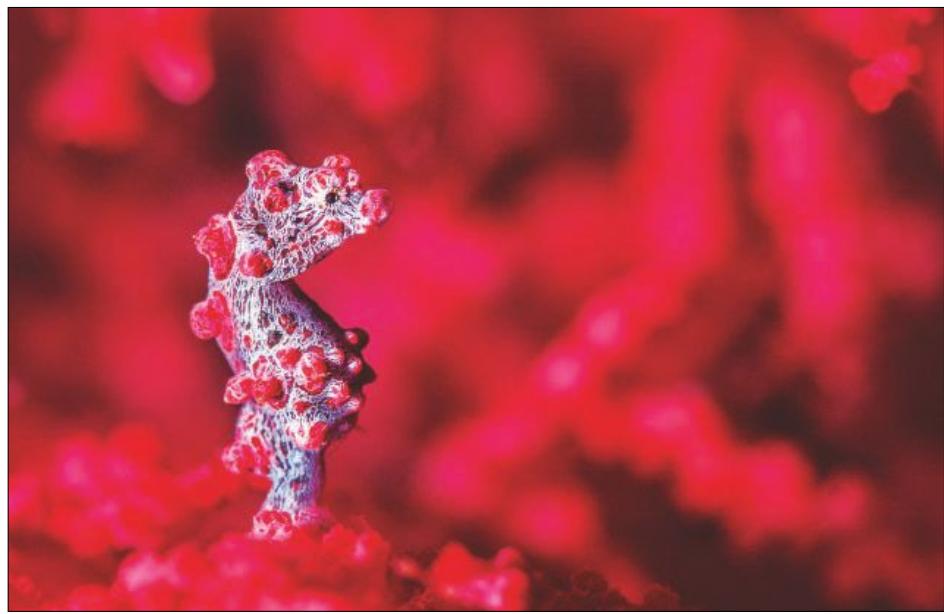
I am eagerly looking forward to the next issue of *BBC Knowledge*.

Anjitha S.,
via email



It was the eyes. The cheetah's eyes on the cover got my attention and, boy, was I hooked! The wildlife special issue blew my mind: the story of Anu and her cubs (a rollercoaster of emotions), the parks in India where the wild things are... I especially liked 'The Urban Jungle' feature. Learning about how animals have made their mark in the urban jungle and adapted to the surroundings was an eye-opener. And the images accompanying the piece were unbelievable. I am waiting to watch the show. The reviews of books, tech and games are interesting. Keep up the good work!

Vignesh Rajan,
via email



I was pleasantly surprised and delighted to read the April 2017 issue of *BBC Knowledge*.

I loved reading Urvashi Butalia's essay on Ismat Chughtai, perhaps the only author I have read in Urdu – not because I can read the Urdu script but because David Sassoon Library in Mumbai has some of her books in the Devnagari script. I thoroughly enjoyed the personal insights that Urvashi brought to the article.

I also got nostalgic reading the short, one-page article on Dr Salim Ali on the last page. It took me back to std VI in school when my English teacher first made us aware of him. I really devoured it. There were also some interesting factoids/ tidbits: like the one on farts. Lol. Was also startled to learn that, in the future, we could access Facebook just by thinking about it in our minds. There were many such tidbits that were very interesting to read.

Could you please cover Mahasweta Devi in the Know your Author section? Please get somebody who knew her personally to write.

Thank you for bringing out such a good issue.

Faheem Ruhani, Mumbai,
via email

Faheem, by happy coincidence, we have Mahasweta Devi in this issue!

– Editor



The Wildlife Special issue is indeed special.

I have roamed a lot of forests like Madumalai, Ranthambore and Kaziranga in search of tigers, but lady luck didn't favour me. I thank *BBC Knowledge* magazine for bringing the striped cat closer to me. Hopefully, this time I will spot one in Pench.

'The Ghost of the Mountain', which profiled the life of Anu, the snow leopard, and her cubs was a pertinent addition to the wildlife issue and I really enjoyed reading it.

The In Focus section

reminded me of my visit to Keoladeo Ghana National Park (Bharatpur Bird Sanctuary).

Dr Salim Ali deserves a standing ovation. His teaching is well embedded in the minds of the rickshaw-pullers who act as first-class guides and birdwatchers in the national park.

Our country needs clones of Ismat Chughtai. I can't picture a stronger woman than her. The feature on her was an interesting read.

The portfolio ('What Lies Beneath') needs special mention.

BBC Knowledge is a magazine that imparts pertinent and pleasurable knowledge. I could go on and on with a list of my favourites in this magazine. I crave it every month. Keep igniting our 'curious' minds.

Suparna Ghosh, West Bengal,
via email



DO WE NEED HOLIDAY HOMEWORK?

Two of the country's leading educators weigh in on the importance of marks in learning



"As with all assignments, I believe that holiday homework should be meaningful for students, give genuine feedback and build on prior learning, enabling them to scaffold their learning.

"Unfortunately, too many instances of holiday homework are heavily reliant on parents and are completed in the last days of the vacation. Teachers, too, struggle to grade the projects or reams of worksheets and, as a consequence, the student comes to believe that this was not, nor will ever be, a worthy use of their time.

"My most memorable holiday homework assignments:

"At 11: I had to draw and colour in a map of the recently dissolved USSR during which I learned so much, primarily because my parents insisted that I complete the assignments myself.

Verdict: The maps were untidy but the learning was spectacular.

"At 13: I had to write one review for the book from which I derived the most meaning. Verdict: I read nearly 20 books that summer and decided that both *The Count of Monte Cristo* and *Great Expectations* will always be the greatest books that could ever be written.

"And, finally, to teachers: Please give holiday homework only if you believe that this is going to be a more productive use of their time than playing outside from morning to evening, travelling and discovering just how wonderful the world is because that is never a "waste of time."

Arjun Rao

Principal, Oakridge International School, Hyderabad



"Why do teachers assign holiday homework? In a nutshell, they want their pupils to remember and retain what they've studied thus far, much like parents, who want their children to keep in touch with what has happened in school. Parents also like having their young ones occupied through the long breaks, and many believe that constant revision is the best way to learn.

"But, what about the kids themselves? I can't think of many who would want to be doing what they think of as 'boring' stuff, that 'ruins their holidays'.

"However, I do believe that, with the right kind of homework assignments, the goals and expectations of all three groups – teachers, parents and children – can be achieved. It's as simple as adopting a 'learning through doing' model.

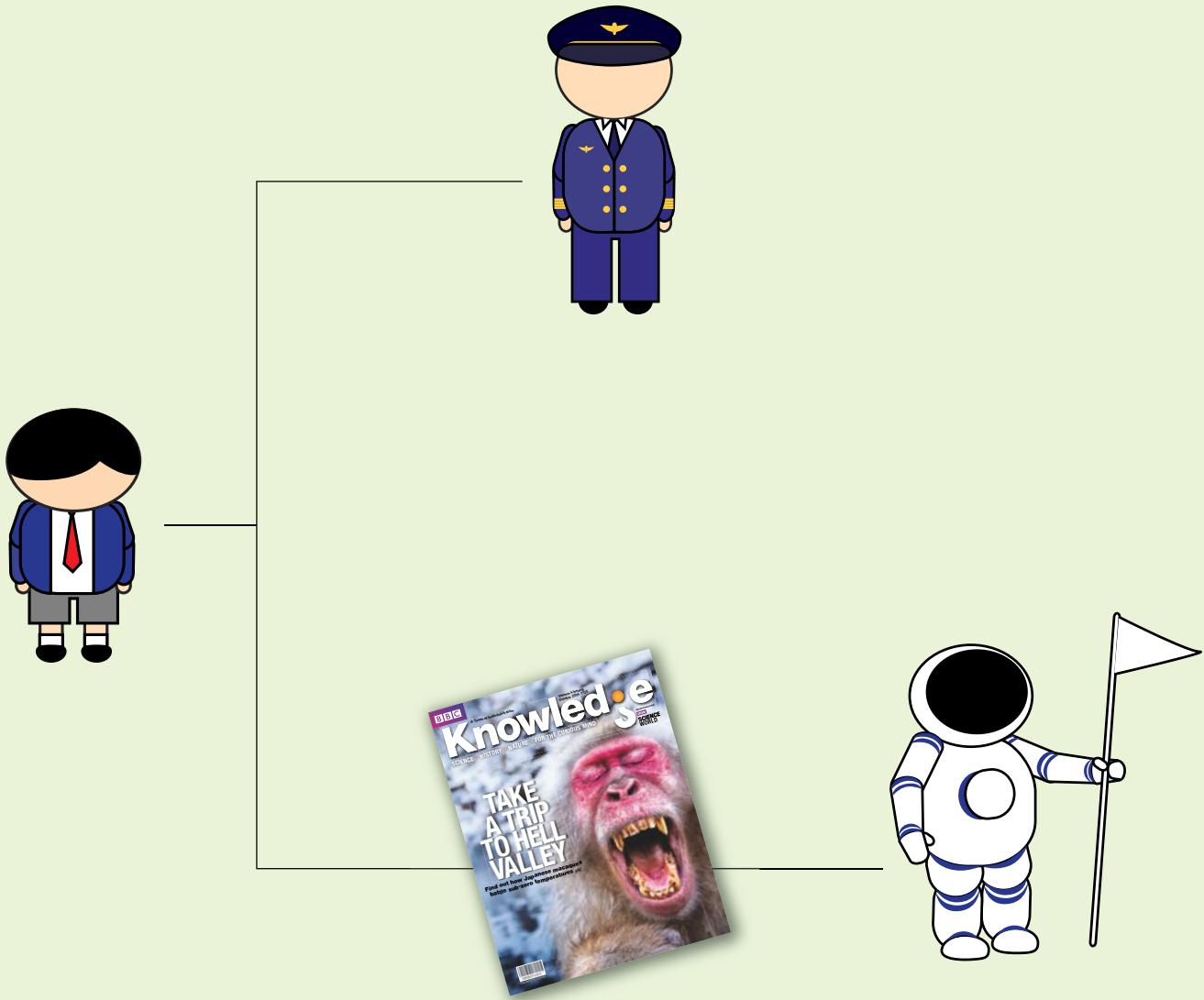
"Homework that is relevant, interesting and engaging will increase a child's understanding and permanent learning, through observation, experimentation and even interactions with peers.

"I have noticed that children enjoy learning, and retain information far more when they can apply it in the real world. It could be something as simple as applying math skills to a visit to the neighbourhood market, and documenting their visit in a scrapbook, or watching films and reading books about a subject matter, rather than completing assignments."

Soniya Lalla

Early childhood education specialist, who helps schools across India set up their pre-primary and primary divisions, and former principal

Panel of Principals is a knowledge circle that taps into the collective wisdom of educators and academicians



There's no telling what knowledge can do.

If anything can give your kids an edge over their peers, or propel them to do more than you thought possible, it's knowledge. So, give them a head start with BBC Knowledge's endless supply of riveting features, captivating photographs and awe-inspiring facts. One thing's for certain, the sooner you start, the further they'll go.

SCIENCE. HISTORY. NATURE. FOR THE CURIOUS MIND.

Q&A

YOUR QUESTIONS ANSWERED



Dr Alastair Gunn
Astronomer, astrophysicist

Alexandra Cheung
Environment/ climate expert

Dr Helen Scales
Marine biologist, writer

Prof Alice Gregory
Psychologist, sleep expert

Luis Villazon
Science/tech writer

Prof Mark Lorch
Chemist, science writer

Prof Robert Matthews
Physicist, science writer

Fire retardant
is dropped near
Clearlake, California,
during the wildfires
of August 2015

How effective are planes in fighting wildfires?

The US Forest Service has commercial contracts for a fleet of 300 helicopters and more than 50 fixed-wing aeroplanes, which dump 40 million litres of fire-retardant sludge onto forest fires each year. But, surprisingly, there isn't very good evidence that it works. A 2011 study found no correlation between the use of fire retardant and fire-fighting success rates. Once a wildfire is raging, airdrops seem to be more about public relations than effective firefighting. LV



PHOTO: GETTY

WHAT CONNECTS...

...RATS AND LANDMINES?

1



The giant pouched rat is a large African rodent, only distantly related to true rats. They can weigh up to 1.5kg and measure 45cm from nose to tail.

2.



Giant pouched rats are omnivorous, but they are particularly keen on bananas. They are also highly intelligent and can easily be tamed using a clicker, which they learn to associate with banana treats.

3



They are much more than just pets though, because they can smell explosives at very low concentrations. A Belgian NGO has so far trained more than 280 rats to sniff out TNT.

4



The rats are used to detect landmines in Mozambique, Cambodia and Angola. A single rat can check 200sqm in 20 minutes – something that would take a human four days to do!



Do fish have an immune system?

Most fish have an immune system similar to other animals with backbones. They produce antibodies that detect and bind to substances invading the body, like viruses and bacteria, and instruct white blood cells to destroy them. Just like in humans, it's possible to vaccinate a fish against future infections by exposing them to a less virulent strain of a disease-causing microbe. Fish also cover themselves in a layer of sticky mucus that traps microbes and contains antimicrobial chemicals. The more stressed a fish gets, the more infection-fighting goo it makes. HS

Why do wagon wheels sometimes seem to move slowly in old films?

Films are shot as a series of individual frames taken at around 24 per second. If the wagon wheel is rotating at precisely the right rate, then a spoke in one frame will have been taken up by another spoke in the next frame, creating the impression the wheel is stationary. If they're slightly out of sync, however, the wheels will appear to move in slow motion. RM

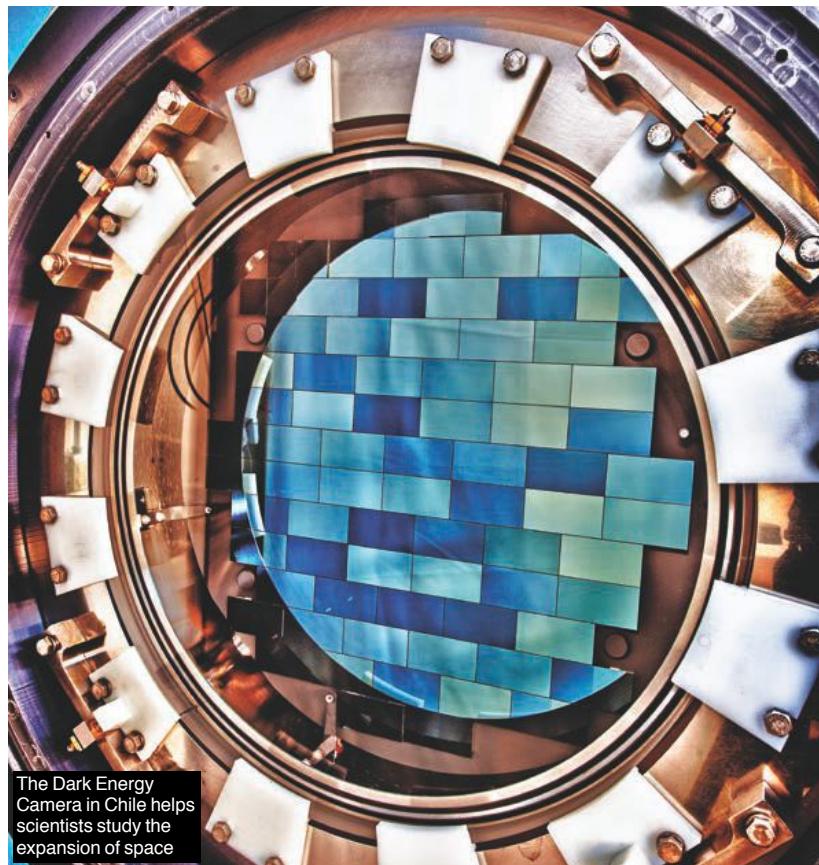


PHOTOS: GETTY X2I, SCIENCE PHOTO LIBRARY

Archaeopteryx was an animal that shared features of both dinosaurs and modern birds

Why didn't dinosaurs evolve to be more intelligent?

They did! Dinosaurs evolved into modern birds and some of them are extremely intelligent. In Japan, there are crows that have learnt to use the traffic to crack the shells of nuts that they drop – and they will wait for the lights to turn red, so they can safely retrieve them. One reason that birds still aren't as intelligent as humans is that a heavy, energy-hungry brain doesn't mix well with birds' main adaptive advantage – flying. It's important to realise that intelligence isn't the goal of evolution, nor is it always the best adaptation to the environment. The enormous sauropod dinosaurs lasted on the planet for 100 million years, despite their tiny brains. We've had 'intelligence' for just a few million years, so it's too early to say whether it is a better strategy. LV



The Dark Energy Camera in Chile helps scientists study the expansion of space

WHAT IS DARK ENERGY?

During the 1990s, astronomers measuring the rate at which the Universe is expanding made a shock discovery: it's actually accelerating, as if the whole cosmos is being propelled by some invisible source of energy. This is so-called dark energy and its origin is one of the deepest mysteries in science. Various explanations have been put forward, with arguably the simplest being that it's a manifestation of so-called quantum vacuum processes. According to the laws of the subatomic world, there is always some uncertainty about the amount of energy filling even empty space. This vacuum fluctuation energy has been detected in the lab, and theorists have shown it can have the 'anti-gravitational' effects of dark matter. So far, however, they have struggled to produce a detailed theory of its cosmic effects. This has led to suggestions that dark energy may simply be a force-field left over from the Big Bang. Sometimes called quintessence, it's capable of getting stronger over time, but again details remain elusive. There have even been claims that dark energy is leaking out from hidden extra dimensions of space that failed to expand following the Big Bang. Until there's a breakthrough in the underlying theory, however, all this is little more than speculation. RM

THE THOUGHT EXPERIMENT

How could I survive being washed up on a desert island?



1. WATER

You can only survive three days without water. Scavenge the beach for containers and set each one in the sand, at the bottom of a wide, shallow pit. Line the sides with palm leaves, arranged so that rain drips into the bottles. While you wait for rain, explore the island to look for streams.



2. FOOD

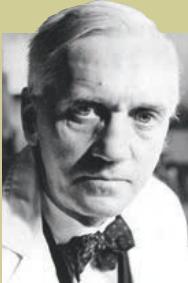
Coconuts are a great food source. Wedge one on the ground, with the pointed end facing upwards. Find the largest rock you can lift and drop it onto the coconut to break the husk fibres apart. One survivor of the 2004 tsunami ate nothing but coconuts for 25 days before being rescued, so your chances are good!



3. SHELTER

Unless you can sleep, you will lose the ability to concentrate, plan and stay motivated after just one or two nights. A bundle of small branches spread on the ground and covered with palm leaves is still better than sleeping directly on the sand. After that, build a low bed frame by tying saplings together.

WHO REALLY DISCOVERED?

PENICILLIN

ALEXANDER FLEMING



HOWARD FLOREY



ERNST CHAIN

It's one of the most famous stories in medical science: Scottish bacteriologist Alexander Fleming comes into his lab in London one day in 1928, and finds that bacteria on a test dish seem to have been wiped out by some mould that had landed in the dish. Fleming discovers the mould is secreting a compound he calls penicillin – it's the world's first antibiotic. Antibiotics have since saved countless people from deadly bacterial infections. Yet Fleming himself was unconvinced the penicillin could be turned into an effective treatment and lost interest in his discovery. Credit for turning a chance finding into one of the greatest medical breakthroughs ever should go to the Australian pathologist Howard Florey and the German-born biochemist Ernst Chain. During the late 1930s, they purified and stabilised penicillin, and, in 1941, became the first to treat a patient. Despite a brief improvement, the patient died, as there wasn't enough of the wonder drug. This led Florey to cajole the giant US pharmaceutical companies into setting up mass-production facilities. By the D-Day landings of 1944, there was enough penicillin to treat thousands of injured troops who would otherwise have died. The following year, Fleming won the Nobel – along with Florey and Chain. RM



Can a computer generate a truly random number?

Computers are often required to produce random numbers as they're useful for a host of tasks, from taking random samples of data to simulating the formation of galaxies.

But computers produce these numbers using mathematical formulas, which means they aren't truly random. This isn't as bad as it seems, as true randomness is prone to producing bizarre patterns that can fool researchers into seeing effects that don't exist.

To avoid this, the so-called pseudo-random number generators (PRNGs) formulas used in computers undergo statistical tests to keep the risk of long 'runs' below a certain threshold. Even so, some computer-generated random numbers have still caused problems. Subtle patterns in the output of the so-called RANDU generator created by IBM in the 1960s is suspected to have undermined the reliability of many research projects over the years. RM

Why is the Moon colourless?

Despite appearances, the Moon is not entirely devoid of colour. Apollo astronauts described its colour as 'brownish'.

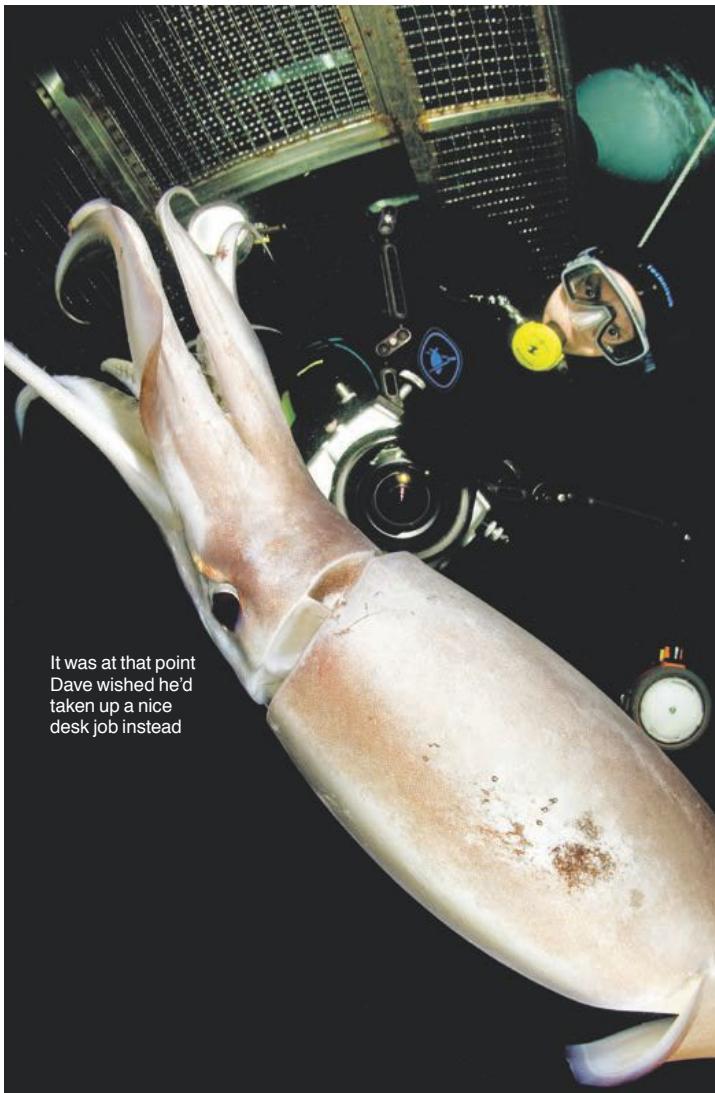
Careful study shows that the dark areas, or 'maria', display hints of blue or brown while the highland areas have faint traces of yellow, pink and pale blue. These differences are mainly due to varying amounts of metals such as iron or titanium in the surface minerals.

Unfortunately, the human eye isn't sensitive enough to pick out these slight differences in colour from a distance. However, much of the lunar surface contains minerals that are naturally grey and these dominate the colour we perceive from Earth. AGu

**CAN SOLAR PANELS BE RECYCLED?**

Panels that convert solar energy into electricity last for decades, but, when they do eventually wear out, they can be turned into new products – including fresh solar panels. Most of

the materials they're made from, such as glass, aluminium and copper, has been recycled for years. The semiconductor materials in them, such as silicon and cadmium telluride, can virtually all be recovered by specialist companies. RM



It was at that point
Dave wished he'd
taken up a nice
desk job instead

How do squid survive the extreme pressures of deep water?

A big challenge facing squid in the deep sea is keeping their cells working. Under high pressure, important molecules like proteins in cell membranes and enzymes become squashed and bent out of shape and either work more slowly or not at all.

One way squid counteract this is by loading their bodies with trimethylamine-N-oxide, or TMAO, which helps large molecules keep their shape. For many deep sea animals, the deeper they live, the more TMAO they have in their bodies. TMAO also gives rise to the distinctive fishy smell of many sea creatures – the deeper the species lives, the more it smells. HS

PHOTOS: GETTY X9

WHY DO WE SHRINK AS WE AGE?

The cartilage pads between the joints in your legs and spine gradually wear away as you get older, and osteoporosis can cause the vertebrae themselves to shrink slightly. You also lose muscle as you age and all of these factors mean your skeleton slumps down a little more. Between the age of 30 and 70, this adds up to about 3cm height loss for men and 5cm for women, increasing to 5cm and 8cm by age 80. LV



Is there acid snow (like acid rain)?

Acid snow is produced in exactly the same way as acid rain. It all starts when sulphur dioxide and nitrogen oxides are emitted into the atmosphere, typically by power stations burning fossil fuels. Inside clouds, these molecules react with tiny droplets of water to form sulphuric and nitric acids. The water eventually falls as drops of acid rain, or, if it is cold enough, ice crystals form and fall as acid snow. Acid snow can be particularly damaging since it can accumulate on the ground, before abruptly releasing a large quantity of acidic water into the environment when it melts. AC



Do dogs have visual dreams?

Yes. In 2001, researchers at MIT monitored brain activity in rats as they solved a maze. They found that the animals showed the same brain activity patterns during sleep. The match was so close that the researchers could tell which part of the maze the rat was dreaming about. Cats and mice show similar results, so it is likely that visual dreams are common to all mammals, including dogs. LV

IN NUMBERS

32

The percentage of amphibian species at risk of extinction. Threats are habitat loss, pollution, disease and climate change.

24,000

The number of years ago that humans first reached North America – 10,000 years earlier than previously thought.

47

The percentage of fish that was mislabelled in Los Angeles sushi restaurants, according to DNA tests.

PHOTOS: GETTY X3

TOP 10

10 OLDEST PLANTS ON THE PLANET*



1. Seagrass colony
(*Posidonia oceanica*)
100,000 years old
Balearic Islands, Spain

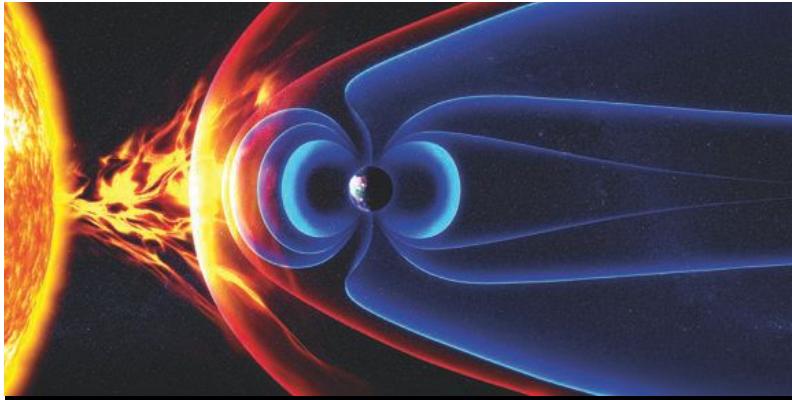
2. 'Pando'
Quaking aspen colony
80,000 years old
Fishlake National Forest,
Utah, the USA

3. 'Jurupa Oak'
Palmer's oak colony
13,000 years old
Jurupa Mountains,
California, the USA

4. Mojave yucca
12,000 years old
Mojave Desert,
California, the USA

5. Huon pine colony
10,500 years old
Mount Reed,
Tasmania, Australia

*Including clonal colonies with interconnected root systems, but discounting plants without reliably determined ages



Do all planets have magnetic fields?

No, not all planets have magnetic fields. The four gas giants have extremely strong magnetic fields, Earth has a moderately strong magnetic field, Mercury has an extremely weak field, but Venus and Mars have almost no measurable fields. Planetary magnetic fields are formed by the interaction between the convection of interior conducting material (molten rock and metal) and the planet's own rotation. Mercury's field is weak because it rotates so slowly. Venus doesn't have an appreciable field because there appears to be little convection in its molten interior. Mars doesn't have an appreciable field – although it did in the past – because its interior has solidified. AGu



How much sleep do we really need?

