

Volume 7 Issue 6 • October 2017 ₹125

Knowledge

SCIENCE • HISTORY • NATURE • FOR THE CURIOUS MIND



THE UNPOPPABLE BALLOON + OTHER MAD SCIENCE IDEAS



THE MANY
CAESARS OF
ROME
HACKERS
CAN WE
STOP THEM?

NEW SERIES
THE CHANGING
PERCEPTION OF
LORD INDRA



MW94171031

R.N.I. MAHENG/2010/35422

HERE'S HOW TO GET IN TOUCH

TEAM INDIA

Chief Executive Officer **Deepak Lamba**

Chief Community Officer & Editor **Primrose Monteiro-D'Souza**

Senior Assistant Editor **Moshita Prajapati**

Deputy Art Director **T. Krishna Prabakar**

Digital Imaging Editor **Shailesh Salvi**

Senior Editorial Coordinator **Lalitha Luke**

Brand Manager **Ritika Betala**

Chief Financial Officer **Subramaniam S.**

Publisher, Print & Production Controller **Joji Varghese**

UK TEAM

Editor **Graham Southorn**
Deputy Editor **Andy Ridgway**
Art Editor **Joe Eden**
Publisher **Andrew Davies**
Managing Director **Andy Marshall**

IMMEDIATE MEDIA^{CO}

Chairman **Stephen Alexander**
Deputy Chairman **Peter Phippen**
CEO **Tom Bureau**
Director of International Licensing and Syndication **Tim Hudson**
International Partners Manager **Anna Brown**



BBC WORLDWIDE UK PUBLISHING

Director of Editorial Governance **Nicholas Brett**
Publishing Director **Chris Kerwin**
Publishing Coordinator **Eva Abramik**
UK.Publishing@bbc.com
www.bbcworldwide.com/uk--anz/ukpublishing.aspx



SUBSCRIPTIONS

General Manager Product Strategy
Assistant General Manager (RMD Magazines)

Priyadarshi Banerjee
Suparna Sheth

subscriptions.wwm@wwm.co.in
suparna.sheth@timesgroup.com

SUBSCRIPTION CENTRES: North **011 – 66111255** East **033 – 39898090** West **022 – 39898090** South **080 – 39898090**

To subscribe online, visit: mags.timesgroup.com/bbc-knowledge.html • SMS: KNOWSUB to 58888



HEAD	Business Strategy & Special Projects	Sunil Wuthoo	sunil.wuthoo@wwm.co.in
WEST	Vice President	Gautam Chopra	gautam.chopra@wwm.co.in
MUMBAI	General Manager	Neelam Menon	neelam.menon@wwm.co.in
PUNE	Chief Manager	Ekta Dang	ekta.dang@wwm.co.in
AHMEDABAD	Chief Manager	Kamal Rajput	kamal.rajput@wwm.co.in
NORTH	Vice President	Anjali Rathor	anjali.rathor@wwm.co.in
SOUTH	Vice President South & Business Head – <i>Femina Tamil</i>	Pravin Menon	pravin.menon@wwm.co.in
CHENNAI	Deputy General Manager	O. N. Rajesh	on.rajesh@wwm.co.in
EAST	Assistant Vice President Senior Manager	Alka Kakar Bijoy Choudhary	alka.kakar@wwm.co.in bijoy.choudhary@wwm.co.in



Editorial, advertising and subscription enquiries

BBC Knowledge Magazine, Worldwide Media, The Times of India Building, 4th floor, Dr. D. N. Road, Mumbai 400001



Printed and published by Joji Varghese for and on behalf of Worldwide Media Pvt. Ltd., The Times of India Building, 4th floor, Dr. D. N. Road, Mumbai 400001 and printed at Rajhans Enterprises, No. 134, 4th Main Road, Industrial Town, Rajajinagar, Bangalore 560044, India. Editor- Preeti Singh. The publisher makes every effort to ensure that the magazine's contents are correct. However, we accept no responsibility for any errors or omissions. Unsolicited material, including photographs and transparencies, is submitted entirely at the owner's risk and the publisher accepts no responsibility for its loss or damage. All material published in BBC Knowledge is protected by copyright and unauthorized reproduction in part or full is prohibited. BBC Knowledge is published by Worldwide Media Pvt. Ltd. under licence from Immediate Media Company Bristol Limited. Copyright © Immediate Media Company Bristol Limited. All rights reserved. Reproduction in whole or part prohibited without permission. The BBC logo is a trade mark of the British Broadcasting Corporation and is used under licence. © British Broadcasting Corporation 1996. CIN: U22120MH2003PTC142239

From the editor



READY FOR SOME MAGIC?

Yes, this *is* a scientific magazine, but, sometimes, isn't science magical too?

We've got a fascinating set of experiments this issue in our **DIY Science** feature – go on, try them all! What's life without a little fun in the most unexpected ways? Do write in and tell us how you got along...

Then, there's a cool story about how **hackers are working their way through the world wide web**, causing financial mayhem and political problems, or just indulging in some mischief. Also, on the cool front, but in a totally different way, the **giant otters of the Peruvian Amazon** are taking on the caimans of the river, and winning for the most part, and we have the beautiful **flora and fauna of Ecuador** in our Portfolio section.

We have the many **Caesars of Rome** with us too. I was surprised at their diverse personalities and even by just how many they were; I think you will be too. Our other history story details the 1865 **tragedy on the Matterhorn**, and, even more interestingly, what the opinions on mountaineering were at the time.

Among our India stories, alongside Urvashi Butalia's profile of **Premchand** this issue, we're thrilled to have mythology expert Devdutt Pattanaik join us in a new series on Indian mythology. He begins with a analysis of how the **perception of the great god Indra has changed down the centuries**, and it makes fascinating reading.

Because, when it comes down to it, all knowledge is magical, isn't it?

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

EXPERTS THIS ISSUE



Dr. Stuart Farrimond is a science and medical writer, presenter and educator. He passionately communicates science and health sciences. In this issue, he brings us science experiments to do at home, safely and with friends and family!



Chris Hall is a science and technology journalist. In this issue, he sheds light on the rise of hacking and its transformation today, and possibilities of nipping it in the bud.



Devdutt Pattanaik is a writer, illustrator and lecturer of mythology, who draws attention to its relevance in modern times. Based in Mumbai, he has over 30 books, and over 800 articles to his credit. To know more, visit www.devdutt.com



Padma Shri Urvashi Butalia is a renowned Indian author and publisher. In this issue, she lays out the life and works of Premchand, one of India's greatest writers.



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.

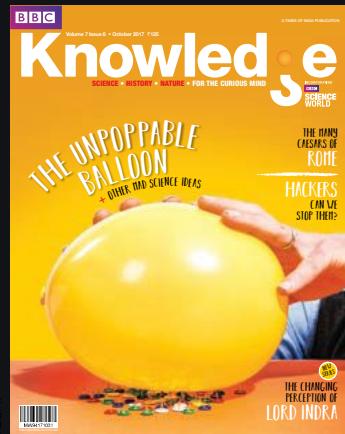


DOWNLOAD THIS CURRENT ISSUE FROM

www.zinio.com • www.magzter.com
• www.reliancejio.com

BBC Knowledge

CONTENTS



123RF

52 Cover Story

DIY Science
Entertaining and eye-opening experiments
to try at home with family and friends

44

FEATURES



- 60** Tragedy on the Matterhorn
Follow the conquest of the great Alpine peak and see how a story of triumph turned to tragedy



- 64** Lake of Giants
See how a family of magnificent giant otters establishes dominance over a lake in the Peruvian Amazon



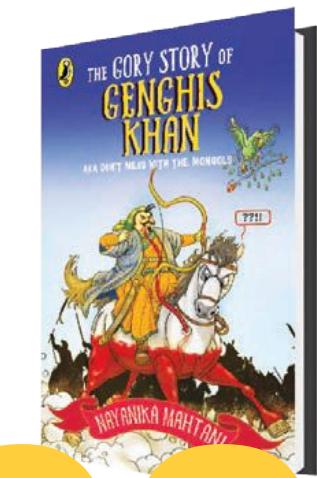
- 72** The Transformation of Lord Indra
In a new series on Indian mythology, expert Devdutt Pattanaik traces the changing perception of Lord Indra



- 76** Hackers: Can They be Beaten?
When it comes to hackers, who draws the line between pure evil, social menace and harmless fun?



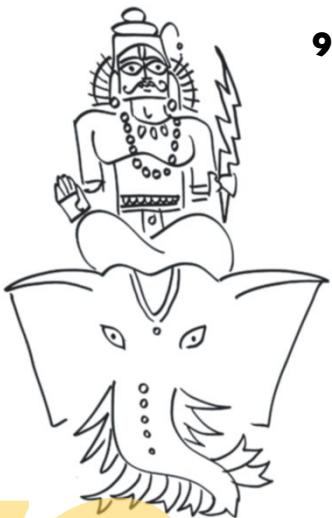
- 84** The other Caesars
History has painted Rome's first rulers as monsters, but there are also those that brought peace and stability to the empire



38



8



72

96



REGULARS

8 Q&A: Your Questions Answered
Curiosity isn't a bad thing when exercised in moderation. Find the answers to all the questions you want to ask

18 Snapshots

Enthrall and inform yourself with these amazing photographs!

24 Discoveries & Innovations

Video games could be good for you, and a chance to look at the snazzy new Mars Rover. More inside!

36 On the Shelves

Author interviews, new books and gadgets, and games reviews

42 News from the World of Travel & Food

Mount Everest, Mumbai's Dr Bhau Daji Lad City Museum, bunny chow and more

44 Portfolio: Miniature Marvels

A treasure trove of beautiful creatures in Ecuador

90 Know Your Author: Premchand

Urvashi Butalia details one of India's greatest authors

93 Puzzle Pit

Challenge your grey cells with a veritable buffet of teasers and puzzles

96 In Focus: Cassini

Bid farewell to a space craft well travelled

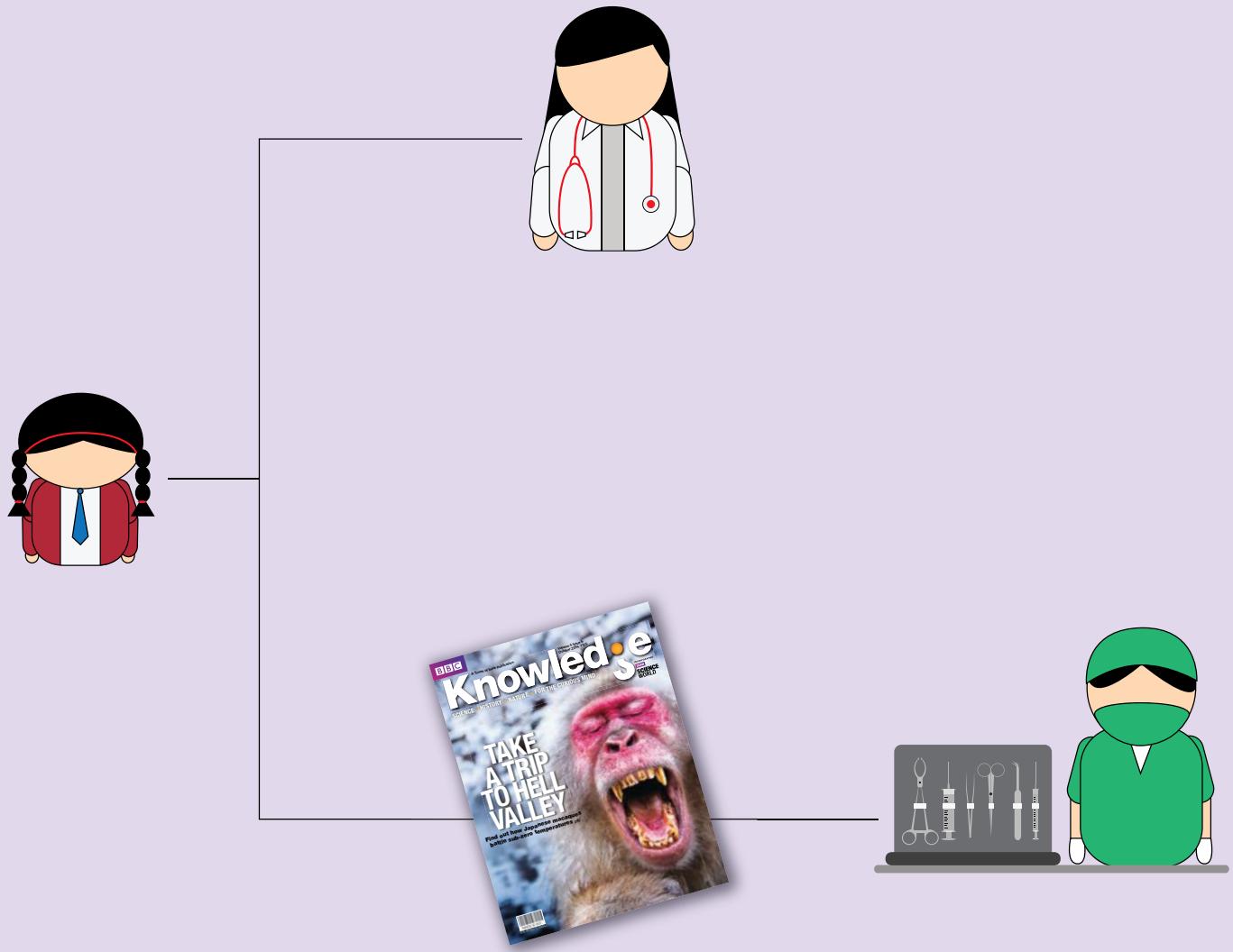
24



52



36

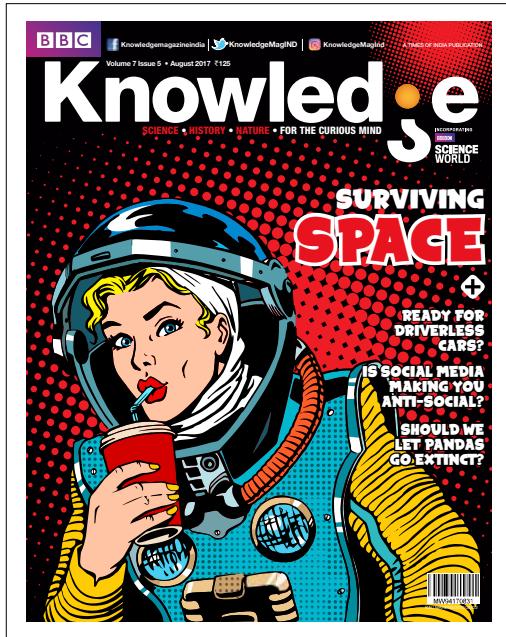


There's no telling what knowledge can do.

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.

letters



Even though I have a very hectic schedule, I would like to take a moment to say a big thank you for giving us such 'knowledge'.

I came to know of *BBC Knowledge* only recently, when a friend suggested I read it. I started reading the issue with great curiosity, and my excitement built with each page I turned.

The name of the magazine "*BBC Knowledge*" is very apt for what it is giving its readers. I hope to continue gaining knowledge with the coming magazines. Keep up the good work. Thank you!

– Rajesh Palanisamy

FROM TWITTER.



It's so cool to read some amazing stuff including about the #multiverse theory in this latest edition of @KnowledgeMagIND . #BBCKnowledge

– Swarit Sohaard



Hello *BBC Knowledge*! I am a fresh MBA student and was looking around for things to read and expand my horizons with when I came across your magazine. I have been a student of commerce, but the way your magazine got me instantly interested in science was amazing! The multiverse theory, the technological implications and market for AI and self-driving cars, the social media piece were my favourites from the issue. The Snapshots were an added bonus! I will now follow your magazine regularly and will recommend it to many more! Keep up the great work. Cheers!

– Swaraj Dudhwade



Hello *BBC Knowledge*,
I am a head nurse with a maternity hospital. We receive magazines and, this time, someone stocked your latest issue for us. I never imagined that so much information could be included in just a single issue. I identify strongly with the social media article as today's youngsters are completely obsessed with it. Not just them, even we grown-ups are! Will make all my colleagues read your magazine and will request that we get it regularly!

Thank you.

– Kusum Sharma



Recently, I did research on 'Terraforming Mars' and Dr. Lewis Dartnell's story on surviving space (August 2017) was of great help. I must say the Q&A section is getting more interesting day by day as our Earth grows older. We really need to delve deeper into areas like AI and machine learning so that the controls are in safe hands and so that robotics can be used for the benefit of mankind. Thus Dr Peter Bentley's article makes an interesting read.

I was smitten with Dhritiman Mukherjee's photographs. They truly depict 'Incredible India'. It would be great if his "100 Days in the Himalayas" photographs could be published. We also really have to ponder over why we are becoming anti-social.

At a time when India is going through border tension, I feel Manto comes into play. The emotion captured in *Toba Tek Singh* stands as a perfect example of the horrors of Partition.

– Suprava Ghosh

Q&A

YOUR QUESTIONS ANSWERED

Dr Alastair Gunn
Astronomer, astrophysicist

Alex Franklin-Cheung
Environment/ climate expert

Dr Peter J Bentley
Computer scientist, author

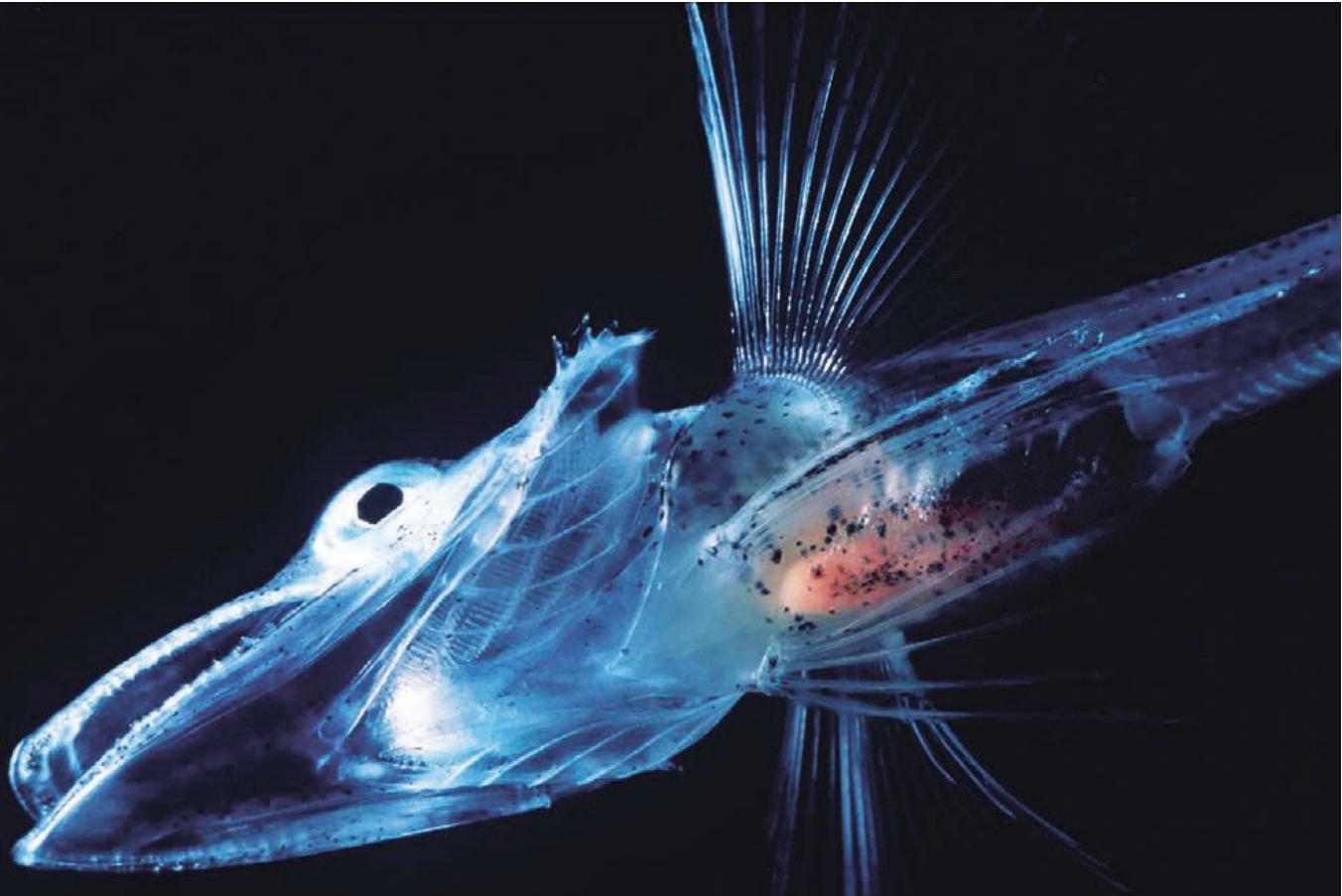
Prof Mark Lorch
Chemist, science writer

Dr Helen Scales
Oceans expert, science writer

Prof Robert Matthews
Physicist, science writer

Luis Villazon
Science/tech writer

Prof Alice Gregory
Psychologist, sleep expert



WHY DO SOME FISH HAVE COLOURLESS BLOOD?

Antarctic icefish have colourless blood with no red blood cells and no haemoglobin, the oxygen-carrying pigment. This probably comes down to a genetic mutation, and means their blood carries 90 per cent less oxygen than red blood. They survive partly because frigid Antarctic waters are oxygen-rich. Icefish also have enormous hearts that pump huge volumes of blood around their bodies, making sure they get enough oxygen. Antifreeze in their blood stops them from freezing (the salty Southern Ocean gets down to -2°C) but, as they are so well-adapted to the cold, their future in a warming world remains uncertain. **HS**



WHY DO ROCKETS FOLLOW A PARABOLA AFTER LAUNCH?

Students have long been taught that all projectiles follow a curved path known as a parabola. The explanation is that, as they fly, they cover distance both horizontally and vertically – but only the latter is affected by the force of gravity, which bends the path of the projectile into a parabola. For long-range rockets, things are more complex. For example, air resistance must be taken into account. But, even ignoring that, a projectile doesn't really follow a parabola – because the Earth isn't flat. This means that gravity doesn't simply pull objects straight back down. Instead, it pulls them towards the centre of the Earth, whose direction changes as the projectile moves further down-range, away from the launch site. Detailed calculations then reveal that the true trajectory is not a parabola, but part of an ellipse. RM

HOW LONG COULD YOU SURVIVE ON BEER ALONE?

Beer typically has around 40 calories per 100ml (one pint = 568ml). To get your daily 2,000 calories just from beer, you'd need to drink 11 pints every day, which is hardly healthy. But the alcohol is the least of your problems. Beer, even real ale or Guinness, contains no fat, almost no protein and – crucially – no vitamin C. Without any source of vitamin C, you'll experience symptoms of scurvy in two or three months and be dead in six. LV



NUMBERS

25

The percentage of the world's population who eat chillies every day.

100

The number of tiny needles embedded into a painless skin patch vaccine that could be used instead of traditional syringes.

6,000

The number of wildebeest that drown during the migration every year.