The cliché is that we need eight hours a night, but the actual answer to this question is more complicated. Our sleep requirements change throughout life. Guidelines proposed by the National Sleep Foundation in 2015 recommended that newborns have 14 to 17 hours per night, teenagers have eight to 10 hours, and adults have seven to nine hours. These guidelines focus largely on 'average' requirements, but individuals can differ greatly from one another. For example, it may be appropriate for certain teenagers to have as few as seven hours per night, or as many as 11. If you're not functioning your best, it's worth considering whether you're getting enough sleep. AGr



ILLUSTRATIONS: RAJA LOCKEYX2

6. 'Old Tjikko'
Norway spruce
9,550 years old
Fulufjället Mountains,
Sweden

7. 'Old Rasmus'
Norway spruce
9,500 years old
Härjedalen,
Sweden

8. Antarctic moss
5,500 years old
Elephant Island,
Antarctica

9. Bristlecone pine
5,066 years old
White Mountains,
California, the USA

10. 'Methuselah'
Bristlecone pine
4,848 years old
White Mountains,
California, the USA



Why do we forget things?

Multiple explanations have been proposed. We may forget because we didn't store the memory effectively in the first place. It is also possible that memories decay over time. As they have not been revisited, their biological 'trace' becomes weak. Another theory suggests that new memories can interfere with older ones. Or that memories have been encoded and stored but that there is a problem with retrieval. Scientists sometimes refer to 'motivated forgetting' too, which involves forgetting an unwanted memory such as a trauma. This is controversial as there is also evidence that such unwanted events may be particularly difficult to forget. Forgetting is not always a bad thing! It would waste cognitive resources if we remembered every last detail of the world around us. AGr



Are fireworks bad for the environment?

Fireworks propel a cocktail of chemicals into the atmosphere, many of which can harm both people and the environment. The vivid colours in firework displays come from metallic compounds such as barium or aluminium that can have negative impacts on animal and human health. Additionally, to produce the oxygen needed for an explosion, many fireworks contain oxidisers known as perchlorates.

These can dissolve in water, contaminating rivers, lakes and drinking water.

Finally, fireworks release a fine cloud of smoke and particulate matter, affecting local air quality. Some newer, 'cleaner' fireworks replace perchlorates with safer alternatives, or use compressed air to reduce the smoke created.



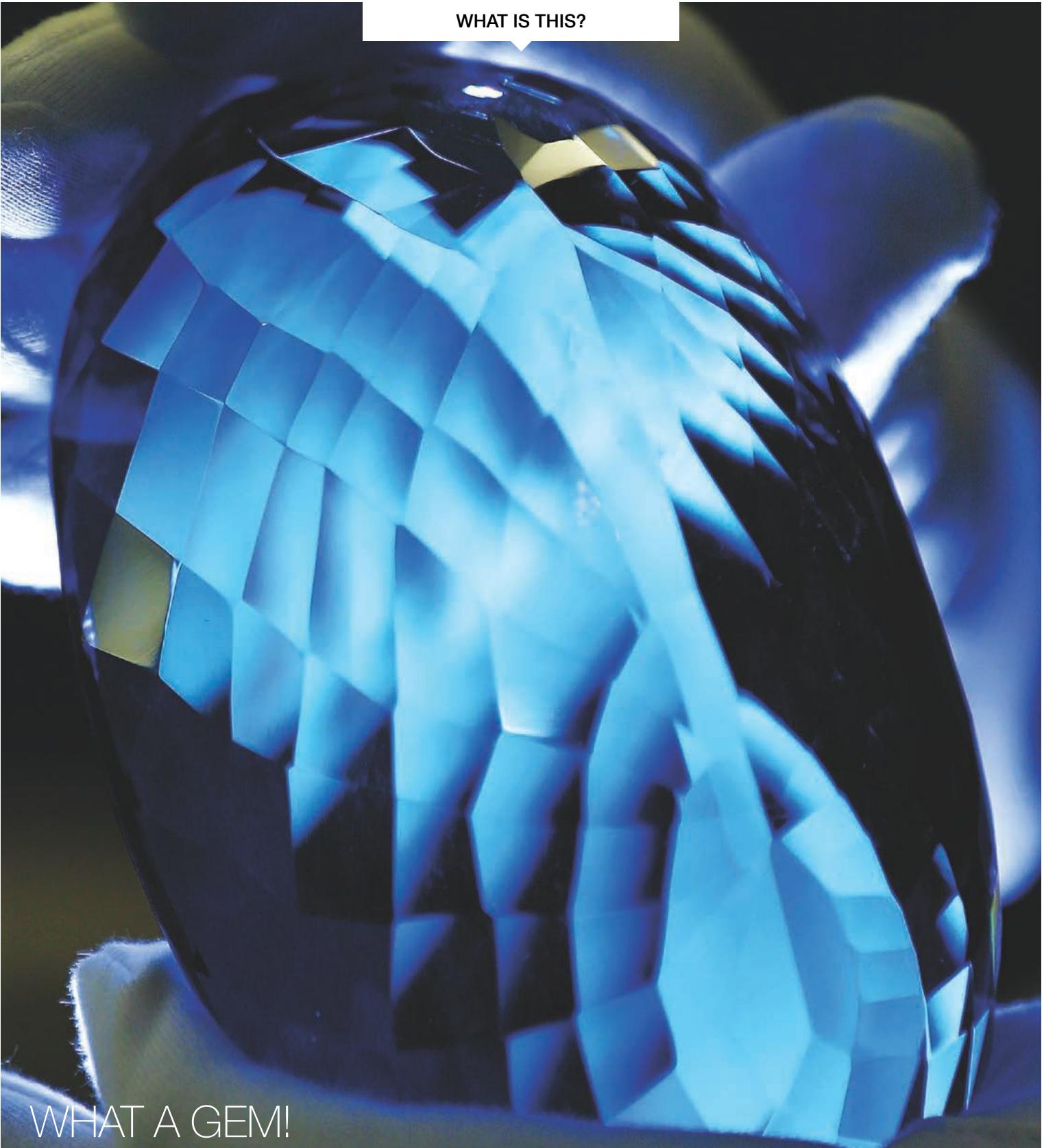
Does sucking your thumb really ruin your teeth?

Sucking a thumb or dummy up to the age of two is fine, but several studies have shown that, beyond that, there is a risk that the front teeth can be pushed outward, or the side teeth shifted so that the top and bottom sets don't meet. A 2001 study by the American Dental Association found that about 20 per cent of children who suck their thumb beyond the age of four have a misaligned bite. LV



Why are fats solid at room temperature but oils liquid?

To form a solid, molecules need to pack together nicely, while, in a liquid, there is less order and the molecules flow around each other. Fat molecules are mostly made up of long, straight hydrocarbon chains. Because they are straight, they pack neatly with their neighbours (think of the way uncooked spaghetti packs together in a jar). Oils generally have chains that are kinked; this stops them interacting so tidily and so they stay liquid (imagine the storage problems you'd have if there was a bend in the middle of every piece of spaghetti). By definition, fatty molecules that form liquids are called oils and those that form solids are called fats. ML



WHAT IS THIS?

WHAT A GEM!

This is an enormous cut topaz that weighs around 2kg. With a length of 15cm and a width of 10.5cm, it's the largest gemstone of its kind. It was discovered in its raw state in Brazil three decades ago, by the British explorer Max Ostro. Naturally, topaz is colourless, but impurities and differences in structure can give it a pale blue, red or yellow colour. To make the stones look more vivid, they are exposed to heat or radiation to enhance the colours, before being cut.

NEXT ISSUE

What's the dodo's closest relative?
Is the flag still on the Moon?
Why can't we remember early life?



SEVEN EARTH-SIZED EXOPLANETS FOUND

The system of planets found orbiting nearby dwarf star TRAPPIST-1 may be our best chance yet of finding alien life

DISCOVERIES

DISPATCHES
FROM THE
CUTTING EDGE



TRAPPIST-1, an ultracool dwarf star located just 40 light-years from Earth in the Aquarius constellation, was first detected by researchers from Liege using the Transiting Planets and Planetesimals Small Telescope (TRAPPIST) in Chile, and later confirmed by NASA's Spitzer Space Telescope and the Very Large Telescope, also in Chile. The planets were detected by observing dips in the star's light output caused by each of the seven planets passing in front of it, events known as transits. The researchers found that all of the planets

are comparable in size to the Earth, while density measurements suggest that the innermost six are rocky.

Current climate models suggest the three innermost planets are probably too hot to support liquid water, and the one furthest from the star is too cold. However, the remaining three sit comfortably within the habitable zone and could host oceans of surface water – a feature thought to be essential for the existence of life.

"The energy output from dwarf stars like TRAPPIST-1 is much weaker than that of our Sun. Planets would need to be in far closer orbits than we see in the Solar System if there is to be surface water," said researcher Dr Amaury Triaud. "Fortunately, it seems that this kind of compact configuration is just what we see around TRAPPIST-1."



As the planets in the TRAPPIST-1 system are so close together, they'd be visible in each other's skies, as seen in this illustration

EXPERT COMMENT

The star is relatively small, just 8 per cent the mass of the Sun, and would appear to glow salmon pink when observed from the surface of the planets, the researchers say.

Now that astronomers know that the planets are there, the next job is to find out what they are really like. The first step is to make an accurate determination of their densities. When searching for habitable worlds, rocky planets are the clear preference because – put simply – they provide a surface for life forms to walk, slither or otherwise move across.

The European Space Agency (ESA) will launch CHEOPS (CHaracterising ExOPlanet Satellite) in 2018. The main science goals of the mission are to measure the densities of planets with radii between one and six times of Earth. The TRAPPIST-1 system will be high on the list.

The next step will be to analyse the planets' atmospheres to see if any look like they could be habitable. "The main goal will be trying to detect the signature of water," said CHEOPS scientist Dr Vincent Bourrier. Water vapour in a planet's atmosphere could betray widespread oceans and a water cycle. Its signature appears in the infrared region of the spectrum and this is where the NASA-built James Webb Space Telescope (JWST) comes in.

ESA will launch the JWST in the same year as CHEOPS. With its 6.5m-diameter infrared mirror, JWST will make analysing exoplanet atmospheres easier than ever. One of its first targets is likely to be the seven worlds of the TRAPPIST-1 solar system.

**"ROCKY
PLANETS ARE
THE CLEAR
PREFERENCE
BECAUSE THEY
PROVIDE
A SURFACE FOR
LIFE FORMS"**

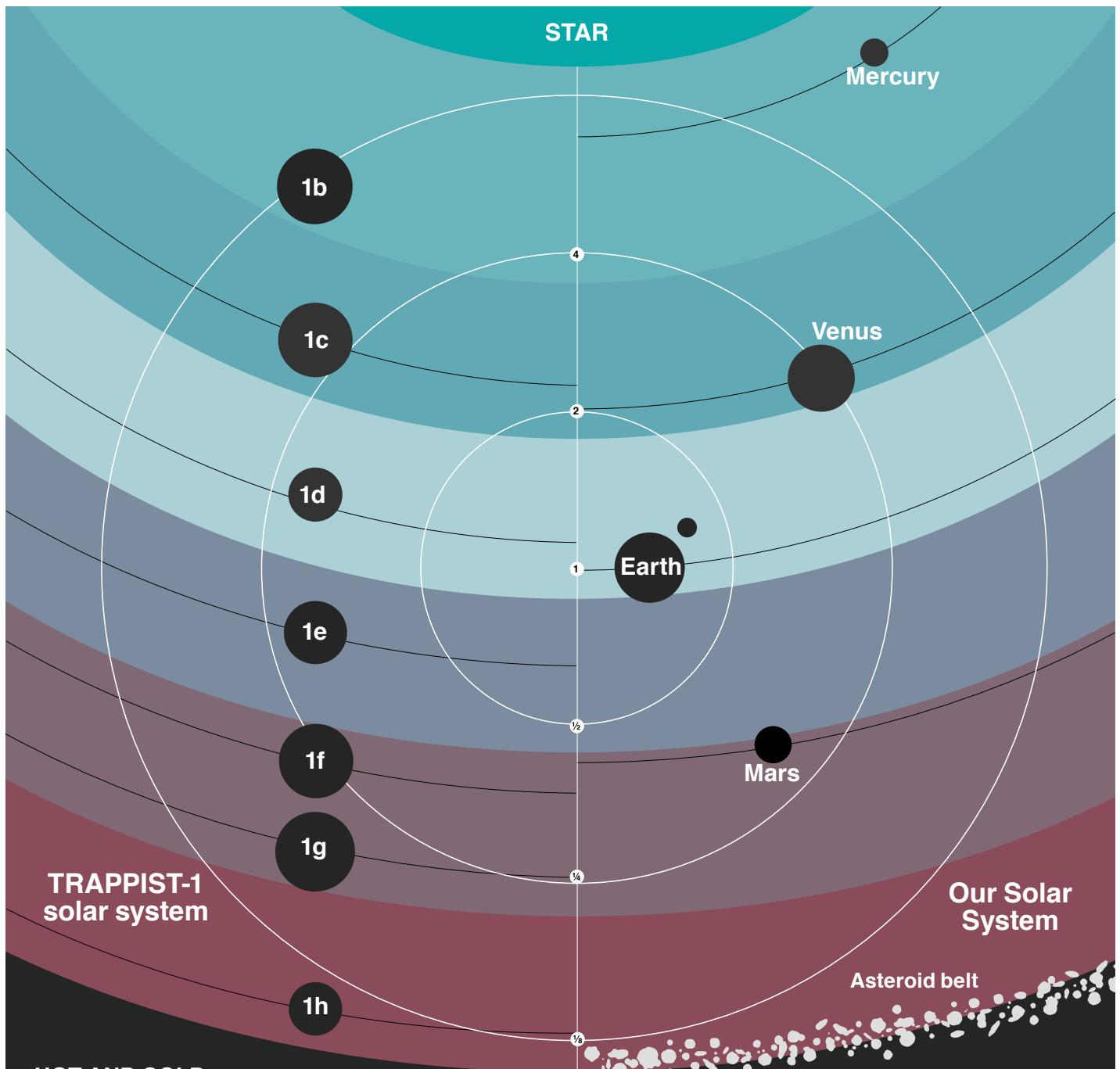
While finding water vapour would increase the belief that the planet under investigation is potentially habitable, there are other factors that could affect a planet's ability to support life.

To investigate those, Bourrier and his team have already used the Hubble Space Telescope to look at the ultraviolet signature of TRAPPIST-1's two innermost planets. His work shows that those planets could have had their atmospheres completely eroded away by the radiation from the star – rendering the planets barren. Could this have happened to the other worlds of TRAPPIST-1?

Actually proving that a planet is habitable may be really tough. Astronomers will have to look for 'biomarkers'. These are gases that only exist together in an atmosphere because they are being replenished by the metabolisms of living creatures. Oxygen and methane are good examples in our own atmosphere. So far, there are no firm plans to build a space telescope capable of making such an exacting measurement, although NASA and ESA have both studied engineering concepts.

NASA's next exoplanet mission, the Transiting Exoplanet Survey Satellite (TESS), also launching next year, could reveal many more solar systems like TRAPPIST-1. This mission will survey 200,000 stars and is expected to discover thousands of exoplanets, from the size of Earth up to Jupiter and larger." ☐

Stuart Clark is an astronomy writer. His most recent book is the *The Search For Earth's Twin* (Quercus).



HOT AND COLD

This illustration compares the energy received by TRAPPIST-1's planets, relative to Earth. TRAPPIST-1's planets are named 1b-1h. It is thought that 1b, 1c and 1d are probably too hot to support liquid water, and 1h is too cold. But the other three could host oceans – and, therefore, life.



**TRAPPIST-1
solar system**

Orbital period
Days

	b	c	d	e	f	g	h
Orbital period Days	1.51	2.42	4.05	6.10	9.21	12.35	~20
Distance to star Astronomical units (AU)*	0.011	0.015	0.021	0.028	0.037	0.045	~0.06
Planet radius Relative to Earth	1.09	1.06	0.77	0.92	1.04	1.13	0.76
Planet mass Relative to Earth	0.85	1.38	0.41	0.62	0.68	1.34	-

* 1 AU = distance from Earth to Sun

SPACESUITS GET STYLISH

When astronauts head to the International Space Station in Boeing's CST-100 Starliner capsule next year, it looks like they will do so in some style: the company has designed new spacesuits to provide crew members with improved functionality, comfort and protection – and they also look pretty snazzy.

Dubbed the 'Boeing Blue', the suits are around 40 per cent lighter than previous examples and feature a wide polycarbonate visor for improved peripheral vision, a built-in communications headset and touchscreen-friendly gloves. To improve comfort, the hood-like helmet simply zips on, overcoming the need for the cumbersome metal neck ring seen on previous designs.

"It feels good to be walking around in Boeing Blue," said Chris Ferguson, director of Starliner crew and mission systems at Boeing. "Spacesuits have come in different sizes, shapes and designs, and I think this fits the Boeing model, fits the Boeing vehicle."

NASA awarded contracts to Boeing and SpaceX in 2014 to develop commercial spaceships that could be used to ferry astronauts to and from the ISS. Boeing plans to carry out an unpiloted test flight of a CST-100 in Earth orbit in June next year. If successful, Boeing will then send a test pilot and a NASA astronaut for an orbital test flight in August.



FROM LEFT TO RIGHT: NASA's Project Mercury spacesuit; Russia's Strizh spacesuit; Shannon Lucid's training suit; the 'Boeing Blue'



We wonder where Boeing got its inspiration from... ?

THEY DID WHAT?!

MOTHS TAUGHT TO DRIVE CARS

What did they do?

A team from Tokyo University got male silk moths to drive robotic cars towards the source of sex pheromones produced by a female. The moths were tethered to a treadmill linked to optical sensors that tracked their movements and steered the vehicle.

Why did they do that?

The scientists hope that the research will eventually lead to the development of biomimetic robots that can sniff out odours and locate their sources. Such robots could replace dogs and other animals used for detecting explosives or drugs.

What did they find?

The moth drivers passed the test with flying colours, taking just two seconds longer than free-walking moths in finding the source of the scent. Though like most of us, they picked up a few minor faults.





It's like looking in a mirror...

Meet your many times great granddad: a bag-like creature without an anus

It may not look much like Aunty Jean or Uncle Bob, but this tiny sea creature could be your oldest known ancestor.

Dubbed *Saccorhytus*, thanks to its oval, sack-like body and large mouth, the newly-discovered species lived nestled in the sand on the seabed of central China 540 million years ago. It was found lodged inside microfossils unearthed by a team from the University of Cambridge and is thought to be the most primitive example of a deuterostome – one of the major groups of the animal kingdom that includes several smaller groups, including vertebrates.

"We think that, as an early deuterostome, this may represent the primitive beginnings of a very diverse range of species, including ourselves," said researcher Prof Simon Conway Morris. "To the naked eye, the fossils we studied look like tiny black grains,

but under the microscope the level of detail is jaw-dropping. All deuterostomes had a common ancestor, and we think that is what we are looking at here."

By isolating the fossils from the surrounding rock, and then studying them under an electron microscope and a CT scanner, the team was able to build up a picture of how *Saccorhytus* might have looked and lived. It was covered in a thin, flexible skin suggesting that it had some kind of musculature and could have got around by wriggling. Intriguingly, the researchers were unable to find any evidence that the creature had an anus.

"If that was the case, then any waste material would simply have been taken out back through the mouth, which, from our perspective, sounds rather unappealing," Conway Morris said.

WHAT WE LEARNED THIS MONTH

DOGS ARE FANS OF SOFT ROCK

If you find your pooch is getting a bit stressed, put on some Billy Joel. A team at the University of Glasgow has found soft rock music can have a calming effect on pent-up pups.

BLACK HUMOUR IS A SIGN OF INTELLIGENCE

If you want to know how smart someone is, tell them a sick joke. Those with a particularly dark sense of humour score more highly in IQ tests, researchers at the University of Vienna have found.

TOMATOES REALLY HAVE LOST THEIR FLAVOUR

Spanish researchers have found that constant breeding for size and yield has caused a loss of 13 volatile compounds responsible for the fruit's distinctive tangy taste leaving our tummies watery and insipid.

BURSTING BALLOONS ARE LOUDER THAN SHOTGUNS

Next time you find yourself at a party, you might want to step away from the balloons. Popping balloons can make bangs up to 168 decibels, four decibels louder than a 12-gauge shotgun, a team at the University of Alberta has found.

INNOVATIONS

PREPARE YOURSELF FOR TOMORROW



DRONING ON

Uber uses UAVs for ads

As if the traffic wasn't bad enough in Mexico City, these commuters have to put up with these ad-toting drones too. The slogans carried by the

UAVs are urging people to use their cars less, and use Uber instead – the ad at the front says

"This is why you never see the volcanoes," a reference to the smog blocking out the vistas in the city. The makers of the ride-sourcing app see

Central and South America as a key area for growth and, true to form, are utilising the very latest technology to get their message directly to potential users. While it's a smart publicity stunt, we can't help but worry about it catching on over here.



VIRTUAL REALITY

You can touch this

With the VR revolution gathering pace, the ability to provide haptic feedback – a sense of touch when you come into contact with objects in the virtual space – has become something of a holy grail for developers. But now, Seattle-based AxonVR thinks it's cracked it.

Debuting in prototype form at CES in January, the AxonVR system involves the user donning an 'exosuit' equipped with thermal and pneumatic microfluidic actuators that apply pressure and temperature to the skin to replicate the feel of virtual objects. The suit is made from a lightweight, flexible material that AxonVR is calling HaptX, and that it claims can convincingly recreate sensations "ranging from the brush of a butterfly's wings to the impact of a punch... from the warmth of a cup of coffee to the chill of a snowball."

Sadly, though, there's no word yet as to an actual release date. While consumer products such as gaming systems are a long-term goal, it's thought the technology is likely to first find real-world applications in such areas as product prototyping, rehabilitation for medical patients and military training simulators.

CARS

Drowsiness detector

US companies Freer Labs and Changhong Research Labs have joined forces to create a car headrest that can read a driver's brainwaves and alert them if they're in danger of falling asleep at the wheel.

The technology involved is described by the companies as a "non-contact neuro-bio monitor." In essence, it's an electroencephalogram (EEG), but without the need to stick any sensors to your scalp. The system is able to detect the user's levels of concentration on the task in hand – ie, driving – and, if said levels start to dip, will provide an alert via an as-yet-unspecified feedback mechanism, perhaps sounding an alarm or shaking your seat to jolt you back to full alertness.

Two unnamed car companies – one in the US, one in the UK – are currently trialling the headrests, but it's likely to be a while before they're built into any vehicles available to the public.

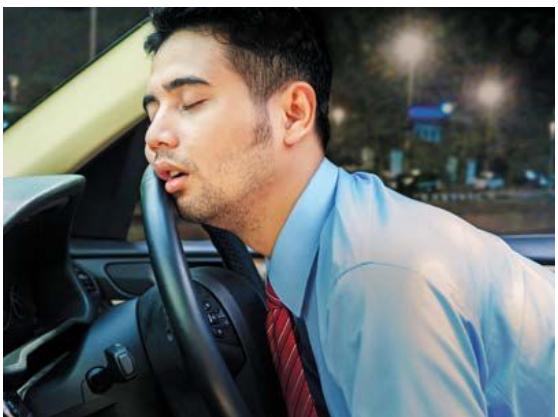


PHOTO: GETTY

HEALTH

Wrist doctor

Could smartwatches tell you you're about to get ill – before you get any actual symptoms? That's what a team of researchers at Stanford University has been investigating – and the answer, it appears, is 'yes'. The team used the sensors in an Intel Basis Peak smartwatch to gather biometric data from 40 volunteers over two years, and found that, when we're about to develop an infection, our pulse rate and skin temperature tend to be elevated up to three days before it sets in. Intel has since discontinued the Basis Peak, but the research suggests a more useful future for wearables where users can be alerted if they're about to get ill.

FIVE REASONS TO SWITCH

Nintendo is re-inventing the console again...



1 PLAY WHEREVER YOU LIKE

The heart of the Switch is a 6.2-inch touchscreen tablet, which gives you a choice of two configurations: slap it into the supplied docking station and play games on your TV with the two Joy-Con controllers, or take the tablet out of the dock, stick the controllers on the side and bring it with you on your travels. It's not a new idea, but this is probably the best implementation of it we've seen to date. What's more, its games won't be region-locked, so you'll easily be able to play Japanese or US titles.

2 ABOUT THOSE CONTROLLERS...

The Switch's Joy-Con controllers are versatile, to say the least. You can attach them to the Grip gamepad; clip them onto the Switch tablet for mobile gaming, as mentioned above; or hold them in your left and right hands, like a pair of Wii remotes. The right Joy-Con is equipped with an infrared motion and distance sensor, which, when combined with the HD Rumble force-feedback system, enables some truly innovative gameplay mechanisms.



3 GET READY TO RUMBLE

HD Rumble is being described as the most nuanced haptic feedback system currently available. At the console's launch, Nintendo was touting its ability to replicate the subtly different feel of shaking a glass with one ice cube in it, or two. It's this 'high resolution' that makes possible games such as Milk, in which players compete to milk a cow – a task that involves responding to the most subtle changes in physical feedback.



4 NO SCREEN REQUIRED

Alongside the new console, Nintendo is introducing the 1-2 Switch suite of mini-games, many of which are designed to be played without looking at the screen at all (or at least barely). These include Milk, mentioned earlier; a safe-cracking game where HD Rumble lets you know when a lock's tumblers fall; and a two-player, Western-themed duelling game.



5 A TASTE OF THE OLD SCHOOL

The starting line-up of games for Switch is solid, if unexceptional. What's perhaps more interesting is that a whole host of NES, SNES and NeoGeo games will also be available for Switch. The Switch was designed to bridge the gap between hardcore and casual gaming; with this announcement, Nintendo's targeting the retro market as well.

FROM TOP TO BOTTOM: The tablet can be placed in a docking station, so games can be played on the TV; Milk makes the most of the Switch's haptic feedback system; the right Joy-Con has an infrared camera that detects the shape, movement and distance of objects; the Joy-Con controllers clip into the tablet for on-the-go gaming

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READ Books to prepare you for a dystopian future

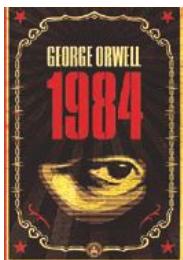
WORDS: MOSHITA PRAJAPATI



THE MAZE RUNNER SERIES

James Dashner

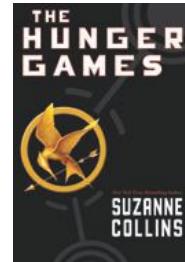
Thomas wakes up in an elevator with no memory apart from his name. He is greeted by strangers, all boys, who tell him the tale of the maze, terrifying in its appeal and dangerous in its function. The only way to reach the 'world' on the other side is to try and remember who he is.



1984

George Orwell

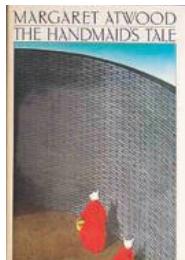
It's almost like Orwell was warning us about our future from his present (he wrote the book in 1949). Words from the book – "1984" and "Big Brother" – have entered the modern-day lexicon with ease and are synonymous with media, truth and news being controlled and manipulated by the government.



THE HUNGER GAMES

Suzanne Collins

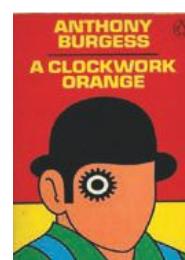
Katniss Everdeen's world consists of 12 districts all ruled by the rich and powerful Capitol, under President Snow. She volunteers to participate in a death-to-finish fight, the Hunger Games a reality show for citizens of Capitol, and starts a rebellion against Capitol and its governance. One worries that a time when one majority superpower controls weaker powers doesn't seem to be too unimaginable.



THE HANDMAID'S TALE

Margaret Atwood

The closest after *1984* in terms of life imitating fiction, Atwood's book speaks of a theocratic society that dictates the life and function of its population based on gender. A commentary by Offred (meaning "she belongs to Fred") on the defined role of woman – as breeding machines to ensure the growth of human population, a terrifyingly real and possible reality – ensures it's on our dystopian list.