COULD YOU THROW A FRISBEE ON MARS?



Since the Martian atmosphere is about 100 times less dense than Earth's, the 'lift' a frisbee experiences would also be about 100 times less. But the gravitational force on Mars is about a third of that on Earth, so a frisbee on Mars would act as if it is about 33 times heavier ($100/3$). Since the lift depends on the size of the frisbee, the angle of attack and the velocity it is thrown (as well as the air density), it would still be possible to make a frisbee glide, but it would require much more effort on the part of the thrower! AGu



DO SEAGULLS DRINK SEAWATER? AND, IF SO, HOW DO THEY DEAL WITH THE SALT?

All seabirds drink seawater – yet birds have less efficient kidneys than mammals, and so excess salt is even more toxic to them than to us. Seabirds cope with this by using specialised salt glands next to their eye sockets. These look like miniature kidneys and work in a similar way, pumping salt ions out of the bloodstream against the normal flow of osmosis. The extra-salty water drips down the side of their beak. **LV**

HOW DO WE TALK IN OUR HEADS?



Talking in our heads is referred to by psychologists as 'inner speech'. It involves some similar processes to 'overt' speech – it recruits brain regions involved in language, such as the Broca's and Wernicke's areas, and is even accompanied by minute muscle movements in the larynx. However, there are notable differences too, with brain areas useful in inhibiting overt speech playing a greater role in inner speech. The exact brain mechanisms involved may come down to why we are talking in our heads in the first place. For example, when we read a book, brain regions involved in attention may be more active than when we are mentally preparing for a race. **AGr**

CAN THE PLACEBO EFFECT HARM YOU?



Just as the placebo effect causes positive results if you believe you are taking beneficial medicine, there is a negative version, called the nocebo effect. This creates harmful effects such as pain, high blood pressure, dizziness and rashes if you believe that these are possible side effects of the medication you have been given, even though it's a placebo. **LV**

WHAT CONNECTS

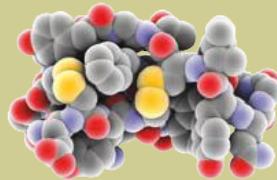
...FROGS AND FRESH MILK?

1



Frogs, like all amphibians, have thin, porous skin that they can breathe through. But this also poses a risk because it makes it easier for bacteria to infect them.

2



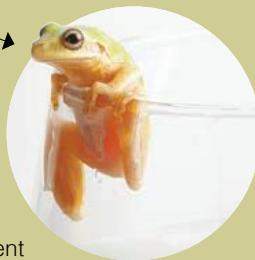
To protect themselves, frogs secrete substances called cationic antimicrobial peptides (CAMPs). Other animals secrete CAMPs too, but frogs produce much more, including some peptides that are effective against multi-resistant bacteria.



3

Milk goes off because of bacteria, especially species of Lactobacilli and Pseudomonas. These ferment the lactose in milk into lactic acid, and hydrolyse milk proteins into various unpleasant tasting by-products.

4



According to Russian folklore, putting a live frog in milk would help it stay fresh. Recent research has found that CAMPs from the Russian brown frog could kill the bacteria in milk and prevent it from turning.

HOW IS HELIUM TURNED INTO A LIQUID AND A SUPERFLUID?

At -269°C, helium gas condenses to become a liquid. Cool it even further and it becomes a state of matter called a superfluid. In this state it has no measurable viscosity and so does some odd things, such as climbing up the walls of a dish, leaking through apparently solid materials and staying motionless while its container is spun. To create the liquid and superfluid states, you cool down helium gas to a few degrees above absolute zero. This is achieved by compressing the gas, and then expelling it through a small nozzle. As the gas expands, it rapidly cools (you'll have noticed this effect if you've ever used an aerosol deodorant). The process is repeated until the gas that rushes out of the nozzle is cold enough to condense to a liquid, then if you repeat the cycle a few more times the helium will become cold enough to turn to a superfluid. **ML**



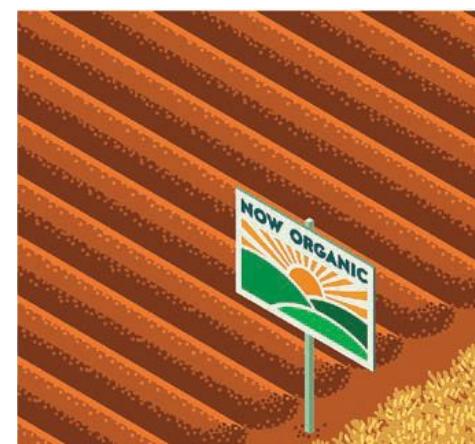
HOW DO HOUSEHOLD CLEANING PRODUCTS AFFECT THE ENVIRONMENT?

Even after passing through water treatment plants, small quantities of chemical compounds from cleaning products can find their way into rivers, ponds and lakes and have adverse effects on aquatic life. Phosphates in laundry and dishwasher detergent have a fertilising effect, triggering the widespread growth of algae that saps away the water's oxygen, reducing biodiversity. By reducing water tension, surfactants allow other pollutants in water bodies to be absorbed more easily by plants and animals. Many other compounds can be toxic to wildlife, or affect growth and reproduction, for instance by mimicking the effects of hormones in mammals and fish. **AFC**



THE THOUGHT EXPERIMENT

WHAT WOULD HAPPEN IF ALL EARTH'S INSECTS VANISHED?



1. Food chain collapse

Most non-marine food chains depend on insects. Almost all birds eat insects, and even those that eat seeds as adults still feed insects to their young. It takes 200,000 insects to raise a swallow chick to adulthood. Insects also break down plant matter and help recycle nutrients into the soil. Without any insects at all, most bird and amphibian species would be extinct in two months.

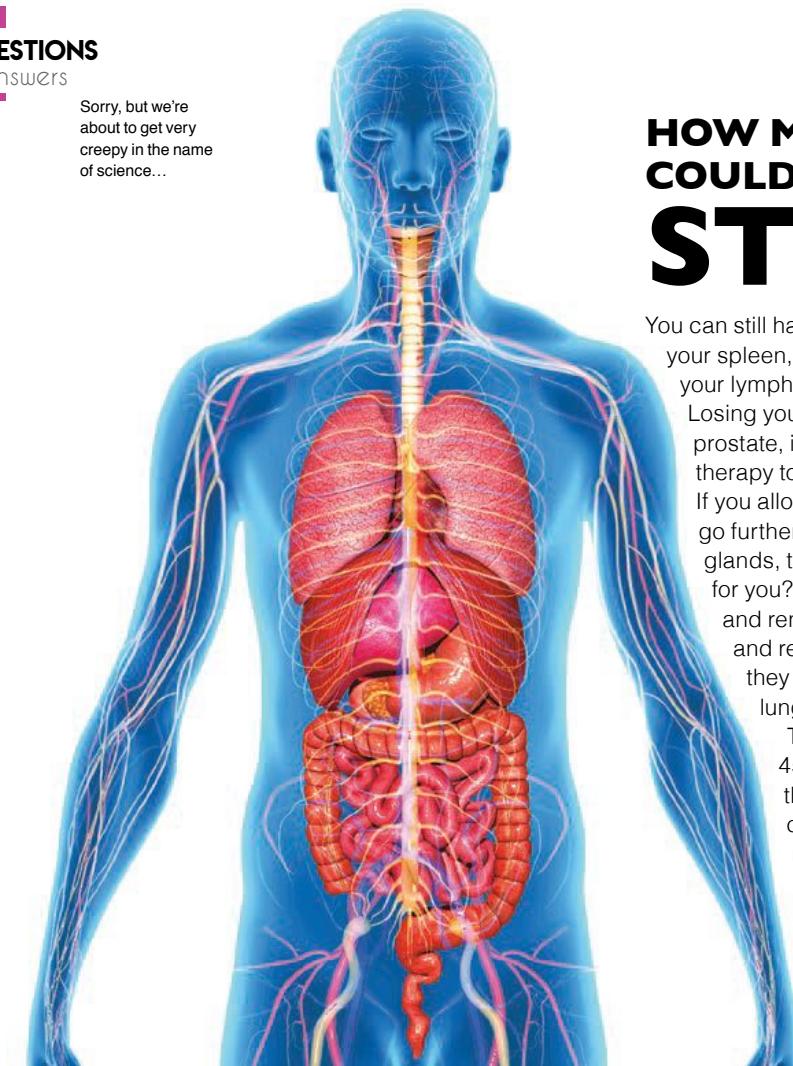
2. No pollination

Of the world's food crops, 75 per cent are pollinated by insects. Without insects, we could still grow many foods, but onions, cabbage, broccoli, chillies, most varieties of tomato, coffee, cocoa and most fruits would be off the menu. So would sunflower and rapeseed oil. Demand for synthetic fibres would also surge because bees are needed to pollinate both cotton and flax for linen.

3. Less Insecticide

On the plus side, if there were no longer any insects, we wouldn't need the 430,000 tonnes of insecticides that are sprayed onto crops every year. In the US, pesticide residues cause between 4,000 and 20,000 cases of cancer each year, according to the National Academy of Sciences. But this is a small compensation for total ecological collapse and global famine.

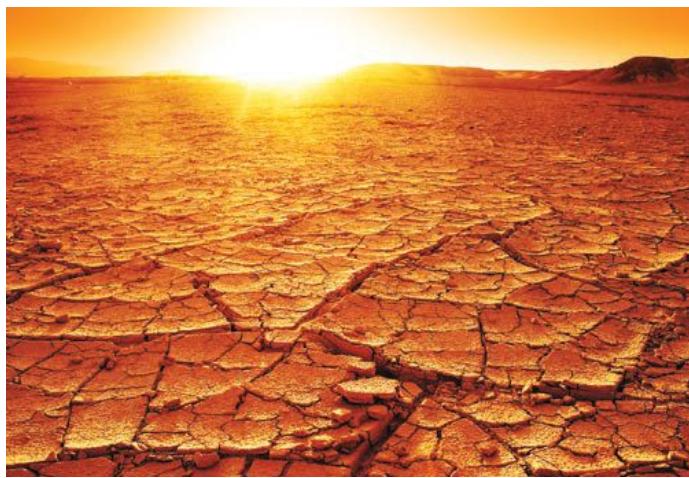
Sorry, but we're
about to get very
creepy in the name
of science...



HOW MANY ORGANS COULD YOU LOSE AND **STILL LIVE?**

You can still have a fairly normal life without one of your lungs, a kidney, your spleen, appendix, gall bladder, adenoids, tonsils, plus some of your lymph nodes, the fibula bones from each leg and six of your ribs. Losing your uterus, ovaries and breasts, or your testicles and prostate, is also quite survivable, although you might need hormone therapy to avoid other long-term problems, such as brittle bones. If you allow yourself artificial replacements and medication, we can go further and remove your stomach, colon, pancreas, salivary glands, thyroid, bladder and your other kidney. Still not enough for you? Theoretically, surgeons could amputate all of your limbs, and remove your eyes, nose, ears, larynx, tongue, lower spine and rectum. Supported by machines in an intensive care unit, they could also take away your skull, heart and your remaining lung, at least for a short while.

This adds up to a theoretically survivable loss of around 45 per cent of your total body mass. But any trauma that destroyed all these organs all at once would almost certainly kill you from shock and blood loss. And surgically removing them one at a time over many months would likely also be fatal, due to infections in your immune-compromised state. **LV**



HOW HOT COULD EARTH GET BEFORE IT'S UNINHABITABLE FOR HUMANS?

Humans need to sweat to survive in warm conditions, and that's only possible if the combination of temperature and humidity – known as the wet-bulb temperature – stays below around 35°C. According to a 2012 study by scientists at MIT, this limit could be reached globally if our planet warms by around 12°C. Fortunately, few scientists think global warming will do this in the foreseeable future. **RM**



WHAT IS BEING DONE TO PRESERVE POMPEII?

The main threat to the already excavated buildings and mosaics is moisture, which attacks the plaster and mortar. But Pompeii has attracted the best archaeological conservationists from around the world. In 2012, a 10-year project began installing protective roofs, removing existing moisture and researching the chemical structure of ancient plasters. There is also a moratorium on new archaeological excavations. **LV**

...WHEN I SLEEP?

Sleep consists of two radically different physiological states. There is rapid eye movement sleep (REM) and non-rapid eye movement sleep (NREM). The sleep stages seem to have different functions, but why we sleep is still not completely understood. Babies spend half of their sleep in REM, but this drops to a quarter by the age of two. It is therefore thought that REM sleep is particularly vital for the developing brain. In NREM sleep, brain activity slows and a person woken at this stage may feel groggy.



1. Pituitary gland

During non-REM sleep, the pituitary gland produces growth hormone and secretes prolactin. This counteracts dopamine, to lower general arousal levels.



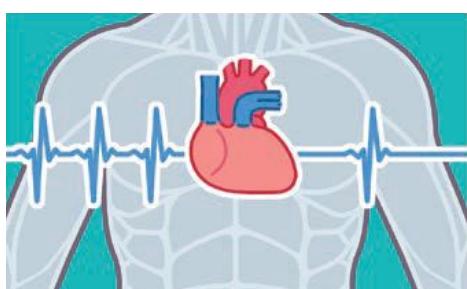
2. Mouth

You produce less saliva, which reduces the need to swallow. Five per cent of adults also grind their teeth at night, mostly during the early stages of sleep.



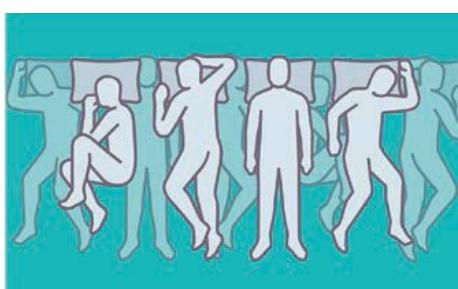
3. Lungs

The throat muscles relax so your airway narrows when inhaling. This can cause snoring, or temporarily halt your breathing for a few seconds (sleep apnoea).



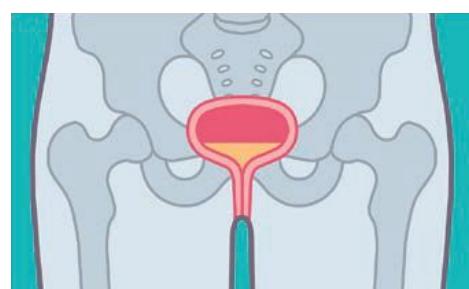
4. Heart

Your pulse drops by 10-30bpm while you sleep, lowering your blood pressure. Less blood flows to the brain, and more is diverted to your muscles.



5. Limbs

The extra blood swells your arms and legs slightly. Muscles are paralysed while dreaming, but, between dreams, you change sleeping position 35 times a night.



6. Bladder

Vasopressin hormone levels rise. This reduces the amount of urine collected in the bladder to between a half and a third of normal daytime levels.

WHY DO CHAMPAGNE BUBBLES RISE FROM THE BOTTOM OF A GLASS?

The bubbles are filled with carbon dioxide (CO₂), a gas 800 times less dense than the surrounding liquid.

Molecules of this gas accumulate in imperfections in the glass and start to form a bubble, whose low density supplies enough buoyancy to break off and float towards the surface. In the process, they run into more molecules, making the bubble even bigger and more buoyant, and accelerating its ascent. **RM**



If your champagne glasses are grubby, bubbles will form on the specks of dirt, betraying your shoddy washing-up skills

...Hand Cream

There are two ways that hand creams act to moisturise your skin. Occlusive agents form a barrier that traps water, while humectants attract more water to your skin. The problem is that the humectants are water soluble, while the occlusive agents dissolve in oil. So, to get them to mix in an easy-to-use formulation, the creams also need an emulsification system. **ML**

80% Water

Gives the cream volume and dissolves some ingredients.

Glycerine 3%

Is a typical humectant used to draw water in from the atmosphere.

5% Thickeners

PEG or polyacrylic acid (which may appear as carbomer on the label) are long polymer molecules that increase the viscosity of the cream, making it easier to apply.



Fats and oils 7%

Coconut oil, petroleum jelly or lanolin (a waxy substance secreted by woolly animals such as sheep) might be used as occlusive agents that form a barrier to block escaping water.

2.5% Emulsifier

Glyceryl stearate and stearic acid help to stabilise the oil/water mixture.

Preservatives and fragrance 2.5%

These improve the product's shelf life and make it smell nice.

DO ALL FISH AND SHELLFISH CONTAIN MERCURY?

Mercury levels in the oceans have tripled since the Industrial Revolution, thanks to mining and the burning of fossil fuels.

All sea creatures absorb some of this heavy metal directly, and, once it's in the body, there's no way of getting rid of it. The amount of mercury in fish varies between species. Long-lived predators like tuna and swordfish tend to contain the most, because they also absorb mercury from their prey and they've had a long time to accumulate it. The lowest levels are found in short-lived species lower down the food chain, such as oysters and shrimp. **HS**



DOES HOLDING YOUR BREATH MAKE YOU STRONGER?

It won't make you stronger in the sense of building muscle in your heart or diaphragm, but holding your breath while training for certain sports has been shown to improve the ability of your muscles to cope with short, intense exertions. This works by increasing the concentration of bicarbonate in the blood, which helps to neutralise the lactic acid produced during anaerobic exercise. For this technique to work, you need to exhale normally and hold your breath when your lungs are empty, rather than taking a big breath in and holding that. There are significant risks, though. A 2009 study found that free divers who regularly held their breath for several minutes had elevated levels of a protein called S100B in their blood, which is an indication of long-term brain damage. **LV**

WHY DOES 37°C FEEL SO HOT WHEN OUR BODIES ARE AT THAT TEMPERATURE ALREADY?

That's the temperature of your core. Your skin is usually around 34°C, and your face, fingers and toes can be much colder. The receptors in your skin react to differences in temperature, so, when you put your hand on your bare stomach, your hand registers warmth but your belly shrieks 'cold!', even though both are 'skin temperature'. Similarly, the inside of your mouth feels warm to your finger, but not to your tongue. **LV**



HOW DO STARS DIE?

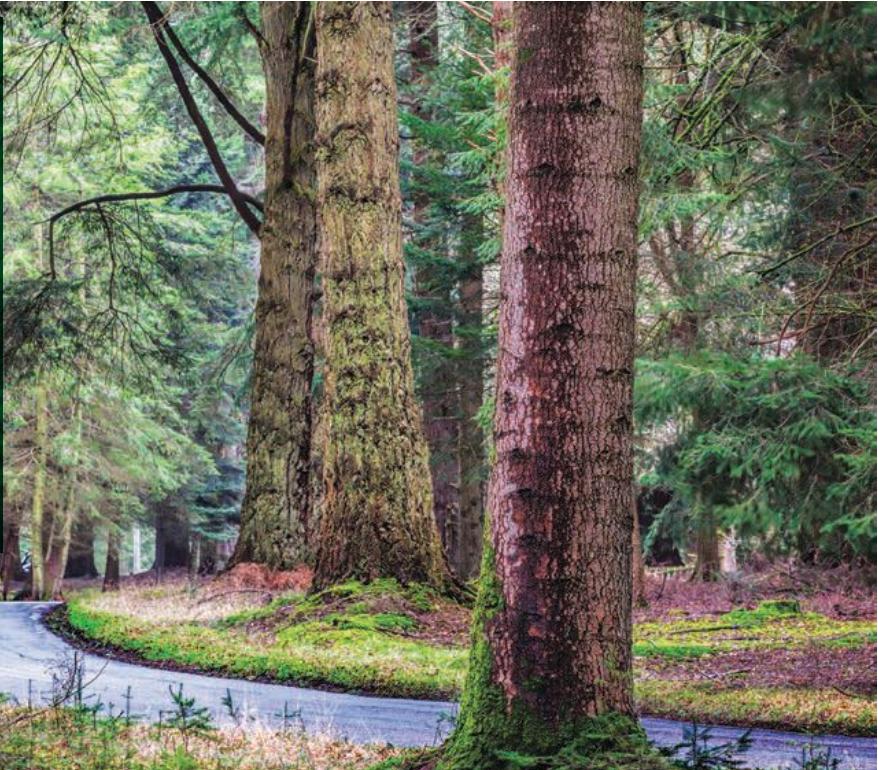
Stars die because they exhaust their nuclear fuel. The events at the end of a star's life depend on its mass. Really massive stars use up their hydrogen fuel quickly, but are hot enough to fuse heavier elements such as helium and carbon. Once there is no fuel left, the star collapses and the outer layers explode as a 'supernova'. What's left over after a supernova explosion is a 'neutron star' – the collapsed core of the star – or, if there's sufficient mass, a black hole.

Average-sized stars (up to about 1.4 times the mass of the Sun) will die less dramatically. As their hydrogen is used up, they swell to become red giants, fusing helium in their cores, before shedding their outer layers, often forming a 'planetary nebula'. The star's core remains as a 'white dwarf', which cools off over billions of years.

The tiniest stars, known as 'red dwarfs', burn their nuclear fuel so slowly that they might live to be 100 billion years old – much older than the current age of the Universe. **AGu**

DO TREES REDUCE AIR POLLUTION LEVELS?