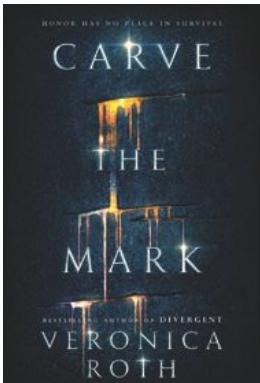


A CLOCKWORK ORANGE

Anthony Burgess

The future as envisioned by Burgess is surreal and nightmarish. Criminals enjoy a free run after dark, gangs run riot, and the state authorities use physical force and psychological triggers to restore order to a crumbling society. A more depressing imagining of our future could not be written.

New Reads



Carve The Mark

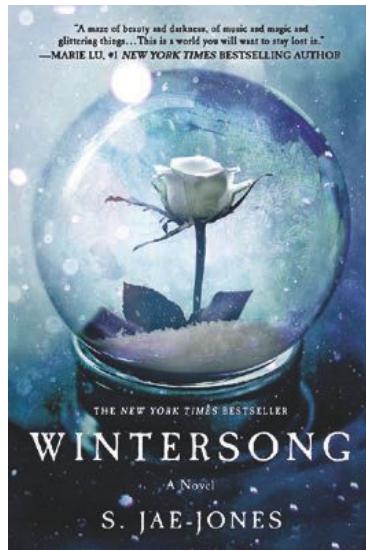
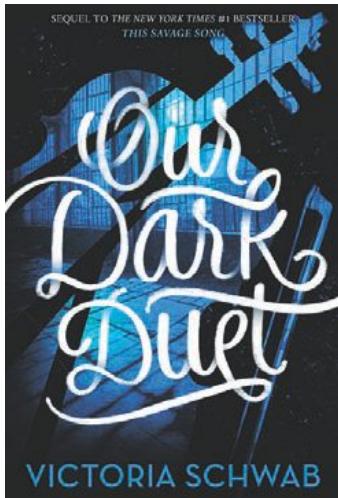
Veronica Roth

Where there is evil, there must be good. Violence and vengeance rule in galaxies and, to combat this, everyone is born with a unique gift that will shape their future. Not good news for our lead characters, Akos and Cyra, whose gifts make them vulnerable to others. Will they survive, escape the clutches of a brutal tyrant, and restore balance to the universe?

Our Dark Duet

Victoria Schwab

Kate Harker is a monster hunter and very good at it. August Flynn is a monster, who can never be human. The war between humans and monsters has reached a dangerous threshold; there's a new demon in town who feeds on chaos, and has the power to bring humans' inner demons out to play. Kate must keep her wits about her and August must play his part as they battle the demon together.



Wintersong

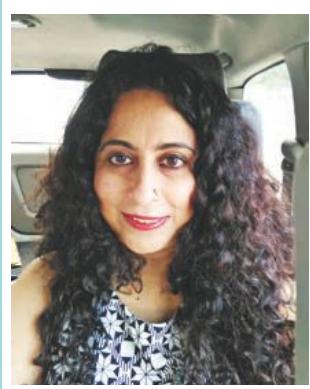
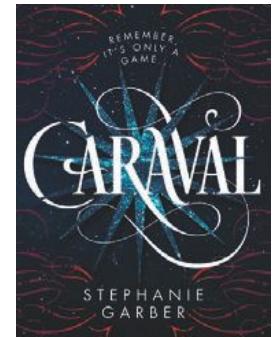
S. Jae-Jones

For 18 years, Liesl has heard tales about the mysterious Goblin King who surfaces every winter to take a bride for himself. This year, he chooses Liesl's younger sister. Left with no choice, Liesl races to the Underground to rescue her sister and herself before their fate is sealed.

Caraval

Stephanie Garber

Scarlett has always been mesmerised by the Caraval, a magical circus that occurs once a year and where the audience participates in the show. Joined by her sister, Tella, and a mysterious sailor, she arrives at the circus, only to have Tella kidnapped immediately by Legend, the circus master. Tella has five days to rescue her sister from the magic, audience and performers, as they all repeatedly tell her that everything is an elaborate performance.



ANITA Nair's book, *Muezza and Baby Jaan*, chronicles Islamic folklore and its myths, drawing both children and adults alike into that fabled world. The Bangalore-based author won the Sahitya Akademi Award in 2012, and writes in longhand using a fountain pen. *Muezza and Baby Jaan* is her second book for children.

EXCERPTS FROM AN INTERVIEW

How did you develop the idea for *Muezza and Baby Jaan*?

It basically came about during my research. I read anecdotes about the Prophet's cat and the kind of relationship they had, and that's when I realised that he would be the perfect storyteller. As for Baby Jaan, I came across some trivia about *djinns* and how they often appear in the desert as white camels, and, out of the blue, I had both my protagonists.

Why Islamic folklore?

All across India and the world, everyone has some basic knowledge about other religions, except perhaps for Islam. We know who Jesus's mother was and we know Ram's wife was Sita. But even the intelligentsia does not really know Islam and its stories. Islam has

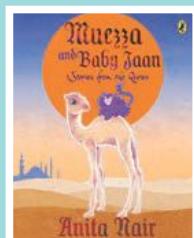
been misinterpreted and that is a risk every religion faces. I thought it was important to look up the scripture of Islam, namely the *Quran*, so it could be seen for what it truly is – a religion of peace and love.

Which is your favourite tale in the book?

The story of Qutmir the dog, who stood guard outside the cave for 300 years, is my favourite.

You have had books published in three different genres and for different age groups. How is writing for children different?

My writing process for this book wasn't any different. The thing about children is that you can't talk down to them. They smell patronisation from a mile away. So the storytelling has to be engaging and not just instructive. Besides, children these days have abysmally shorter attention spans, so it's important to talk to them in their language.



Do you see yourself more as an author or as a storyteller?

Definitely a storyteller.

What can we expect next from you?

I'm working on multiple projects – a literary novel, a collection of stories, a children's book and a screenplay.

Anita Nair spoke to Moshita Prajapati

GADGETS



EDITOR'S
CHOICE

EINSTEIN A-GOGO PROFESSOR EINSTEIN

Who hasn't always wanted their own animatronic Albert Einstein? This walking, talking robotic recreation of the famous physicist connects to an app on your iOS or Android tablet to play educational science and maths games, as well as functions as a personal digital assistant à la Siri, Cortana or Alexa. The robot has already exceeded its Kickstarter funding target, and should start shipping in April. \$598, www.professoreinstein.com

THE STYLOPHONE IS REBORN

STYLOPHONE GEN X-1

The popular '60s musical toy gets a 21st-century makeover. The new Gen X-1 version takes the basic analogue synth that sold over three million units between 1968 and 1975, and adds the kind of sound-shaping capabilities you'd find on a 'proper' synthesizer, including envelope, delay and filter controls, plus a low-frequency oscillator with rate and depth knobs and a choice of square and sawtooth waveforms. If the original was good enough for David Bowie, Kraftwerk and Orbital, just think what you could do with this! £60, www.dubreq.com



PIGS WILL FRY

BACON EXPRESS

While we don't find cooking an English breakfast particularly taxing, we're oddly drawn in by the Bacon Express – essentially a 'toaster' for slices of ex-pig. There's a dial on the side to select the cooking time, while, inside the machine, up to six strips of bacon hang vertically so that the fat drips off, making for a healthier meal.

£32; www.nostalgaelectrics.com



CRASH-PROOF COPTER

NIMBUS 195

Ever fancied buying a drone, but been put off by the certain knowledge you'd crash and smash it in about five minutes flat? The Nimbus 195's chubby body is built from tough but lightweight carbon fibre, while its propellers are made of flexible plastic. The result is a drone that can fly full-pelt into a wall or be run over by a car, and still live to tell the tale. It's waterproof, too.

\$750; www.aerodyne-rc.com



BREATHE EASY

ONE-LINK ENVIROCAMI

Baby monitor cameras are 10-a-penny, but this one will do a lot more than just let you keep an eye on your child while they're sleeping: it can also reassure you that they're breathing properly. Its 1080p night-vision camera detects the

tiny movements kids make as they breathe and uses this information to track their respiration rates, while built-in environmental sensors also monitor the room's temperature, humidity and carbon monoxide levels. £TBC; www.firstalert.com

T20:T20 VISION

FUJIFILM X-T20

This X-T20 camera replaces the X-T10 in Fujifilm's APS-C range. It's got a 24.3MP sensor, and now shoots 4K video at a frame rate of 30fps. It's equipped with a touchscreen LCD viewfinder that can be rotated if you need to shoot at awkward angles, and offers fast autofocus of 0.06s, with a choice of five modes for tracking moving objects. If that doesn't suit, then also new from Fujifilm are the X100 fixed-lens compact at \$1,300 and the mirrorless, medium-format GFX-50S at \$6,500.

\$900; www.fujifilm.com



NASA Science Investigations: Plant Growth
Roam freely around a faithful recreation of the ISS, and grow some vegetables while you're at it.
Free; iOS/Android



Filmic Pro
Lets you apply studio-quality post-production techniques to video shot on your iPhone 7 – though you'll need to put some work in if you want good results.
£9.99; iOS



Run The Solar System
Learn about the planets and asteroids as you build up to a 10K run, with this immersive training app for runners developed by the British Science Association.
Free; iOS/Android



NEWS FROM THE WORLD OF TRAVEL & FOOD

INFO NUGGETS FROM ACROSS THE GLOBE

MYANMAR



The **Kakku Pagoda Complex** in **Taunggyi** has over 2,500 stupas clustered together in just one square kilometre. It is a religious centre of the Pa-O people.

EGYPT



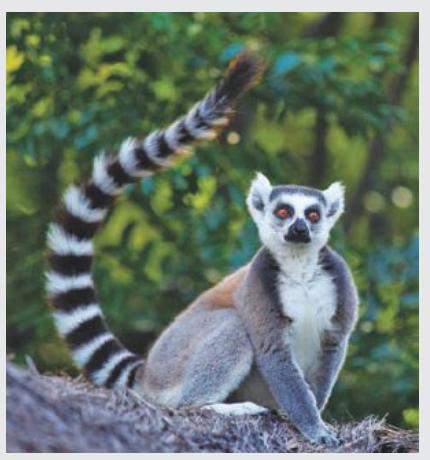
You can now trek the **Sinai Trail**, Egypt's first long-distance public hiking trail, with Bedouin guides from three different tribes. It's a different way to get up close and personal to the country's desert landscapes and people.

SRI LANKA



Fishermen in **Southern Sri Lanka** perch themselves on stilts to cast their lines. The practice is said to have begun during WWII. Today, there are more 'model' fishermen than real ones on the stilts.

MADAGASCAR



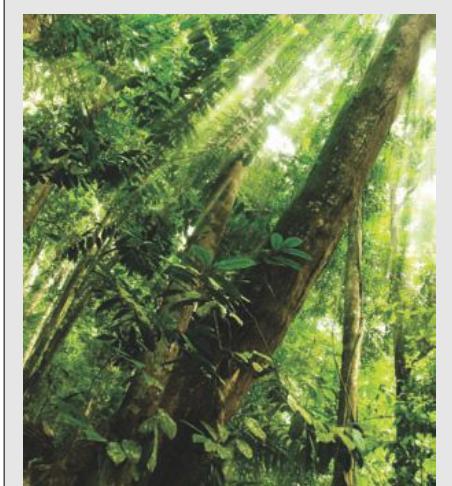
Lemurs are revered and protected by cultural taboo in **Madagascar**. They are believed to have souls that will seek revenge if hunted. Despite this, they are endangered from being hunted for meat.

ICELAND



Geysir in **Southwestern Iceland** is the original hot-water spout after which geysers are named. It can hurl boiling water up to 70 metres in the air.

MALAYSIA



Malaysia has the world's tallest tropical rainforest tree in **Sabah** and you will soon be able to visit it on a trek. The tree is a yellow meranti over 94 metres high.



5 GREAT-TO-KNOW FACTS ABOUT

ALCATRAZ, SAN FRANCISCO, THE USA

- Alcatraz was once known to be America's most notorious prison. Over three decades – from 1934 to 1963 – it held the likes of mob boss Al Capone and the killer ornithologist, Robert Stroud, who was nicknamed the 'Birdman of Alcatraz'.
- No prisoners have been known to escape by swimming the mile-long stretch of freezing water in San Francisco Bay between the island and the mainland. The most famous of the 14 escape attempts staged had Frank Morris and the Anglin brothers, John and Clarence, fashioning dummy heads to place on their pillows and climbing out onto the roof
- in 1962. All three remain officially missing.
- Food at Alcatraz was supposedly the best in the US prison system – to remove one of the common excuses for riots. Prisoners could eat all they liked, but could not waste. Cutlery was counted before and after meals to prevent inmates from squirrelling away potential weapons.
- Closed in 1963 because it was too expensive to run, Alcatraz is now a protected landmark and one of the city's most-visited attractions.
- Each year, over 2,000 athletes swim the bay in the Escape from Alcatraz Triathlon.

TRAVEL WITH FOOD



Banh Mi, Vietnam

A stuffed sandwich found in Vietnamese bakeries, the *banh mi* makes a hearty snack or a light meal. A nod to the days of French colonisation, the baguette here is made with rice flour along with the usual wheat flour. Fillings include

cooked pork and sausage, liver paté, grilled chicken, canned sardines and fried eggs, garnished with cucumber slices, chopped coriander, and shredded and pickled carrots and radishes. Vegetarian versions are made at Buddhist temples for religious events.

Snapshots

Natural-born killer

LEMBEH, INDONESIA

This blue and white harlequin shrimp was snapped by photographer Aldo Costa, who spotted it while diving in the waters off Lembeh, Indonesia.

The little crustaceans can grow to about five centimetres in length, and they live together as couples, with one male and one female. However, their beautiful appearance belies predatory habits that would make Bonnie and Clyde blush. The pair of shrimp go hunting for starfish, their main food source. Once they've found one, they'll work together to overpower it and flip it on its back. They'll then start consuming its tube feet, which are structures that the starfish uses for locomotion. Sometimes, they carry the unfortunate animal back to their lair, to continue eating it alive over a period of days or weeks. Incredibly, the shrimp have been recorded bringing food to the starfish, to keep it alive for even longer.

The starfish underneath the shrimp in this image had better make its escape – quickly!



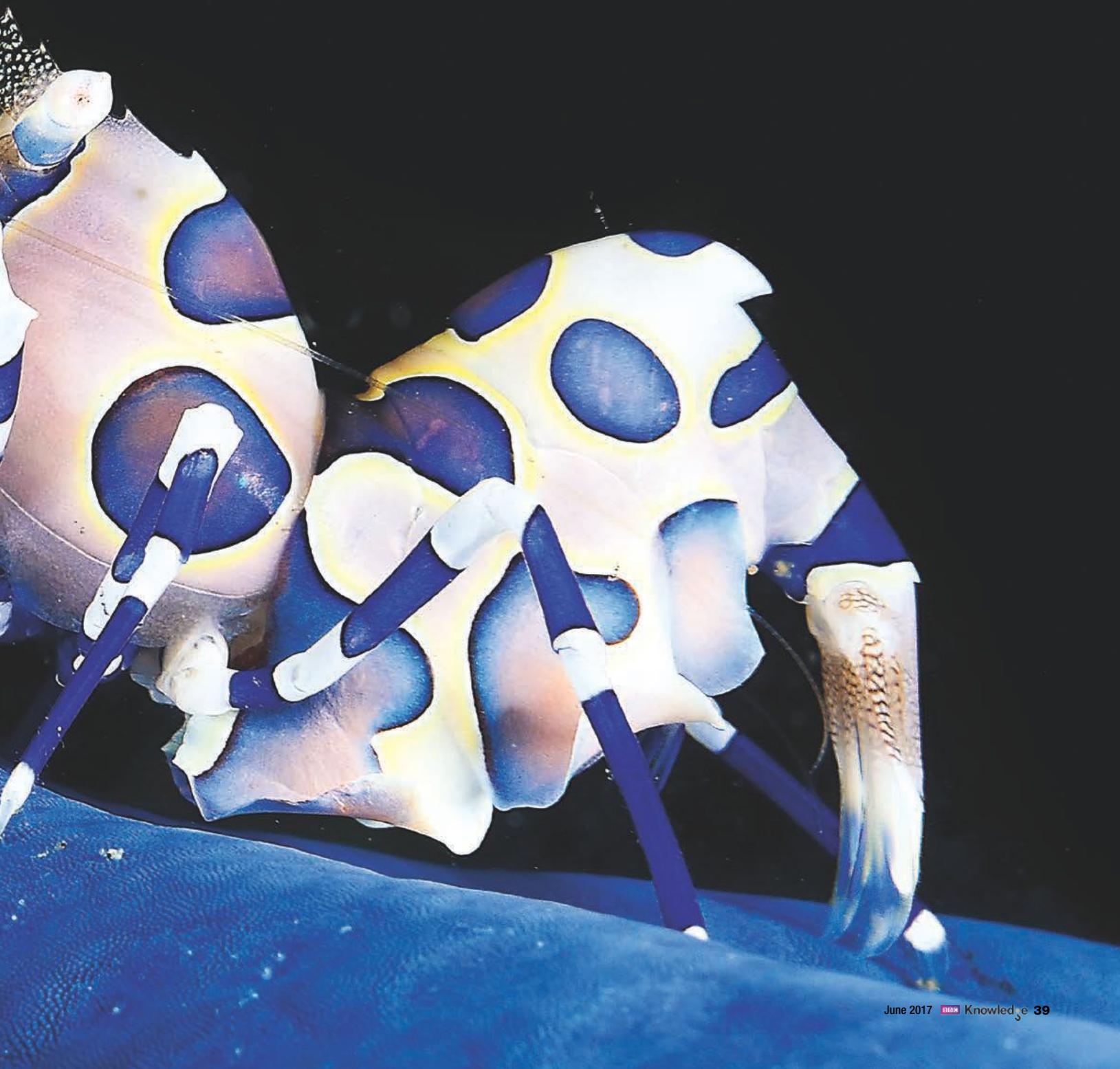




PHOTO: OLIVIER GRUNEWALD



Harsh climates

DANAKIL DEPRESSION, ETHIOPIA

The Dallol salt dome, seen here, rises from the floor of the Danakil Depression – part of the East African Rift, and one of the hottest places on Earth – in northern Ethiopia.

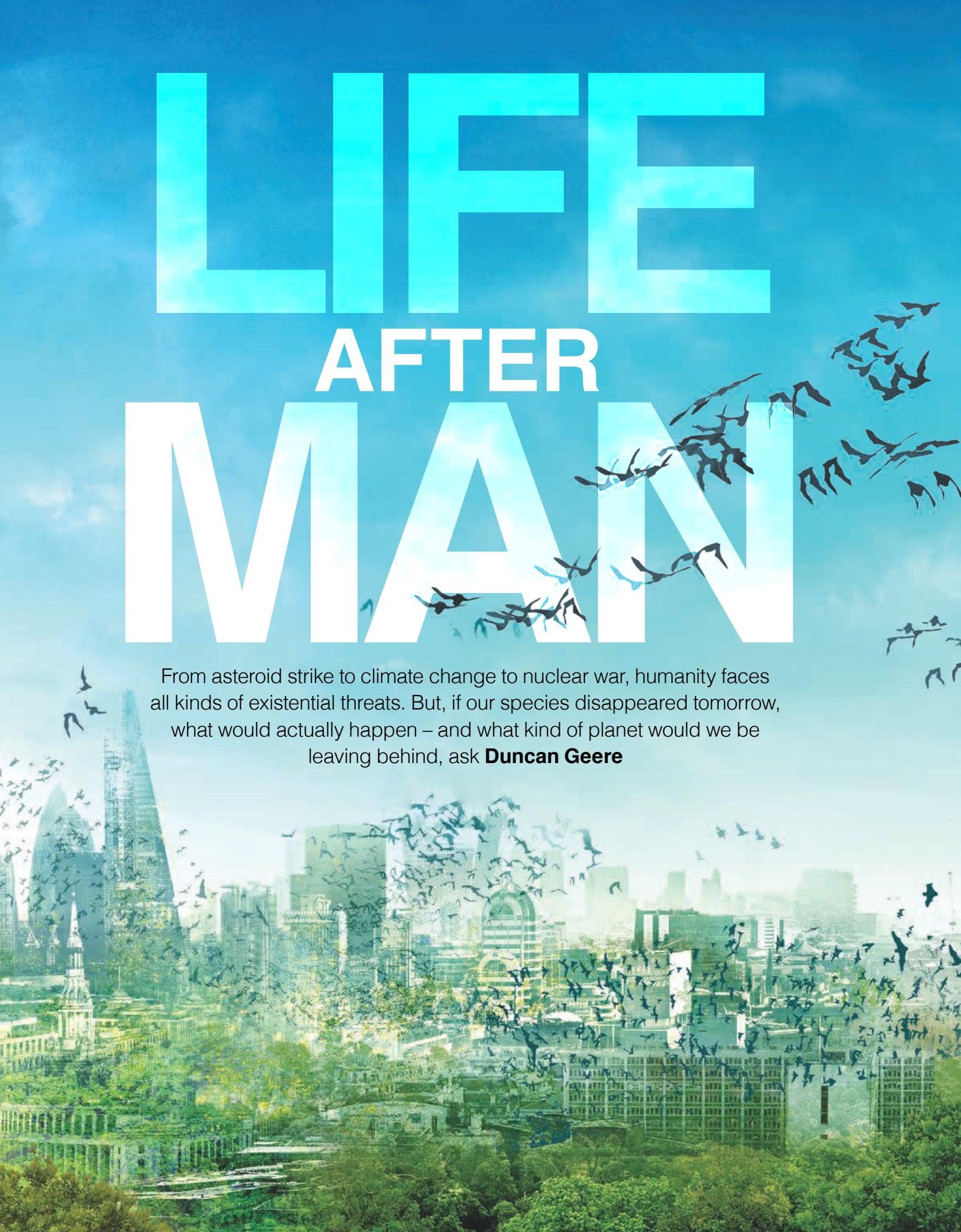
The Dallol salt dome lies at the heart of a system of hot springs, geysers, salt flows and oily lakes that give off acidic gas and smoke. The dome forms as briny water from springs evaporates when it reaches the surface, leaving the salts behind. As conditions here are thought

to be similar to those that prevailed on our planet when life first emerged, the area is of great interest to those studying 'extremophile' life forms.

Until recently, scientific research in the area has been limited, due to the war between Ethiopia and neighbouring Eritrea. But January 2016 saw a team of ecologists, microbiologists, geologists and crystallographers spend two weeks gathering samples under military protection. Since then, they've been busy analysing all the specimens they've collected. All we know so far is that they can "confirm the presence of extremophilic microorganisms," but astrobiologists, in particular, will be waiting to read their findings with great interest.



LIFE AFTER MAN



From asteroid strike to climate change to nuclear war, humanity faces all kinds of existential threats. But, if our species disappeared tomorrow, what would actually happen – and what kind of planet would we be leaving behind, ask **Duncan Geere**

W

E are living through the dawn of a new epoch in our planet's history – the Anthropocene. Humans have always shaped aspects of their environment, from fire to farming.

But the influence of Homo sapiens on Earth has reached such a level that it now defines current geological time.

From air pollution in the upper atmosphere to fragments of plastic at the bottom of the ocean, it's almost impossible to find a place on our planet that humankind has not touched in some way. But there's a dark cloud on the horizon. Well over 99 per cent of the species that have ever existed on Earth have died out, most during cataclysms of the sort that killed off the dinosaurs.

Humanity has never faced an event of that magnitude, but, sooner or later, we will.

THE END IS NIGH!

Human extinction, many experts believe, is not a matter of 'if', but 'when'. And some think it will come sooner rather than later. In 2010, eminent Australian virologist Frank Fenner claimed that humans will probably be extinct in the next century thanks to overpopulation, environmental destruction and climate change.

Of course, Earth can and will survive just fine without us. Life will persist, and the marks we've left on the planet will fade faster than you might think. Our cities will crumble, our fields will overgrow, and our bridges will fall. "Nature will break down everything eventually," says Alan Weisman, author of the 2007 book *The World Without Us*, which examines what would happen if humans vanished from the planet. "If it can't break stuff down, it eventually buries it."

Before too long, all that will remain of humanity will be a thin layer of plastic, radioactive isotopes

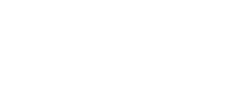


and chicken bones – we kill 60 billion chickens every year – in the fossil record. For evidence of this, we can look to areas of the planet that we've been forced to vacate.

In the 19-mile exclusion zone surrounding the Chernobyl power plant in Ukraine, which was severely contaminated following the 1986 reactor meltdown, plants and animals are thriving in ways they never did before. A 2015 study funded by the Natural Environment Research Council found "abundant wildlife populations" in the zone, suggesting that humans are far more of a threat to the local flora and fauna than 30 years of chronic radiation exposure.

The speed at which nature reclaims a landscape depends a lot on the climate of an area. In the deserts of the Middle East, ruins from thousands of years ago are still visible, but the same can't be said of cities only a few hundred years old in tropical forests.

In 1542, when Europeans first saw the rainforests of ▶



**"OF COURSE,
EARTH CAN AND
WILL SURVIVE JUST
FINE WITHOUT US.
LIFE WILL PERSIST"**

HOW COULD IT HAPPEN?

Six ways that the naked ape Homo sapiens could come to a sticky end



SYNTHETIC VIRUS

With millions of deaths chalked up to natural viruses like smallpox, influenza, HIV and Ebola, it's unsurprising that experts see an engineered virus as one of the key existential threats to humans. The first synthetic virus was created in 2002, and, with the genomes of over 3,000 viruses available online, it may only be a matter of time until one is deliberately released.



CLIMATE CHANGE

The rate at which humans are altering Earth's atmosphere is unprecedented, and will have dire consequences unless it is slowed. As the planet heats up, vast swathes of the world will become uninhabitable, leading to mass migration and conflict. Harvests will fail and the oceans will empty of fish. With nothing to eat and nowhere to live, it's hard to see us surviving for long.



SUPERVOLCANO ERUPTION

The eruption of a supervolcano, like the one below Yellowstone, could pump out so much ash that it would block out the Sun, sending the Earth into an ice age and driving huge numbers of species extinct along the way. Without the Sun's energy driving almost every natural process, humans have little hope of holding on.

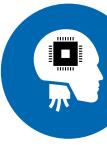


Just like these Roman ruins, today's buildings would still be recognisable in the future

AI TAKEOVER

Experts estimate that we'll arrive at an AI as smart as a human within the next few decades.

But it won't stop there: soon the AI will be far smarter, and we'll no more be able to comprehend its thinking than a dog can comprehend ours. The likely result? Immortality, if we can keep our digital servants focused on the right goals. Or extinction, if we can't.



NUCLEAR APOCALYPSE

The number of nuclear-armed countries is rising. Any significant exchange of nuclear weapons would have a similar effect to the eruption of a supervolcano, with ash blocking out the Sun. A nuclear winter, combined with the radioactive fallout, would result in a world where, as former Soviet leader Nikita Khrushchev once said, "the living will envy the dead."



ANTIBIOTIC RESISTANCE

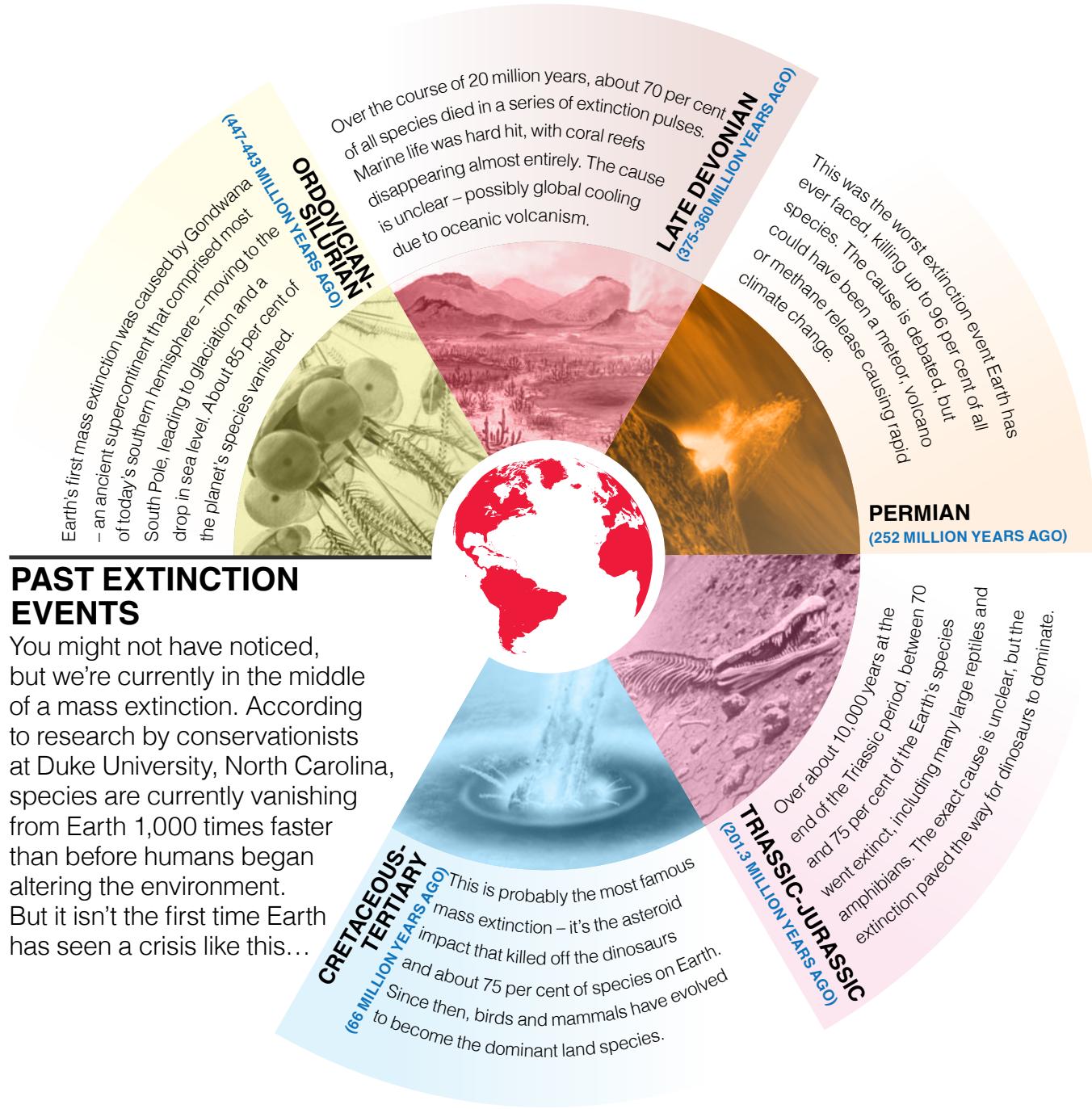
The discovery of penicillin in 1928 changed the world: an infection was no longer a death sentence but a minor inconvenience. But the overprescription of antibiotics, combined with the meat industry's fondness for routine antibiotic injections into healthy animals, has bred an increasing number of superbugs that are immune to our strongest medicines. Without scaling back our use or discovering new sources of the drugs, we'll be on a fast road back to the bad old days.

Brazil, they reported cities, roads and fields along the banks of major rivers. After the population was decimated by diseases that the explorers brought with them, however, these cities were quickly reclaimed by the jungle. The ruins of Las Vegas are certain to persist far longer than those of Mumbai. Only now do deforestation and remote sensing techniques offer us a glimpse of what came before.

Plant and animal species that have formed close bonds with humanity are the most likely to suffer if we disappear. The crops that feed the world, reliant as they are on regular applications of pesticides and

fertilisers, would swiftly be replaced by their wild forebears. "They're going to get outcompeted, fast," says Weisman. "Carrots will turn back into Queen Anne's lace, corn may go back into teosinte – the original ear of corn that wasn't much bigger than a sprig of wheat."

The sudden disappearance of pesticides will also mean a population explosion for bugs. Insects are mobile, reproduce quickly and live in almost any environment, making them a highly successful class of species, even when humans are actively trying to suppress them. "They can mutate and adapt faster than anything else on the planet except for maybe



microbes," explains Weisman. "Anything that looks delicious is going to get devoured."

The bug explosion will in turn will fuel a population increase in bug-eating species, like birds, rodents, lizards, bats and spiders, and, then, a boom in the species that eat those animals, and so on all the way up the food chain. But what goes up must come down – those huge populations will be unsustainable in the long term once the food that humans left behind has been consumed. The reverberations throughout the food web caused by the disappearance of humankind may still be visible as much as 100 years into the future, before things settle down into a new normal.

Some wilder breeds of cattle or sheep could survive, but most have been bred into slow and docile eating machines that will die off in huge numbers. "I think they will be very quick pickings for these feral carnivores or wild carnivores that are going to start proliferating," says Weisman. Those carnivores will include human pets, more likely cats than dogs. "I think that wolves are going to be very successful and they're going to outcompete the hell out of dogs," Weisman says. "Cats are a very successful non-native species all over the world. Everywhere they go, they thrive."

The question of whether 'intelligent' life could evolve again is harder to answer. One theory holds that intelligence evolved because it helped our early ancestors survive environmental shocks. Another is that intelligence helps individuals to survive and reproduce in large social groups. A third is that intelligence is merely an indicator of healthy genes. All three scenarios could plausibly occur again in a post-human world.

"The next biggest brain in the primates per bodyweight is the baboon's, and you could say that they're the most likely candidate," says Weisman. "They live in forests, but they've also learned to live on forest edges. They can gather food in savannahs really well, they know how to band together against predators. Baboons could do what we did, but, on the other hand, I don't see any motivation for them. Life is really good for them the way it is."

POLLUTED PLANET

The shocks that could drive baboons (or other species) out of their comfort zone could be set in motion by the disappearance of humans. Even if we all vanished tomorrow, the greenhouse gases we've pumped into the atmosphere will take tens of thousands of years to return to pre-industrial levels. Some scientists believe that we've already passed crucial tipping points – in the polar regions particularly – that will accelerate climate change even if we never emit another molecule of CO₂.

Then, there's the issue of the world's nuclear plants. The evidence from Chernobyl suggests that ecosystems can bounce back from radiation releases, but there are about 450 nuclear reactors

PHOTOS: GETTY X3, SCIENCE PHOTO LIBRARY X2, ALAMY

"SPECIES THAT HAVE CLOSE BONDS WITH HUMANITY ARE MOST LIKELY TO SUFFER"



around the world that will start to melt down as soon as the fuel runs out in the emergency generators that supply them with coolant. There's just no way of knowing how such an enormous, abrupt release of radioactive material into the atmosphere might affect the planet's ecosystems.

And that's before we start to consider other sources of pollution. The decades following human extinction will be pockmarked by devastating oil spills, chemical leaks and explosions of varying ▶

Domestic cats, like these that inhabit Aoshima Island in Japan, will probably do well in a human-free world

sizes – all ticking time bombs that humanity has left behind. Some of those events could lead to fires that may burn for decades. Below the town of Centralia in Pennsylvania, a seam of coal has been burning since at least 1962, forcing the evacuation of the local population and the demolition of the town. Today, the area appears as a meadow with paved streets running through it and plumes of smoke and carbon monoxide emerging from below. Nature has reclaimed the surface.

THE FINAL TRACES

But some traces of humankind will remain, even tens of millions of years after our end. Microbes will have time to evolve to consume the plastic we've left behind. Roads and ruins will be visible for many thousands of years (Roman concrete is still identifiable 2,000 years later) but will eventually be buried or broken up by natural forces.

It feels reassuring that our art will be some of the last evidence that we existed. Ceramics, bronze statues and monuments like Mount Rushmore will be among our most enduring legacies. Our broadcasts, too: Earth has been transmitting its culture over electromagnetic waves for over 100 years, and those waves have passed out into space. So 100 light-years away, with a large enough antenna, you'd be able to pick up a recording of famous opera singers in New York – the first public radio broadcast, in 1910. Those waves will persist in recognisable form for a few million years, travelling further and further from Earth, until they eventually become so weak they're indistinguishable from the background noise of space.

But even radio waves will be outlived by our spacecraft. The Voyager probes, launched in 1977, are whizzing out of the Solar System at a speed of almost 60,000km/hour. As long as they don't hit anything, which is pretty unlikely (space is very empty), they'll outlive Earth's fatal encounter with an inflating Sun in 7.5 billion years. They will be the last remaining legacy of humankind, spiralling forever out into the inky blackness of the Universe. ☐

PHOTOS: GETTY X13, SCIENCE PHOTO LIBRARY, 123RF X3

Duncan Geere is a freelance journalist who writes about science, technology and the environment.



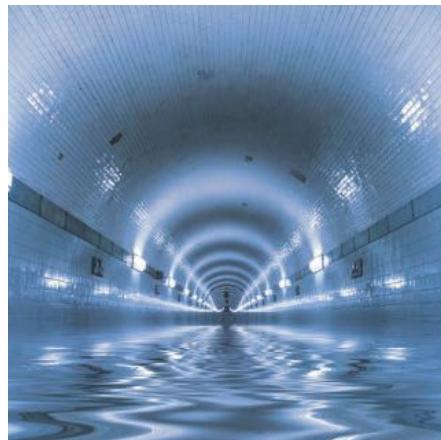
7 DAYS

Fuel runs out at the emergency generators that pump coolant into nuclear power plants. Approximately 450 reactors around the world begin to melt down.



NO MORE HUMANS ANY MORE...

A post-apocalyptic timeline



2 DAYS

Without active maintenance and pumping, New York City's subways flood with water and become impassable.



1 YEAR

Human head and body lice go extinct, while cockroaches in cities at temperate latitudes freeze to death. Domestic and farm animals perish in enormous numbers.





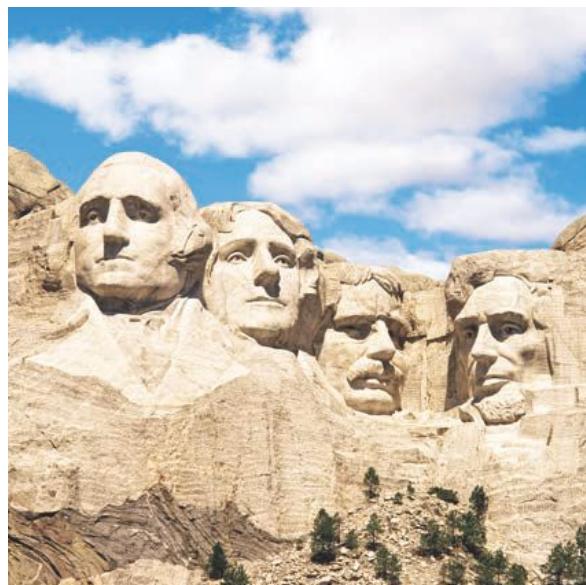
3 YEARS

Pipes burst in colder regions, flooding cities with water. Buildings lose structural integrity as they expand and contract with temperature changes.



100,000 YEARS

CO₂ in the atmosphere returns to pre-industrial levels. Microbes evolve to biodegrade plastic. Plutonium bombs made during the age of humans become safe to handle.



20 YEARS

The Panama Canal closes, rejoining North and South America. Many crops disappear, outcompeted by wild varieties.



300 YEARS

Most of the world's bridges fall. Dams silt up and overflow, washing away entire cities. Suburbs become forests as endangered species rebound.



10,000, 000 YEARS

Bronze sculptures are still recognisable, as are the faces on Mount Rushmore. Life still thrives on Earth, but in new forms.

In the Pink

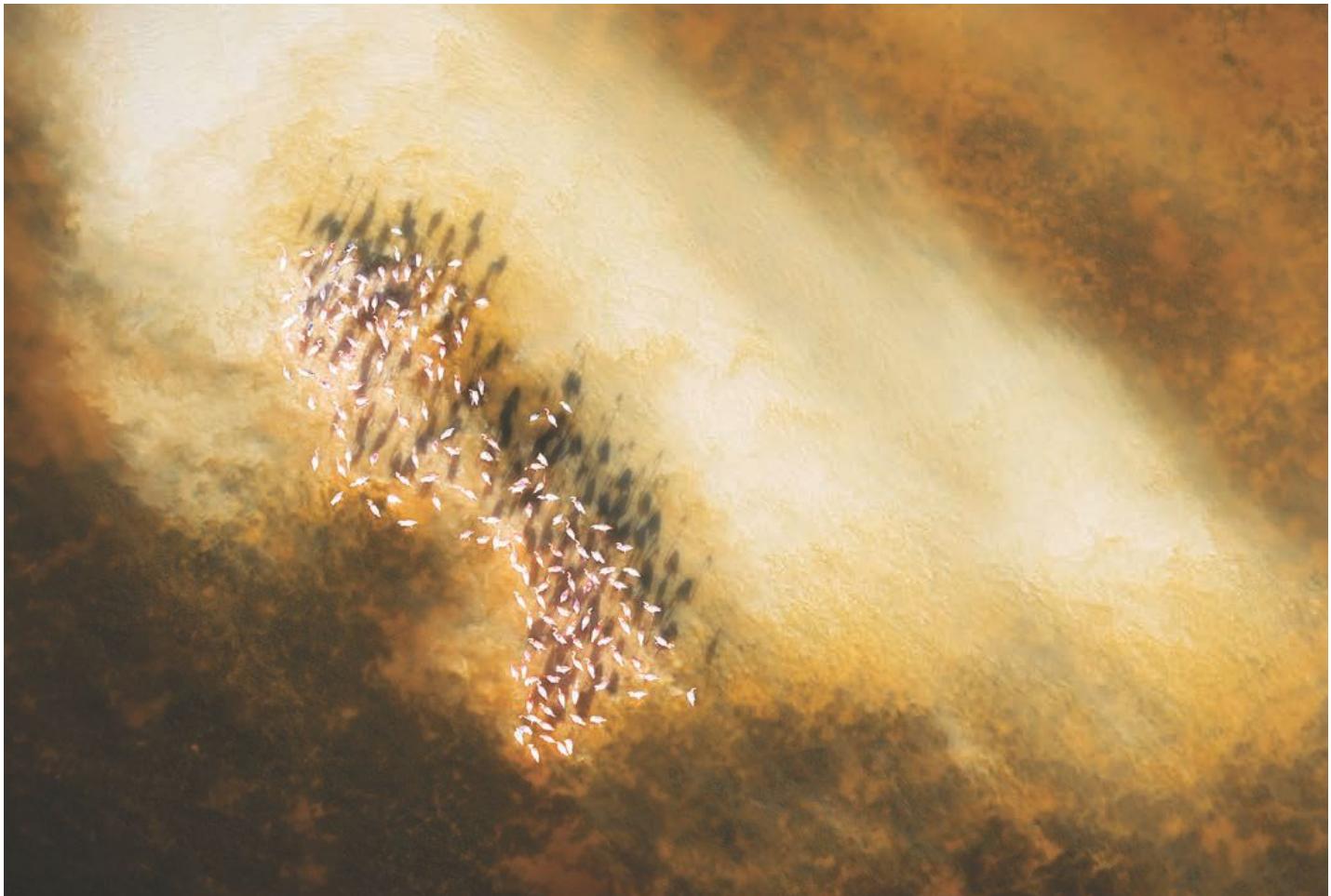
Caribbean flamingos create a colourful spectacle in Mexico's Yucatán Peninsula. Wildlife photographer **Alejandro Prieto** has documented these extraordinary birds in this stunning wetland habitat

Text by Paul Rose





A parent flamingo, most likely the father based on the adult bird's height, feeds its chick. Flamingos lay a single, large, white, chalky egg and raise one youngster per breeding season, which occurs between May and July. Both the male and female have a role in nest building, egg incubation and feeding. Flamingos secrete 'milk' from specialised cells that line their crop, and feed their chick by dribbling the protein-rich liquid into their offspring's beak. The milk is packed full of carotenoids and quite literally drains the parent birds of their pink colour.



Flamingos are well-known for being gregarious, but Caribbean flamingos can buck this trend. Some colonies of only three or four pairs have been noted. Normally, however, it's a case of 'the more, the merrier'. When it's time to breed, flamingos will gather in tightly-packed groups to perform their courtship dances, involving elaborate shows of colour, wing movements and noise.

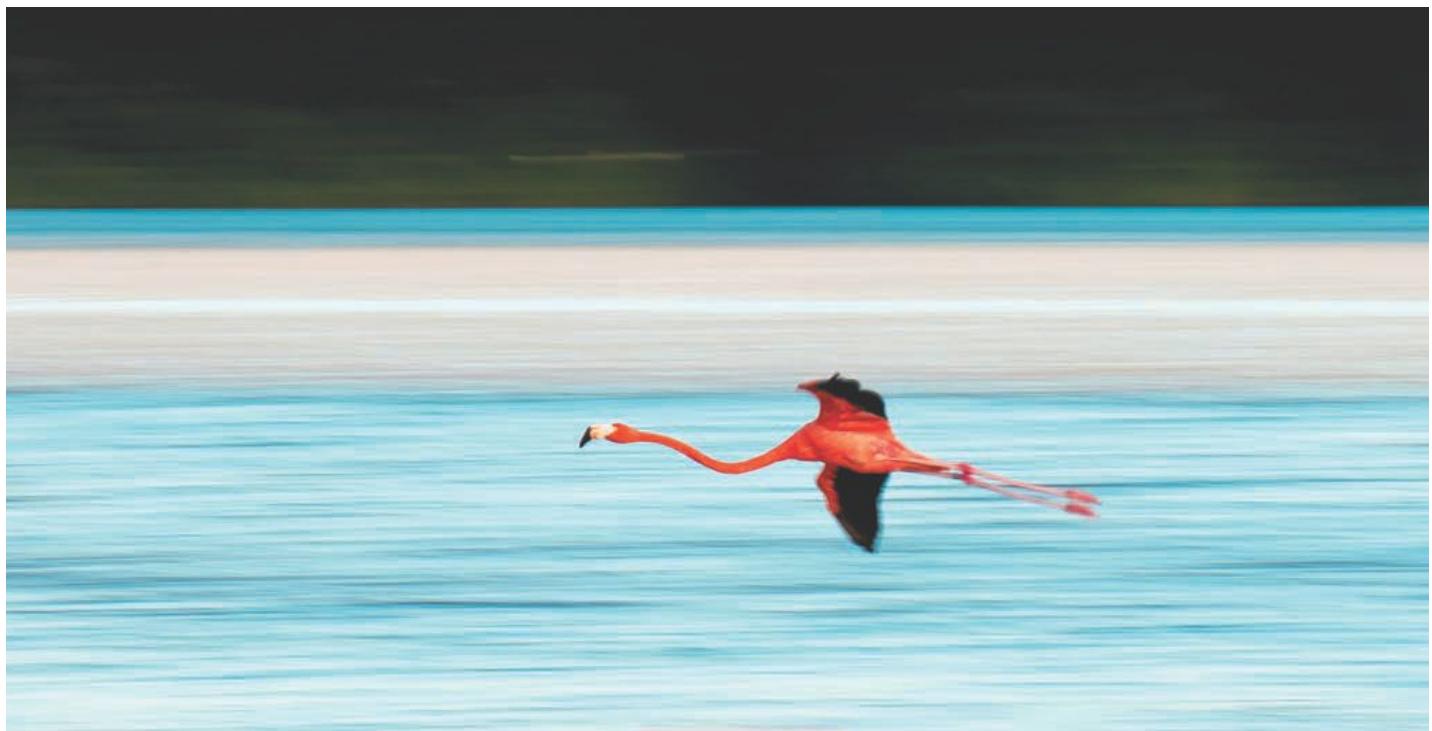
Flamingos are nomadic rather than migratory, roaming great distances to find feeding and breeding grounds. Flamingo populations can be hit hard by climatic changes, such as El Niño, which can flood nest sites or reduce the availability of food. Man-made habitat changes that affect the salinity of wetlands also pose a risk to the survival of these birds.



Outside of the breeding season, feeding, preening and loafing (resting) account for most of a flamingo's daily activities. Feeding flocks spread themselves out widely to avoid competition and reduce squabbling. The Caribbean flamingo is a generalist feeder, and consumes plant and animal material by using its tongue to pump water inside its beak and filter out suspended food particles.



Carotenoid pigments that flamingos ingest are metabolised within the bird to produce their eye-catching pink colour. Carotenoids also change the colour of the flamingo's skin, mucous membranes, egg yolk, crop milk and fat. Caribbean flamingos were once considered a subspecies of the paler greater flamingo. Although similar in size, differences between these two birds mean they are now classified separately.





A single bird sits at Rio Lagartos, the species' main nest site in Mexico. Nest mounds create an austere sight at the end of the breeding season, though flamingos will reuse such mounds in future years if conditions in the area remain favourable. Both parents build the mounds, which involves rolling up small pellets of mud and shaping them into a cone-shaped nest. Birds will continue to raise the level of their nests by building throughout the incubation period, hence the nests' differing heights. After breeding, parent birds are instantly recognisable by their white feathers, which will remain until each individual rebuilds its carotenoid stores and molts into a new set of pink plumage.

All flamingo species gather their youngsters together in nursery groups, watched over by 'babysitters' while the parents go off to feed and bathe. As its own filtering mechanism develops, the chick is fed directly by its parents. Gradually, over the course of three to four years, the grey juvenile plumage changes to the deep pink of the mature bird.



A pale parent flamingo mingles within a gaggle of non-breeding birds. Colour is integral to flamingo society; intensity and brightness of hue are used by birds to select partners and to signal intention to breed. Both colour and dancing are required to synchronise mass breeding attempts.



Like all flamingos, Caribbeans have jet black primary and secondary wing feathers. *Phoenicopterus*, the genus to which the Caribbean flamingo belongs, translates as 'crimson wing', highlighting the deep pink covert feathers that contrast with these black plumes. This differentiation of red, pink and black is harnessed by courting flamingos in their breeding displays. Flashes of black ripple against the overall pink background of the dancing flock as birds perform wing-salutes and twist-preens.





Flamingo nesting colonies are noisy, bustling affairs as the birds are active around the clock caring for growing chicks. The light of a full moon shows this hive of activity, as birds stand guard over their young or incubate newly-hatched birds to keep them warm. Flamingos can be crepuscular in their non-breeding activities too, taking advantage of bright moonlight to forage for swarms of brine shrimp when there's less competition from other waders. ☽

Alejandro Prieto is a professional wildlife and conservation photographer from Guadalajara, Mexico. You can see more of his amazing pictures at www.alejandroprietophotography.com.



With around 30,000 flamingos gathering on the Yucatán Peninsula at any one time, it's a spectacular sight when they take to the air.

Flamingos require a runway to get airborne as they are heavy birds with relatively small wings. This Mexican population breeds in locations throughout the Rio Lagartos Estuary.

The Caribbean flamingo has an increasing population trend, but the birds are still vulnerable to human encroachment on nesting and wintering grounds, and from the wider implications of climate change.



THE VIRUSES THAT MADE US

VIRUSES GIVE US INFECTIONS,
FROM THE COMMON COLD
TO EBOLA AND AIDS.
BUT NEW RESEARCH SHOWS THAT
THEY MAY ALSO HAVE PLAYED
A KEY ROLE IN SHAPING THE
EVOLUTION OF HOMO SAPIENS,
WRITES KAT ARNEY

Z

IKA, Ebola, flu, even the boring old common cold – we're all familiar with the viruses that plague humanity. But while we know they make us sick, it may be surprising to discover that, over millions of years, we've managed to harness and domesticate these crafty invaders. From the earliest stages

of life to the smiles on our faces, viruses have had a huge influence on our human species.

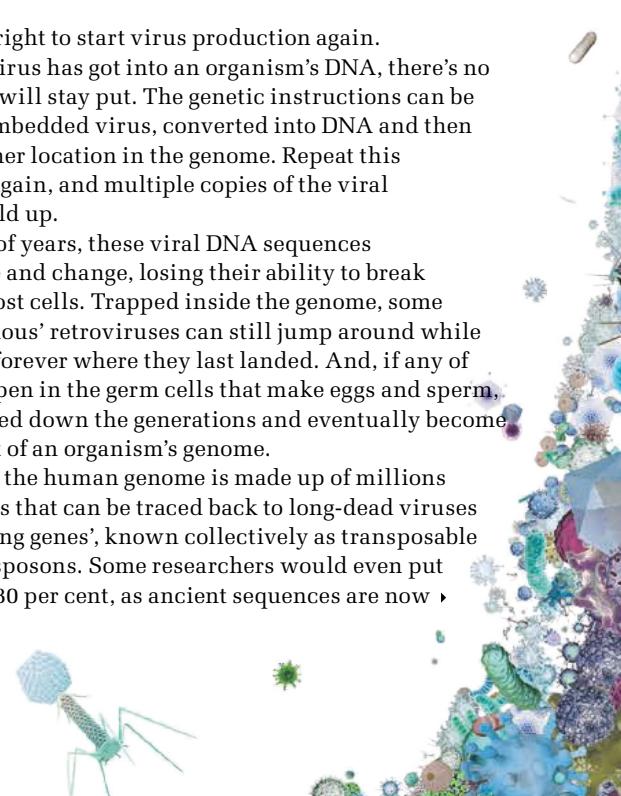
Viruses are little more than a string of genes (usually in the form of a molecule called RNA) packaged in a protein coat, and they all work in the same basic way. Once a virus has infected a cell, it hijacks the cell's own molecular machinery to copy its genes and churn out viral proteins. New viruses are assembled from these freshly-manufactured parts, which eventually burst out in search of new cells to attack.

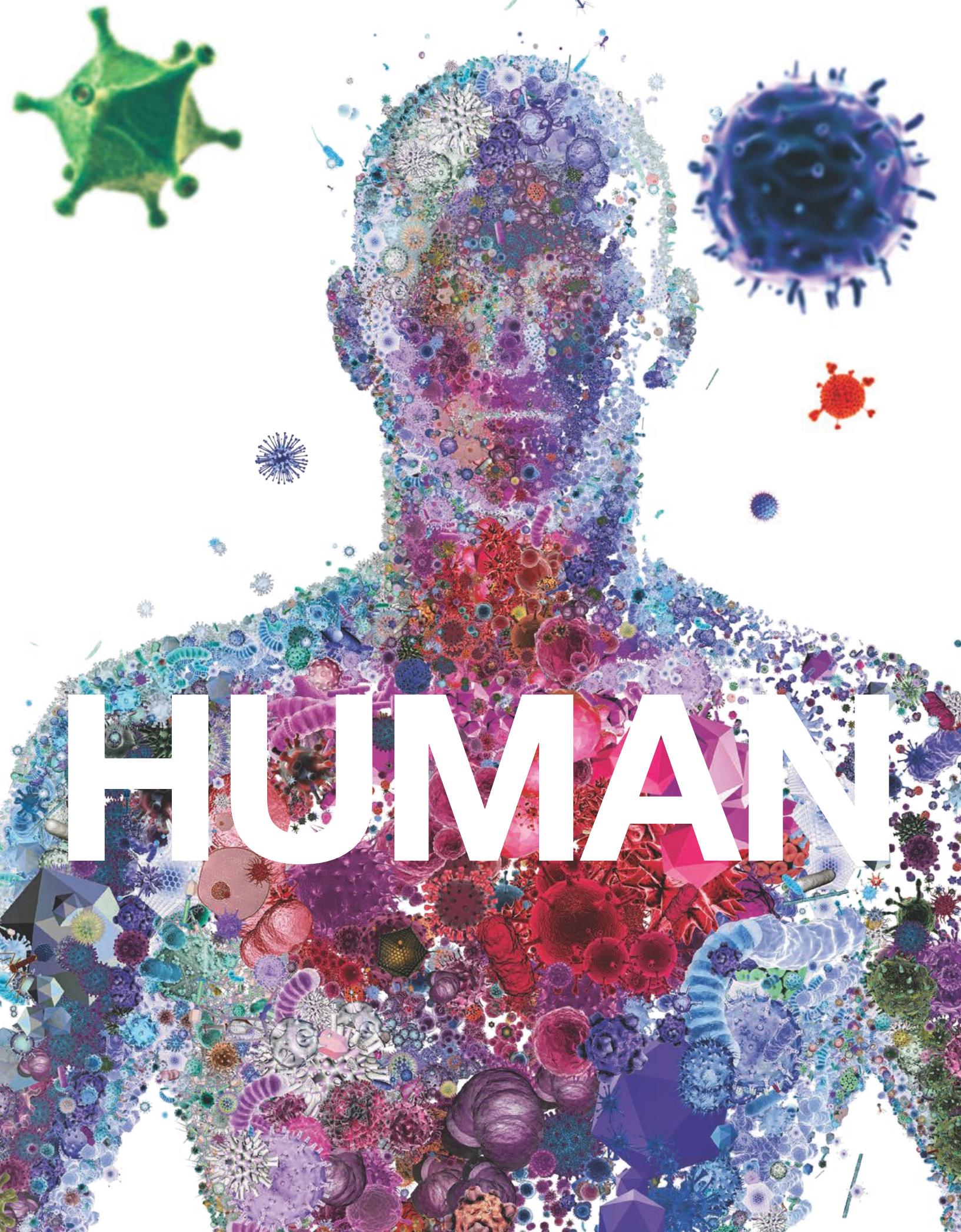
For most viruses, such as flu, the story ends there. But a handful of retroviruses – including HIV – are even sneakier, smuggling their way into our DNA. They insert themselves randomly into the genome of an organism, lying low

until the time is right to start virus production again. But once a retrovirus has got into an organism's DNA, there's no guarantee that it will stay put. The genetic instructions can be 'read' from the embedded virus, converted into DNA and then pasted into another location in the genome. Repeat this cycle again and again, and multiple copies of the viral DNA quickly build up.