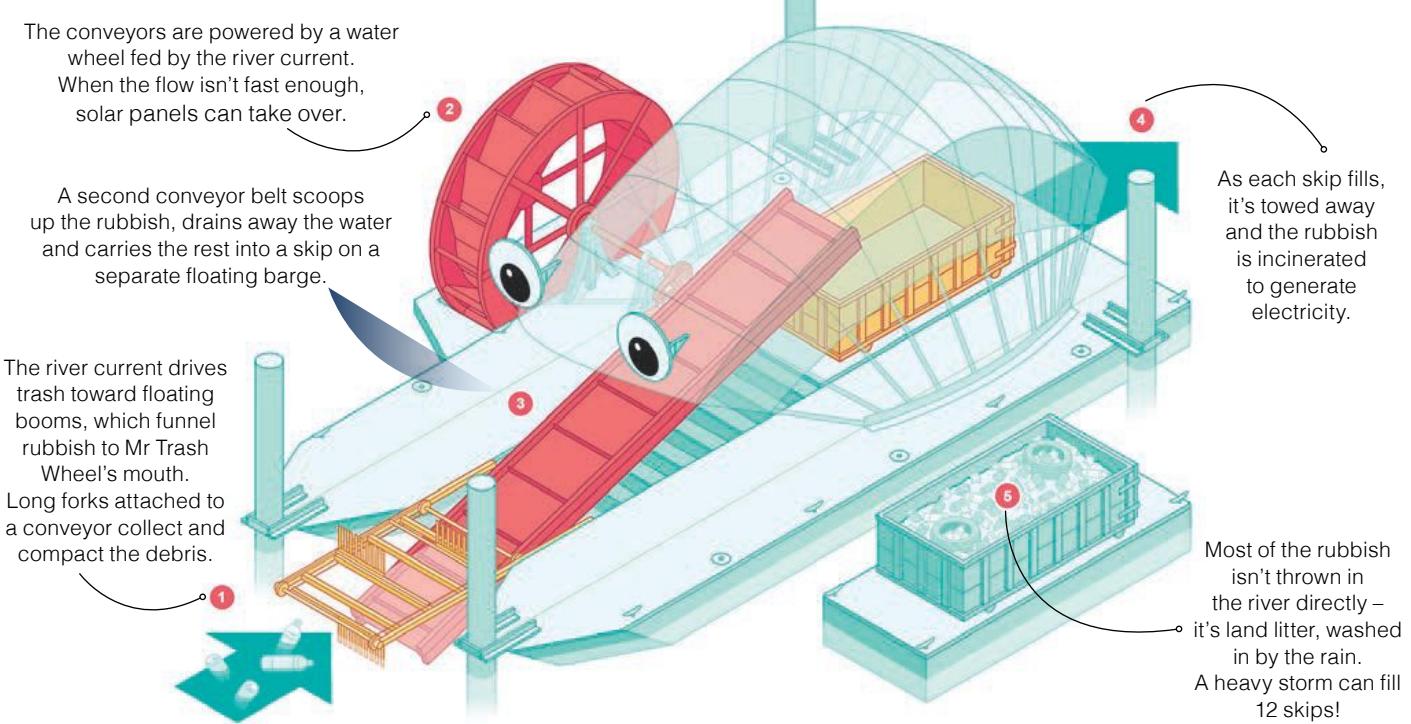
The relationship between trees and air pollution is a complicated one. Particulate matter suspended in polluted air tends to settle onto leaves, and certain gases including nitrous dioxide (NO_2) are absorbed by leaves' stomata, filtering the air and reducing pollution levels slightly. But trees and other vegetation also restrict airflow in their immediate vicinity, preventing pollution from being diluted by currents of cleaner air. In particular, tall trees with thick canopies planted alongside busy roads can act like a roof, trapping pockets of polluted air at ground level. To reliably improve air quality, city planners need to give careful consideration to how trees are placed. AFC



HOW IT WORKS

MR TRASH WHEEL

At the mouth of the Jones Falls River, where it feeds into Baltimore Harbour in the US, sits Mr Trash Wheel. Since 2014, this semi-autonomous floating rubbish collector has scooped up more than 500 tonnes of detritus, including 90,000 cigarette butts, 4,920,000 coffee cups and 3,760,000 crisp packets. Mr Trash Wheel cost \$720,000 (£560,000) to build, and has now been joined by Professor Trash Wheel, a 'female' version in a different part of the harbour.



WHAT IS THIS?



ALTERING PERCEPTIONS

This creepy-looking robot, called Alter, was designed by scientists in Japan. The robot is connected up to electronic sensors that detect minute changes in the environment. These differences in temperature, humidity or other elements will influence the robot's movements, which are controlled by a brain-like neural network without any input from humans.

Snapshots





PHOTO: ALAMY

Slippery customer

NAMIB DESERT, NAMIBIA

If you find yourself wandering through the vast deserts of Namibia, watch where you put your feet! The Peringuey adder, also known as *Bitis peringueyi*, spends much of its time buried under the sand. As an ambush predator, the snake needs to remain unseen, and the sand provides the perfect camouflage.

Dr Brian Crother from Southeastern Louisiana University, the USA says: "The desert adder burrows into the sand, leaving its eyes, which sit on top of his head, and its black-tipped tail exposed. The black tail tip is gently waved about and used as a lure to bring lizards [its prey] within striking distance."

As a desert-dweller, the snake has a number of adaptations to survive in the harsh environment. First, it can travel using a form of locomotion called 'sidewinding', where just two points of its body are in contact with the sand at a time. This allows it to move quickly across loose terrain, and reduces contact with the hot sand. Second, water from morning fog condenses on its body, which it then drinks.

Swell snap

HAWAII, THE USA

Photographer Sash Fitzsimmons claims he risked his life to take this incredible image. And physicist and oceanographer Dr Helen Czerski agrees that it's a dangerous business.

"The energy of a barrel wave like this one ultimately comes from the wind pushing the ocean surface into ripples and then up into bigger and bigger waves," she says. "As the water gets shallower, that energy is concentrated and the waves steepen until they break in these beautiful long barrels. One cubic metre of water weighs a tonne, so the rapid movement of this much water represents a huge amount of kinetic energy. Both the surfer and the photographers need superb judgement – and a bit of luck – to stay safe."

To take the photograph, Fitzsimmons used a GoPro camera with a fisheye lens. It was fitted with a dome to push water away from the camera, allowing him to capture the action above and below the surface.

PHOTO: CATERERS NEWS









PHOTO: RALDOVANDI/SOLENT

Only have eyes for you

**EMILIA-ROMAGNA,
ITALY**

Peering through a hole in a poplar leaf, these two damselflies look ready to invite us in for a cup of tea. The pair, who appear to be holding hands, were spotted close to the river Po in northern Italy.

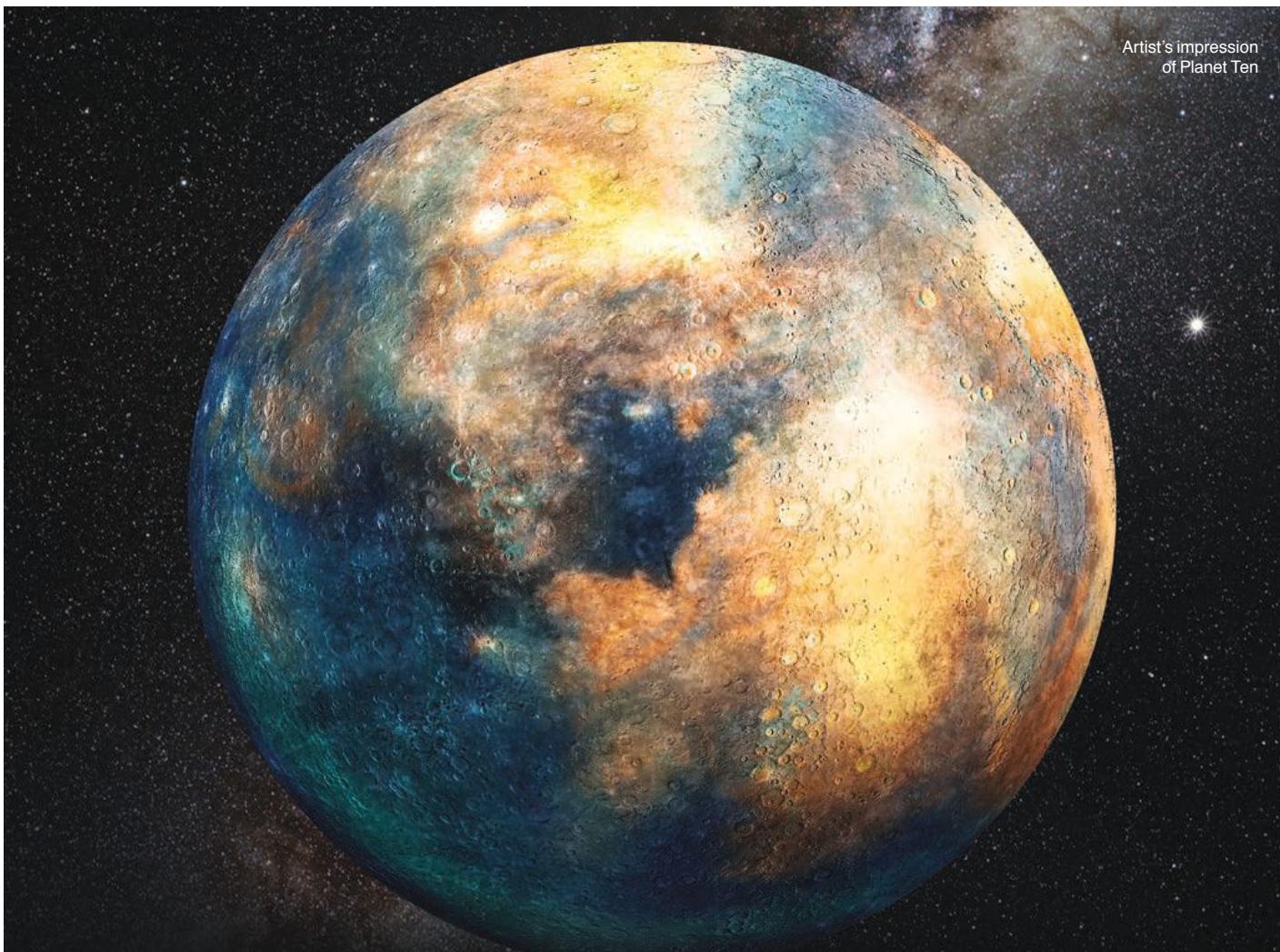
"Damselflies are often sexually dimorphic," says Prof Adam Hart, an entomologist at the University of Gloucestershire. "This means that the males and females differ, typically in size and colouration, with males often more colourful and smaller than females."

Here, the larger, green damselfly on the right is more likely to be the female, and she's probably been wooed by an elaborate courtship display. "The males will hover, flap, bob, flicker and display their wing spots in order to show themselves off," says Hart. "They'll also engage other males in 'flights of attrition', where the two rivals try to exhaust each other with aerobatics."

Once successful, the male will clasp the female behind her head, and the female will curve her abdomen around to pick up his sperm. The shape of the two mating damselflies often resembles a heart. Incredible!

DISCOVERIES

DISPATCHES FROM THE CUTTING EDGE



SPACE

IS THERE A TENTH PLANET?

Astronomers in the US have inferred the existence of an unknown 'planetary mass object' affecting the movements of space rocks in a distant asteroid belt

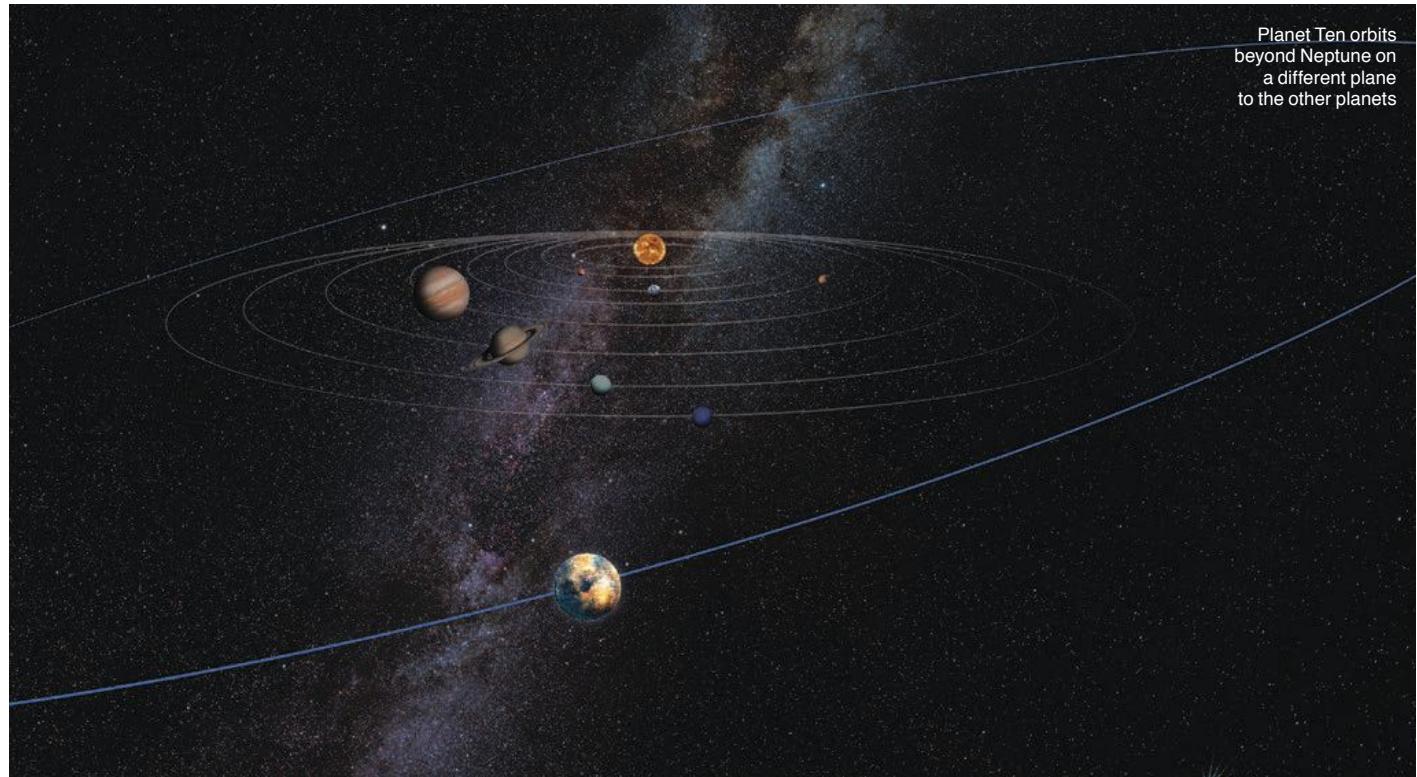
It seems the Solar System may be a little more crowded than we thought: a planet around the size of Mars could be hidden among its outer fringes.

A team from the University of Arizona has discovered a mysterious mass, dubbed Planet Ten, that appears to be tugging at the orbits of a population of space rocks known as

the Kuiper Belt in the icy outskirts of the Solar System.

The Kuiper Belt lies beyond the orbit of Neptune and extends to a few hundred Astronomical Units (AU), with one AU representing the distance between Earth and the Sun.

The Earth and the other major planets all orbit the Sun in roughly the same plane. However, Kuiper Belt Objects (KBOs)



Planet Ten orbits beyond Neptune on a different plane to the other planets

are far enough away from the gravitational attraction of the gas giants to be tilted away from this plane, and are affected by interactions with one another.

This angle, known as the inclination, can be calculated. If the observed angle differs from the one calculated, then it's possible that the smaller KBOs are being pulled out of line by something more massive – potentially an undiscovered planet. This method is how the existence of the so-called Planet Nine was predicted last year.

After analysing more than 600 objects in the Kuiper Belt, the researchers found a discrepancy of 8° at around 50AU away from the Sun.

"The most likely explanation for our results is that there is some unseen mass," said researcher Kat Volk. "According to our calculations, something as massive as Mars would be needed to cause the warp that we measured."

The researchers say we may not have directly observed the planet because we haven't yet searched the entire sky for distant objects in the Solar System. However, a chance may come in 2020 when the Large Synoptic Survey Telescope (LSST) is completed.

"We expect LSST to bring the number of observed KBOs from currently about 2,000 to 40,000," researcher Renu Malhotra said. "There are a lot more KBOs out there – we just have not seen them yet. Some of them are too far and dim even for LSST to spot, but because the telescope will cover the sky much more comprehensively than current surveys, it should be able to detect this object, if it's out there."

PHOTOS: HEATHER ROPER/LPL, NASA/JPL-CALTECH/SWRI/MSSS/JASON MAJOR

"THE MOST LIKELY EXPLANATION FOR OUR RESULTS IS THAT THERE IS SOME UNSEEN MASS"

EXPERT COMMENT

Colin Stuart

Astronomer and author

"All eyes are on the outer Solar System right now. First, astronomers found tantalising clues of a ninth planet beyond the orbit of Neptune. But now there might be a tenth, too."

We shouldn't really be surprised. The early Solar System was a much more chaotic place than the largely serene environment of today. Another planet is thought to have whacked into the Earth to form the Moon, for example. What's more, computer models of Solar System formation work better if there were more than four gas planets to begin with. Today's gas planets were the gravitational victors in the Solar System's childhood squabbles. Planets Nine and Ten, should they be confirmed, were likely bullied into far-flung orbits.

But why is it taking until now to find them? After all, we've found more than 4,000 planets beyond our Solar System. We don't spot those exoplanets directly – we look for changes in the light from their host stars to infer their presence. For us to see a distant planet in our own Solar System, light has to trek from the Sun all the way out there and back to the Earth, fading all the while. So they're on the edge of what we can see with current telescopes. With the potential Planet Ten, the task is even trickier due to its likely position close to the bright Milky Way. Should the planets be found, more than a decade since Pluto was knocked off its planetary perch, the textbooks will need ripping up again."

MATHS

COMPUTATIONAL ORIGAMI TAKES A BIG LEAP FORWARD

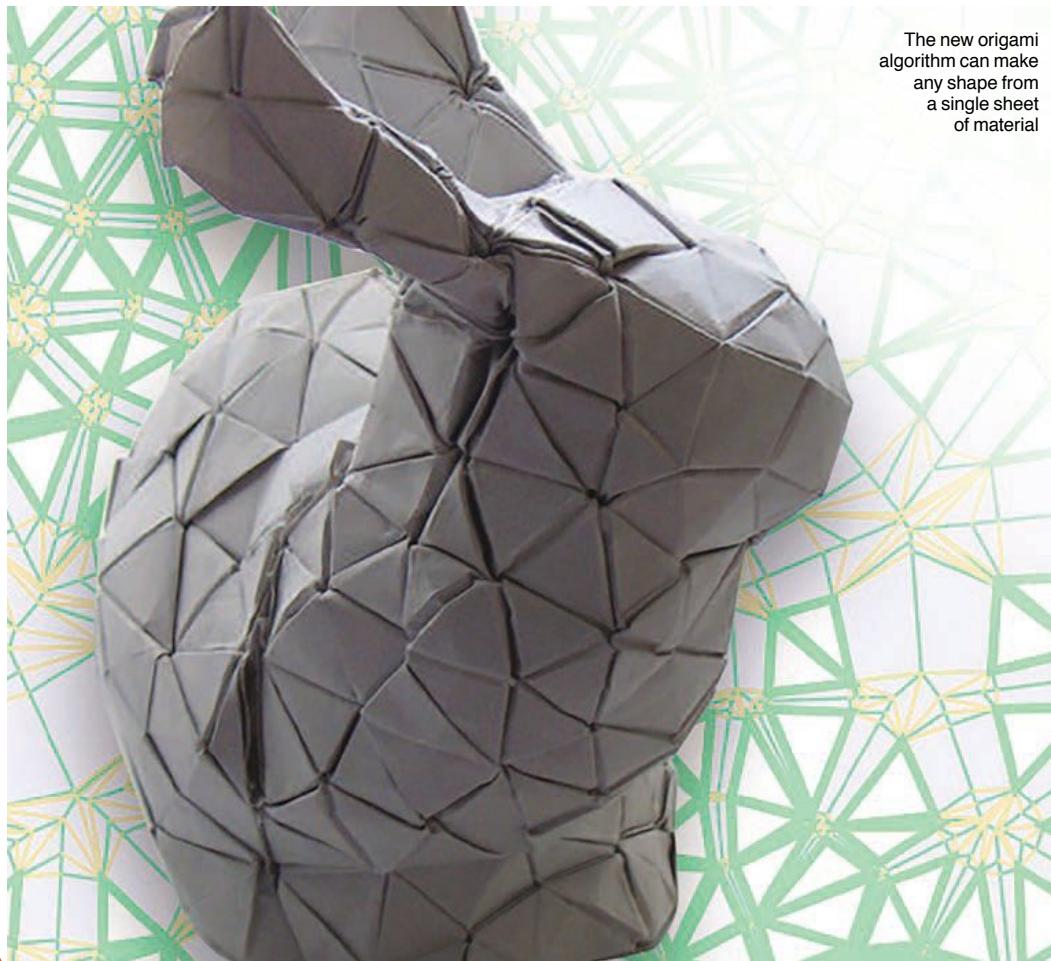
An MIT professor of computer science and an assistant professor in civil engineering at the University of Tokyo have joined forces to come up with a better way of... making paper rabbits. Or rather, they have created an algorithm that enables the creation of any 3D shape from a single sheet of a given material.

MIT's Prof Erik Demaine has previous experience in this area: his 1999 PhD thesis described the same thing. The difference, though, is that his previous algorithm essentially involved taking a long, thin strip of paper or other material and winding it into the desired shape. This tends to leave you with lots of seams in the finished 3D shape, and is inefficient in terms of the amount of paper (or other material) required. The new algorithm, on the other hand, preserves

the boundaries of the original sheet of paper, and minimises the number of seams. "It's a totally different strategy for thinking about how to make a polyhedron," said Demaine.

If you've ever unfolded a paper cup from the water cooler, and ended up with a circular piece of paper, that's the perfect example of how the new algorithm works – the outer edge of the circle ends up as the rim of the cup. Demaine's old method, however, would have created a non-watertight cup shape by winding a thin strip of paper into a coil.

The technique could have practical applications in manufacturing, particularly in areas such as designing and building spacecraft, where materials efficiency is of paramount importance.



The new origami algorithm can make any shape from a single sheet of material

THEY DID WHAT?!



ROBOT TAUGHT TO COMPOSE MUSIC

WHAT DID THEY DO?

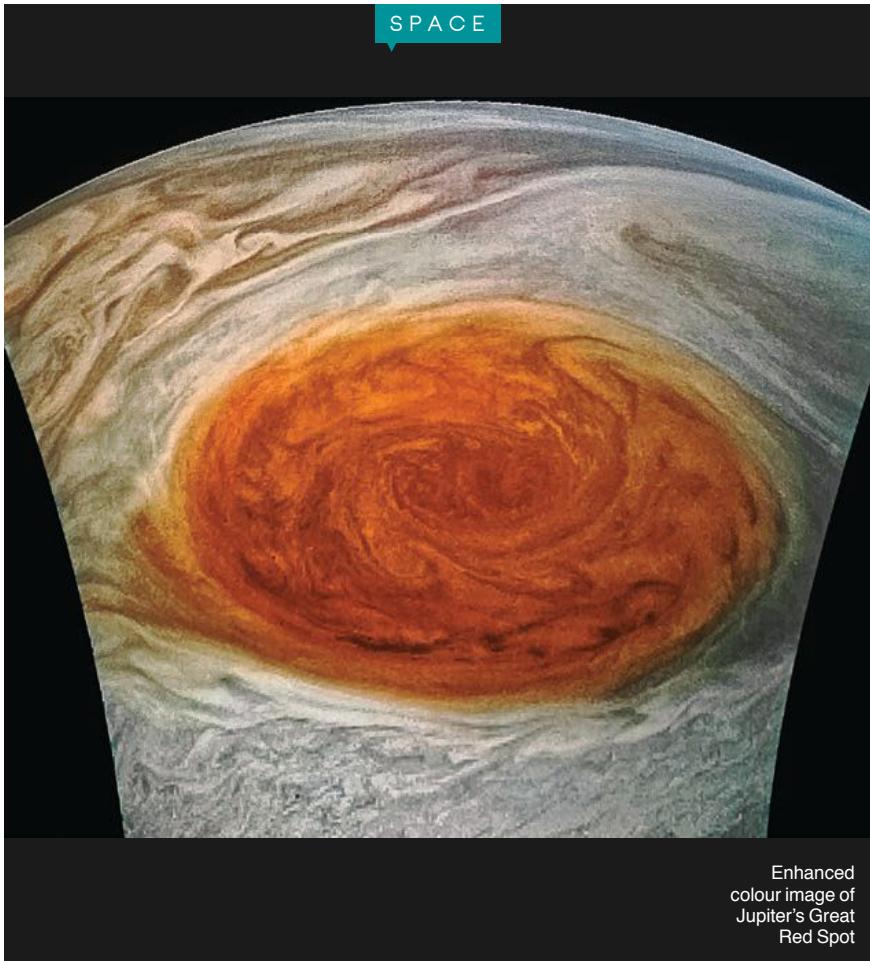
Computer scientists at Georgia Institute of Technology in the US have taught a robot to compose its own musical pieces, and then play them on the marimba – an instrument similar to a xylophone.

HOW DID THEY DO THAT?

The robot – nicknamed 'Shimon' – was fed nearly 5,000 complete compositions, ranging from pop songs to classical pieces, and over two million smaller fragments such as riffs, solos and codas. Using deep learning techniques, its AI system then analysed the material and devised its own set of rules for composition. Using these rules, it then 'wrote' and played recognisably musical creations of its own.

WHY DID THEY DO THAT?

Project leader Mason Bretan is interested in exploring the possibilities of AI and computer learning in music composition. Maybe the first robot masterpiece is just around the corner.



Enhanced colour image of Jupiter's Great Red Spot

JUPITER'S GREAT RED SPOT CAPTURED IN UNPRECEDENTED DETAIL

NASA's Juno probe has delivered the goods yet again. This time, with photos of Jupiter's iconic Great Red Spot that were taken on July 10, 2017.

The stunning images were pieced together by citizen scientists using raw data taken from the JunoCam as the probe passed just 3,500km above the planet's cloud tops – the closest any human-made object has come to the storm.

"I have been following the Juno mission since it launched," said citizen scientist Jason Major, who produced one of the images. "It is always exciting to see these new raw images of Jupiter as they arrive. But it is even more thrilling to take the raw images and turn them into something that people can appreciate. That is what I live for."

Measuring 16,350km across, Jupiter's Great Red Spot is a vast, raging storm 1.3 times as wide as Earth. It has been under observation since 1830 and is believed to have existed for more than 350 years.

Early analysis of data taken by Juno portrays Jupiter as a highly turbulent world, with a complex interior structure, energetic polar auroras, and huge polar cyclones.

"For hundreds of years, scientists have been observing, wondering and theorising about Jupiter's Great Red Spot," said Juno's principal investigator Scott Bolton. "Now we have the best pictures ever of this iconic storm. It will take us some time to analyse all the data from not only JunoCam, but Juno's eight science instruments, to shed some new light on the past, present and future of the Great Red Spot."



THE FORGETFUL

Do you often find it difficult to remember what you had for dinner last night? You might be a genius. Canadian researchers have found that jettisoning unimportant memories helps us to focus on the most important information.

COFFEE DRINKERS

Make mine a quadruple espresso! People who drink two to three cups of coffee a day are 18 per cent less likely to die from heart disease, cancer, stroke, diabetes and kidney disease, a team at the University of California has found.

GOOD MONTH

BAD MONTH

SMARTPHONE ADDICTS

If you break out in a sweat when your smartphone's out of reach, it may be time to rethink your habits. A University of Texas team has found that having a smart device in sight reduces our ability to focus and perform tasks.

TEENAGERS

So much for the vitality of youth! Researchers at the University of Baltimore have found the activity levels of the average 19-year-old are the same as those of people in their sixties!



"Video games are continually challenging our skills, making the brain perform at 100 per cent of its capacity"

NEUROSCIENCE



ABOVE:
Do computer games make you more violent, or just more clever?

Do video games change the brain? Different studies have reached different conclusions, so Marc Palaus, a neuroscientist at Spain's Universitat Oberta de Catalunya, reviewed the research

Do video games affect behaviour?

Video games are likely able to affect the way we behave in a number of ways. For instance, there's concern about whether violence in games makes young people more violent. It's not uncommon for news outlets to blame games every time a crime happens, but how true is that claim? This is controversial even within the scientific community. Yes, exposure to violence seems to affect the brain, but studies have also found that we're good at distinguishing between real and virtual violence, and aggressive behaviour is better explained by other, mainly socio-economic factors. Numerous studies about the effects of

games on the brain had been published, but all that information had not been put together until now.

How did you review the research?

We gathered all scientific articles to date and compared results. In total, we found 116 experiments, the first from the 1980s. Many compared regular video game players with people who had never played; others trained people in a game for several weeks and studied its effects. Changes in the brain were measured using magnetic resonance imaging (MRI) or electroencephalography (EEG), which detect whether brain regions increase or reduce in size, and how this affects their activity.

Are games bad for the brain?



The clearest negative impact is the risk of abuse and addiction by people with predisposing personality traits. Video games can affect the reward circuits, containing the pleasure centres of the brain. This, in turn, could affect other brain functions in the frontal lobe, possibly affecting the capacity for planning, inhibiting distractions and mental problem-solving. Games that heavily rely on online multiplayer modes are the most associated with addiction, due to social interactions being more rewarding than just playing against the computer.

Can games be good for you?

Since video games usually display increasing levels of difficulty, they are continually challenging our skills, making the brain perform at 100 per cent of its capacity, resulting in effective cognitive training. Various mental functions seem to benefit from this effect.



In some hospitals, video games are already used to help rehabilitate stroke patients

IN NUMBERS

**1,203
KM**

The distance Chinese researchers were able to successfully preserve quantum entanglement in a pair of photons – that's a new record

**66
MILLION**

The numbers of trees planted by 1.5 million volunteers in Madhya Pradesh, India, in 12 hours in an attempt to combat climate change

**5,100
SQ KM**

The size of a giant iceberg that broke off an Antarctic ice shelf in the Weddell Sea. That's an area almost four times the size of Greater London

Of these, attention is the most studied, and its enhancement allows us to better process objects in our visual field, selecting those which are relevant and ignoring the rest. Attention improvements have a positive effect on 'executive functions', mental processes involved in controlling behaviour, solving problems and facilitating learning – functions that are closely linked to intelligence. Visuospatial skills – our capacity to process visual and spatial information – are also improved.

Can games be useful?

Video games contribute to the correct functioning of our brain, and can even improve it. So we have to get rid of our prejudices and accept them as valid entertainment. This also opens the door to using games as a form of training in clinical settings, especially for those with cognitive deficits.



Dave the cockatoo had been practising for his Counting Crows audition

ZOOLOGY

COCKATOOS GOT RHYTHM

Birds might generally be better known for their singing, but new research carried out by Prof Rob Heinsohn from the Australian National University (ANU) has proved they can also be a dab hand on the drums.

The palm cockatoo – also known as the goliath or great black cockatoo – is native to New Guinea and to Australia's Cape York Peninsula, an area of untamed wilderness in the far north of Queensland.

It was here that Heinsohn's team were, for the first time, able to capture enough film of the reclusive species' drumming behaviour, which had previously been reported anecdotally, for serious study. The footage was obtained

as part of a wider study into the bird's conservation needs.

Heinsohn and his team at the ANU Fenner School of Environment and Society analysed seven years' worth of footage of 18 male cockatoos, and found that all 18 of the birds drummed regularly.

"The large smoky-grey parrots fashion thick sticks from branches, grip them with their feet and bang them on trunks and tree hollows, all the while displaying to females," said Heinsohn. "The icing on the cake is that the taps are almost perfectly spaced over very long sequences, just like a human drummer would do."

What's more, each cockatoo was found to have its own signature style, with some drumming faster or slower, and others introducing distinctive flourishes to the otherwise regular beat. It's thought that this enables other cockatoos to determine who is drumming where.

INNOVATIONS

PREPARE YOURSELF FOR TOMORROW



It's the hero Mars
deserves, but not
the one it needs
right now

MEAN MACHINE

PHOTO: NASA

To kick off the 'Summer of Mars' events programme at the Kennedy Space Center in Florida, NASA recently unveiled an 8.5m-long concept Martian rover that wouldn't look out of place in the Batcave. The vehicle consists of a detachable rear section housing a science laboratory, and a front section that's equipped with radio and GPS. Sadly, it is only a concept: according to the latest information on NASA's website, the actual rover used in the Mars 2020 mission is likely to be similar in size and appearance to Curiosity, the 3m-long rover that's been busy exploring the Red Planet's surface since 2012.

ON THE ROAD TO SMART CARS

With 3D scanning, gesture control and a touchscreen key, is BMW's new 5 series the smartest connected car yet? Here's how it tested

BMW 5 SERIES 530D XDRIVE

Price: From £36,025

Technology Package:
£1,405

Remote Control
Parking: £395
Driving Assists: £2,250

SPECS

Engine: 3.0L Diesel

Power: 265Bhp
@ 4,000Rpm

Gearbox: 8-Speed
Automatic

Official Mpg: 53.2

CO₂ EMISSIONS:
138G/KM



CONNECTIVITY

First off, the iDrive system is brilliant. It's instant. Unlike many in-car entertainment systems there's no delay between input and response. The new 5 series tech package also offers Apple Carplay without wires via Bluetooth – the first car to do so. But, to really unlock the car's box of tricks, you have to get an app, BMW Connected. You can sync your Office 365 calendar to the car's database and it'll tell you when to leave to make a 9am meeting. But here's the real showstopper. If you lose your car in the car park, the app will get the car to scan its environment, using the radar and cameras used for self-parking, to create a picture of its surroundings. Luckily a bright yellow van had pulled up alongside the car, so from there it was easy to spot. Yes, it's a bit frivolous, but the idea is an astonishing way to pull together the tech that's already in the car.

TECHNOLOGY

Before we get to the car, we need to talk about the key. It's a touchscreen remote that lets you check the car's fuel tank, turn on the air conditioning, and, if you really want to show off, remotely park or pull out of a spot while you're standing on the pavement. Park the car from behind the wheel, and sensors and cameras bring up a reactive view of the car on the 10.25-inch touchscreen. Pull up to a wall, and the screen switches to a top-down view to show you closing the gap. Parallel park and the camera pans to a corner view compiled from a couple of cameras. The tech itself isn't new, but the way it adapts to the current situation feels telepathic. There's more wizardry found in the car's gesture control tech, borrowed from the 7 series, which lets you skip tracks or turn up the volume by waving your hand in the air.



DRIVE

For the most part, we let the 5 series pilot itself (with our hands on the wheel, of course). The lane assist and cruise control functions let the car do most of the actual driving on the motorways. And after driving nearly 500km (more than 300 miles), I felt confident that the car could spot hazards before me. Off the motorway it's a fiercely capable all-rounder. The suspension is soft and supple, but can be stiffened for B-road meandering. Our 530d with four-wheel drive was leisurely when needed, but had the option of 620Nm of torque to take you from 0-60 in 5.4 seconds. In adaptive mode, the car will tweak the suspension according to your steering input and what corners it can see on the GPS. Ultimately, it's a car that can lower your heart rate as well as raise it.



VERDICT

This is the most well-rounded car we've driven. It feels like a yacht on the motorway, and a speedboat on the B roads. Above all, we were most impressed with the tech inside. The ubiquity of smartphones means our expectation of how simple and responsive technology should be is stratospherically high. In-car tech usually suffers from this comparison, feeling sluggish and unresponsive next to our smartphones. But the 5 series subverts that trend. Whether you're using the self-parking, driving assists or the connected app, everything is effortless, making it the saloon to beat right now. 9/10

ENVIRONMENT

NEVER MIND THE PESTICIDES, HERE'S A BUG-ZAPPING FENCE!

Farmers under pressure to reduce chemical pesticides can take heart from the news that the US Department of Agriculture is about to start trialling a device that can kill insects with a laser.

Developed by Seattle company Intellectual Ventures Lab (IVL), the 'Photonic Fence' isn't really a fence at all, but a small box containing lasers, cameras and an AI computer system. The cameras scan the air around the device for 100 metres, and the AI system measures the shape, speed, acceleration and wingbeat frequency of any bugs detected, to establish which are potentially harmful. Any insects identified as a threat can be zapped by the lasers, with a 'kill rate' of up to 20 insects per second.

By deploying several such devices, farmers could effectively create a virtual fence around their crops that kills harmful pests but leaves bees and other beneficial or harmless insects unharmed.

As well as protecting crops, it's hoped the Photonic Fence could also prove useful in the fight against malaria, by eliminating only the Anopheles mosquitoes that spread the disease without upsetting the balance of the local ecosystem in the way that blanket use of chemical pesticides would.

The US trials began in August. If the device is proven to work, then IVL hopes to bring a commercial product to market, though that will still be some years away.



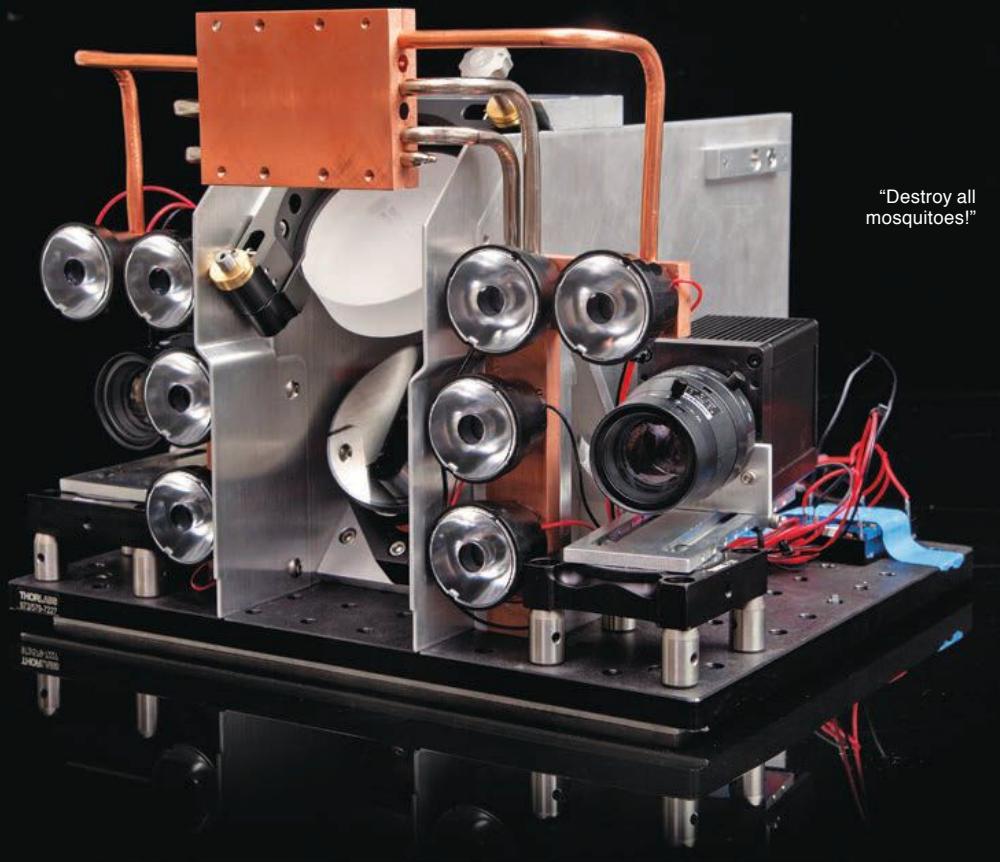
AVIATION

HELICOPTERS: NOW WITH WINGS!

At the recent Paris Air Show, Airbus was showing off its new Racer concept helicopter, which has both a main rotor and a pair of propeller-sporting wings.

Racer (an acronym for 'RApid and Cost-Effective Rotorcraft') would take off and land vertically, just like a normal helicopter, but would boast a top speed of 400km/h (250mph), which is nippier than traditional choppers. If you're getting a sense of déjà vu here, that's because the Racer is essentially an updated take on the X3 concept that Eurocopter (now Airbus) took to the Paris Air Show in 2011.

The craft is designed for the operation of high-speed passenger services, particularly between urban centres (such as London and Berlin) where its vertical take-off and landing capabilities eliminate the need to travel to and from airports. But it could also find a role in military or search-and-rescue operations. Airbus hopes to have a commercial craft based on the Racer concept available by 2020.





HYPEROLOOP FOR THE UK?

Hyperloop One has announced its Vision For Europe – a series of proposed routes for Hyperloop transportation systems in mainland Europe and the UK.

First proposed by Elon Musk in 2012, Hyperloop is a hybrid electric/maglev system designed to shift people and cargo long distances at very high speeds, by placing them in pressurised pods that travel through tubes in which a partial vacuum is maintained. There are several companies and teams of scientists and engineers working worldwide to develop Hyperloop systems, including Hyperloop One, Hyperloop Transport Technologies and TransPod.

Citing the success of Eurostar trains in capturing 70 per cent of cross-Channel traffic in just a few years, Hyperloop's Vision For Europe proposes routes linking Corsica to Sardinia, Spain to Morocco, and Estonia to Finland. There are also suggested routes in Germany, Poland and the Netherlands, plus three in the UK.

One of these routes would link Cardiff and Glasgow, via Bristol, Oxford, London, Cambridge, Nottingham, Newcastle and Edinburgh. For this route, Hyperloop One has been working with engineering firm AECOM. A second route, dubbed the Northern Arc, has been proposed in association with architects Ryder and engineering firm Arup, and would link Liverpool to Glasgow via Manchester, Leeds, Newcastle and Edinburgh. Finally, the North-South Connector route, which has been developed in association with students and faculty at the University of Edinburgh and Heriot-Watt University, would link London and Edinburgh via Manchester and Birmingham.

All three of the routes are, it should be stressed, strictly speculative propositions at this stage. But the fact that so many leading businesses and academic institutions around the world are taking the Hyperloop project seriously suggests it may become a reality sooner than we think.

CODING FOR GIRL SCOUTS

Girl Scouts in the US can now earn badges for coding, hacking and cybersecurity awareness. The new badges have been introduced in a bid to encourage more young women to pursue careers in the IT sector.



CITIZENS OF SPACE

Asgardia, a 'virtual nation' set up by a Russian scientist last year, already has some 2,000,000 citizens. And, now, it's launching its own small satellite where all those citizens' data will be stored, along with Asgardia's flag, constitution and 13-month calendar.

TEMPERANCE TAG

Police in Lincolnshire are trialling a leg-mounted tag that, instead of tracking the movements of low-level offenders, monitors their alcohol intake. It's designed to ensure offenders stick to booze-free conditions imposed as part of a community sentence.



A HEADBAND TO TREAT DEPRESSION?

A South Korean biomedical start-up called Ybrain has developed a headband that they claim will offer relief from the symptoms of depression. The device, called Mindd, works using a technique called transcranial direct-current stimulation (tDCS). Here, a low-voltage electrical current is applied to specific areas in the brain via electrodes placed on the skull.

tDCS is not new – the basic principles have been understood since the early 19th century. But the past decade or so has

seen increased interest in its use in treating neurological and psychiatric conditions, and a 2016 meta-analysis of hundreds of studies concluded that it's "possible or probably effective" as a treatment for depression.

tDCS equipment can stimulate particular brain regions either 'anodally' (increasing neuronal activity) or 'cathodally' (decreasing neuronal activity). The Mindd headset applies anodal stimulation via electrodes in the headband to the frontal lobe, an area where decreased

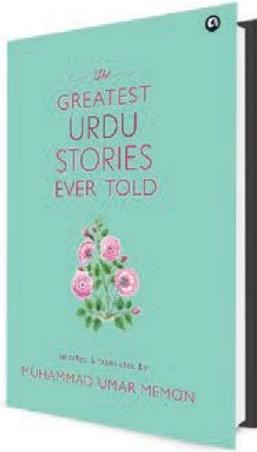
activity is associated with depressive disorders. Mindd is not intended as a DIY solution: patients would use it in their own homes, and all data regarding treatment would be sent automatically to their doctor.

The headband is currently undergoing clinical trials at Harvard Medical School, and at 12 hospitals in South Korea. Early results are said to be promising, and if all goes well Ybrain hopes to market the device to health providers by 2019. **K**

ON THE SHELVES

BOOKS

WORDS: MOSHITA PRAJAPATI



THE GREATEST URDU STORIES EVER TOLD

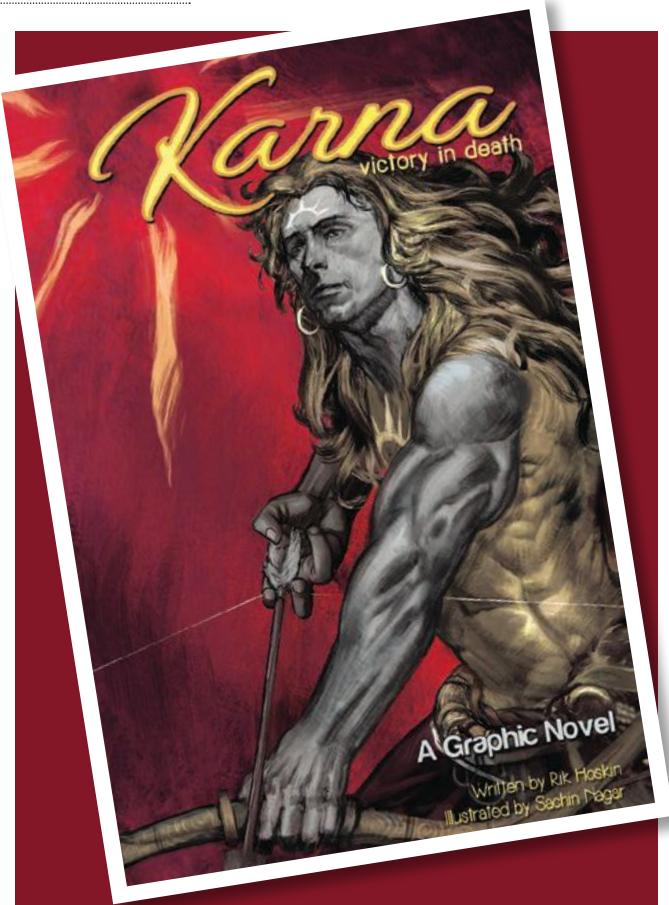
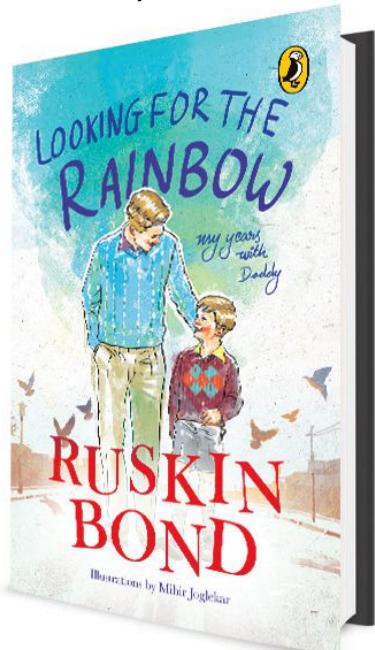
Translated and edited by Muhammad Umar Memon
Aleph; ₹492

Every one of the 25 stories in this anthology of Urdu stories has been carefully selected by renowned Urdu translator and editor, Muhammad Umar Memon, to illustrate a facet of form in the Urdu literary tradition. Translated into English with the poetic grace of Urdu intact, these stories reveal the hidden, mystical, romantic, traditional, modern, social and political aspects of the period. At the core of every story written by the celebrated Urdu writers of the sub-continent lies an exploration of the depth of the human spirit and the contemplation of its mysterious way of working.