Over millions of years, these viral DNA sequences randomly mutate and change, losing their ability to break free from their host cells. Trapped inside the genome, some of these 'endogenous' retroviruses can still jump around while others are stuck forever where they last landed. And, if any of these events happen in the germ cells that make eggs and sperm, they will be passed down the generations and eventually become a permanent part of an organism's genome.

Around half of the human genome is made up of millions of DNA sequences that can be traced back to long-dead viruses or similar 'jumping genes', known collectively as transposable elements or transposons. Some researchers would even put this figure up at 80 per cent, as ancient sequences are now ▶





HUMAN

degraded beyond the point of being recognisably virus-like, weathered within the genome like molecular fossils.

For many years, the large chunks of repetitive virus-derived DNA littering the human genome were dismissed as 'junk'. A proportion of this repetitive stuff undoubtedly is little more than junk in our genetic trunk, but, as researchers look more closely at individual viral elements, a more sophisticated picture is emerging. And it turns out that, as well as being our genetic enemies, some of the viruses embedded in our genome have become our slaves.

Making mammals

Around 15 years ago, US researchers discovered a human gene that was only active in the placenta. They called it syncitin, because it makes a molecule that fuses placental cells together, creating a special layer of tissue known as a syncitium. Curiously, syncitin looks a lot like a gene from a retrovirus. Another syncitin gene was later discovered, which is also involved in forming the placenta as well as preventing the mother's immune system from attacking the foetus in her womb. Again, the gene looks like it has come from a retrovirus.

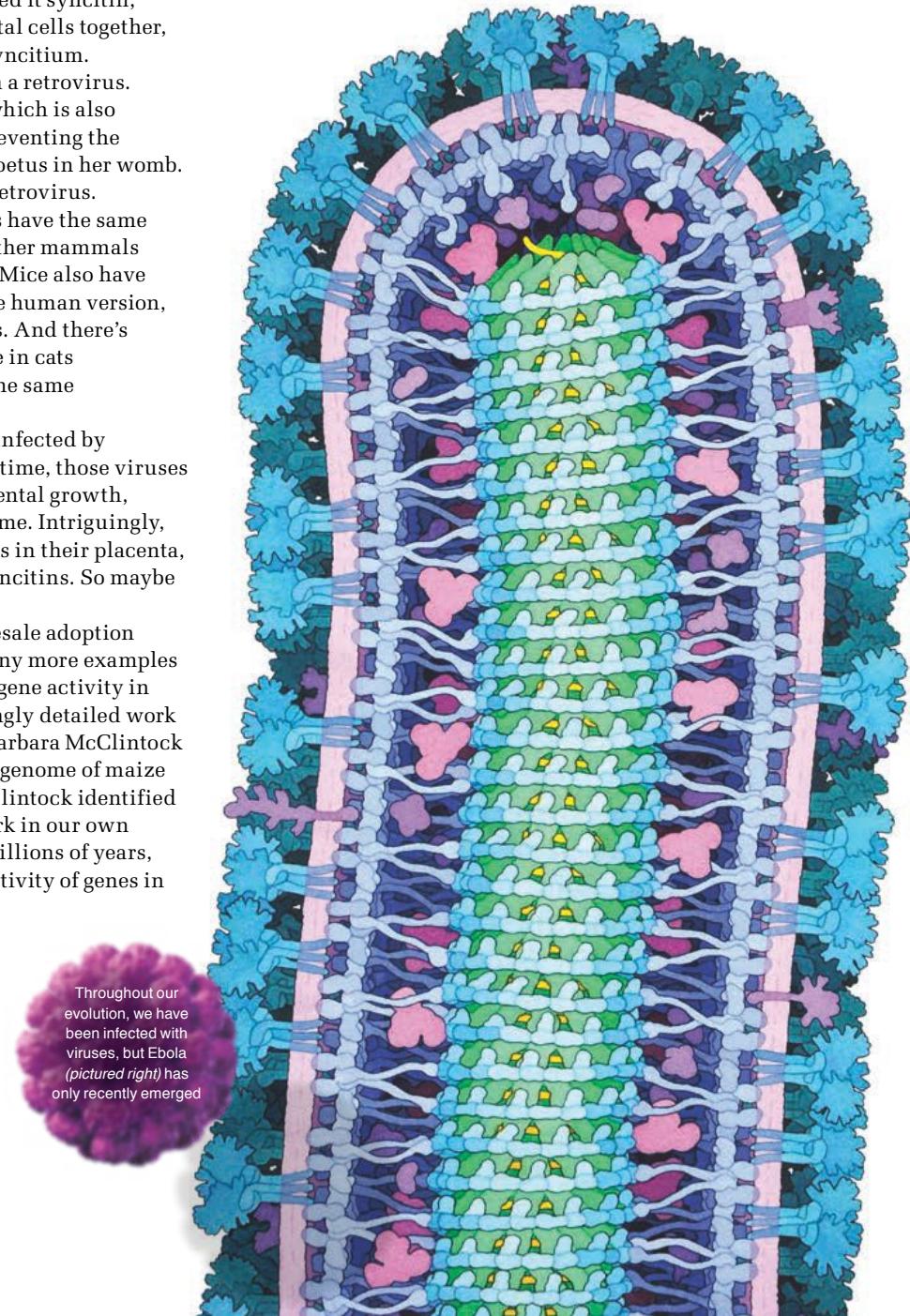
But, while humans and other large primates have the same two syncitin genes, they aren't found in any other mammals with similar fused cell layers in the placenta. Mice also have two syncitin genes: they do the same job as the human version, but they look like completely different viruses. And there's another separate virally-derived syncitin gene in cats and dogs, both of which are descended from the same carnivorous ancestors.

Clearly, all these mammalian species were infected by particular viruses millions of years ago. Over time, those viruses have been harnessed to play a key role in placental growth, making them a permanent fixture in our genome. Intriguingly, pigs and horses don't have a layer of fused cells in their placenta, nor any genes that look like virally-derived syncitins. So maybe they never caught one of these fusing viruses.

While the case of syncitin reveals the wholesale adoption of a virus gene to do our bidding, there are many more examples of how ancient viral sequences can influence gene activity in today's humans. Back in the 1950s, painstakingly detailed work by the long-overlooked American geneticist Barbara McClintock revealed that 'jumping genes' could affect the genome of maize plants. And, just like the 'jumping genes' McClintock identified in maize, the endogenous retroviruses that lurk in our own human genome have been on the move over millions of years, jumping around at random and altering the activity of genes in their immediate vicinity.

Our cells invest a lot of energy in attempting to stop these viral elements from going on the hop. They're labelled and locked down with chemical tags, known as epigenetic marks. But, as the viral elements move, these molecular silencers move with them, so the viral sequences' effects can spread to neighbouring genes wherever they land.

"AS WELL AS BEING OUR GENETIC ENEMIES, SOME OF THE VIRUSES EMBEDDED IN OUR GENOME HAVE BECOME OUR SLAVES"

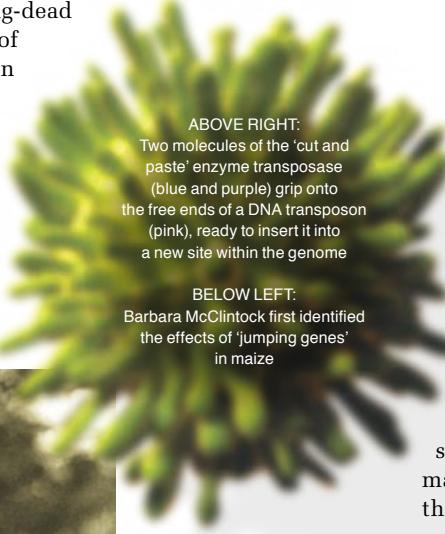


Conversely, viruses are also full of DNA sequences that attract molecules that switch genes on. In a functional retrovirus, these 'switches' activate the viral genes so it can become infectious again. But, when a virus-like sequence gets spliced into another region in the genome, this ability to act as a genetic switch can end up going rogue.

In 2016, scientists at the University of Utah found that an endogenous retrovirus in the human genome – which originally came from a virus that infected our ancestors roughly 45 million to 60 million years ago – switches on a gene called AIM2 when it detects a molecule called interferon, which is the 'danger signal' that warns the body that it's suffering a viral infection. AIM2 then forces the infected cells to self-destruct, to prevent the infection from spreading any further. These ancient viruses have become 'double agents', helping our cells to tackle other viruses that are trying to attack us.

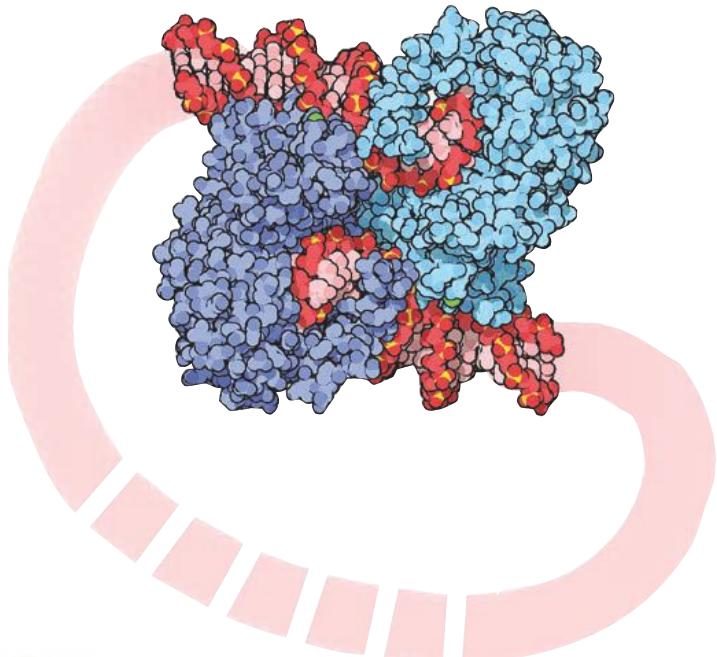
Another example of a virus that may have shaped our species is found near a gene called PRODH. PRODH is found in our brain cells, particularly in the hippocampus. In humans, the gene is activated by a control switch made from a long-dead retrovirus. Chimpanzees also have a version of the PRODH gene, but it's not nearly so active in their brains. One possible explanation is that an ancient virus hopped a copy of itself next to PRODH in one of our long-dead ancestors, millions of years ago, but that this didn't happen in the ancestral primates that went on to evolve into today's chimps. Today, faults in PRODH are thought to be involved in certain brain disorders, so it's highly likely to

PHOTOS: DAVID S GOODMAN/RCSB PROTEIN DATA BANK X2, GETTY X2, ALAMY



ABOVE RIGHT:
Two molecules of the 'cut and paste' enzyme transposase (blue and purple) grip onto the free ends of a DNA transposon (pink), ready to insert it into a new site within the genome

BELOW LEFT:
Barbara McClintock first identified the effects of 'jumping genes' in maize



have had at least some kind of influence on the wiring of human brains.

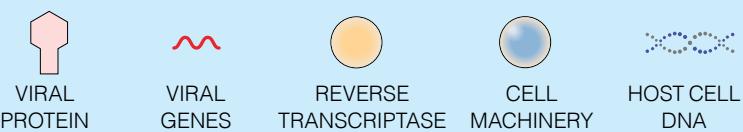
Similarly, variations in genetic switches are responsible for the differences between the cells that build our human faces as we grow in the womb and those of chimps. Although our genes are virtually identical to chimpanzee genes, we certainly don't look the same.

So the difference must lie in the control switches. Judging by their DNA sequences, many of the switches that are active in the cells that grow our faces seem to have originally come from viruses, which must have hopped into place sometime in our evolutionary journey towards becoming the flat-faced species we are today.

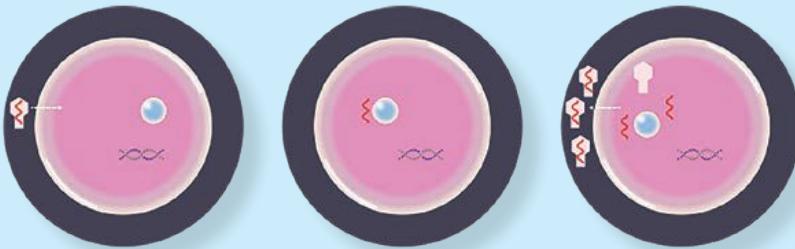
The virus tamers

As well as searching for examples of long-dead viruses that have altered our biology, scientists are searching for the control mechanisms that underpin their effects. The key culprits are special silencing molecules called KRAB Zinc Finger Proteins (KRAB ZFPs), which grab hold of viral sequences in the genome and pin them in place. Prof Didier Trono and his team at the University of Lausanne in Switzerland have discovered more than 300 different KRAB ZFPs in the human genome, each of which seems to prefer a different virally-derived DNA target. ▶

HOW VIRUSES WORK



MOST VIRUSES (EG. FLU)



INFECTION

First of all, the virus infects a host cell. Its protective protein coat breaks down and the virus releases its genes.

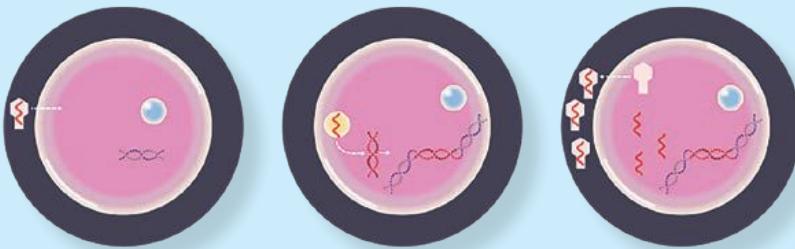
HIJACK!

The virus then takes over the cell machinery that makes genes and proteins. The virus forces it to copy its own genes and make viral proteins.

DUPLICATION

New viruses will be assembled inside the host cell. Eventually, they will break out and go in search of new hosts to infect.

RETROVIRUSES (EG. HIV)



INFECTION

The virus infects a host cell. Its protein coat is broken down and the viral genes (in the form of a DNA-like molecule called RNA) are released into the cell.

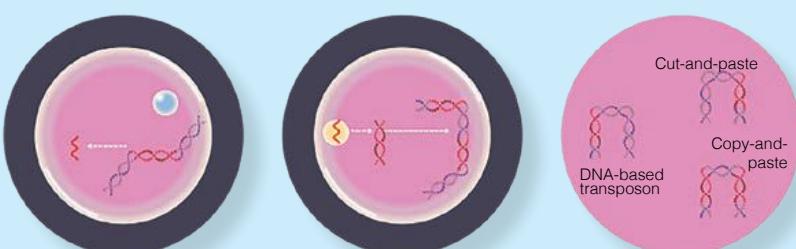
INSERTION

In the cell, the viral RNA uses an enzyme called reverse transcriptase to convert its RNA into DNA, which it inserts into the host's genetic material.

DUPLICATION

Once integrated into the cell's DNA, the virus uses the cell machinery to create more viral proteins and RNA, which assemble on the cell's surface.

TRANSPOSONS (JUMPING GENES)



CREATION

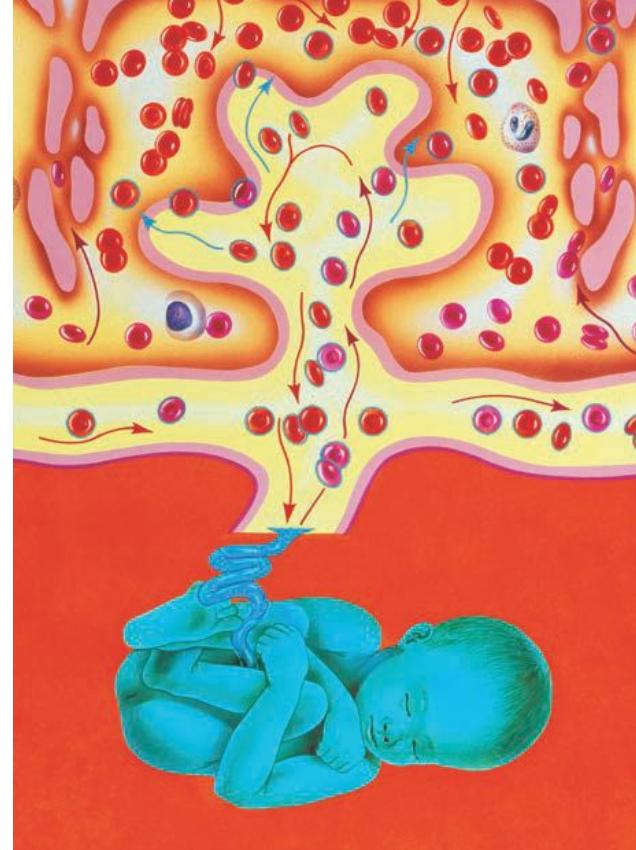
Retroviruses embedded in the cell's DNA create viral RNA.

INSERTION

Reverse transcriptase is then used to convert the viral RNA into viral DNA. The viral DNA is inserted somewhere else into the host's DNA.

OTHER METHODS

Not all transposons use the RNA copying step. Others can move through the genetic sequence using DNA-based 'cut-and-paste' or 'copy-and-paste' methods.



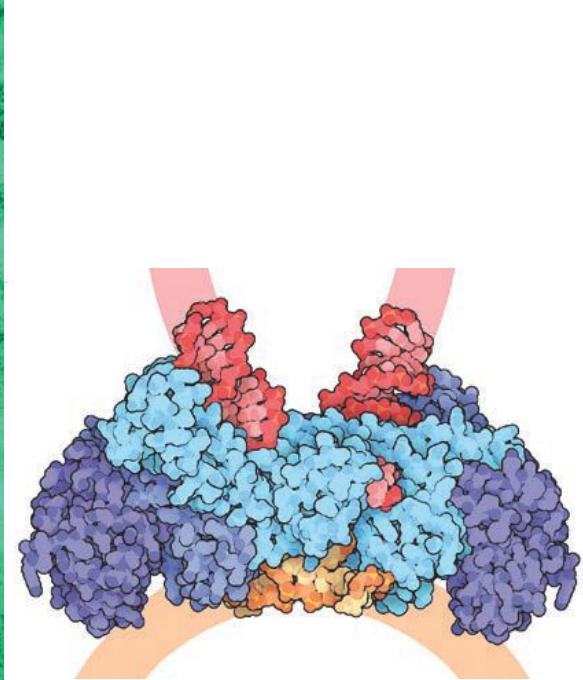
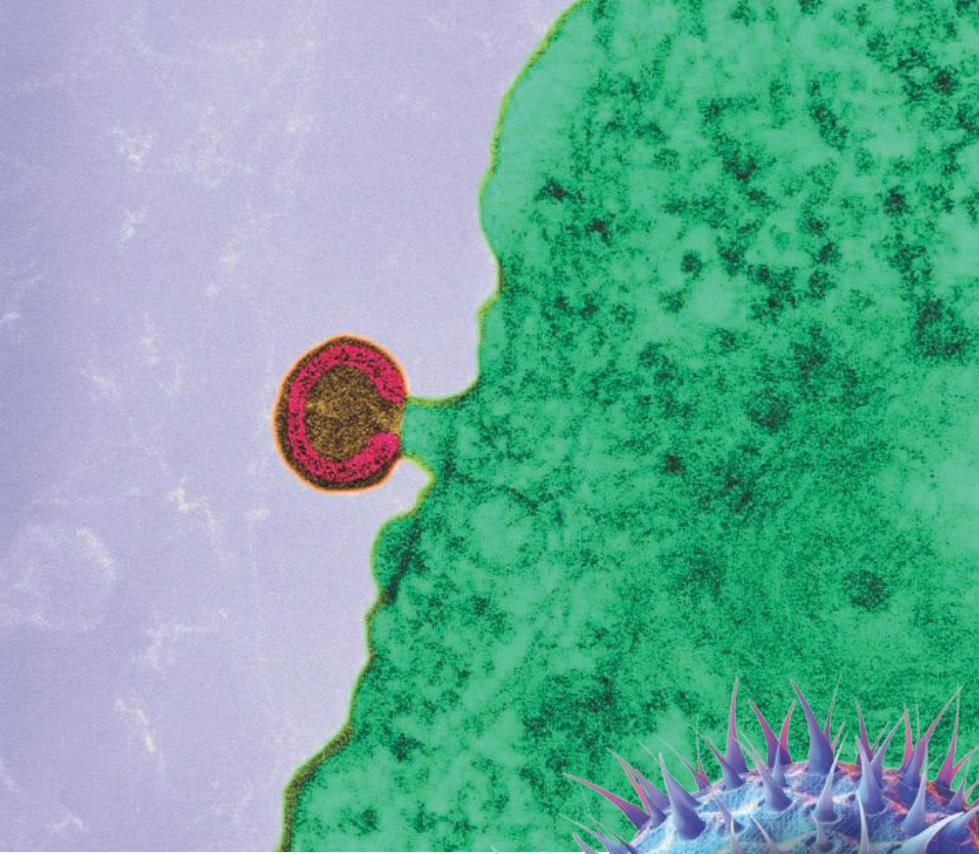
Once there, they help to recruit the molecular machinery that turns genes on or off.

"These KRAB ZFPs have been viewed as 'killers' of these endogenous retroviruses," Trono explains. "But they are actually exploiters of these elements that allow the organism to exploit the wealth of possibility that resides in these viral sequences."

Trono and his team believe that KRAB ZFPs are the missing link between viral sequences that are actively harmful and those that have become tamed control switches. They have evidence that the proteins have evolved alongside the viral elements in a kind of 'arms race', initially suppressing them but eventually overpowering them.

"We think that what they do is domesticate these elements," Trono says. "And by domestication, I mean not just making sure that the viruses stay put, but turning them into something beneficial for the host, which is a very refined way of regulating gene activity in all possible cells and situations."

Supporting this idea is the finding that distinct groups of KRAB ZFPs are active in different types of cells. They're also found in specific patterns in different species. If they were just suppressing viruses, the argument goes, the same array of proteins should be present in all cells. What's more, why would they be found bound to the many thousands of long-dead viral elements that Trono and his team have identified? There's no point suppressing a dead retrovirus,



so they must be playing an important role in controlling gene activity.

Although his idea is still a little controversial, Trono sees the KRAB ZFPs as a force of viral slavedrivers, harnessing these elements to do our bidding and turning them into genetic control switches. Over many millions of years, this could have been a powerful motor for creating new species. For example, if a virus randomly goes on the hop in one ancestral creature and not another and is then tamed over time by a KRAB ZFP, it will create new control switches that could have a big impact on an animal's appearance or behaviour.

What's more, these jumping elements become more active during times of environmental change. As times get tough, species need to find new ways to adapt or they will die out. Activating these mobile elements reshuffles the genome, throwing up novel genetic variations that provide rich fodder for natural selection to work on.

Friend or foe?

It's clear that the viruses trapped in our genome have brought us enormous benefits on an evolutionary timescale. But they aren't all so helpful. Around one in 20 human babies is born with a new viral 'jump' somewhere in its genome, which could deactivate an important gene and cause disease. There's increasing evidence that jumping transposons contribute to the genetic chaos inside cancer cells. And intriguing research suggests that brain cells

ABOVE LEFT:
Viruses may have played a key role in the evolution of the human placenta

ABOVE:
HIV virus in human lymph tissue

ABOVE RIGHT:
The enzyme HIV integrase allows HIV to embed itself in a host cell's DNA

are particularly good locations for reactivating jumping genes, possibly increasing the diversity of nerve cells and enhancing our brainpower but also potentially causing ageing-related memory problems and conditions such as schizophrenia.

So, are these viruses inside our DNA our friends or our enemies? Paolo Mita, a postdoctoral fellow researching transposons at NYU School of Medicine in New York, suggests that it's a bit of both.

"I call them our 'frenemies', because, when you look at their role in one human lifespan, most likely if they are mobilised there are going to be negative effects," he explains. "In the short term, they are our enemies.

On the other hand, if you are looking across time, these elements are a powerful force of evolution and they are still active in our species today. Evolution is just the way that organisms respond to changes in the environment, and, in this case, they are definitely our friends because they have shaped how our genome works now."

And are the viruses infecting us today, such as HIV, going to have an impact on our evolution in the future? "Of course! The answer is why not?" laughs Mita. "But it will be many generations until we can look back and say this evolution has happened. But you can see the remnants of previous arms races in the genome between the endogenous retroviruses and the host cells. It's a continuous battle, and I don't think it has ever stopped."

Kat Arney is a science writer and broadcaster. She hosts BBC Radio 5 Live's *The Naked Scientists* and is the author of *Herding Hemingway's Cats: Understanding How Our Genes Work*.

In thrall to THE RED PLANET

Eric Rabkin argues that depictions of Mars in literature and film – both as the cradle of hideous invaders, and humanity's potential saviour – frequently reflect the political climate back on Earth



A detail from a poster promoting William Cameron Menzies's 1953 horror film *Invaders from Mars*, above an image of the red planet. Mars has exerted a powerful hold over the residents of Earth for millennia

Left: A poster for 1954's sci-fi film *Devil Girl from Mars*

ALIEN INVASION

HG Wells's *The War of the Worlds* arrived in a period in which wars of empire raged across the globe

Introducing the world to hideous, tentacled Martians – who lay waste to mankind with devastating heat-ray guns – it's hardly surprising that HG Wells's novel *The War of the Worlds* made quite an impact when it was published in hardback in 1898.