LOOKING FOR THE RAINBOW: MY YEARS WITH DADDY

Ruskin Bond
Puffin Books; ₹250

Released to mark the author's 83rd birthday, the memoir delves deeply into the short but impactful two years Ruskin Bond spent with his father. It tells of collecting stamps, watching movies at Connaught Place in Delhi, eating meals at Dario's on Mall Road in Shimla, of the advice to 'paddle your own canoe', and the shared love for books. Each vignette offers a nostalgia-tinged view into the life of little Bond with senior Bond and the irrevocably honest understanding they had of each other. True insights into a father-son relationship are rare, and Ruskin Bond, going back over 70 years, paints them so vividly with the tender emotions of an eight-year-old boy that it will take you down memory lane to your own childhood.



KARNA: VICTORY IN DEATH

Rik Hoskin
Illustrations: Sachin Nagar
Campfire Graphic Novels; ₹350

It's difficult to not want to root for Karna, a man who fulfils all the tropes of a superhero, but is let down by his human side and his society. Born out of wedlock, the result of a boon between a princess and a god, Karna is never allowed to achieve his potential because of his low-born status — that of a charioteer (his true birth hidden from him till too late). Karna's journey is defined by his decision to fight against his enforced destiny. Blinded by vengeance, he chooses to side with the arrogant Prince Duryodhana, who leaves the reader confused. Does he truly care for Karna or is he just (mis)using him to destroy the Pandava clan using Karna's superior skill as a warrior? One is never sure. The graphic novel captures Karna's anguish, agony, rebellion, sacrifice and steely resolve with raw, bold strokes in emboldened ink and text. The final showdown at Kurukshetra pits brother against brother, forcing the reader to ponder: Would Karna be on the other side of the battle line had he been accepted by society, or not led astray by Duryodhana? Or is this a lesson to tell us that even superheroes, with a heart of gold and good intentions, can be flawed?

NAYANIKA MAHTANI

AUTHOR OF THE GORY STORY OF GENGHIS KHAN

What made you decide to write a book on Genghis Khan?

The idea was born of my attempt to introduce my daughters to Asian history – and to try and do it in a fun way. As I sifted through sources, I was captivated by this exiled, illiterate, nomadic boy, who defied all the odds to become the world's greatest conqueror. What drew me in further was that there seemed to be staggeringly conflicting reports on him. Was he the vilest of all villains that had ever lived or was he the most farsighted hero the world has seen? I decided it was time to take a trip to the 12th century to do some finding out.

What kind of research did you undertake before writing the story?

I would haunt the British Library – where the lovely staff would put up with my unending requests for books. My constant writing companion was Urgunge Onon's translation of *The Secret History of the Mongols* – a fabulously rich source of material written shortly after Genghis Khan's death. Other sources include Jack Weatherford's *Genghis Khan and the Making of the Modern World* and translated versions of the *Baburnama*, the *Mu'izz al-ansab* (a genealogy of the Chingizids and Timurids), *Il Milione* (The Travels of Marco Polo) and the *Jami' al-Tawarikh* – written by Rashid al-Din, a vizier in the Ilkhanate Mongol Empire in the 14th century.

What was the most fascinating piece of information you learned about Genghis Khan or the Mongols?

Did it make it into the book?

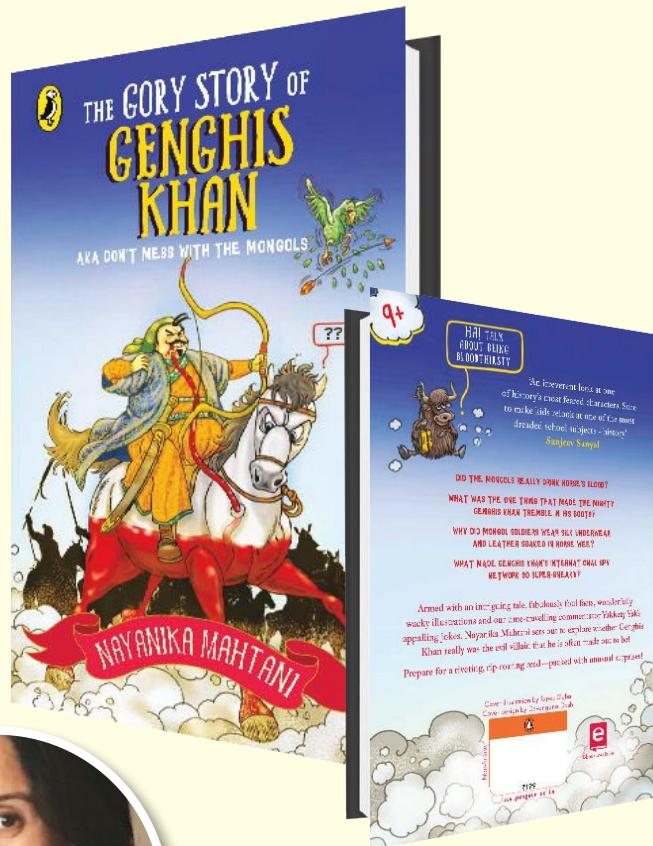
To me, the most unusual circumstances of his birth and the prophecy surrounding it sounded straight out of mythology. But, apart from these little nuggets of trivia that the book is peppered with, the most fascinating thing for me was trying to recreate his childhood to uncover what Genghis Khan was like as a boy. It was fabulous to trace his journey through his chequered childhood – and watch the building blocks of his character emerge – which went on to shape not only his destiny, but also to deeply impact our modern world.

The narrative follows a fun format of narration. Tell us how you came upon this idea...

There was a lot of historical information that needed to be packed in, but I really wanted this to be a fun book that invited children in (including reluctant readers and those who 'dreaded history'), to hopefully discover that history is cool and fun and relevant! So I introduced the time-travelling commentator



**I WANTED THIS TO
BE A BOOK THAT
INVITED CHILDREN
IN, TO HOPEFULLY
DISCOVER THAT
HISTORY IS COOL
AND FUN AND
RELEVANT**



and guide Yakkety Yak who takes the kids on this adventure to Mongolia while telling the most appalling jokes. We also meet Yuherdit Hearfurst, the Mongolian reporter from the *Steppe on It* show, who brings us the news faster than anyone else. As also Ireed Thesigns, a Mongol folklore expert – who is really good at reading the signs that the heavens are sending Genghis Khan. Once we had our cast and crew in place, the narrative format just seemed to fit. In my head, I can see this story being played out as a stage production or a film – but my head's always seeing some show or the other. ☺

What projects are you currently working on?

I'm working on my next children's book, apart from a couple of scripts for film/digital media.

Any advice for young budding authors out there?

I learned quite late in life to embrace the possibility of failure – which I find is very liberating. So don't hold back – just go out there and tell your story! No one else can tell it quite like you can. ☺

ON THE SHELVES GAMES

WORDS: PARTH MEHTA



INJUSTICE 2

Publisher: NetherRealm Studios

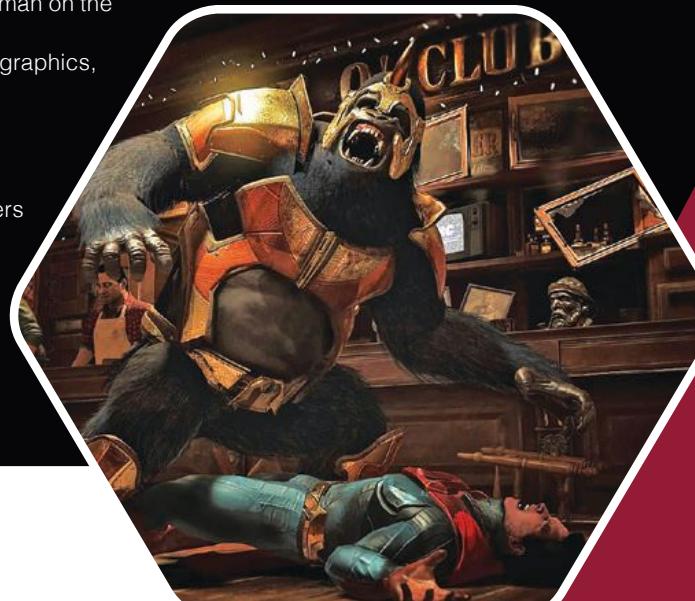
Format: PlayStation 4 and X-Box

Injustice 2 picks up five years after Injustice: Gods Among Us's hard-hitting climax — Superman is imprisoned in the red sun jail, Batman and his gang of reformed criminals are struggling to maintain peace after Superman's attempts to take over the world. Meanwhile, Superman's allies are planning to free him to protect the world from a new threat — the alien Brainiac. He is here to destroy Earth (as all villains are known to do) and Batman, with his reformed allies, is here to stop him. The heart of the game is the conflict that arises within Batman and Superman on the best method to defend Earth.

The game delivers and surpasses its predecessor's gameplay mechanics, graphics, presentation and character content. The narrative and visuals are impressive and a definite step up from the previous game. There is massive scope for customisation — a huge roster of superheroes and supervillains to choose from, each with their distinct fighting style in keeping with their personality. The fighting mechanics haven't changed much from the previous game; players have an arsenal of special moves and pre-programmed combos to choose from.

A new addition is the Gear System, which is a RPG-like loot-dropping system that rewards players with costume pieces and equipment that can be used to customise character appearances and modify their fighting abilities.

ALL IN ALL, INJUSTICE 2 IS AN ENTERTAINING GAME!



KNOW YOUR CHARACTER

EZIO AUDITORE DA FIRENZE

CHARACTER BIO

The fan favourite Assassin Ezio Auditore of Florence from the 15th century Italian Renaissance is perhaps the second greatest Assassin, second only to his ancestor Altair Ibn La'Ahad.

Ezio is a handsome and spoilt young man, popular with the ladies. He enjoys a pampered childhood with his family, until his father and brother are publicly hanged in a Templar conspiracy. Ezio finds out that his father was secretly a Master of a Brotherhood of Assassins who work against the Templars for the good of the country. With the help of his uncle Mario, he begins his journey to bring justice against his family's conspirators and to restore the family name, gradually rising within the ranks to become the Assassin Master.



STRENGTHS

Leadership,
ability to convince

ABILITIES

Extreme Parkour,
eagle vision, stealth,
master in
concealment, expert
in combat

WEAPONS

Hidden assassin
blade, assassin
sword, crossbow,
throwing knives,
utility bombs

Assassin's Creed II,
Assassin's Creed:
Brotherhood,
Assassin's Creed:
Revelations

GAMES

ARCH ENEMY

The Templar leader,
Cesare Borgia

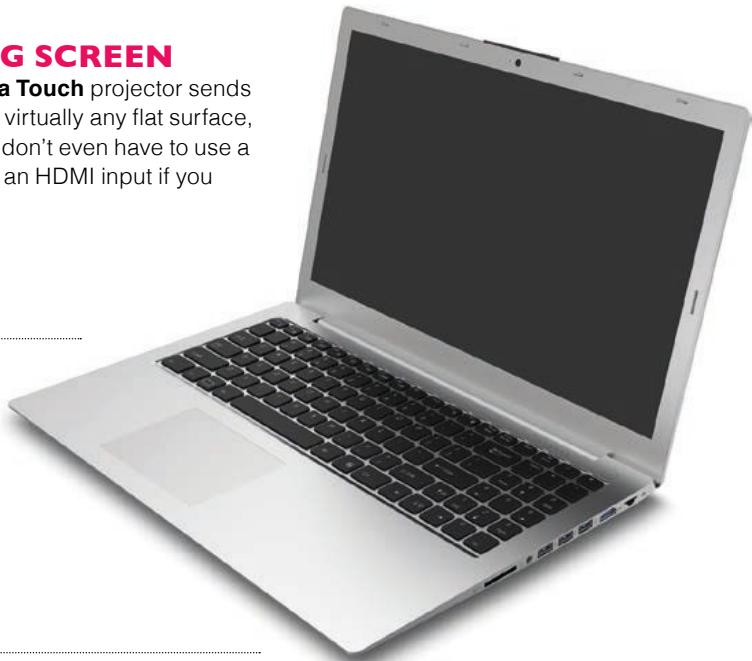
ON THE SHELVES GADGETS



TINY TOUCH, BIG SCREEN

Sony's ultra-compact **Xperia Touch** projector sends an 80cm 'touchscreen' onto virtually any flat surface, and runs on Android so you don't even have to use a laptop with it – though it has an HDMI input if you need it.

Sony Xperia Touch
www.sony.com, £1,300



KEEP IT PURE

If privacy and security are concerns for you, then **Purism's Librem** 13 or Librem 15 could be just the laptop you're looking for. It has a bespoke, security-focused Linux operating system, and kill switches for Wi-Fi, Bluetooth, mic and camera.

Purism Librem laptops
www.puri.sm, From \$1,699 (£1,300 approx)



SEAWEED SNEAKERS

These eco-friendly, amphibious trainers from **Vivobarefoot** and **Bloom Foam** are made entirely from reconstituted algal biomass, which is harvested from waterways that have a high risk of harmful algal blooms. Better than jelly shoes, any day!

Vivobarefoot Ultra III www.vivobarefoot.com, £TBC



SUPER SPIDER-MAN

Sphero's new IoT-enabled Spider-Man toy will let kids tag along on missions to battle villains – every choice they make influences the adventure. And unless he's installing updates, Spidey stays offline, so he's safe from snoopers.

Spider-Man Interactive Super Hero,
www.sphero.com, £150



NINTENDO NOSTALGIA

The SNES is back! Available from 29 September, the **SNES Classic Mini** is smaller than the original and eschews the cartridges, coming instead with 21 preloaded games including Super Mario Kart and The Legend Of Zelda. Nostalgic fun awaits.

SNES Classic Mini
www.nintendo.com, £69.99

MARQUIS DE SOUND

The contraption may look like an exhibit from Scotland Yard's infamous Black Museum but it's actually a headphone amp. It's the perfect gift for the death metal lover who has everything. But at £6,000, it ain't cheap!

Metaxas & Sins Marquis

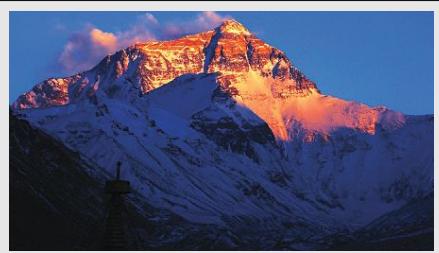
www.metaxas.com,
£6,000



NEWS FROM THE WORLD OF **TRAVEL & FOOD**

INFO NUGGETS FROM ACROSS THE GLOBE

NEPAL & CHINA



Mount Everest is around 27 times taller than the Eiffel Tower! Part of the Mahalangur range, the international border between Nepal and China runs across its summit, measured at 8,848 metres above sea level.

THE CARIBBEAN



The idyllic island of **St Maarten-St Martin** in the Caribbean is one of a kind – it's governed by both the Netherlands and France. It is the smallest inhabited island to be divided between two nations, in a division dating back to 1648.

ISRAEL



Tel Aviv owes its UNESCO World Heritage status to its 1930s Bauhaus architecture. It is called the White City for its over 4,000 buildings in this style – the largest number of any city in the world, which can be seen on a tour.

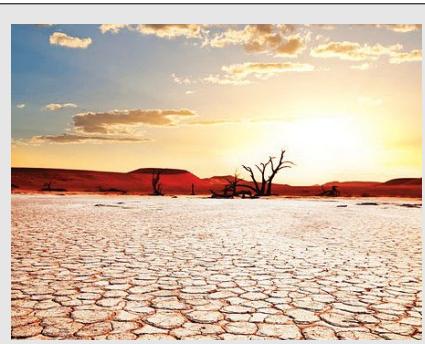
42

ITALY



The **Duomo** Cathedral in Milan took nearly six centuries to complete! Even today, restoration work is still on to maintain the 14th-century edifice, and there is a public campaign on to raise funds for its preservation.

THE NAMIB DESERT



Temperatures in the **Namib desert**, lying across Namibia, South Africa and Angola, can reach a sweltering 60°C in the day and fall below 0°C at night. This coastal desert may be the oldest desert in the world and contains some of the driest regions in the world.

THE USA



It is estimated that, if you were to spend a night in all of **Las Vegas**'s hotel rooms, it would take you nearly 288 years to do it. This city in the state of Nevada bills itself as the entertainment capital of the world, and is famous for its mega casino hotels.

123RFX7



10 REASONS TO LOVE THE DR BHAU DAJI LAD MUMBAI CITY MUSEUM

1. IT'S HOUSED IN A BEAUTIFUL BUILDING

The oldest museum in Mumbai, the Dr Bhau Daji Lad Mumbai City Museum (formerly the Victoria & Albert Museum) cocoons collections that showcase the city's cultural and industrial heritage within an impressive edifice on the city zoo grounds. This two-storey structure, with its Palladian exterior, high Victorian interior, Corinthian columns, detailed woodwork, etched glass and gold ceiling, along with Minton tiled floors, is a well-preserved testament to 19th century architecture.

2. IT OFFERS FREE PUBLIC TOURS

The museum organises free public tours on weekends. The tours are conducted in English and Hindi or Marathi.

3. IT'S GOT RARE TREASURES

The curated repertoire includes a vast collection of archaeological finds, maps and historical photographs of Mumbai, clay and silver models, pottery and paintings. Its permanent collection

includes miniature clay models, dioramas, maps, lithographs, rare documents and books that capture life in the erstwhile city of Bombay in the 19th century.

4. IT'S GOT GREAT WORKSHOPS FOR CHILDREN AND ADULTS

The museum organises workshops for children thrice a month, designed around the permanent collections, at which young enthusiasts could learn the art of *raagmala* painting or how to throw a pot. Pre-registration is a must. Adults can also sign up to learn to make terrariums, films on their phone, or go on a photo walk around the Byculla neighbourhood.

5. IT ORGANISES SCAVENGER HUNTS!

In a bid to open up the museum space to a younger demographic, the museum puts together scavenger hunts for children, with clues revolving around the building's collections. Other activities include the Byculla for Kids Walks, and story-writing sessions for kids and adults.

6. IT SCREENS MOVIES!

The Movies at the Museum series hosts public screenings of art movies, documentaries, and animation movies in association with the Alliance Francais of Mumbai and the Consulate General of Canada.

7. IT HOSTS INTERESTING TEMPORARY EXHIBITIONS

There's always a great photography or natural history exhibition or some other installation awaiting your attention.

8. IT'S GOT COOL MERCH

The revamped Museum Shop is, happily, a trove of wares you'll want to take home. Inspired by many of the historical items on display, you'll find calendars, notepads and tote bags engraved with images of old Bombay, boxes with enamel paintings and filigree work and, of course, postcards and envelopes with designs harking back to a rich past.

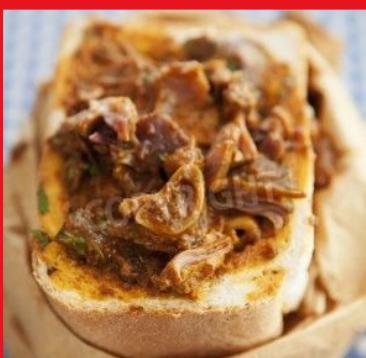
9. IT OFFERS INTERNSHIPS AND DOCENT COURSES

Don't be surprised if your tour guide looks a little young. The museum offers internships and docent courses to young adults and adults with an interest in history, art history and design, and in the workings of a museum. The year-long courses offer them a chance to participate in research activities and curation, and lead a museum tour for the public.

10. IT'S GOT AN INFORMATIVE WEBSITE

The website of the Dr Bhau Daji Lad Mumbai City Museum (www.bdlmuseum.org) is a great place at which to plan your visit and make the most of your time in this cool place.

TRAVEL WITH FOOD



BUNNY CHOW South Africa

Iconic and eye-catching, bunny chow is bread bowls filled with curry, a dish invented by the Indian community in Durban in South Africa. They were and continue to be great portable meals on a budget. The 'bunny' comes from the word '*bania*', Hindi for merchant.

M I N I A T U R E

IMAGINE

The Chocó is one of the most biodiverse places on Earth, but it is threatened by deforestation. **Javier Aznar** visited El Jardín de los Sueños, a private reserve in Ecuador, to photograph the small hidden treasures in this rich coastal rainforest

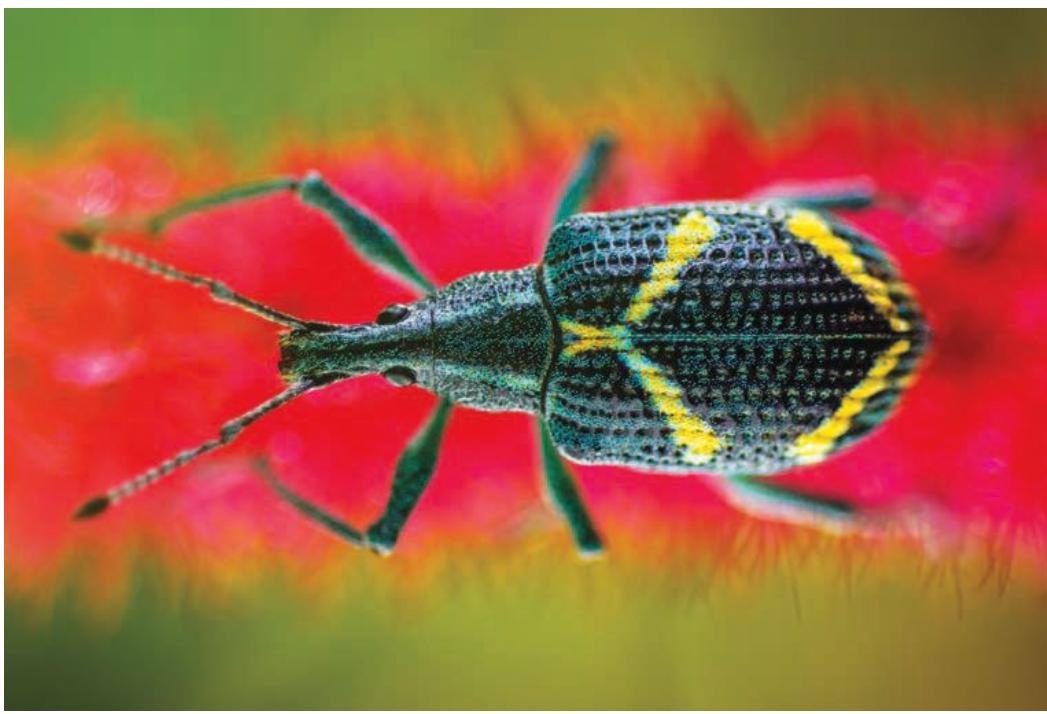
The ornate rain frog is classed as a vulnerable species because its distribution is severely fragmented. The amphibian is threatened by habitat loss and agricultural pollution

WEEPS





A river runs through pristine primary forests inside the El Jardín de los Sueños. The Chocó is one of the wettest regions in the world, home to a huge number of species, including more than 10,000 vascular plants and 130 amphibians. It's separated from the Amazon basin by the Andes mountain range



ABOVE A hooded mantis is perfectly camouflaged on a plant. This ambush specialist will spend long periods staying still as it waits patiently for an insect to stray within reach so it can grasp it with its front legs. The extended thorax of the mantis aids in leaf mimicry and makes it inconspicuous to its own predators.

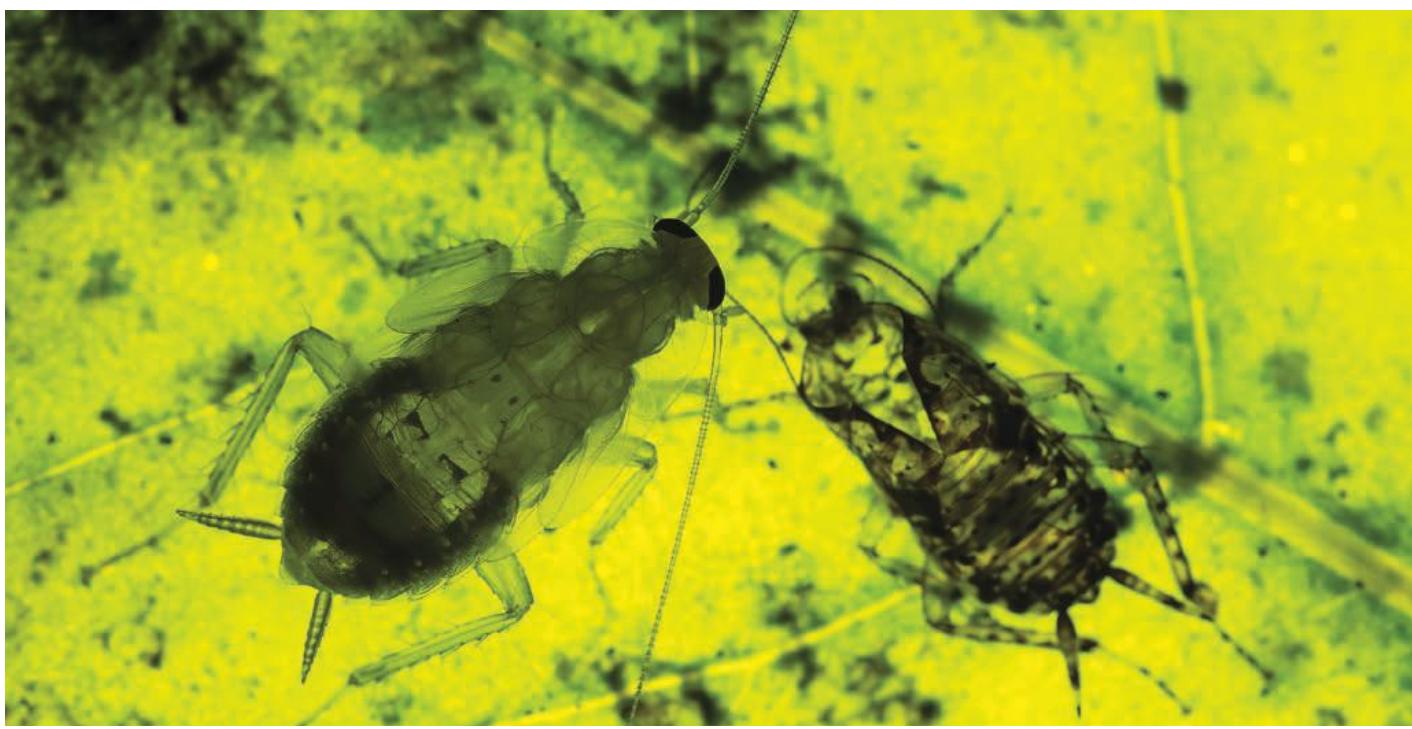
LEFT *Exophthalmus parentheticus*, measuring 2.5cm in length, on a forest flower. The striking angular marks on the weevil are a clever silhouette-breaking device, which interrupts its outline, making it more difficult to spot in the jungle.



LEFT A green huntsman spider stalks its prey through the herbage, using its long legs to sense vibrations and then lunge suddenly and effectively. This female has started to create a silken cradle under the unfurling fern frond; here she will weave a cocoon in which to lay her eggs.

TOP RIGHT On a rainy night, hundreds of male atrato glass frogs call from vegetation around a river as they attempt to attract a mate. Eggs are deposited by females on plants in clutches of up to 35. Males, measuring 23mm, will guard their offspring. When the tadpoles are ready, they drop into the water and the cycle continues.

BOTTOM RIGHT 'Ecdysis' is the term used to describe the moulting of the exoskeleton of an invertebrate, which is shed during growth. This cockroach nymph has outgrown its old cuticle and has found a protected place to complete the moulting process. Once it has pulled its body out of its old skin, the cockroach must wait for the new cuticle to harden and darken.



A fallen tree next to a river has been colonised by turkey tail.

Fungi such as these are abundant organisms in the tropical forest. They invade wood and soil and break them down into nutrients that can be used by a variety of other plants and animals





ABOVE A conehead katydid nymph sits on a leaf. When adult, with fully grown wings, katydids 'sing' by rubbing a comb-like row of pegs under the left wing on a plectrum-like ridge on top of the right wing, 'kay-tee-did' being the onomatopoeic representation of a common call.

LEFT A female Alpaida spider cradles an egg sac. The silk igloo hides the vulnerable eggs from predators and parasitoids. The mother will also remain on guard to see off any potential enemies. When they hatch, the spiderlings will have to disperse quickly, not only to escape their foes but also to avoid cannibalism. 



Javier Aznar is a wildlife photographer from Spain and a member of the iLCP Emerging League Photographers. Find out more at www.javieraznar-photography.com

DIY SCIENCE

Here are some entertaining and eye-opening experiments to try at home with family and friends.

No specialist equipment is needed. Just remember to wash hands after carrying out the activities and make sure that children are supervised by an adult

WORDS: DR STUART FARRIMOND
PHOTOGRAPHY: STEVE SAYERS/THE SECRET STUDIO





! SAFETY NOTES

Do not drink ferrofluid!

Rare earth magnets are powerful!
Do not swallow. Do not allow young
children to play with them.

Ferrofluid will stain,
so protect skin
and surfaces.

YOU WILL NEED:

- Ferrofluid (available online)
- Rare earth magnet (these are extremely strong magnets, usually made out of neodymium)
- Paper towels and cleaning materials
- Gloves
- A plate, or a large, washable table surface

FUTURISTIC FERROFLUID

METHOD:

1. Wearing your gloves, pour a little of the ferrofluid onto a plate or a wipeable table surface (avoid woods that might stain).
2. Place the rare earth magnet underneath the plate or table and watch the black liquid spring into life. Hedgehog-like spiky tufts will form directly above the magnet, following its movements as you slide it around the underside.
3. Blow on it to watch the spikes spin! You can even make the ferrofluid crawl up surfaces and – if you don't mind making a mess – hover the magnet over the surface to see it defy gravity by 'dripping' upwards onto the magnet, transforming it into an eerily squidgy, slimy black ball.

WHAT'S GOING ON?

A ferrofluid is an oily liquid blended with microscopic particles of metal. It is combined with a liquid 'surfactant' to prevent clumping. It forms such crazy shapes in the presence of a magnet because the metal particles try to align themselves along the path of the magnetic field.

You can buy small bottles of ferrofluid online, or you can try making your own by mixing a cupful of laser printer toner with a little cooking oil. Be aware that not all modern laser printer ink is magnetic, so only try it if you have some spare. Like black printer ink, all ferrofluids stain easily, so make sure that you wear gloves and be careful where you pour it. You may want to consider putting on an apron.»

EXTRACT DNA IN YOUR KITCHEN

YOU WILL NEED:

- Safety glasses
- A small handful of strawberries (or broccoli, peeled kiwi fruit, spinach or split peas)
- Food blender
- Sieve
- Bowl
- Tall glass or test tube
- Salt
- Washing-up liquid
- Pineapple juice
- Methylated spirit (meths)
- Ice or a freezer
- Toothpick, tweezers or small skewer
- A large pipette or turkey baster

TV cop shows have made DNA extraction glamorous – with just a tuft of hair or speck of blood, crime scene investigators can isolate the genetic fingerprint of the 'perp' and bring them to justice. So you may be surprised to learn that DNA can be extracted from organic material in the kitchen, with just a few household ingredients.

WHAT'S GOING ON?

The washing-up liquid opens the fat-like membrane that makes up the walls of each strawberry cell's nucleus, inside which the DNA is stored. The DNA is tightly coiled around specialised nuggets of packaging proteins, which need to be broken up before they can be extracted, and the pineapple juice contains a protein-digesting enzyme called bromelain that does this. Every DNA molecule is extremely long and is peppered with tiny positive and negative electrical charges, each of which is hugged by opposing tiny charges of the surrounding water molecules. The sodium and chlorine from the salt form a coat around the DNA, helping it clump together when mixed with alcohol. The methylated spirit causes DNA molecules to separate from the mixture and 'precipitate' out as a solid mass. DNA is delicate, so the meths needs to be poured in carefully without stirring.

METHOD:



1. Put a handful of strawberries in a blender with half a cup of water and a pinch of salt. Blitz for at least 30 seconds until it achieves a smooth consistency.



2. Separate the tough, fibrous material by pouring the mixture through a fine sieve. Use the back of a spoon to squeeze all the juice through, leaving only the cellulose behind.



3. Add a good squirt of washing-up liquid (about 30ml). Stir it and leave it for five to 10 minutes. Add a splash of pineapple juice.



4. Decant the (now undrinkable) strawberry juice into a tall glass or test tube. We did this with a turkey baster to avoid splashes.



5. Put on your safety glasses, and use a turkey baster to draw some ice-cold methylated spirits out of the bottle and trickle it down the side of the glass.



6. The meths will float on the surface. At the boundary of the two liquids, wispy threads will materialise. This is the strawberry's DNA and can be plucked out (see right).

SAFETY NOTES

Wear safety glasses when using methylated spirit.

Do not drink methylated spirit.

Keep fingers away from sharp blades on kitchen equipment.

Wash hands after touching plants, soil or animals.

Do not allow children to visit a beach unsupervised.





FUN FOR NATURE LOVERS



SEARCH FOR SEAWEED FOR SCIENCE!

A trip to the coast will feature in many people's summer plans; if you're visiting Britain, you have an ideal opportunity to take part in the Big Seaweed Search, which is being run by the Natural History Museum in collaboration with the Marine Conservation Society.

Seaweed plays a vital role in creating underwater habitats and providing food for fish and other marine creatures. We don't yet fully understand what impact climate change is having on seaweed species, but armed with nothing more than a pen, some paper and a smartphone or camera, you can help scientists get to grips with what is happening.

Visit nhm.ac.uk/seaweeds to download a seaweed guide and recording form, then start rockpooling! Submit your observations and photos online.



CREATE A WORLD IN A JAR

This summer, why not make a self-contained ecosystem? Called a 'terrarium', your small biosphere will house plant life that can survive without human intervention for years – perhaps even decades!

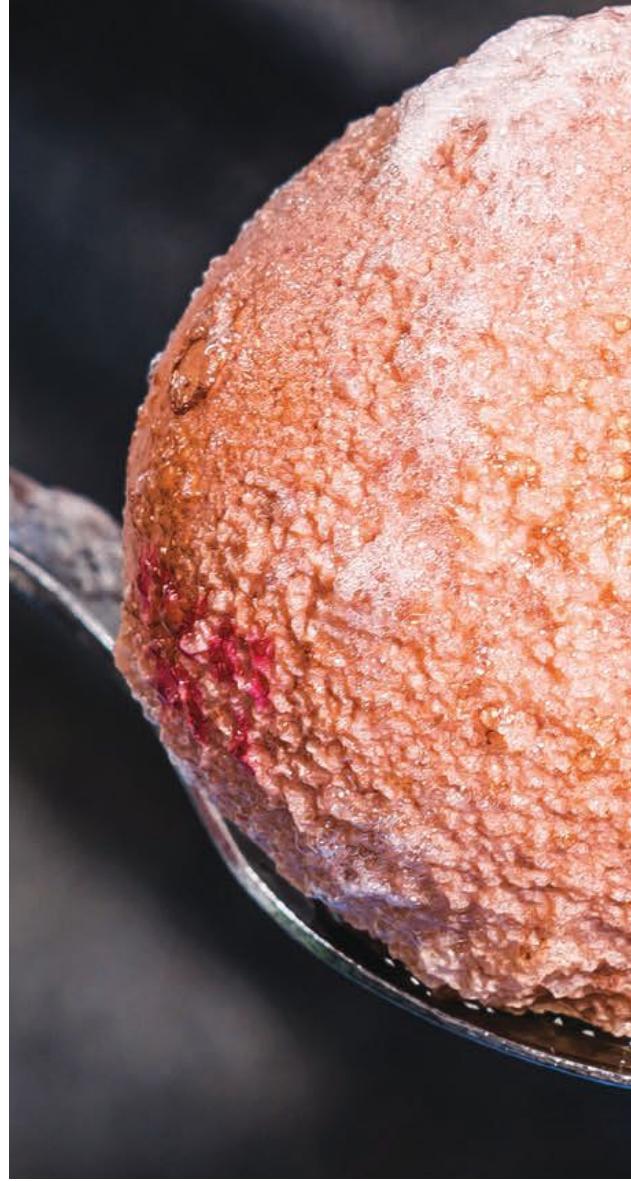
Pour a 2- to 3cm layer of gravel or pebbles into a jar. This will allow a space for moisture to drain. Add a thin layer of activated charcoal, which is available from pet shops – this will help to remove impurities from the water. Add a 2cm layer of good potting soil.

Next, choose a plant that grows well in humid conditions, such as a strawberry begonia, spiderwort or fern. Trim back the roots so it doesn't grow too large, plant it in the soil and add some sphagnum moss around the edge. Spray in a little water to moisten the leaves, then seal the jar and place it in a bright, indoor spot, near a window and away from radiators.

You may need to open the jar once a week to clean it if there is a lot of condensation; other than that, your newly built ecosystem should look after itself. ▶

SOFT DRINKS VS YOUR TEETH

We often hear about the dangers of sugary soft drinks, but this eye-opening experiment shows you that all acidic drinks can be bad for your pearly whites – even the ones you thought were healthy...



WHAT'S GOING ON?

YOU WILL NEED:

- Eggs
- Selection of soft drinks (we used orange juice, soda, cola and an energy drink)
- Tap water (this acts as a control, for comparison)
- Enough glasses or mugs for each drink
- Sticky labels
- A toothbrush

The results may shock you: orange juice, which is typically seen as a 'healthy' drink, is naturally high in citric acid and causes more dramatic changes than cola. Fizzy water is also acidic because it contains dissolved carbon dioxide, which forms carbonic acid. Commercial soft drinks are remarkably corrosive because manufacturers add extra acids to give them a 'tang'. But it's energy drinks that are consistently among the worst offenders, typically being as acidic as vinegar.»



METHOD:

1. Collect a selection of soft drinks.
2. Place an egg in each glass.
3. Pour enough of each drink into separate glass to completely cover the egg. Don't forget to include one with tap water.
4. Label each glass and leave overnight. Leave for a week to witness even more dramatic results!
5. Carefully remove each egg to examine the shell.
6. Rub gently with a toothbrush to simulate the effect of brushing your teeth after exposure to the acidic drinks (see main image).





FUN FOR STARGAZERS



WATCH NATURE'S FIREWORKS DISPLAY

The streaks of light we call 'shooting stars' are really meteors: tiny fragments of stone or ice that plough into Earth's atmosphere at around 160,000km/h and burn up on entry. On any clear, dark night, you might spot the odd meteor but, at certain times of year, they appear in a dramatic flurry.

You don't need any special equipment for meteor spotting: just wear warm clothes and head somewhere very dark, well away from city lights. A sunlounger will, however, make for more comfy viewing!



BUILD A SUNDIAL

The simplest sundial needs nothing more than a waterproof paper plate, a straw, and a permanent marker. Poke a small hole in the middle of the upturned plate and fix it on the ground or a table outside. Poke the straw through the hole and, at midday, write '12' on the edge of the plate in line with the straw's shadow. Then mark the position of the shadow every hour, and continue the next day until you have all the daylight hours recorded.

You now have a reliable 'clock' that will serve you the whole summer – no charging needed!

The adventurous can build a more permanent sundial with wood and nails. Printable sundial templates are also available at go.nasa.gov/2tgh33Y



CHART THE GALAXIES AT HOME

With opportunities for stargazing limited on short summer nights, many enthusiasts turn to citizen science astronomy projects. From your home computer, you can join thousands of other amateurs in helping scientists make sense of the endless stream of data and imagery from space telescopes like Hubble and Kepler and ground-based observatories such as Paranal and Mauna Kea.

Zooniverse (www.zooniverse.org) hosts most of the major citizen science astronomy initiatives. Some are easy, others more taxing, but each project will give you the necessary training before introducing you to the new data. A personal pick is the Milky Way Project, which asks you to analyse stunning infrared imagery of the Galaxy.

ELEPHANT TOOTHPASTE

METHOD:

1. This experiment is messy! Either work at a table that's easy to clean, or head outside.
2. The dried yeast needs to be rehydrated to 'activate' the microbes. Thoroughly mix two or three tablespoons (or one sachet) of yeast with some warm water in a bowl. Leave for a couple of minutes while you get everything else ready.
3. Put on gloves and safety glasses.
4. Pour half a cupful of hydrogen peroxide into the bottle (more if you're using a larger bottle).
5. Add a good squirt of washing-up liquid.
6. Pour in up to two tablespoons of glycerine.
7. You are going to be making toothpaste, so why not add some food colouring? I drizzled some orange food colouring down one side of the bottle and blue down the other.
8. Pour the (now activated) yeast into the bottle using the funnel.
9. Stand back as the bottle erupts with a thick foam that seems to just keep on going. It looks like toothpaste, but it's definitely not for brushing teeth with!

YOU WILL NEED:

- Safety glasses
- Gloves
- Washing-up liquid
- Dried yeast (make sure that it has not expired)
- Warm water
- Food colouring
- Empty 500ml plastic drinks bottle
- 9% hydrogen peroxide (this is a mild skin disinfectant that you can buy over the counter at pharmacies)
- Funnel
- Glycerine (find this in the baking section of the supermarket, or in bigger bottles at a pharmacy)

WHAT'S GOING ON?

'Elephant toothpaste' isn't toothpaste at all, but a foam of oxygen bubbles that have been ensnared by the washing-up liquid and thickened by the glycerine.

Chemically, hydrogen peroxide is made of two hydrogen atoms and two oxygen atoms (H_2O_2). This makes it similar to water (H_2O) but with an extra oxygen atom (O) – yet hydrogen peroxide is poisonous to living things, which is why we use it as a disinfectant, and why we keep it away from our mouths and eyes. Yeast, however, carries a protective enzyme called catalase that destroys hydrogen peroxide. The moment the living yeast cells touch the liquid disinfectant, the enzymes go to work tearing the hydrogen peroxide molecules apart, into water and oxygen. The oxygen bubbles up vigorously to form a rapidly growing foam that erupts from the top of the bottle, such is the fervour of the reaction.

You can try this science demonstration with liver instead of yeast, as this organ also contains enzymes that destroy hydrogen peroxide.

SAFETY NOTES

Hydrogen peroxide can irritate eyes and sensitive skin, so wear safety glasses and gloves. Do not swallow hydrogen peroxide or splash in eyes.



THE UNPOPPABLE BALLOON

You don't need a planet-sized brain to understand that a balloon plus a sharp pointy object equals a big bang. But, when you up the ante, the sums don't always seem to add up, as this entertaining experiment shows...

YOU WILL NEED:

- A packet of drawing pins
- An inflated balloon (have one on standby, just in case)

METHOD:

1. Scatter a handful of drawing pins evenly over a flat surface, all pointing upwards.
2. Push an inflated balloon down onto the bed of pins.
3. Be amazed as it doesn't pop!



WHAT'S GOING ON?

We intuitively think that more spikes mean more damage, but this isn't true. One drawing pin would burst a balloon easily, but, when the balloon is pressed down over many small points, pressure is spread between each one, so you need to push down much harder before any one point has the force to pierce the taut rubber. This principle also explains how circus performers can lie on a bed of nails.

You can even test the theory by walking on

eggs without them cracking! Place two large boxes of eggs on the floor, making sure all the eggs are uncracked, about the same size and with their 'pointy' ends facing down. Put down some plastic sheeting if you're worried about making a mess. Take off your shoes and socks and, with someone to help you balance, ease your weight down onto both sets of eggs, spreading your weight as evenly as possible. The lighter you are, the easier it will be, so perhaps this is one just for the kids...K

Dr Stuart Farrimond is a science writer, presenter and educator, and hosts a weekly science segment on BBC Radio Wiltshire. He has written *The Science of Cooking*.

TRAGEDY ON THE MATTERHORN

The conquest of the last great Alpine peak in 1865 should have been a triumph, but instead ended in the deaths of four climbers.

Peter H Hansen examines its impact on attitudes to mountaineers

A moment was all it took for joy to be supplanted by horror. Less than an hour after Edward Whymper had laughed in jubilation from the summit of the Matterhorn on July 14, 1865 – having completed the first successful ascent of the Alpine peak on the Swiss-Italian border – his triumph was shattered by tragedy.

Among his group was an inexperienced young climber who slipped on a treacherous section of descent, dragging off the mountain three others who were roped to him. On hearing the cries of the falling men, Whymper and his two local guides had just an instant to brace themselves before the force of the accident broke the rope tying them to the falling climbers.

"For a few seconds," Whymper recalled, "we saw our unfortunate companions sliding downwards on their backs, and spreading out their hands, endeavouring to save themselves. They passed from our sight uninjured, disappeared one by one, and fell from precipice to precipice." The four hapless climbers plummeted 1,200 metres, their bodies dashed to pieces on the glacier below.

The Matterhorn accident was one of the deadliest mountaineering catastrophes of the 19th century, sparking a wide debate about mountaineering, masculinity and empire.

Whymper was the unlikely leader of a climbing team that had been formed only days earlier. This engraver from south London had laid siege to the Matterhorn since 1861, climbing on

its southern (Italian) ridges by himself or with guides. On the eve of his 1865 attempt, however, the bravest of these guides, Jean-Antoine Carrel, transferred his services to a group of climbers from Turin who hoped to plant the flag of the recently unified Italy on the summit.

Whymper felt betrayed. By chance, though, he met Lord Francis Douglas, the amiable, 18-year-old younger brother of the Marquess of Queensberry. Douglas's Swiss guide, Peter Taugwalder, had inspected the northern side of the Matterhorn and believed that it could be climbed from the Swiss village of Zermatt.

The new companions crossed into Switzerland. There, they met the Reverend Charles Hudson, a muscular English clergyman. He was travelling with Douglas Hadow, an 18-year-old climbing novice, and Michel Croz, a well-known French guide who had previously climbed with Whymper. One of Taugwalder's sons also joined the team.