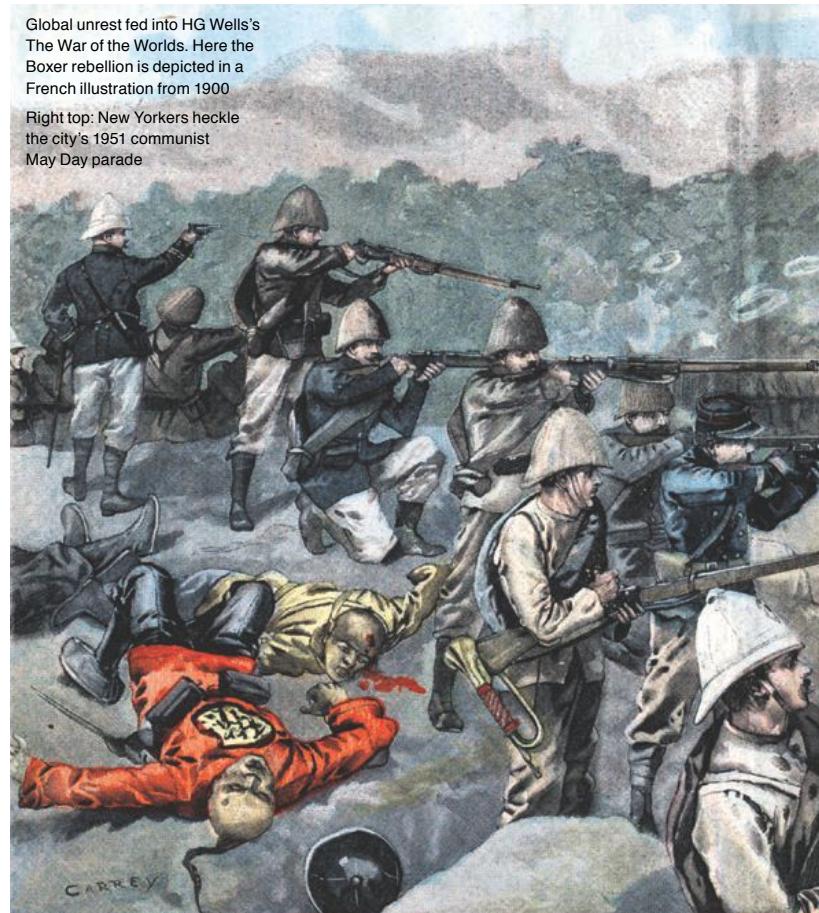
The novel tapped into a climate of global anxiety, as the world's imperial powers continued to flex their muscles but encountered increasingly determined opposition as they did so. The Cuban War of Independence, the Philippine Revolution and the Spanish-American War were just three of the conflicts to rage in the dying days of the 19th century.

The War of the Worlds was one in a long line of British invasion narratives – beginning with George Tomkyns Chesney's *The Battle of Dorking* in 1871, a fictional account of a German attack on Britain.

An invasion dominates Wells's novel too. But, in this case, it's not humans responsible for it. When Martian forces make a surprise crash-landing in southern England, British troops are helpless to stop their relentless and bloody advance. "With infinite complacency, men went to and fro about the globe, confident of our empire over this world," the novel's narrator tells us. "Yet, across the gulf of space, intellects vast and cool and unsympathetic regarded our planet with envious eyes and slowly, and surely, drew their plans against us."

As Britain stood on the brink of a second conflict with the Boers of southern Africa, and with tensions rising that would end in the First World War, it was but a small step to substitute Martian invaders with human armies.

Global unrest fed into HG Wells's *The War of the Worlds*. Here the Boxer rebellion is depicted in a French illustration from 1900
Right top: New Yorkers heckle the city's 1951 communist May Day parade



1



2

THE RISE OF THE RED MENACE

Amid anti-communist witch-hunts, films and novels offered contrasting portrayals of Mars

As Nazism was consigned to history in 1945, so too – for a short while at least – was film-makers' fascination with Mars. Hollywood now turned inward, looking for relief and escape after the horrors of war and economic turmoil. Mars was no longer deemed interesting subject matter and no theatrical films between 1945 and 1950 used Mars in their titles.

But, by the start of the 1950s, a new enemy had emerged, striking fear into Americans: communism and the USSR. For years the two superpowers leapfrogged in an arms race that saw the US produce atomic and hydrogen bombs and the USSR launch a man into space. Politically, they fought by proxy in the Korean War (1950–'53); domestically, they traded spies and speeches.

The trial and execution of Julius and Ethel Rosenberg, Americans convicted of passing top-secret information about the atomic bomb to the Soviet Union, only served to fan anti-communist feelings. The pair were investigated as part of Senator Joseph McCarthy's 'Red Hunt'. Anyone discovered to be a 'Red' – named for the colour of the USSR's flag and that of international communism – could be imprisoned or black-listed for employment.

From 1950 until McCarthy was censured as a demagogue by the Senate in 1954, Mars, as the red planet, was only ever filmed in a sinister light. *Invaders from Mars* (1953) and *Devil Girl from Mars* (1954) are just two of the films that cast it as the cradle of malevolent forces.

While cinema tended to portray Mars as a source of evil, in novels, the planet often offered humanity redemption. Ray Bradbury's 1950 linked-story collection, *The Martian Chronicles*, is an outstanding example of a tradition going back at least to the turn of the century in which Mars, in prose, offers mankind the chance to occupy a new Eden. One story, 'The Green Morning', sees the protagonist, Benjamin Driscoll, plant seeds that grow magically overnight into lush trees that oxygenate the Martian atmosphere. ▶

NEXT STOP MARS?

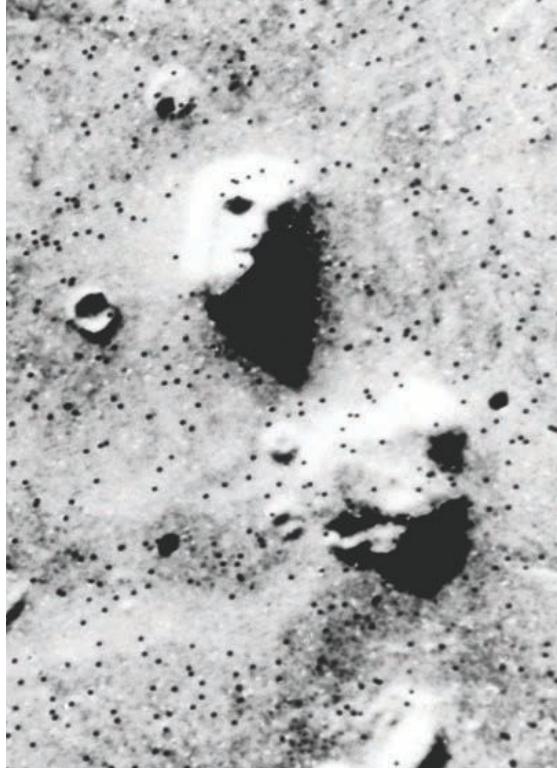
One “giant leap for mankind” put the red planet firmly back on the cultural agenda

After man first set foot on the moon on 20 July 1969, humans walking on Mars – rather than Martians walking on Earth – seemed more of a distinct, if distant, possibility.

The moon landing had a global psychological impact. For the first time, humanity could claim to have found, walked on and photographed a truly new land.

The moon itself was rarely taken seriously as a possible home. Instead, in the aftermath of Neil Armstrong’s ‘giant leap’, it opened up the tantalising possibility of humans colonising Mars. If only the atmosphere were not too thin; if only there were water.

Terraforming – the process of modifying another planet’s environment to make it hospitable to humans – was a word first used in a 1949 short story, but it became a staple concept of science fiction novels from the 1970s onwards. One of the most famous examples is Kim Stanley Robinson’s Mars trilogy (1993 – ’96). This centuries-long saga drew on contemporary scientific and philosophical developments to take readers from the touchdown of the first hundred people on Mars to their subterranean habitat, the drilling of deep holes to release heat and water, and the ultimate thickening of the atmosphere.



3



Buzz Aldrin walks on the moon in 1969. Suddenly Mars didn't seem so unattainable

4

SAVING FACE

Could humanity's salvation lie on Mars's rocky exterior?

In 1976, Mars was back in the news once again, courtesy of the Nasa Viking 1 mission’s ‘discovery’ of what appeared to be an enormous human head (*left*), nearly two miles long, on the surface of the planet. Although refined imaging showed the ‘face’ to be nothing more than a cluster of rocks, with each new advance, Mars became more approachable.

Recent films and books, such as the 2015 movie *The Martian*, based on a 2011 book by Andy Weir, treat the challenge of Mars not as that of a god of war but a hostile environment that can be overcome by human tenacity and science. The film sees astronaut Mark Watney stranded on Mars and forced to find a way to survive until a rescue mission can be sent.

But future expeditions to Mars might not be confined to fiction. Back in the real world, the Mars One organisation aims to have landed humans on the planet by 2032, with the purpose of creating “a second home for humanity.”

Elon Musk, founder and owner of SpaceX – which develops rockets and sells launch services to fund efforts to reach and inhabit Mars – has declared: “The future of humanity is going to bifurcate in two directions: either it's going to become multiplanetary, or it's going to remain confined to one planet and, eventually, there's going to be an extinction event.”

We may develop the technology to explore Mars’s environment; we may not. Either way, there’s little doubt that we’ve long viewed the planet through the prism of our own environment here on Earth.



5

PANIC ON THE STREETS OF NEW YORK

A fabricated Martian invasion hit a raw nerve in a country facing the prospect of war

Just after 8.30pm on 30 October 1938, the thousands of Americans tuned to the radio show *Mercury Theater on the Air* suddenly heard an alarming news flash: huge Martian fighting-machines were emerging from meteor-like spacecraft that had landed near Grover's Mill, New Jersey. What they were listening to was an adaptation of HG Wells's *The War of the Worlds*. Many, however, mistook it for an invasion on American soil.

"Something's wriggling out of the shadow like a gray snake," a desperate voice shouted down the airwaves. "Now it's another one, and another. They look like tentacles to me... There's a jet of flame springing from the mirror, and it leaps right at the advancing men. It strikes them head on! Good Lord, they're turning into flame!... Enemy now turns east... Evident objective is New York City..."

The so-called Panic Broadcast, directed and narrated by 23-year-old radio actor and future filmmaker Orson Welles, caught America at a vulnerable moment. Still besieged by the Great Depression, which had seen half of its banks close

and unemployment soar to 25 per cent, the nation was struggling, and many people felt themselves just a short mischance from disaster.

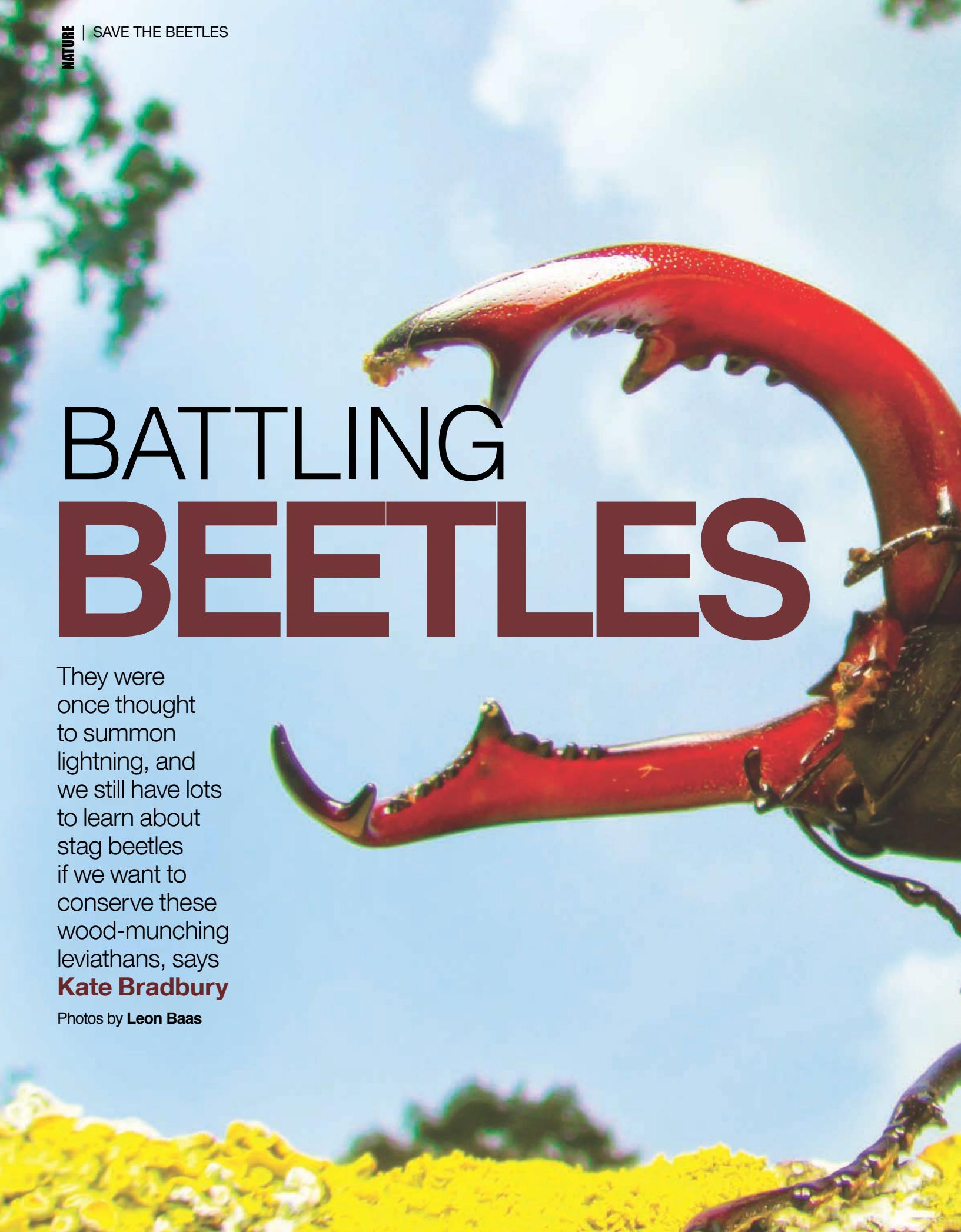
Adding to the sense of dread was the rise of German imperialism across the Atlantic. Hitler was now the dark colossus of Europe, annexing Austria just a few months before Welles's broadcast. Following the Nuremberg Laws of 1935 (which enshrined anti-Semitic Nazi doctrine in law), New York, a city with some 1.7 million Jews, seemed an obvious target for German aggression. An invasion, Martian or otherwise, was no longer unthinkable.

Papers such as *The New York Times* seized on Welles's broadcast (which you can listen to at [youtube.com/watch?v=Xs0K4ApWl4g](https://www.youtube.com/watch?v=Xs0K4ApWl4g)), sparking a popular outcry against fake news. Congress even considered limiting freedom of speech, while the Federal Communications Commission launched an investigation to see if any laws had been broken. Ultimately, the real-life fears of 1938 overshadowed the fictional, and Welles escaped with an on-air apology. ■

Police distribute food to needy New Yorkers. Orson Welles's Panic Broadcast preyed on the fears of a fragile nation

Eric Rabkin is professor emeritus of English language and literature at the University of Michigan. His books include *Mars: A Tour of the Human Imagination*.

BATTLING BEETLES



They were once thought to summon lightning, and we still have lots to learn about stag beetles if we want to conserve these wood-munching leviathans, says

Kate Bradbury

Photos by Leon Baas



THE phone rings at 9.30pm on a Tuesday in June: "Guess what I've got in my hand?" Richard 'Bugman' Jones – entomologist and regular contributor to *BBC Wildlife Magazine* – caught a female stag beetle flying round his garden earlier in the evening, and now has a shiny, antlered male to complete the set. I can't wait to see them up close for myself, so I pay him a visit next day.

Richard proudly shows me his Tupperware boxes of live stag beetles – a male and two females – as well as the collection of body parts gathered over the years, including one spectacular haul after an incident involving a playing field and a lawn mower. "I had more," he says casually. "But I donate the best specimens to [London's] Horniman Museum."

Richard lives in Dulwich, the capital's stag beetle heartland. "Back in the day, South-East London was full of woodland," he says. "When the city started to take shape, buildings were erected piecemeal – not like now when a bulldozer just razes everything to the ground. Much of the habitat was left intact." This means that some of the ancient, dense woodland

of South London is buried as rotting stumps and fallen logs under the gardens of Peckham and East Dulwich. Stag beetles are literally breeding in London's past.

"They're docile really and will only nip if you push your finger between their mandibles," says Richard, holding the live male and demonstrating, but the ferocious-looking beetle doesn't want to play.

SubUrban warrior

The stag beetle *Lucanus cervus* is Britain's biggest beetle, with males reaching up to 7.5cm long. In the UK, the species is mostly found in south-east England and is truly urban, carving out an existence in the heart of London as well as in suburban areas such as Surrey and Colchester. We don't know why populations are concentrated here, though there are several theories.

One is that the line of chalk running from the North and South Downs through Hampshire and up into the Chiltern Hills and Wiltshire might be responsible. A researcher discovered a fungus that helps stag beetle larvae by breaking down tough woody cells, making ▶

Big questions remain about how many of our magnificent stag beetles remain, where they are, and why they're so fussy about the kind of wood they eat

them easier to digest. Because this fungus cannot survive in chalk regions, could its absence be acting as a barrier to the beetles? But the same fungus is also found in the north of England, where there are no stag beetles, so other factors may be at play.

Another possible explanation is that the species reached the limits of its current British range in the last ice age. There is a suggestion that because the adults don't feed, the species is limited in how far it can disperse.

Breeding battles

Whatever the reason, this is a gem of an insect to have so close to the urban sprawl. Having spent up to seven years living in dead wood as larvae, the adults at last emerge to breed, lay eggs and die, usually within the space of a few weeks. Only the males have antler-like mandibles. They emerge before the smaller females to establish a territory, and use their massive jaws to attract mates and for stag-like territorial rutting with rivals.

The best time to see them is at dusk in May, June or July. The lumbering males fly clumsily in circles to defend their territory, and they may be picked up on bat detectors, which emit a wonderful clicking sound as they buzz past. The beetles are drawn to windows lit up after dark and you can also tempt them to land with soft fruit. The short-lived adults don't eat, but they enjoy tree sap and fruit juice, particularly mango, licking it with their orange tongues.

In medieval times, stag beetles got a bad press: they were said to summon thunder and lightning, and to visit fires to steal hot coals and set buildings alight. Their many names included thunder-beetle, billywitch, devil's imp, horny bug, cherry eater, oak-ox and horse pincher.

Sadly, these days they are better known for the decline in their population. Habitat loss and fragmentation are key problems, while roadkill and predation by magpies have an impact, too. Human ignorance also plays a part: many of us keep our gardens far too tidy, putting down paving and decking, building greenhouses and removing the tree stumps and dead wood in which stag beetles breed. Some people even mistake them for cockroaches and stamp on them on the pavement, oblivious to the years they have spent underground, waiting for their few weeks of glory.

Males use their massive jaws to attract mates and for stag-like territorial rutting with rivals

Male stag beetles grapple with their 'antlers', trying to flip their rivals over or hurl them to the ground

From Egg to Adult **STAG BEETLE** LIFE-CYCLE

Stag beetles



ILLUSTRATION BY DAN COLE/THE ART AGENCY

Love and wood

But stag beetles also have an army of dedicated fans. Richard tells me about the ‘Willy the stag beetle’ stories his father made up for him and his siblings, and about chasing one “flying like a model aeroplane” through the streets of Bromley as a young adult. “They’re so majestic,” he says, as he sifts through his drawer of stag beetle body parts.

Another stag beetle hotspot is Colchester in Essex, where Maria Fremlin, a retired lab technician, has dedicated the past 15 years to studying them in loving detail. As well as creating habitats for the beetles in her garden, Maria has reared them in a terrarium in her garage, filmed them, monitored local populations and written a clutch of research papers. “All they need is love and wood,” she says.

Deborah Harvey of the University of London has herself been studying stag beetles for more than

a decade. “It’s difficult to know how many there are because this is mainly a garden species in Britain,” she explains. “You can’t just wander into people’s backyards to count beetles.”

Deborah collaborates with the People’s Trust for Endangered Species (PTES) and assisted its ‘Bury Buckets 4 Beetles’ project, which has encouraged gardeners to create artificial egg-laying sites. More than 1,000 beetle buckets have been buried since 2005, with about a quarter attracting residents.

One example of behaviour that helps Deborah find the larvae is stridulation. This is believed to be a form of communication, and involves a grub rubbing its second and third legs together. “They don’t like being too far apart, so they stridulate to check the whereabouts of the others,” she explains. “We can now simply bury sensitive microphones in the soil to determine where larval populations are, ▶

Males fly in clumsy circles to protect their territory. You can tempt them with fruit juice and hear them clearly on a bat detector



"Another worry is flooding. Heavy rains leave several stag beetle hotspots submerged"

HOW TO HELP Stag beetles

MAKE LOG PILES

Partially bury the logs to a depth of about 30cm. Stag beetles are known to favour oak, sycamore, apple, pear, false acacia and buddleia wood. Even if you don't live in a stag beetle hotspot, a log pile is still valuable, because there are plenty of other wood-boring beetles that will use the habitat.



For instructions on how to make these, visit www.ptes.org/steppingstones. But resist the temptation to check them afterwards – any disturbance is likely to kill developing larvae.

SHARE SIGHTINGS

Report any stag beetles that you spot – dead specimens are useful, as well as live adults – at www.stagbeetle.info.

CREATE BREEDING BUCKETS AND STEPPING STONES

Other great additions to your garden are stag beetle 'breeding buckets' – plastic buckets drilled with holes, filled with a mixture of wood chips and soil, then buried – and 'stepping stones'.



Female stag beetles don't have 'antlers'

without digging up the habitat." Deborah also sets traps for adults using ginger and mango as bait, but, even now, she's still no nearer to determining the percentage of their decline.

Back in London, Richard Jones is balancing a male stag beetle on his shoulder like a pirate's parrot. "Many Londoners aren't very aware of wildlife," he says, "but there's good local knowledge of stag beetles." And, while he admits that the habitat isn't getting any better, he points out that suburban gardens are unlikely to disappear in one fell swoop. "If one habitat is destroyed, there's probably another next door," he explains.

Stag beetles are well equipped to cope with changes in climate – to an extent, anyway. "They can survive winter temperatures as low as -8°C, and happily mate on cool summer days at just 8°C," explains Deborah Harvey, "but they won't breed at temperatures over 32°C."

Another worry is flooding. Heavy rains leave several stag beetle hotspots submerged. "They can survive underwater for a week," says Deborah. "But it could be three more years before we see the true impact of the prolonged wet weather in early 2014."

If the adult beetles do struggle to increase their range, could we help them relocate further north? Deborah doesn't see why not, but points out that you need substantial numbers in an area to establish a population.

The good news is that stag beetles are adapting. They no longer breed solely in dead oak wood, they're now laying eggs in a variety of rotting woods, including sycamore, buddleia and false acacia. "We don't know why they pick certain materials," says Deborah. "They breed in rhubarb roots, compost bags and fence posts, and under sheds. We simply can't find a link." Still, the fact that they are adapting means these magnificent beetles might have a long future here. ☐

Kate Bradbury frequently contributes to *Gardeners' World Magazine* and *Gardeners' Question Time* on BBC Radio 4 in the UK.

CAN YOU SUPERCHARGE YOUR BRAIN?

Your brain is the finely-tuned machine that controls all your actions and emotions, so it makes sense to keep it well-oiled. But, asks **Rita Carter**, are there any scientifically proven methods to ensure it works better for longer?



LEARN A LANGUAGE OR INSTRUMENT

So far only two types of mental exertion have been shown to improve or preserve overall cognitive ability. One is musical training; the other is learning a new language, or practising a second one you have already learned.

Gottfried Schlaug, director of the Music and Neuroimaging Laboratory at Harvard University, the USA, explains: "Listening to and making music is not just an auditory experience; it's a multisensory and motor experience. Playing an instrument changes how the brain interprets and integrates a wide range of sensory information, and making music over a long period of time can change brain function and brain structure"

As for the role of language-learning in boosting brain power, a team at Edinburgh University assessed mental alertness in a group of 33 students (aged 18 to 78) who undertook a one-week Scottish Gaelic course. After the course, they were encouraged to practise their new language for five hours a week. At the end of the course, their attention was found to be better than comparison groups who had done other types of courses or no course at all, and, nine months later, those who had been practising had bumped up their attention span even more.

Lead researcher Dr Thomas Bak of the School of Philosophy, Psychology and Language Sciences at the University of Edinburgh, the UK, said the results confirm the cognitive benefits of language-learning. "I think there are three important messages from our study: first, it is never too late to start a novel mental activity such as learning a new language. Second, even a short, intensive course can show beneficial effects on some cognitive functions. Third, this effect can be maintained through practice."

"Even a short, intensive course can show benefits on some cognitive functions"





PROTECTION

Absolutely the best thing you can do to preserve your brain is to protect it from injury. This may sound obvious, but the long-term effects of brain trauma are only just being recognised.

According to Headway, the brain injury charity, about one million people in the UK currently live with memory loss, confusion and psychosis due to brain injuries that may have happened years before. People with a history of brain injuries suffer earlier cognitive decline and succumb to dementia earlier than others, and – scarily – they are at least three times as likely as others to go to prison.

Falls, sports-related incidents and road accidents are the main causes of head injury. So the first, simplest thing you can do for your brain is to wear sensible shoes and a protective helmet when you are cycling or doing any kind of sport where there's a chance of getting your head bashed.

"The simplest thing you can do for your brain is to wear sensible shoes and a helmet when you are cycling or doing any sport where there's a chance of getting your head bashed"

NUTRITION

The other thing you can do is to protect your brain from internal injury – and that means eating properly.

The brain is a famously hungry organ, using about one-fifth of the body's calorific intake. Brain food is delivered by the blood via a dense mesh of vessels. If the blood hits a bottleneck, it may form a clot, causing a stroke. Depending on its size and location, a stroke may deal a catastrophic blow, or pass by barely noticed. Such minor strokes are called Transient Ischemic Attacks (TIAs), but, while they might not cause much problem when they happen, repeated TIAs cause severe cognitive decline. Vascular dementia (as such a decline is known) is almost as common as Alzheimer's disease. ▶

HELP PREVENT STROKE BY ADDING THESE FOODS TO YOUR DIET:



Antioxidants, which clean up the detritus left by normal metabolic processes. Dark-coloured foods such as blueberries, dark chocolate, kidney beans and artichokes are brimming with antioxidants.



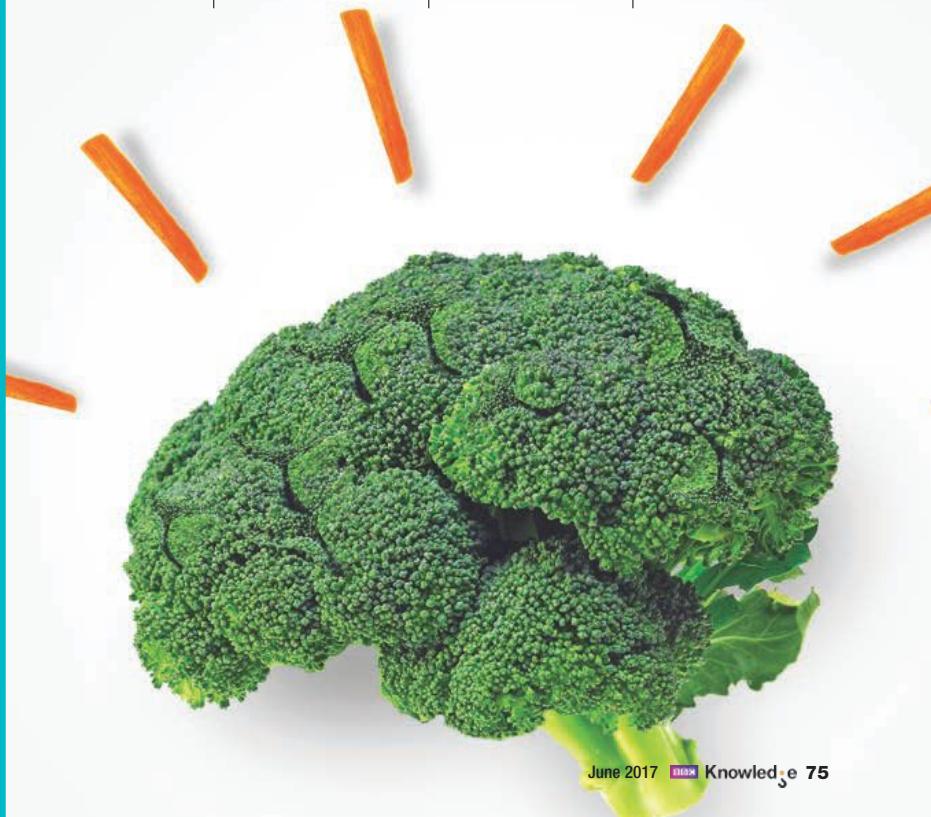
Vitamins A, B, C, D and E, which between them help clean away rubbish, strengthen arteries and keep brain cells healthy. Find them in wholegrain cereals, eggs, chicken, nuts and leafy greens.