Since the mid-1850s, many an Alpine summit had felt the scrape of British hobnailed boots attempting first ascents, but the 4,478-metre (14,692ft) Matterhorn remained unconquered. As Whymper's team ascended the north-eastern ridge, they knew the Italians were

already climbing on the other side of the mountain. The race to be first was on.

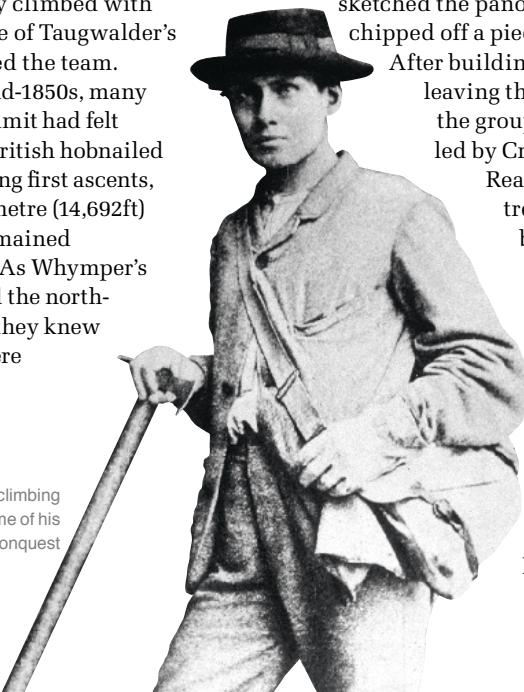
Unexpectedly, the team discovered that the Swiss slopes formed a natural staircase up which Whymper clambered with mounting excitement. Beneath the highest pinnacle, Whymper unroped himself and raced to the top. Had they beaten the Italians?

The snow was untrodden. Laughing with joy, the climbers spotted the Italians below, mere dots on the ridge. Whymper and Croz shouted and waved their arms, but were unsure whether they had been seen: "We drove our sticks in, and prised away the crags, and soon a torrent of stones poured down the cliffs. There was no mistake about it this time. The Italians turned and fled."

At the summit, Croz tied his shirt to a tent-pole, creating an impromptu flag visible from all directions. Whymper sketched the panoramic view and chipped off a piece of rock as a souvenir. After building a pile of stones and leaving their names in a bottle, the group began the descent, led by Croz.

Reaching the steepest, most treacherous section, Croz began to manually place Hadow's boots in each step. At a crucial moment, though, Hadow slipped and knocked him over, and Hudson and Douglas were yanked off their feet. Hearing their cries, Whymper and Taugwalder planted themselves ▶

Edward Whymper in climbing gear around the time of his Matterhorn conquest





The moment at which the safety rope linking Edward Whymper's group of climbers snapped, sending four of the men hurtling to their deaths, is depicted in Gustave Doré's engraving of 1865

This engraving by Edward Whymper, showing his party tackling a tricky Alpine descent, illustrates his book *Scrambles Amongst the Alps*



firmly to absorb the jerk of the rope: "We held; but the rope broke midway between Taugwalder and Lord Francis Douglas."

From the moment the rope broke, it was impossible to save those below. Whymper examined the rope and found it to be the weakest cord they had brought, not intended to be used for protection while climbing.

Whymper and the two Taugwalders made the sorrowful descent to Zermatt, from where rescuers left to search for survivors. They found bloodstains, fragments of clothes and shattered human remains. Croz, Hadow and Hudson were identified from shreds of clothing and tufts of beard. Scraps of Lord Francis Douglas's clothing were found, but there was no sign of his body – except, perhaps, for the birds of prey circling the cliffs above the debris field. Visitors to Zermatt's Alpine Museum can today see relics including the frayed end of the rope.

AFTERMATH OF THE ACCIDENT

An inquest in Switzerland found that Hadow was responsible for the accident, clearing Whymper of wrongdoing, but this did little to quell a heated debate about the accident in Britain. *The Times* viewed the

ascent of the Matterhorn as "utterly incomprehensible", and asked what right mountaineers had to throw away the gift of life: "Is it duty? Is it common sense? Is it allowable? Is it not wrong?"

Charles Dickens lambasted the climbers as foolhardy braggarts. Mountaineers were not heroic, he said, nor to be compared to those who braved cholera, visited typhus patients or fought in the Crimean War. "We shall be told that 'mountaineering' is a manly exercise," he wrote. "It is so, inasmuch as it is not womanly. But it is not nobly manly when it is selfish." Mountaineering, according to Dickens, was no more manly than gambling and indicated "contempt for and waste of human life – a gift too holy to be played with like a toy, under false pretences, by bragging vanity".

But novelist Anthony Trollope compared mountaineers to soldiers, sportsmen and explorers. Death on a mountain was the same as death in battle or on an African expedition. He saw all these as blood shed for the honour of the country. He hoped that the "accident on the Matterhorn may not repress the adventurous spirit of a single English mountain-climber", and looked forward to hearing of new ascents in Asia or South America.

Comparisons to imperial exploration shifted opinion about the Matterhorn accident in favour of the climbers. The *Illustrated London News* likened the victims to English explorers who had died in the Australian outback. Climbing mountains trained Englishmen to follow the call of duty, its editors argued, and contributed to military prowess, commercial prosperity, and scientific knowledge. "There would be small philosophy – nay, small knowledge of the world shown in discouraging adventure. It has given us the empire."

Such celebrations of manliness, exploration and empire persuaded some critics to reassess their dim view of mountaineering. While awaiting Whymper's account of the accident, *The Times* conceded: "Perhaps it is necessary that there should be an order of men to attempt what no one else will attempt, to show what can be done, and the feats which human courage and endurance can perform."

Even John Ruskin, who had censured mountaineers for treating the Alps like "soaped poles in a bear-garden," was moved to temper his criticism. "No blame ought to attach to the Alpine tourist for incurring danger," Ruskin wrote shortly

"CLIMBING MOUNTAINS, IT WAS ARGUED, TRAINED ENGLISHMEN TO FOLLOW THE CALL OF DUTY, AND CONTRIBUTED TO MILITARY PROWESS, AND SCIENTIFIC KNOWLEDGE"

after the Matterhorn accident.

"Some experience of distinct peril, and the acquirements of quick and calm action in its presence, are necessary elements at some period of life, in the formation of manly character."

Whymper made similar points in *Scrambles Amongst the Alps* (1871), a lavishly illustrated account of his climbs during the 1860s that remains a touchstone of mountaineering literature. He closed his account of that fateful climb by tallying the benefits of mountaineering beyond enjoying physical fitness and the beautiful scenery: "We value more highly the development of manliness, and the evolution, under combat with difficulties, of those noble qualities of human nature – courage, patience, endurance, and fortitude."

In 1867, Whymper set out to explore the interior of Greenland, but later plans to climb in the Himalayas were stymied by political conditions. Instead, he travelled to Ecuador with Jean-Antoine Carrel, his erstwhile Matterhorn partner and rival. During 1879 and 1880, they collected scientific specimens, researched altitude sickness, and climbed Chimborazo (6,268 metres), among other peaks.

"The real effect of the accident itself," the *Saturday Review* wrote in 1865, "has been to stimulate enterprise and to crowd Zermatt to overflowing." Crowds have only grown over the 150 years since then: Zermatt has become one of the most popular Alpine resorts.

A new and enlarged base-camp lodge, the Hörnlhütte, has been set up near the spot where Whymper and his party slept before that first ascent in 1865. On July 14, the peak remains closed to all climbers in remembrance, and to honour the people – more than 500 of them – who have died on the Matterhorn since that tragic day in 1865. **K**

PETER H HANSEN is professor of history at Worcester Polytechnic Institute in Massachusetts, the United States of America.



The men who fell 1,200 metres to their deaths during the Matterhorn descent (From top): Michel Croz, Douglas Hadow, Francis Douglas and Charles Hudson

ACCIDENTS AT ALTITUDE

The history of climbing is littered with the bodies of unfortunate mountaineers and their guides

THE 'HAMEL CATASTROPHE' Mont Blanc, 1820

The insistence of Dr Joseph Hamel, a Russian naturalist, on climbing Mont Blanc after a heavy snowfall – against his guides' advice – proved disastrous. On August 20, an avalanche killed three of his Chamonix guides, a tragedy sometimes cited as the first notorious Alpine mountaineering accident.

The deaths led in 1821 to the creation of the Company of Guides of Chamonix to regulate pay, provide compensation for families, and ensure guides have authority to make decisions during ascents. The victims became entombed in the slow-moving Bossons Glacier; their remains only emerged from the ice during the 1860s.

THE MALLORY MYSTERY Mount Everest, 1924

English mountaineers George Mallory and Andrew Irvine were last seen alive on June 8, 1924, sighted through a break in the clouds as they ascended towards the summit of Everest.

Their disappearance so close to the top formed the dramatic climax to the expedition film *The Epic of Everest*, and sparked years of speculation: had they completed their first ascent before their deaths?

In 1999, Mallory's frozen body was discovered, presumably at the spot where he fell and died.

There was no sign of Irvine, and no proof that they had reached the summit before the fatal accident.

AVALANCHE ON EVEREST Mount Everest, 2014

On April 18, 2014, a large block of ice collapsed onto the Khumbu Icefall, the most hazardous section of the most popular route up Everest, killing 16 Nepali expedition workers, most of them ethnic Sherpas. Thirteen bodies were recovered, but three remain trapped in the ice. The high death toll led to protests by local workers at Everest Base Camp, demanding better regulation, compensation for families and the cancellation of further climbs that year as a mark of respect for the victims.

LAKE OF GIANTS

In the Peruvian Amazon, a family of giant otters fends off hundreds of caiman to dominate a lake. Only through teamwork and guile can they beat their reptilian rivals, says **PHILIPPA FORRESTER**

PHOTOS BY CHARLIE HAMILTON JAMES

IT'S 4.30am, dark and hot, on a late November morning. Needles of rain are bouncing off black water and a tree floats by. But wildlife cameraman Charlie Hamilton James has only one thing on his mind as his small boat putters across the fast-flowing River Manu in the Peruvian Amazon. Five days after leaving England, he has reached his destination – a wooden raft in the middle of a large oxbow lake called Cocha Salvador.

As grey light seeps across the sky, the expanse of water on which Charlie is floating becomes distinct from the forested banks. The humidity starts rising sharply. Manu National Park, the most biodiverse place on Earth, begins to wake up.

A black caiman cruises silently past, eyes level with the surface, barely visible bumps atop long-toothed jaws. Macaws stir and call, and rainforest insects chirp and hum – noises Charlie has not heard for 10 years. He is still waiting for the sounds that he travelled all this way for.

Suddenly, the still air erupts into whistles, sliding-scale squeals and energetic banter. The caiman sinks, the water closing over the top of its head, leaving no trace of the animal's

2.5m-long bulk. For now, the reptile exits stage left among the overhanging bankside vegetation as the lake's resident 'mob' appears centre stage.

OTTER OBSESSION

Here, at last, is the family that Charlie has waited so long to see again: a boisterous gang of giant otters, each up to 1.8m long, with sleek bodies, seal-like heads and huge webbed feet. They dive, leap and raise their heads high above the surface, peering curiously to see who is on their lake.

As Charlie's camera whirrs into action, he can't help smiling. He has been obsessed with otters for most of his life, and, as his wife and fellow film-maker, I have shared a decade of this passion. The European otter that Charlie and I have got to know so well is playful, inquisitive and supremely adapted to an aquatic life – but that's where any similarity with its Amazonian cousin ends.

The otter that lives along rivers and coasts is usually secretive and, on the whole, solitary and nocturnal – behaviour that is a world away from the complex sociality displayed by this group of exuberant monsters. Europe's otters seem modest by comparison – cute, even – whereas these,





Due to their sheer size, giant otters bear an uncanny resemblance to seals. A family will defend 5km² of lake, regularly patrolling the borders of its territory



Tight-knit giant otter families – here, overseen by mob leader Diablo (left) – do everything together: they hunt, play and sleep as a group, even sharing babysitting duties

brutes are hardly beautiful to most human eyes. In all honesty they have faces only their mothers could love.

DIABLO'S CLAN

Charlie studies each of the lake's giant otters in turn. Ever since he filmed this family for *Wildlife on One* a decade ago, he has wondered what became of it – in particular, a youngster known as Diablo. He was just a cub then, and Charlie had witnessed his first swim. Had he survived to adulthood?

Giant otters have one key distinctive feature – a creamy patch under the chin, the shape of which is unique to each animal. Charlie had memorised the pattern on Diablo's throat; as he sees an otter swimming across the lake, he's certain that he is looking at the same individual.

Diablo is clearly now the dominant breeding male of a large clan consisting of himself and his mate Sophia, two cubs from the previous spring, plus five other adults and sub-adults. They all defer to Diablo – he's the boss.

The pale 'bib' on each giant otter's throat is as unique and distinctive as a human fingerprint



Diablo's family is the subject of the longest-running study of giant otters, started by Frankfurt Zoological Society (FZS) in 1990. So you might think that we've learned pretty much all there is to know about these charismatic mustelids. But Diablo has kept a few surprises for Charlie.

As he watches this first morning, he notices that Diablo's family seems protective of its den, and it soon becomes apparent why. Not two or even three, but six tiny cubs emerge. They are already a few weeks old, so must have been born in October. In Manu, giant otters usually bear two to four cubs, generally between April and July, so to find so many young at this time of year is completely unexpected.

Six cubs! Is that a record? Dr Rob Williams, who leads the FZS research project, is intrigued. "It means that the family has produced two litters of cubs this year," he says. "On a couple of occasions, we suspected that this was happening, but we've never been able to prove it – until now."

The forest is often impassable in November, which is the rainy season, so the researchers tend to visit Cocha Salvador several months later, when they usually expect to find two or three cubs. Charlie's discovery suggests that the otters give birth to more young than they had thought and that, by the time the zoologists arrive, only two or three survive. "The cubs are almost certainly being taken by caiman," Rob muses.

SWIMMING LESSONS

Over the next six months, Charlie films the cubs every day as they discover how to survive in a lake that's home to 700 hungry caiman. First, they must learn to swim – essential, you might think, but ▶



Black caiman can exceed 4m in length and tackle prey as large as pigs, so are formidable opponents



Cubs are cared for by their aunts and uncles, as well as by the breeding pair. If danger threatens, they are quickly moved to safety

DANGER IN THE WATER THE AMAZON GOLDRUSH

In the past, hunting was the worst threat facing Diablo and his kind: otter-fur coats were all the rage in Milan in the 1970s. But, today, one of the main dangers comes not from fashion but from gold.

Gold-mining operations have degraded many lakes in the Amazon Basin: the accompanying dredging and tree-felling releases sediment into rivers, severely depleting fish populations, while the mercury that leaches into the water during the gold-extraction process poisons fish and, ultimately, the otters that eat them.

Even if mining stopped immediately, the heavy-metal contaminants could potentially linger in the food chain for up to 300 years.



Pollution from gold mining has led to local extinctions of giant otters in much of their Amazonian range

Diablo (*left*) and his cohorts close ranks. A mob defending its territory is a daunting sight for a cameraman, let alone an intruding giant otter



giant otter cubs don't much like water. One cub in particular – Dali, the smallest of the litter – hates it. Every time his elders place him near the lake edge, he resolutely heads for the warmth and security of the den.

With his big head and skinny body, Dali has yet to gain the toned muscles and sleek overcoat of the adults, and is clumsy and vulnerable. It seems improbable that he will ever reach maturity – and, were it not for his encouraging, sometimes bullish family, he most certainly wouldn't.

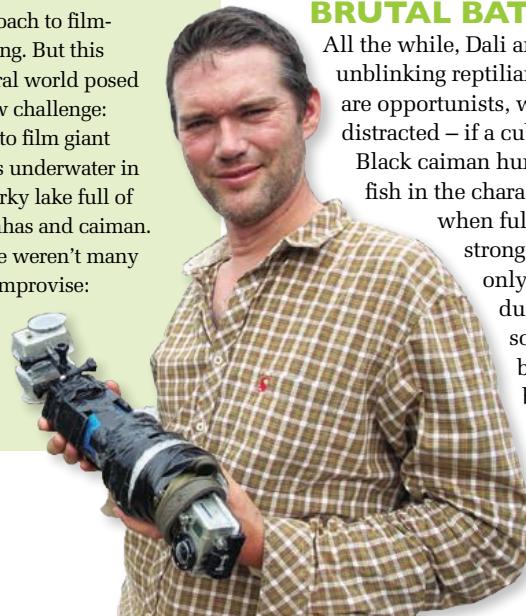
FILMING GIANTS UNDERWATER



Charlie's camera-cum-toy filmed giant otters playing underwater

Charlie is well known for his 'Heath Robinson' approach to film-making. But this natural world posed a new challenge: how to film giant otters underwater in a murky lake full of piranhas and caiman. There weren't many

gadgets on Charlie's makeshift raft, so he had to improvise: he emptied his metal water bottle and strapped a small underwater camera to it to make a floating toy. But would the otters like it? He needn't have worried: they loved it and we also loved the resulting, rather crazy, footage.



Several times, Dali is unceremoniously dunked in the lake by one of his older carers and left to struggle back to the bank. Though this is rudimentary as swimming lessons go, it proves effective and he does, eventually, get the hang of what those enormous webbed feet are for.

Dali's next lesson is in fishing. Having come to terms with getting his feet wet, his initial attempts at 'fishing' involve screaming at adults who have caught something, in the hope that they will simply hand it over. This ploy works – occasionally – but Dali has a lot to learn: as an adult, he will need to catch about 3 kilos of fish a day.

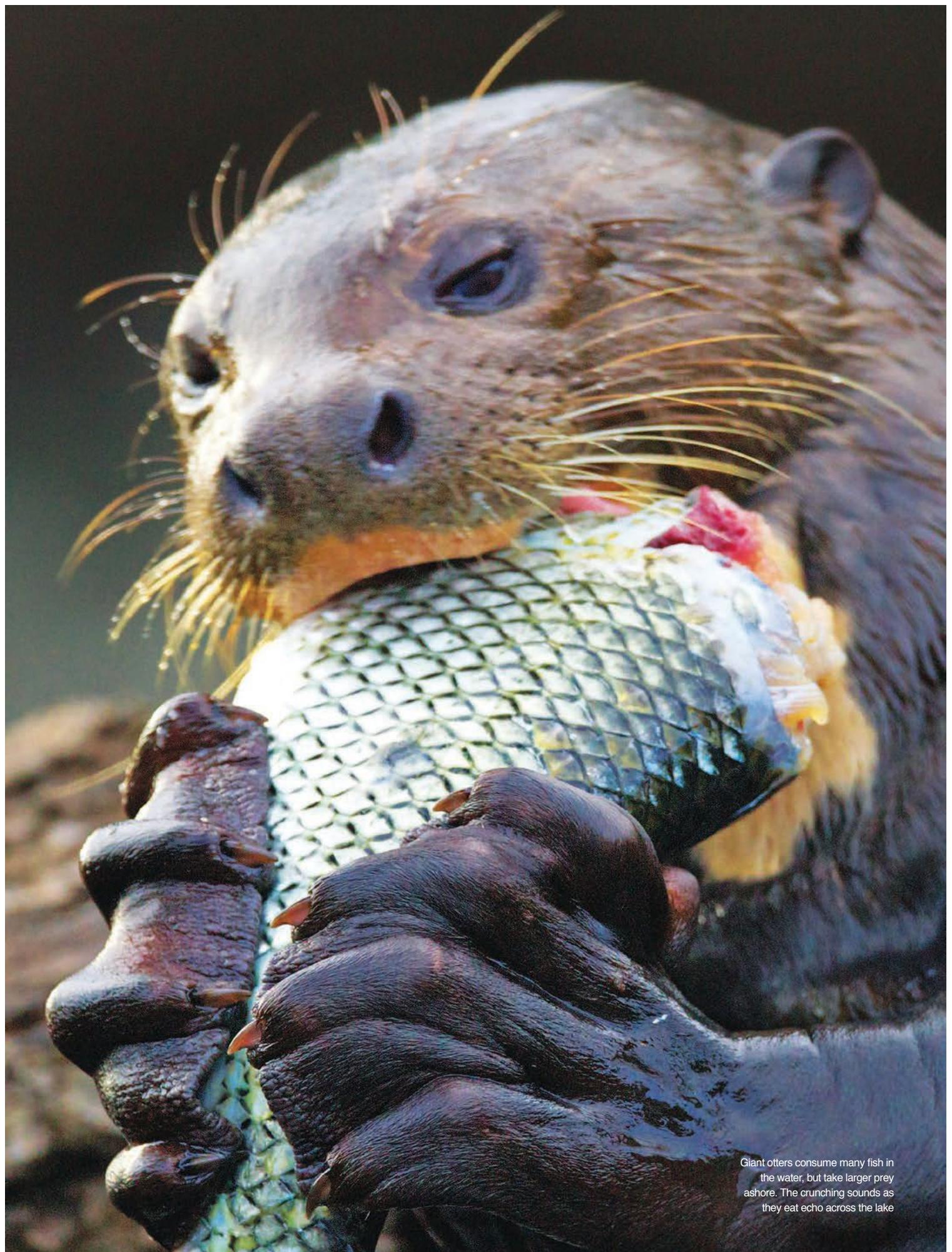
And that's not all: swimming up to 100m to the shore every time you catch a fish is a waste of energy and also exposes you to the greatest risk of attack by caiman, so eating while swimming must be mastered, too.

BRUTAL BATTLES

All the while, Dali and his siblings are being watched by unblinking reptilian eyes. The lake's numerous caiman are opportunists, waiting for one of the babysitters to be distracted – if a cub becomes separated, it's an easy meal.

Black caiman hunt the same prey as giant otters (mostly fish in the characin family, including piranhas), and, when fully grown, they are both larger and stronger than the mustelids. The otters can only co-exist with these formidable rivals due to their tight social bonds and sophisticated vocalisations. They survive because they protect each other – because, together, they are a mob.

Rob and his team have observed numerous epic battles between otters and caiman, including some that had ▶



Giant otters consume many fish in the water, but take larger prey ashore. The crunching sounds as they eat echo across the lake



Like their Eurasian cousins, giant otters are boisterous animals, using play to reinforce social bonds

fatal outcomes for one or more of the combatants. "The otters often start a fight as soon as they spot a caiman," Rob explains. "I suspect that they may be trying to keep caiman numbers down. They seem to want to ensure that there are no caiman near their den and cubs."

Ordinarily, if a caiman feels sufficiently harassed, it will swim off in search of a little peace and quiet. The really dangerous ones are those that simply won't be intimidated and stubbornly refuse to budge.

BITE FOR SURVIVAL

One morning, Diablo eyes a huge caiman lingering close to the den – too close for comfort. All of the adults gather, their usual whistles intensifying into almost tribal cries and shrieks. Sophia swims up to the caiman's head to distract it while Diablo sneaks up behind to bite its tail. Though powerful, the reptile's jaws are no match for the agility and speed of the otters: as some of the gang hold it under the surface and others bite, all it can do is thrash helplessly. After almost an hour of noisy fighting, the mob finally overpowers its scaly enemy.