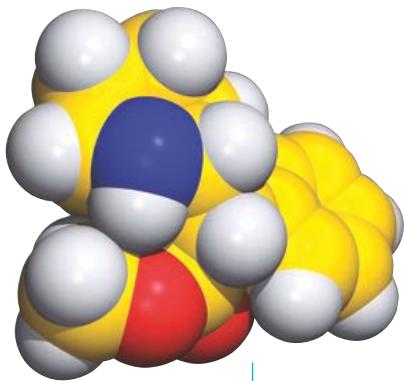
Omega-3 and other non-saturated oils, which strengthen and clean the arteries as well as help to build brain cell membranes. Good sources of omega-3 include oily fish, walnuts and edible seeds.



Neuro transmitter precursors such as tryptophan and glucosinolates. Find them in milk, nuts, seeds, tofu, cheese, red meat, chicken, turkey, fish, oats, beans, lentils, eggs and broccoli.



DRUGS

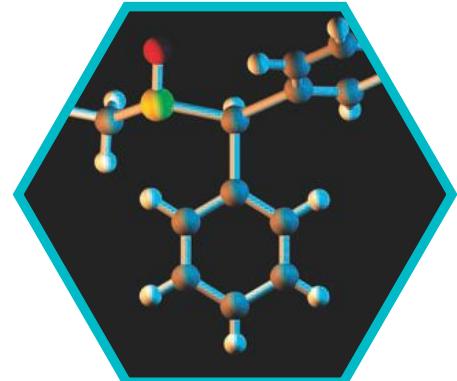



RITALIN

Famous for its use in treating children with Attention Deficit Hyperactivity Disorder (ADHD), Ritalin and its derivatives also seem to help concentration and focus in adults with the condition. It probably does something for healthy people too, but – guess what? – there is no evidence to prove it.

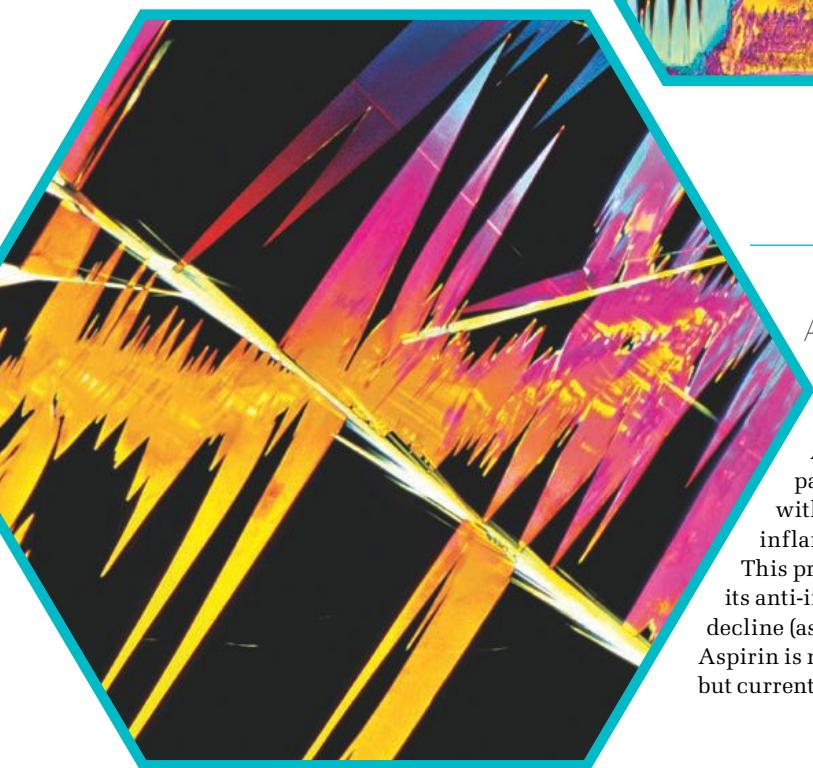
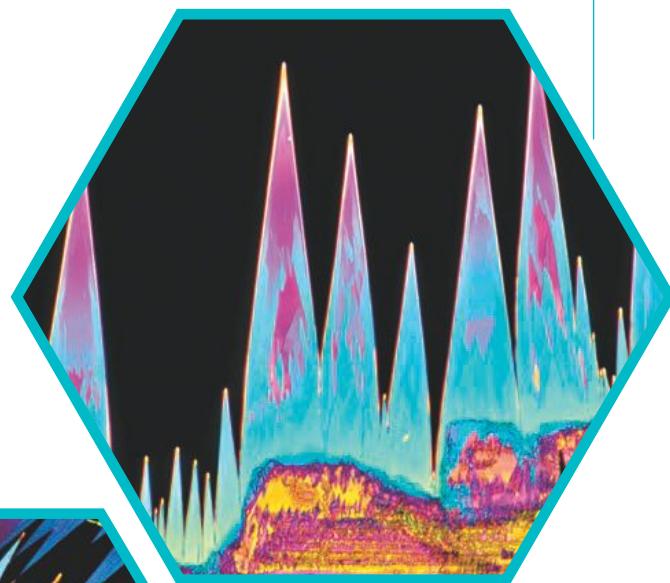
ANTIDEPRESSANTS

Depression is not just a mood disorder, it has profound effects on cognition generally – blurring memory, slowing thought and distorting perception. Most antidepressants, when they work, bring these things back to normal and a few – Bupropion, Prozac, reboxetine and SNRIs (serotonin-norepinephrine-reuptake inhibitors) – may make people brighter than normal, even if they are not depressed. However, antidepressants also tend to have side effects, so unless you actually *are* depressed, taking them probably isn't a great idea.



PRESCRIPTION DRUGS

Modafinil is a prescription drug used to treat narcolepsy, but it's looking as though it might be a general brain sharpener. Researchers at Oxford University and Harvard Medical School (where up to a quarter of students report taking the drug to help their work) reviewed 24 studies of Modafinil and concluded that it improves thinking skills and helps with planning, decision-making, flexibility, learning, memory and creativity, with very little downside. Prof Guy Goodwin, President of the European College of Neuropsychopharmacology (ECNP), said: "It seems to be the first real example of a 'smart drug', which can genuinely help, for example, with exam preparation."



ANTI-INFLAMMATORIES

Inflammation, the process by which body cells go on the attack, is increasingly implicated in brain-based conditions such as depression, memory loss and behavioural disorders.

Alzheimer's disease may also be due to inflammation, at least in part. Evidence is accumulating that the amyloid plaques associated with the disease are not themselves its cause; rather, it is the brain's inflammatory reaction to the plaques that kills off brain cells.

This probably explains why low-dose aspirin – famous for its anti-inflammatory properties – seems to stave off cognitive decline (as well as heart attacks and many forms of cancer).

Aspirin is not recommended for healthy people by medical authorities, but current evidence makes a low-dose daily aspirin pill a rational choice.

NUTRITION



Found in oily fish, omega-3 is often touted as being beneficial for the brain, but the evidence for this is surprisingly weak

"Evidence for herbal supplements fails to stand up to scrutiny"

A varied diet should provide all the brain-healthy nutrients you need, but could you benefit from taking more of them? Here the answers get much less certain.

Omega-3 is the supplement best known as a brain booster. It is the type of oil found in fatty fish like herrings, sardines and mackerel. The literature on oils and the brain would sink a tanker, but most of it is based on small, commercially motivated or otherwise unreliable studies. When these are removed, the evidence that's left is underwhelming. A 2012 review by the Cochrane organisation – widely acknowledged as the ultimate authority on health – found no evidence that omega-3 reduces the risk of cognitive impairment, while a 2015 meta-analysis by Canadian scientists concluded bluntly:

"Omega-3 fatty acids, B vitamins, and vitamin E supplementation did not affect cognition in non-demented middle-aged and older adults."

Similarly, evidence for herbal supplements ginseng and gingko biloba fails to stand up to strict scrutiny, as does that for practically every other 'brain-booster'. The Natural Medicines Comprehensive Database, a non-commercial organisation that continuously collects and reviews data, failed to find a single proven effective supplement among more than 50 they assessed.

They rated a few as "possibly effective" but most simply had "insufficient evidence" to call.

Lack of proof of efficacy is not, however, proof of lack of efficacy. The large-scale, expensive research needed to show beyond doubt if a thing works or not is usually done only for medicinal drugs, so it's not surprising that there isn't any to show what works for healthy people.

Supplements are not without risk – they can interfere with medicines and produce nasty side effects, especially if too many are taken. However, a supplement that gives the recommended daily dose of required vitamins and minerals may be a good idea if you feel your brain needs a boost, especially if you think your diet may be deficient in any way.

BRAIN TRAINING

Any mental exercise helps cognition by building, lengthening or strengthening the pathways that carry information between neurons. Generally, the more pathways you have, the better your cognition.

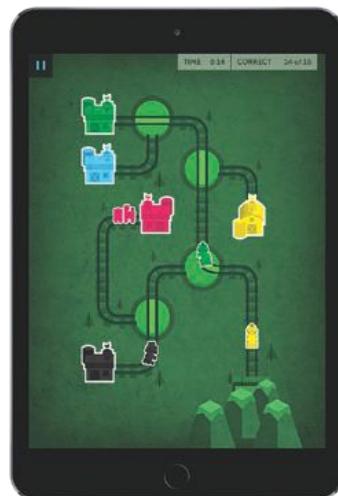
When you carry out a particular mental skill, connective tissue builds up in the part of the brain

responsible for it, just like arm exercises build your biceps. For all-round cognitive improvement, therefore, you should do lots of everything: motor skills (ie, physical activity), talking, socialising, planning, game-playing, calculating, writing, reading and talking. But the problem is that we tend not to do everything, especially as we get older.

This is where brain training comes in. Systems like Lumosity, Brain HQ and

SmartMind claim to exercise all parts of your brain, and thus to raise your cognitive abilities generally, rather than in one particular area. Alas, the proof of this is just not there. Scientists reviewed the literature that brain-training companies cite to support their products and found that, while people got better at individual tests, there was no general improvement in cognition. ▶

Brain-training apps only improve the brain's performance at particular tasks



ELECTRICAL STIMULATION

Devices that send a weak electrical current through your brain via head-mounted electrodes are marketed online as cognitive enhancers. Transcranial Direct Current Stimulation (tDCS) – not to be confused with Transcranial Magnetic Stimulation (TMS) – is claimed by those who sell it to speed up reactions, calm you down, help you focus, increase physical endurance and improve more or less any mental skill you want.

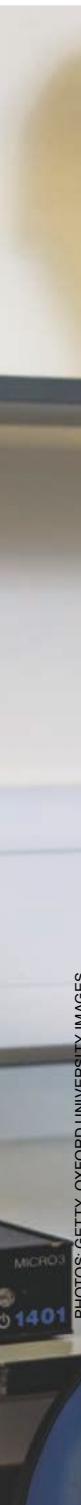
Although it sounds gimmicky, there is actually a vast amount of solid evidential support for tDCS both as a treatment (for pain, depression, tinnitus, dementia and much else) and for enhancement.

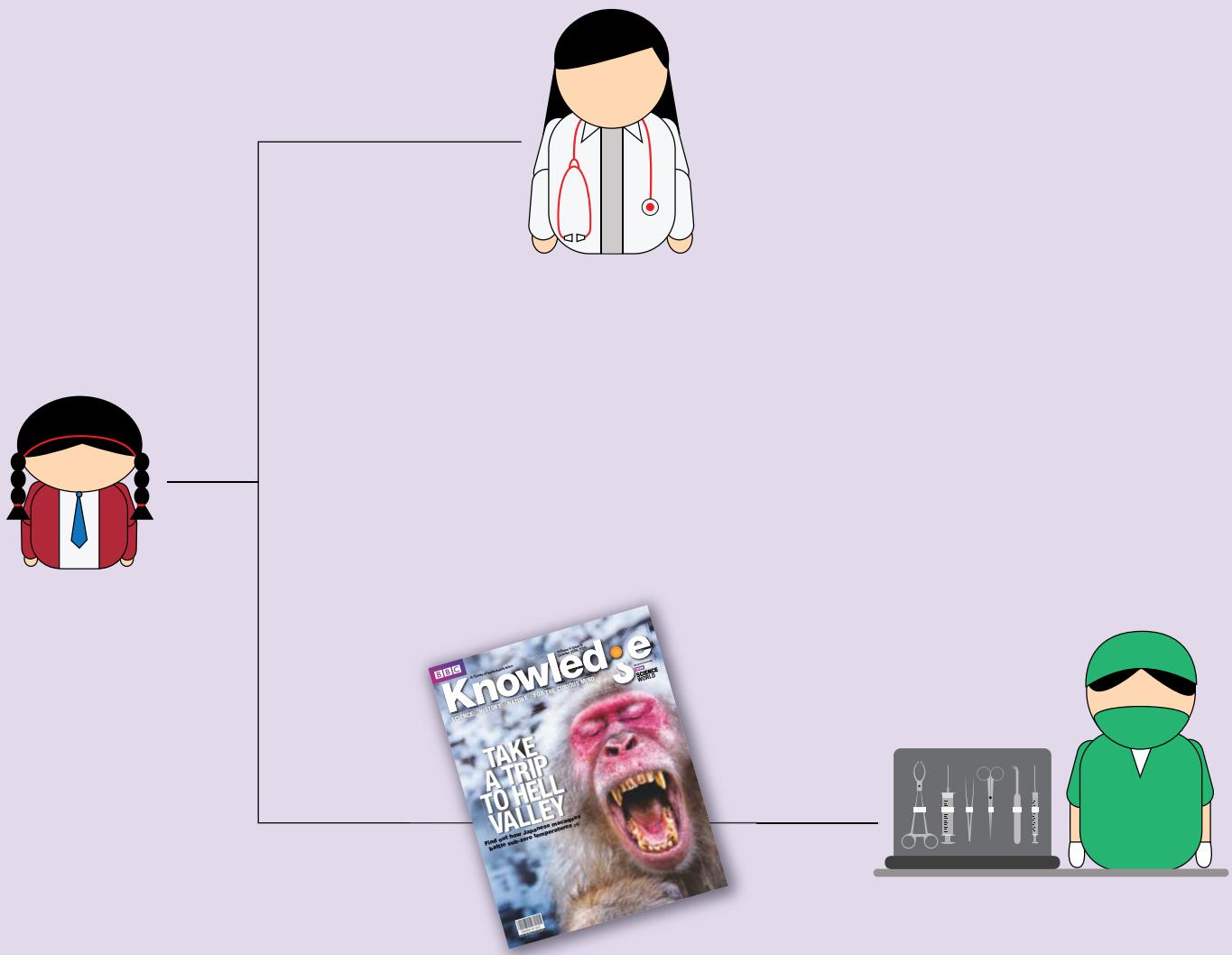
When it is used correctly, it is extraordinarily safe, and comparatively cheap – you can get a tDCS kit for about £100 (₹ 80,000).

However, like brain training, tDCS has not yet shown itself capable of improving overall cognition (rather than individual functions), and much of what's known about it has come from a large, dedicated band of DIY researchers, and, as a result, is anecdotal and/or difficult to assess. Judge the evidence for yourself at www.reddit.com/r/tDCS/.

Rita Carter is a science writer, lecturer and broadcaster, specialising in the brain.

Devices that use tDCS (transcranial Direct Current Stimulation) to 'boost your brain' are widely available, though scientific evidence that they do so is hard to find





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SCIENCE. HISTORY. NATURE. FOR THE CURIOUS MIND.

Small sensation: PT Barnum with the three-foot-tall General Tom Thumb in c1850 (when Tom was about 12). Barnum plucked his diminutive distant cousin from obscurity and made him a star



The Great Pretender

Antonio Melechi reveals how PT Barnum – the brains behind General Tom Thumb, the Feejee Mermaid and a wildly successful circus – turned a flair for outrageous stunts and hoaxes into a multi-million dollar concern

BRITISH travellers to 19th-century America were taken aback by the go-getting commercialism of their Atlantic cousins. In 1834, during a long visit to the eastern states, the economist Harriet Martineau saw that in “a country where the whole course is open to everyone,” the appetite for success led to reckless and ill-considered enterprise. For Martineau, the wildfire culture of self-improvement was tethered to a deep-seated conformism, “a fear of singularity” evident in the tendency to offer indiscriminate praise. “Every book that comes out is exalted to the skies. The public orators flatter the people; the people flatter the orators. The clergymen praise their flocks; and the flocks stand amazed at the excellence of their clergymen.”

When Phineas Taylor Barnum made his first trip to England in 1844, as promoter to General Tom Thumb, the star-spangled showman was every inch the caricature of Martineau's glib-tongued Yankee. Wherever he went, Barnum had one hand on his wallet, ready to “do business.” In London, he made a beeline for Madame Tussauds waxworks, offering top dollar to buy the collection outright. At Lord Byron's ancestral home, he tried to negotiate a price for a tree upon which the poet had etched his name. And during a lightning tour of Stratford, Barnum made a shameless bid to purchase Shakespeare's one-time home, prompting *Punch* magazine to commence a series of drolleries that lampooned his crass speculations.

A native of Bethel, Connecticut, Barnum had tried his hand at all kinds

of work, from encyclopaedia salesman to editor of an abolitionist newspaper, before finding his true metier. In 1835, not long after taking on a grocery store in New York, the 25-year-old caught wind of some intriguing news. A friend had recently sold his interest in an Afro-American slave by the name of Joice Heth, purportedly 161 years of age and the one-time nurse of George Washington. Sensing an opportunity to break into New York's entertainment business, Barnum made his way to Philadelphia's Masonic Hall, where the ‘wonderful negress’ was regaling visitors with recollections of ‘dear old George’, with tearful memories of her Virginia childhood, and a medley of impromptu hymns.



PT Barnum is depicted as a wily old fox preying on people's “phrenological bump of credulity” in a cartoon from *Punch* in 1884. The press didn't share the public's enthusiasm for the showman's hoaxes

Barnum tried to negotiate a price for a tree upon which Lord Byron had etched his name. He also put in a **shameless bid to buy Shakespeare's home**

Barnum was impressed. As “far as outward indications were concerned, she might almost have been called 1,000 years old.” Better still, Heth's current owner was prepared to do a deal: for \$1,000 the supercentenarian nurse was his. Returning to New York, Barnum quickly penned a shower of breathless adverts for his “ancient lady.” Within weeks of showing Heth at Niblo's Garden saloon, the grocer-turned-showman was counting weekly receipts of \$750, and already considering what curiosity he might next purchase.

Entertainment business

At first, Barnum struggled to replicate the success he achieved with Joice Heth. Briefly abandoning the entertainment business, he squandered much of his earnings on a failed cologne and boot-blacking business, enduring a short stint as sales agent for Sears' *Pictorial Illustrations of the Bible*.

Then, late in 1841, after dabbling with journalism and copywriting, he succeeded in acquiring Scudder's American Museum, the beleaguered home to an extensive collection of automata, dioramas and human oddities. Looking to turn the museum into Broadway's premier attraction – and believing that “the only ▶

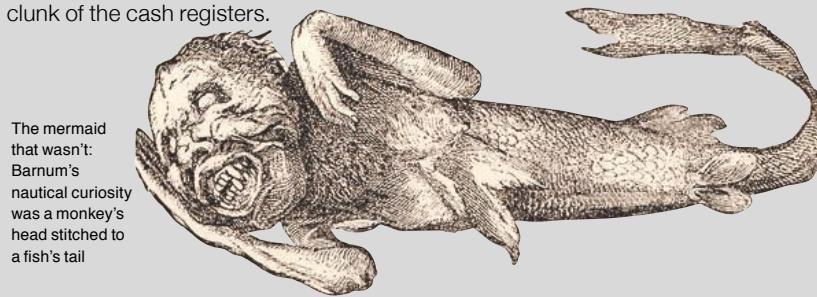
Barnum's greatest wheezes

The Feejee Mermaid

In July 1842, the PT Barnum marketing machine went into overdrive, telling the world about a mermaid that he had acquired for display in his American Museum in New York. The mermaid had, he said, been caught near the Feejee Islands in the South Pacific, and its authenticity had been confirmed by Dr J Griffin of the British Lyceum of Natural History.

The people of New York were transfixed, and flocked to the museum in droves. When they got there, they found something quite different to the beautiful ocean maiden that the Barnum advertising campaign had promised. What they set eyes on was a ghoulish amalgamation of a monkey's withered head and torso and a fish tail, which had been stitched together by Japanese fishermen earlier in the century.

'The Feejee Mermaid' was, of course, a hoax masterminded by Barnum. And the esteemed Dr J Griffin? He was Levi Lyman, Barnum's accomplice-in-deception. The press railed at Barnum's audacity. But that didn't stop the ring and clunk of the cash registers.



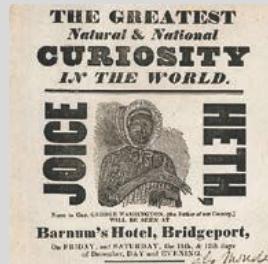
The mermaid that wasn't: Barnum's nautical curiosity was a monkey's head stitched to a fish's tail

The misshapen man-monkey

Barnum repeatedly presented the public with curiosities that he advertised as missing links in the evolutionary chain. One of the first of these freaks of nature was the 'man-monkey', which he brought to Piccadilly's Egyptian Hall in 1844. Barnum claimed the creature had been captured in the forests of California. In fact, it was a seasoned circus performer by the name of Harvey Leech. By blacking Leech up and covering his muscular and misshapen body with matted hair, Barnum expected his Wild Man to appeal to thousands of Londoners. And it did – despite being exposed as a hoax by *The Times*.



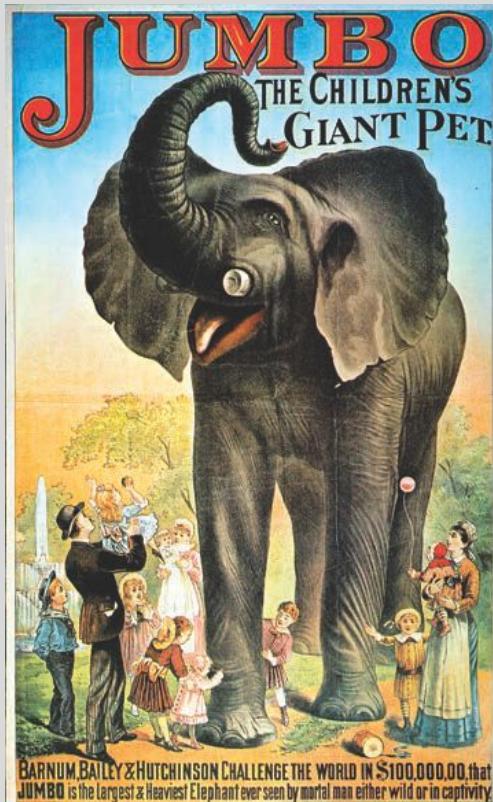
Barnum turned a circus performer called Harvey Leech into the 'missing link'



A poster promoting Joice Heth, Barnum's "ancient lady"

George Washington's 161-year-old nurse

In 1835, Barnum somehow managed to persuade the public that a black woman called Joice Heth was the 161-year-old former nurse of George Washington. And, when interest in Heth waned, he came up with the idea of exposing her as an automaton. "What purports to be a remarkably old woman is simply... made up of whalebone, India-rubber, and numerous springs ingeniously put together, and made to move at the slightest touch, according to the will of the operator." The ruse worked perfectly. By inviting viewers to determine for themselves whether Heth was a flesh-and-blood supercentenarian or a mechanical illusion, Barnum fastened on to a hoax strategy that would serve him only too well in the future.



Jumbo the elephant is the star attraction in this c1882 poster for Barnum & Bailey's circus

Jumbo, the 5-tonne elephant

Forty years after offending the British public with a bid to buy the cottage in which Shakespeare was born, Barnum was at it again. This time, he had his sights set on Jumbo, the five-tonne African elephant who had become a firm favourite with crowds at London's Zoological Gardens. Once Barnum's agent succeeded in agreeing a \$10,000 fee for Jumbo, "the outrageous sale of a national character" led to a groundswell of patriotic opposition. Jumbo-mania peaked in March 1882, when the Zoological Society's decision to sell was legally challenged by two of its own fellows. Despite petitions to parliament, the court found in favour of the society and, over the next three years, Jumbo went on to become the star attraction in Barnum & Bailey's travelling circus, 'The Greatest Show on Earth'.

way to make a million from my patrons was to give them abundant and wholesome attractions for a small sum of money” – he embarked on a manic spending spree, buying and hiring an array of new attractions, drawn “from every branch of nature and art, comprising a cyclopaedical synopsis of everything worth seeing and knowing in this curious world’s curious economy”.

The new exhibits that Barnum brought to his five-storey emporium – among them the Feejee Mermaid, a ghoulish amalgamation of a monkey’s head and a fish’s tail – caused a sensation. But they were only half the story. With unflagging chutzpah, he began to rebrand old exhibits – an Indian war club became ‘The Club that Killed Captain Cook’ – dreaming up all kinds of promotional strategies to make

With unflagging chutzpah, Barnum began to rebrand old exhibits in his museum. So an Indian war club became **‘The Club that Killed Captain Cook’**

the New York museum “the town wonder and the town talk”. In no time at all, takings went through the roof.

After little more than a year, Barnum’s penchant for outlandish publicity allowed him to pay off all debts and secretly acquire a second venue, Peale’s American Museum, so that he could foster a bogus rivalry between the two institutions.

Sing, dance and mime

It wasn’t just America that fell for Barnum’s charms. Soon his curiosities were causing a stir in Britain – none more so than the showman’s three-foot-tall distant cousin, General Tom Thumb. Barnum plucked Tom from obscurity and – having taught him to sing, dance, mime and do impersonations – made him a star, one who performed thrice in front of Queen Victoria.

Barnum was now a seriously wealthy man, able to spend vast sums of money on building a grand Moorish palace in Bridgeport, Connecticut. This lavish new residence was based on Brighton’s Royal Pavilion, and Barnum named it ‘Iranistan’.

But success came at a price. Now a committed teetotaller, Barnum set out “to make my amusements totally unobjectionable to the religious and moral community, and at the same time combine sufficient amusement with instruction to please all.”



A 1920s poster for Barnum & Bailey's 'Greatest Show on Earth'. When Barnum launched his circus 50 years earlier, it soon became a global entertainment phenomenon

In public, Barnum feigned indifference to a growing chorus of criticism of his business practices, apparently preferring “to be roundly abused than not noticed at all.” Privately, he was concerned that continued attention on his hoaxes might come to cast a troublesome shadow over a burgeoning portfolio of business and civic interests. Wishing to be perceived as a Bible-carrying captain of industry, Barnum made furtive overtures in the direction of his most persistent influential critics, asking that they stop referring to “myself or my actions in a spirit of ridicule or abuse.”

Much of the criticism centred around his position as the self-styled ‘Prince of Humbugs’. Barnum, with an eye on a seat in Congress, argued that humbug was simply hype, ‘harmless’ puffery to sell his hoaxes to sensation-seeking customers. Yet, there was no escaping the dictionary definition of the term as “an imposition under fair pretences” or, in verb form, “to deceive; to impose upon.”

Dazzling thrills

The final act in Barnum’s showstopping career began as a business alliance with seasoned circus men WC Coup and Dan Castello. Formed in 1870, ‘PT Barnum’s Grand (or Great) Travelling Museum, Menagerie and Circus’ was America’s largest travelling circus. With ballet

dancers, acrobats, chariot-racers, flame-throwers and an ever-expanding procession of animal acts, this 60-car, railroading behemoth brought a nightly thunderstorm of dazzling thrills into every major town. This was the circus as never seen before. “There are things so mighty, so awful, so truly gigantic,” wrote one observer, “that the mind shrinks before them and shrivels... One of these things is Barnum’s One and Only Greatest Show on Earth.”

When Barnum died in 1891, leaving an estate valued at \$10m, his name remained a byword for the kinds of humbug that his commercial empire had been founded on. The unscrupulous romancing of the press and the museum-going public and the artfully faked monstrosities were, however, by no means his only legacy.

The swaggering emissary of Yankee ‘push’ (wrongly credited with coining the saying that there was a sucker born every minute), Barnum had become the acceptable face of 19th-century capitalism. A ‘Shakespeare of Advertising’, author of one of the century’s bestselling autobiographies (1855’s *The Life of PT Barnum*), his industrious lies and dollar-chasing heroics had lifted him, as one commentator wryly noted, “head and shoulders above the swindlers, blacklegs, blackguards and humble riggers of the day.” Next to these ordinary humbugs, PT Barnum was, truly, in a class of his own. ☉

Antonio Melechi’s books include *Servants of the Supernatural: The Night Side of the Victorian Mind* (Arrow, 2009).

Mahasweta Devi

Author and historian Urvashi Butalia details the life and words of an activist and feminist force

IN the mid 1980s, when people of my generation were relatively young feminists, we fought many battles focusing largely on violence against women. It was in the course of our activism that we came across the work of Mahasweta Devi, one of Bengal's most important writers, who died a year ago at the age of 90. At the time, women's groups across India were demanding changes in the law on rape and dowry (these laws were changed in 1983 as a result of the activism), and the battle they were fighting was a lonely one. This is why it was so exciting to find a writer who wrote about the sorts of issues we were thinking about.

The first of Mahasweta Devi's books I discovered was her iconic novel, *Hazar Chaurasi ki Ma* (Mother of 1084), translated into Hindi. We could not believe that a writer would be writing about Naxalbari and focusing on a woman. Many of our women friends had abandoned their education to join the Naxalite movement, but their story was hardly known, as the narrative was mostly male. Mahasweta's book changed that.

Over the years, we were to get to know much more about her and her work; she became one of the strongest voices for the downtrodden in India.

EARLY DAYS

Born in Dhaka in 1926 into a literary family – both her parents were writers, and her mother, like Mahasweta in later life, was also a social activist –



WRITING AND ACTIVISM

Mahasweta began her professional life as a journalist, and a teacher. Her early life wasn't easy, as the expectations heaped on young girls at the time were extremely restrictive, and Mahasweta's family sometimes did not know how to deal with her.

She once described an incident from her teenage years: "From 13 to 18, I was deeply in love with one of my remote cousins. There was a suicidal tendency in his family, and he, too, committed suicide. Everyone started blaming me... I was crushed. The whole family accused me. From 16 on, my parents and especially my relatives would despair: what can we do about this girl?"

"What can we do with this girl?" This became a sort of iconic question that pursued Mahasweta all her life. As she grew older, she became more outspoken, more committed to her political beliefs to work with the poor and the downtrodden and women.

She began to focus her writings on the stories of the people she met as she walked the length and breadth of some parts of rural India, trying to do whatever she could to help people. After her first book, *Jhansi Rani* (The Rani of Jhansi), written when she was 30, there was no stopping Mahasweta; by the end of her life, she is believed to have written as many as a hundred novels and 20 collections of short stories as well as storybooks for children. One of her children's books, *The Why Why Girl*, about a young girl who constantly asks questions, has been translated into a number of international languages. While several of her works have been translated from Bangla into English, many remain in Bangla.

Mahasweta Devi was one of those rare writers for whom her writing and her activism were both equally important. Moved and disturbed by the fate of tribal peoples, she chose to make them the subject of much of her writing. For her, the discrimination the tribals faced, their fierce resilience and protest in the face of this, the courage of the women, all formed the substance of what she wrote. Asked about what inspired her to write, she said: "The reason and inspiration for my writing are those people who are exploited and used, and yet do not accept defeat. For me, the endless source of ingredients for writing is in these amazingly noble, suffering human beings." She did not only write about tribals, but tried her best to understand their lives and their problems. She spent many years familiarising herself with the situation of tribals and was part of a number of organisations such as the West Bengal Oraon Welfare Society and the All Indian Vandhu Liberation Morcha for tribal welfare. She was also a founding member of the Aboriginal United Association and a tribal magazine, *Bortika*, which she started in 1980.

One of Mahasweta Devi's best known stories was called *Draupadi*, about a tribal woman who is gang-raped by soldiers. A recent performance of this story as a play in a college in Haryana sparked off protests at its negative portrayal of the army. A previous powerful performance by Sabitri, the Manipuri actor who was married to the legendary theatre director, Kanahiyalal, made history when Sabitri stripped naked on stage.

Mahasweta's fierce commitment to the courage and resilience of the downtrodden makes her turn Draupadi (also known as Dopdi in the story) into a woman who will not be victimised and who flaunts her naked body in front of her perpetrators, daring them to look at her, scoffing when they turn away. Here is Draupadi after the assault. She wakes up, her arms and legs

tied to four posts: "Then a billion moons pass. A billion lunar years. Opening her eyes after a million light years, Draupadi, strangely enough, seeks sky and moon. Slowly the bloodied nailheads shift from her brain. Trying to move, she feels her arms and legs still tied to four posts. Something sticky... Her own blood. Only the gag has been removed. Incredible thirst. In case she says 'water' she catches her lower lip in her teeth..."

And here is Draupadi who tears up the rags they throw at her and flings them away, flaunting her nakedness in the soldier Senanayak's face:

"Draupadi comes closer. Stands with her hand on her hip, laughs and says, The object of your search, Dopdi Mejhen. You asked them to make me up, don't you want to see how they made me?

Where are her clothes?
Won't put them on, Sir.
Tearing them.

Draupadi's black body comes even closer. Draupadi shakes with an indomitable laughter that Senanayak simply cannot understand. Her ravaged lips bleed as she begins laughing. Draupadi wipes the blood on her palm and says in a voice that is terrifying, sky splitting and sharp as her ululation. What's the use of clothes? You can strip me, but how can you clothe me again? Are you a man?"

Mahasweta was that rare writer of truth tales. Her stories, her novels are angry, passionate and true and steadfast (two of her works, *Hazar Chaurasi Ki Ma* and *Rudali* have been made into films). She wrote her stories as they came to her, the characters taking over and running away. She ensured that the characters she created, poor, downtrodden, low caste, oppressed were never mere victims but were fierce and full of pride; they did not ask for pity, rather they demanded attention. In her notebooks, she would write down words and ideas she came across and then find a place for them in her stories. She collected words – in an ▶

**As she grew older,
Mahasweta became
more outspoken,
more committed
to her political
beliefs to work with
the poor and the
downtrodden and women.
She began to focus her writings on
the stories of the people
she met as she walked
the length and breadth
of some parts of rural India**

interview with her friend and publisher Naveen Kishore, she once said: "I have lots of things scribbled down... let me see... my notebooks are scattered... there was a time when I would write down words I came across. Here, for example, *Parnanar*. Made of polash leaves. This refers to a strange ritual. Say a man has a train disaster. His body can't be brought home. His relatives then, using straw or other materials...the area I speak of is full of the flame of the forest tree...the polash. So they use the leaves to make a man." And in this way, the ritual of cremation is completed.

GENEROSITY OF SPIRIT

She was also generous with her work. In the mid-'80s when we set up our feminist publishing house, Kali for Women, one of the first things we did was to publish a collection of stories by Indian women. Called *Truth Tales*, it had six stories in translation and one originally written in English. I was sure that we had to have a story by Mahasweta in there – up until then, if I am not wrong, barring a children's story in a National Book Trust collection, she had not been translated into English.

I went to see her in her modest home in what was then Calcutta. She was generous with her time, and with her work. She talked about how strongly she felt about the rightlessness of India's tribal people, the dailyness of the violence tribal women faced, especially at the hands of the State. She chose the story she wanted to give us, she suggested the translator. *The Wet Nurse*, translated by Ella Dutta, became one of the strongest stories in our book (later Gayatri Chakravarti Spivak translated it as *The Breast Giver*). She would do this – people would go to her, ask for her work, she'd give it to them, no question of asking for money, or laying down conditions. And yet, it was not as if she did not need money, for it was this that financed so much of her work.

For a writer so committed to her political beliefs, Mahasweta surprised everyone with the streak of mischief that was so much a part of her. She was impatient with sycophants, refused all gifts that were offered to her, but generous with people she liked or whose work she admired, and she would laugh at, and laugh with, her friends, often turning the humour onto herself. A friend and writer, Deepti Priya Mehrotra, describes how Mahasweta found a book of hers on the Manipuri woman, Irom Chanu Sharmila, and liked it so much that she took on the translation into Bangla herself, meticulously completed it with the help of an assistant and then had it published. Few writers have that kind of generosity. Not surprisingly, she won almost every award there was to win – the Sahitya Akademi Award (1979), the Padmashree (1986), the Jnanpith (1997), the Magasaysay (1997) and the Deshikottam Award (1999).

Her plots were often based on real-life incidents. It was her skill as a writer, and her sensitivity to the subject, which enabled her to lift real-life stories above the level of mere reportage, to fill them with nuance and complexity, and render them literature. In the words of Anjum Katyal, writer and translator of some of Mahasweta's works, "Her language traversed a wide range, incorporating styles of Bengali from all strata of society, including a hybrid Bihari-inflected dialect. Her vocabulary was wildly varied; her tone elliptical, terse, often drily sardonic; her humour, black. Hers was a tough, lean style, with unexpected passages of intense lyricism. Like the woman herself." Katyal goes on to describe how Mahasweta Devi believed in oral histories, in people's stories, in folk knowledge. "She wove these into her writing. Her account of Rani of Jhansi is built out of tales and perspectives she collected while travelling and talking to the common people; one of the first writers to attempt such an alternative history."

Despite her stature as one of Bengal's most eminent writers, Mahasweta Devi did not give up her journalism, continuing to write regular columns.

Mahasweta Devi's work today stands as testament to the writer's courage and strong beliefs. And yet, despite the considerable oeuvre, she only managed to eke out a modest living. Her choice to walk out of a marriage to a well-known man in order to pursue her writing brought her much criticism. She had a complicated and, sometimes, tense relationship with her son, Nabarun, also a writer. His untimely death wounded her deeply.

A few years ago, Mahasweta Devi delivered the keynote address at the Jaipur Literature Festival. She called her presentation 'O to Live Again'.

She said: O To Live Again...

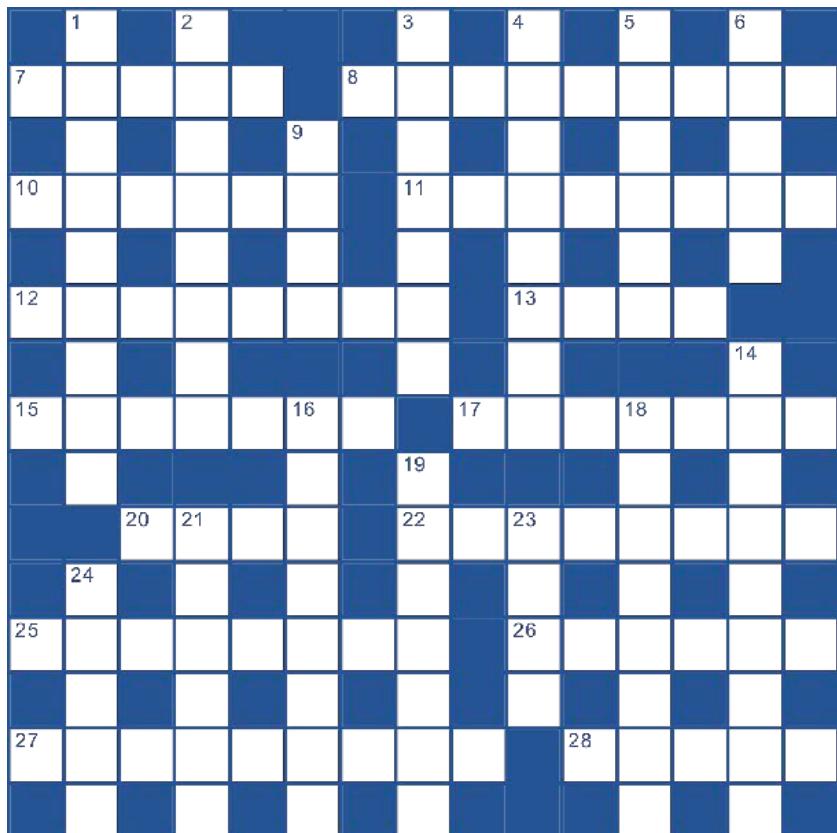
Was yesterday not full of a thousand possibilities? That was the life! What has changed since then? You feel weak, insipid, a dreadful debilitating listlessness worse than malaria fever. It is far, far worse. You are alone."

But then, in true Mahasweta style, she tempered what she said, calling the desire to live again a 'mischievous one'. She said: "I am haunted by the ghosts of so many writers, characters from my stories, or people whom I have 'lived' and yes, loved and lost. Sometimes, I feel like an old house that is privy to the simultaneous conversations of its inhabitants... But what happens when that person has reached the end of her strength?"

Mahasweta Devi may have reached the end of her bodily strength, but the strength of her stories will be with us for a long time to come. □

Urvashi Butalia is the director and co-founder of Kali Women, India's first feminist publishing house. A recipient of the Padma Shri award, she is a historian whose research focuses on the Partition and oral histories. Her book, *The Other Side of Silence*, collates the tales of the survivors of the Partition.

Puzzle Pit



YOUR DETAILS

NAME: _____

AGE: _____

ADDRESS: _____

PINCODE: _____

TEL: _____ MOBILE: _____

SCHOOL/INSTITUTION/OCCUPATION: _____

EMAIL: _____

HOW IT'S DONE: The puzzle will already be familiar to crossword enthusiasts, although the British style may be unusual as crossword grids vary in appearance from country to country. Novices should note that the idea is to fill the white squares with letters to make words determined by the sometimes cryptic clues to the right. The numbers after each clue tell you how many letters are in the answer. All spellings are UK English. Good luck!

CROSSWORD NO. 38

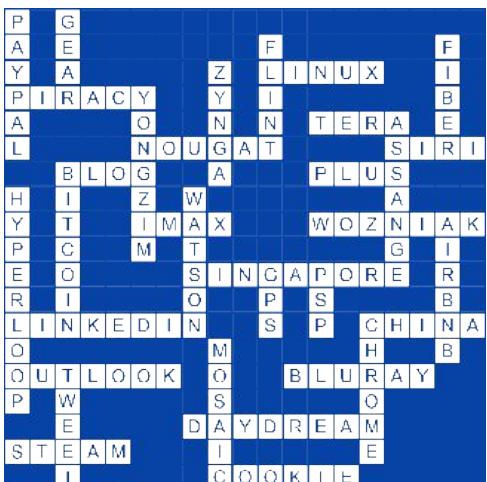
ACROSS

- 7 Aspect (5)
- 8 Had complete control over (9)
- 10 Sent by post? (6)
- 11 Observing or seeing (8)
- 12 Most hurried (8)
- 13 Actor's part? (4)
- 15 Corridor or thoroughfare (7)
- 17 Analysing a sentence (7)
- 20 Napoleon's exile island (4)
- 22 Held in high regard (8)
- 25 Disputed, strove or struggled? (8)
- 26 Summits, top points (6)
- 27 Narrated or told; described (9)
- 28 Young person (5)

DOWN

- 1 Palindromic Indian language (9)
- 2 Exhausts or uses up (8)
- 3 Poems of fourteen lines (7)
- 4 English queen (8)
- 5 Call off, annul (6)
- 6 Implied or signified (5)
- 9 Doing nothing (4)
- 14 Engages the attention of (9)
- 16 Allowing officially (8)
- 18 Framework of the body (8)
- 19 Interfered unnecessarily (7)
- 21 Portable computer (6)
- 23 Bait or ensnare (4)
- 24 Edible ice-cream holders? (5)

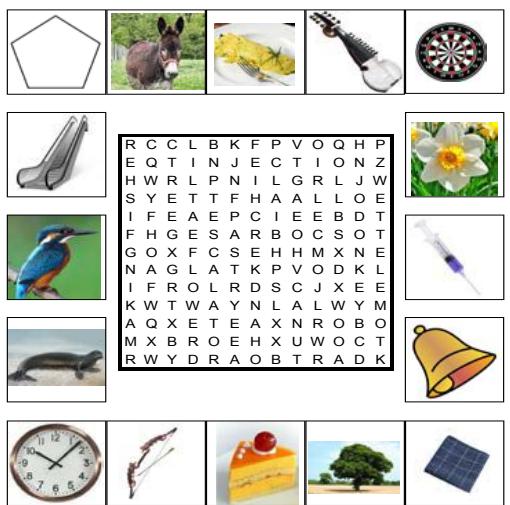
SOLUTION OF CROSSWORD NO. 37



PUZZLE PIT

PICTURE SEARCH

In the jumble below, the words represented by each of the 16 pictures are hidden either horizontally, vertically or diagonally forward or backwards but always in a straight line. See how many of them you can find? Look out for descriptive names.



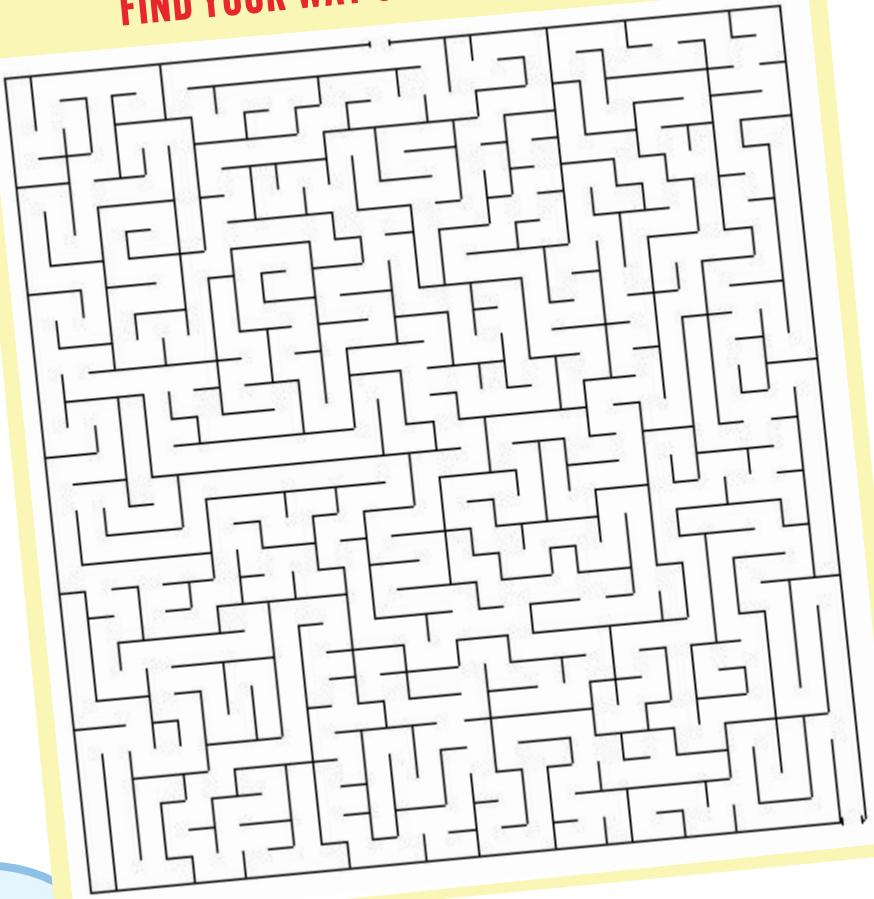
SCRAMBLE

Solve the four anagrams and move one letter to each square to form four ordinary words. Now arrange the letters marked with an asterisk (*) to form the answer to the riddle or to fill in the missing words as indicated.

BEVAO	*			*	
ABCIS			*	*	
EIKNTT			*	*	
DELUBN	*		*		

If I could remember the names of all these particles, I'd be a _____. - Enrico Fermi(8)

FIND YOUR WAY OUT OF THE MAZE



HEAD & TAIL

Look at the clue to fill the blank in the form of a compound word. The second part of the answer is the first part of the next answer, etc.

Come to terms with

Make

— with: terminate

Match played as visitors

Grouse and partridges

Feathered friends' home

Savings

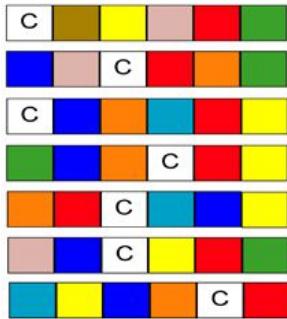
Brinjal

Plant

ENIGMA CODE

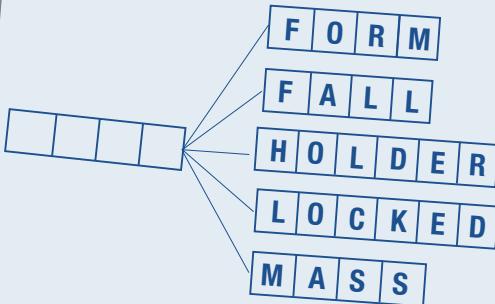
Each colour in our code represents a letter. When you have cracked the code, you will be able to make seven words. The clue to the first word is given to help you get started.

The clue: Uttered obscenities



DOUBLE BARRELED

What word can be placed in front of the five words shown to form, in each case, another word?



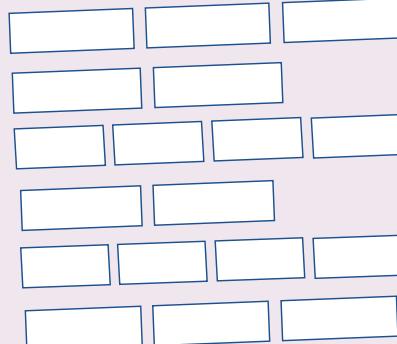
BRAIN TEASERS

- 1) What is represented by this BrainBat? *ists ists*
- 2) Two men play five games of checkers. Each man wins the same number of games. There are no ties. Explain this.
- 3) Four cars come to a four way stop, all coming from a different direction. They can't decide who got there first, so they all go forward at the same time. They do not crash into each other, but all four cars go. How is this possible?
- 4) Solve the letter equation given below:
 $8 = L \text{ on a } S \text{ (or an } O)$
(Hint: Animal kingdom)
- 5) At a recent visit to the reptile house at the local zoo, I counted a total of 27 heads and 70 feet. I was counting snakes, lizards, and people. I know that there were exactly twice as many lizards as people. How many snakes did I count?

PICK & CHOOSE

Solve the six clues by choosing the right combination of sets of letters given below. Each set of letters can be used only once and only in the order given. The number at the end of the clues specifies how many sets of letters are used in the solution.

1. Fine or punishment
2. Crouch in fear
3. Carelessness
4. Appeal
5. Strayed or wandered
6. Large crustacean



ER	PEN	CH	LIG	ER	LOB
ARM	NEG	MEA	TY	EN	CO
WER	ND	AL	CE	ST	ED

BBC KNOWLEDGE QUIZ

See how you fare in the general knowledge quiz given below.

Ratings: 1-3 Poor, 4-5 Fair, 6-7 Excellent

- 1) How many satellites did ISRO recently launch from a single PSLV?

- a) 60
- b) 250
- c) 104

- 2) Who scored the first-ever FIFA World Cup goal?

- a) Pele
- b) Hector Castro
- c) Lucien Laurent

- 3) Who is the author of the *44 Scotland Street* series of episodic novels?

- a) Alexander McCall Smith
- b) Wilbur Smith
- c) Jim Butcher

- 4) Which state is home to Ranthambore National Park?

- a) Gujarat
- b) Rajasthan
- c) Kerala

- 5) What does a mycologist study?

- a) Fungi
- b) Birds
- c) Stars

- 6) Which of these bones is not found in the human ear?

- a) Malleus
- b) Stapes
- c) Radius

- 7) Which rival did Julius Caesar cross the Rubicon to fight?

- a) Vercingetorix
- b) Pompey
- c) Hannibal

BBC Knowledge Quiz: 1. Pompey, 2. Lobster, 3. Negligence, 4. Gujarat, 5. Meander, 6. Spiders, 7. Land, 8. London, 9. Scotland, 10. Wales, 11. Ireland, 12. France, 13. Italy, 14. Spain, 15. Scotland, 16. England, 17. Pompey, 18. Alexander McCall Smith, 19. France, 20. Scotland, 21. Wales, 22. England, 23. Ireland, 24. Scotland, 25. Northern Ireland, 26. Wales, 27. Scotland, 28. Northern Ireland, 29. Northern Ireland, 30. Scotland, 31. Northern Ireland, 32. Northern Ireland, 33. Scotland, 34. Northern Ireland, 35. Scotland, 36. Northern Ireland, 37. Northern Ireland, 38. Scotland, 39. Northern Ireland, 40. Scotland, 41. Northern Ireland, 42. Scotland, 43. Northern Ireland, 44. Northern Ireland, 45. Northern Ireland, 46. Scotland, 47. Northern Ireland, 48. Scotland, 49. Northern Ireland, 50. Scotland, 51. Northern Ireland, 52. Scotland, 53. Northern Ireland, 54. Scotland, 55. Northern Ireland, 56. Scotland, 57. Northern Ireland, 58. Scotland, 59. Northern Ireland, 60. Scotland, 61. Northern Ireland, 62. Scotland, 63. Northern Ireland, 64. Scotland, 65. Northern Ireland, 66. Scotland, 67. Northern Ireland, 68. Scotland, 69. Northern Ireland, 70. Scotland, 71. Northern Ireland, 72. Scotland, 73. Northern Ireland, 74. Scotland, 75. Northern Ireland, 76. Scotland, 77. Northern Ireland, 78. Scotland, 79. Northern Ireland, 80. Scotland, 81. Northern Ireland, 82. Scotland, 83. Northern Ireland, 84. Scotland, 85. Northern Ireland, 86. Scotland, 87. Northern Ireland, 88. Scotland, 89. Northern Ireland, 90. Scotland, 91. Northern Ireland, 92. Scotland, 93. Northern Ireland, 94. Scotland, 95. Northern Ireland, 96. Scotland, 97. Northern Ireland, 98. Scotland, 99. Northern Ireland, 100. Scotland.

Picture & choose: 1. Penalty, 2. Cover, 3. Negligence, 4. Charm, 5. Mammal, 6. Lobster, 7. People, 8. Legs on a Spider (or an Octopus), 9. Snakes, 10. Legs each other, 11. They all made right-hand turns, 12. People, 13. Legs, 14. Legs.

Brain Teasers: 1. Delilah - Land, 2. The two men were playing chess, 3. They all made right-hand turns, 4. Legs, 5. Double barrelled, 6. Escalator, 7. Land, 8. Legs.

Enigma Code: curved, ascended, cantilever, neader, sacred, Tracey, Fermi.

Head & Tail: Make-Do-Away-Game-Birds-Nest-Egg-Plant

Scramble: Words: Bell, bow, block, batboard, donkey, pasty, pentagon, sword, seal, tree, escalator, flower, handkerchief, infection, knifefisher, mermelade,

Picture Search: Bell, bow, block, batboard, donkey, pasty, pentagon, sword, seal, tree, escalator, flower, handkerchief, infection, knifefisher, mermelade,

Solutions:

IN FOCUS

It's two
and a half
minutes to
midnight
on the
Doomsday
Clock...

worry about the global security situation and the preservation of humanity is at an all-time high. And the clock is ticking.

This is not a plot from the latest testosterone-filled action movie or a novel. Nope. This is an analogical commentary on the current threat level representation of how imminent we, as a race, are towards irrevocable catastrophe being unleashed on earth.

The Doomsday Clock was created by the members of the Bulletin of the Atomic Scientists as a response to imminent or future nuclear threats. In 1947, the members, who consisted of the core members of the Manhattan Project (which designed and created the first nuclear bomb; America used those weapons against Japan in WWII), started publishing a newsletter with information about nuclear weaponry in the world. The cover of the first newsletter had the clock on it, with the hands seven minutes away from midnight.

The clock has moved hands 22 times in its existence. The factors the scientists take into consideration range from nuclear threats, climate change, biosecurity, bio terrorism, cyber warfare, among others.

WORDS: MOSHITA PRAJAPATI

THE DOOMSDAY CLOCK

is a timepiece that clocks in how many minutes the world is away from an apocalyptic scenario...

“The Bulletin’s clock is not a gauge to register the ups and downs of the international power struggle; it is intended to reflect basic changes in the level of continuous danger in which mankind lives in the nuclear age...”

– Eugene Rabinowitch,
Bulletin of the Atomic Scientists





Knowledge

The word "Knowledge" is written in a bold, black, sans-serif font. The letter "o" is stylized with a small orange circle positioned above and to the right of the letter's main body.