This brutal battle demonstrates the teamwork and sheer guts that the otter family needs to survive. But struggles like this come at a price: two cubs have been killed, presumably having drowned in the confusion. Now only two of the six in the litter are left – and an adult is missing, too.

A year later, Charlie returns to Cocha Salvador to shoot the final sequences of our film. What has become of Diablo and his family? Amazingly, they're all still alive and well. And, there's more good news – Sophia has produced another litter, so there are four new cubs to look after. For his part, Dali is well on the way to becoming like his father: a big, strong, canny otter. It's too early to say if he will ever lord it over the lake like Diablo, but he's proved he is a survivor. ☺

FACT FILE

GIANT OTTER

Pteronura brasiliensis

► WEIGHT

Male: 26 to 32kg

Female: 22 to 26kg

► LENGTH

Head and body: 1 to 1.3m (male); 1 to 1.2m (female); tail: 45 to 65cm

► ID TIPS

Sleek, muscular body with huge webbed feet and a very long tail. Velvety brown overall; cream throat patch

► DIET

Mainly fish, but also takes amphibians, molluscs, small mammals, turtles and birds



► LIFE-CYCLE

Female bears 1 to 6 cubs, usually during the dry season, after a gestation of 65 to 70 days. Cubs can hunt by 10 months; sexually mature at 2 to 3 years

► HABITAT

Lakes, slow-moving rivers, swamps and flooded forests

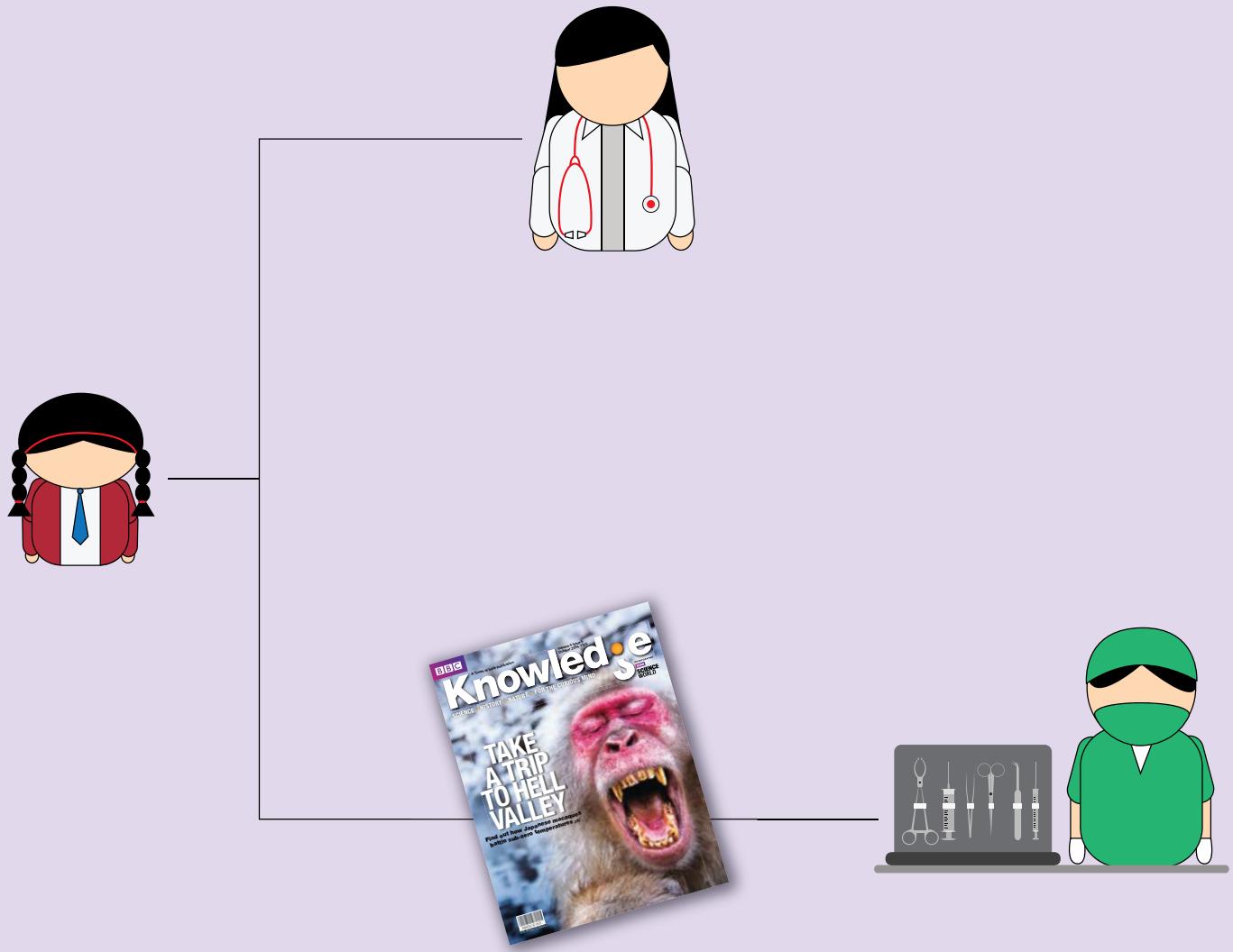
► STATUS

Endangered; threats include water pollution, habitat degradation and hunting

WHERE IN THE WORLD

Giant Otter Range





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.



New Series!

THE TRANSFORMATION OF ମୂର୍ତ୍ତି

Sketches : Devdutt Pattanaik

Indra is within us, writes mythology expert DEVDEUTT PATTANAIK, as he traces the changing perceptions of the god, in the first of a series on Indian mythologies



- Myth is a belief, an article of faith, which cannot be verified scientifically. Believers think it is true; non-believers feel it is false.

While science restricts itself to 'how' questions (how did the world come into being, how are we born), myth answers 'why' questions (why does the world exist, why do we live, or die). Fiction is nobody's truth. Fact is everybody's truth.

Mythology is somebody's truth.

- Mythology is the vehicle of myth; it is a set of stories, symbols and rituals that communicates the myth that binds a community.

The community transmits these stories, symbols and rituals over generations.

Religious mythologies speak of god, demons, heaven, hell, soul, and rebirth. Secular mythologies speak of rights, justice, equality, and diversity.

- Mythologies from India are the major mythologies that originated in India: Hinduism, Buddhism, and Jainism. Belief in rebirth, hence karma, is common to all three of them.



THE *Rig Veda* is the oldest literary work that we have in India, nearly 3,500 years old. It is a set of about 1,000 poems composed in an old form of Sanskrit, known as Vedic Sanskrit. The poems are divided into 10 chapters known as *Mandalas*. These are not books as we know them today, for writing became popular in India less than 2,500 years ago. The Vedic hymns were transmitted orally, chanted carefully over generations, by men known as Brahmins. In these poems, we encounter Indian mythology for the first time.

Those who composed the Vedic chants believed in celestial beings known as *devas*, who rode fabulous horse-driven chariots and travelled through the skies among stars, planets and comets. These gods were invoked in rituals known as *yagnas*, offered food and praise, before being petitioned for health and wealth and victory in battle against demons like *Vritra*.

Indra was the most powerful of these devas. He was their leader, their king. He fought demons and defeated them in battle.

And so he was much admired by kings who went to war.

Indra was connected with another god, Varuna, who was associated with goodness, morality and ethics. And Varuna, in turn, was connected with Mitra, the god of friendships and contract.

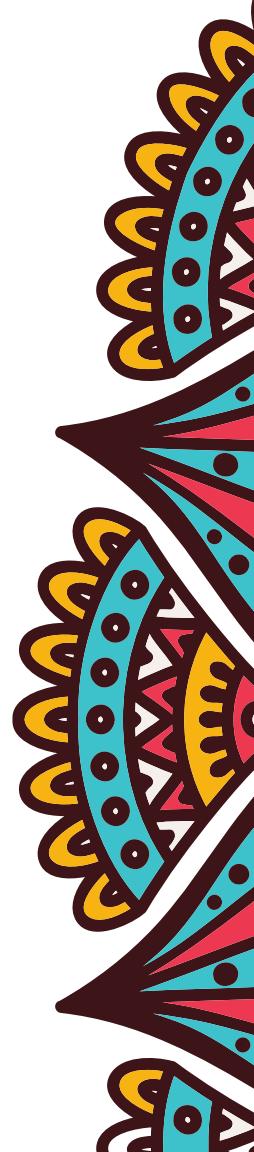
Even today, Hindus value the *Vedas*. However, Indra is a minor god. Varuna is an even more minor god. And Mitra is forgotten. As societies change, myths change, gods change, for society approaches life differently.

The *Rig Veda* was composed roughly in the region where now flows the Indus and its tributaries. About 3,000 years ago, the centre of the Vedic civilisation had shifted to the Ganga in the east. In the rich fertile Gangetic plains, the *yagna* rituals became more elaborate. Fewer people focussed on health and wealth and war and more and more people started focussing on the meaning, purpose and value of life as well as death. In other words, the focus was on less material and more spiritual, less physical and more psychological.

The material side of the *Vedas*, based on rituals, led to the composition of ritual manuals known as *Brahmanas* (hence the word Brahmin for those who memorised and transmitted the rituals and its rules). The spiritual, or psychological, side of the *Vedas*, based on ideas, led to the composition of dialogues known as *Aranyakas* and *Upanishads*.

By this time, Indra had come to be linked with the rain. He now rode an elephant called *Airavata*, with seven trunks, and six pairs of tusks. He had a thunderbolt as weapon, made from the bones of a sage called Dadichi. His abode was *Amravati*, located in *Swarga*, which was paradise, filled with treasures of every kind: the wish-fulfilling tree *Kalpataru*, the wish-fulfilling cow *Kamadhenu*, and the wish-fulfilling gem *Chintamani*.

Varuna was the god of the sea, who held a rope in his hand and rode a dolphin. Indra ruled the east, the direction of the rising sun. Varuna ruled the west, the land of the setting sun. Lakshmi, the goddess of wealth, was Varuna's daughter and Indra's consort. Indra was still the eldest of the *devas*, and their king, most powerful, who constantly did battle with *asuras*. In the *Rig Veda*, 'asura' is a title, »



INDRA APPEARS REPEATEDLY IN THE STORIES OF THE BUDDHA AND THE JINA

for a god; Varuna is called an *asura*. But later, it comes to mean a demon, whom the *devas* despise. But they are also half-brothers, for both *devas* and *asuras* are children of the same father, Kashyapa, but have different mothers, Aditi and Diti. In some stories, Lakshmi is the daughter of an *asura* king, Puloman, and wife of Indra.

The mythology of Indra is now so much richer, a shift over a thousand years, from 1500 BCE (Before Common Era) to 500 BCE; from a semi-nomadic lifestyle based on war to a fully settled agricultural lifestyle dependent on rain. Some things have changed and some things continue as before.

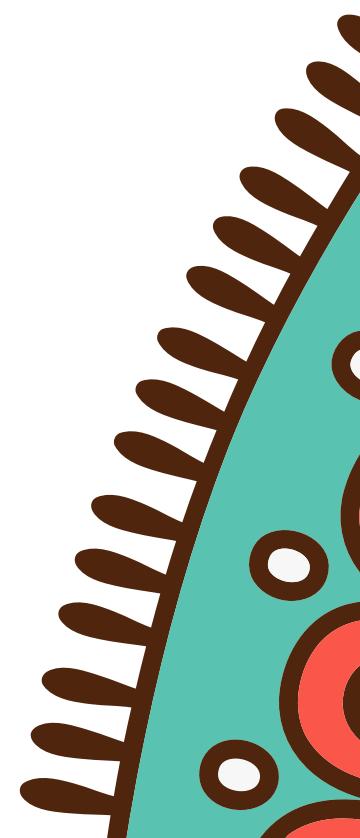
Around 2,500 years ago, society saw, on one side, ambitious kings who wanted to establish kingdoms, and highly organised trading communities with great wealth, who patronised the arts. This group preferred the ritualistic *Brahmanas* that promised success and wealth.

On the other side, there were groups of men who gave up family and all wealth, and went into the forest to meditate and contemplate on the meaning of life and death. This second group favoured the more philosophical *Aranyakas* and *Upanishads*. These were the *shramanas*, the hermits, who had a profound impact on Indian thought. The most popular of these hermits came to be known as the Buddha, the awakened one. The other was Mahavira Jina, the mighty one who conquered his mind. These hermits drew attention to the mind, and saw it as more important than material things.

In the stories of the Buddha and the Jina, Indra appears repeatedly. When Siddhartha Gautama, the prince of the Saka clan, attains supreme awareness and transforms into the Buddha, Indra comes and salutes him and tells him to pass on his knowledge to the world. Indra also enables the Jina's birth, transferring him from the womb of a priest's wife to the womb of a warrior's wife, thus ensuring he is both wise of mind and strong of body, has knowledge as well as wealth and power.

In Buddhist and Jain stories, Indra is known as Sakra. He is identified as the leader of the 33 gods who reside in *Swarga*. This phrase 'thirty three gods' refers to the old Vedic gods of the skies: the 12 Aditya who live in the sky as celestial bodies, the 8 Vasu who live on earth on the directions, the 11 Marutta who stretch as the wind between the sky.





**INDRA
EXISTED 3,500
YEARS AGO,
MAYBE
EARLIER. HE
EXISTS NOW.
HE WILL
ALWAYS EXIST
IN EVERY
PERSON, BOY
OR GIRL, MAN
OR WOMAN**

The final two are Prajapati, the father-god who embodies the sky, and Prithvi, the mother-goddess who embodies the earth. Indra's abode is located atop Mount Meru, in the centre of the world, and the sun and moon go around him.

In Buddhist and Jain stories, Indra salutes the Buddha and the Jina. He sees them as the answer to all his problems. For he is a materialistic god, who is insecure, fearing that every king on earth wants to take away all that he possesses, and so is constantly fighting *asuras* or disrupting the *yagnas* of other kings.

Notice the shift from the chariot-riding warrior-god of the *Vedas* to the later insecure king of paradise. This shift happens slowly over a thousand years. Though god, he is inferior to the sage-teachers of the Buddhist and Jain traditions. It reflects a change in society. People did not value kings and merchants who had a lot of wealth and power, but were never happy; they valued wise hermits who possessed nothing yet were always happy.

But, in any great civilisation, every thought has a counter-thought. So it was in India. While some people believed that happiness lay outside wealth, power and family, others argued that happiness can be found within wealth, power and family, provided we discover the latent wisdom hidden within us. New gods emerged to explain this idea. This marked the rise of the Puranic Age, roughly 2,000 years ago, which had its roots in the *Vedas*, but which was very different in spirit, challenging the monastic ways of Buddhism and Jainism.

Puranic stories introduce the Hindu trinity: Brahma, Vishnu and Shiva. Brahma is the creator of all living creatures, including devas and asuras, which is why Indra calls him, 'Grandfather'. But Brahma is not imagined as a wise god. Neither is Indra. Wisdom is embodied in Shiva, but he is a hermit, sitting silently in serene isolation, until the Goddess, Shakti, forces him to open his eyes, marry her, and start a family with her. In that household, Shiva reveals the wisdom of life through song, dance and stories.

Shiva is described as *swayambhu*, one who created himself. Since Indra has a father, Kashyapa, and a mother, Aditi, and a grandfather, Brahma, he is seen as inferior, for one who is born has to experience death. One who is not born does not experience death. Shiva is *swayambhu*. Shakti is *swayambhu*. What about Brahma? No, he is not. We are told he is born of a lotus that rises from the navel of Vishnu, the wise one, who is eternal. When Vishnu sleeps, the world ceases to exist. When Vishnu awakes, the world comes into being. Like Shiva, Vishnu is *swayambhu*. Understandably, there was great rivalry between those who worshipped Shiva and those who worshipped Vishnu, just as those who followed the Buddha and the Jina often had quarrels with those who preferred the Vedic rituals.

These rivalries have shaped Indian thought over the last 2,000 years. Sadly, these rivalries also overshadowed Indra, the mighty god of the *Rig Veda*. Much of the stories were metaphors for deeper philosophical concepts. Through stories, they were made accessible to the common man. Indra was seen as a metaphor for '*indriya*', our sense organs that are enchanted by the world of sight, sound, smell, touch and taste.

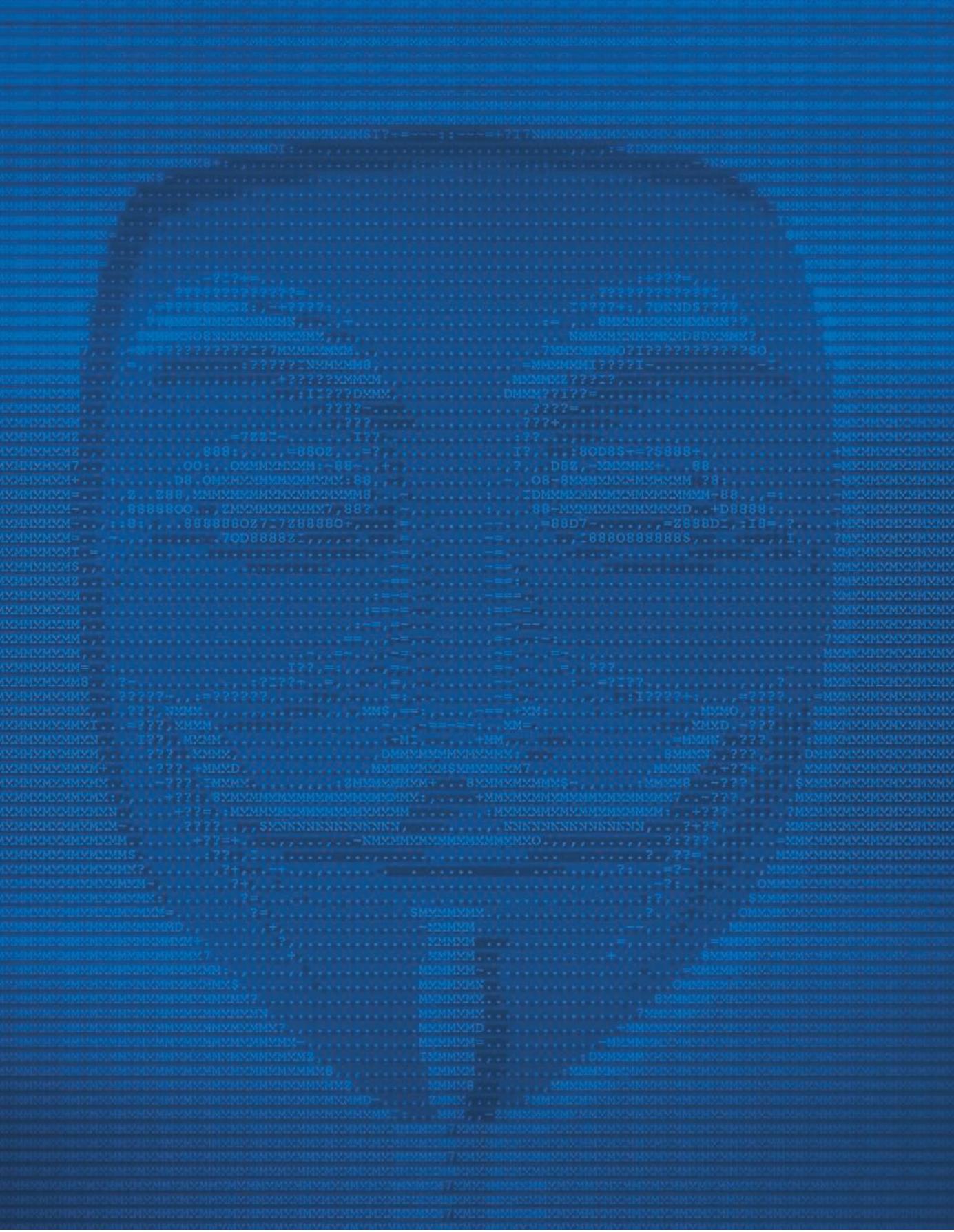
Our senses make us crave things and so we end up constantly battling deprivation and frustration. Thus, we are told, **Indra is within us. He is that part of us seeking conquest and victory and the spoils of war, eternally insecure of competition. He existed 3,500 years ago, maybe earlier. He exists now. He will always exist in every person, boy or girl, man or woman. He will seek the wisdom of sages, and the protection of greater gods, until he becomes wise himself.❶**



ABOUT THE AUTHOR

Devdutt Pattanaik is a writer, illustrator and lecturer of mythology, who draws attention to its relevance in modern times. Based in Mumbai, he has over 30 books, and over 800 articles to his credit. His latest children's books include *The Girl who Chose: Ramayana for Children* (Puffin) and *The Boys who Fought: Mahabharata for Children* (Puffin). To know more, visit www.devdutt.com





HACKERS: CAN THEY BE BEATEN?

The rise of the internet has transformed hacking into an opportunity for crime, activism and political interference.

So who are the hackers and can they be stopped?
Words: Chris Hall

PHOTO: GETTY



THE last few months have been busy for European politics, with Austria, the Netherlands, France and the UK all heading to the polls. Each one of these elections was preceded by fears that hostile powers, acting online, would seek to manipulate the outcome of the elections. These fears came closest to being realised in France, where eventual winner Emmanuel Macron and his En Marche! party were victim to a 9GB leak of emails, just 48 hours before the voting took place. Things are little different across the Atlantic, with four legislative committees, as well as the FBI, investigating alleged Russian influence over the US election, including the hacking of Hillary Clinton's emails. In the UK, hacking was recently in the news when the WannaCry ransomware worm crippled computer systems in 40 NHS hospitals in May. In the wake of each attack, politicians spoke urgently of a need to 'regulate' the internet. Across the West, democracy and freedom are under sustained attack, and at the heart of the battle is the grasp on technology.

Maybe that sounds like hyperbole, or even the stuff of a movie trailer. There are set to be 8.4 billion connected devices in the world by the end of this year – 20 billion by 2020 – and last year, in the US alone, there were more than 1,000 recorded data breaches. Hacking isn't just about pinching passwords any more: the geeks have truly inherited the Earth.

"There's no question that there is more malware now than there has ever been," says David Emms, principal security researcher at antivirus and internet security specialists Kaspersky Labs. "And the volume ▶

is growing massively. We analyse a million objects [of malicious code] per day in our virus lab, and more than 60 per cent of our detections are of code that has never seen before."

CYBER CRIME

Such a proliferation of threats is undeniably concerning, but also hard to grasp. One reason the subject of hacking can feel so nebulous is that the term covers a multitude of sins. Cybercrime attacks can be serious offences such as theft, extortion, espionage, libel or fraud, but they can also be low-level nuisance behaviour. Where this comparison with real-world crime differs is that every hack and every leak can feed into greater crimes.

For example, stolen user data can be bundled up and traded on the dark web (the dark web refers to encrypted sites that cannot be found using standard browsers or search engines), while compromised machines join sprawling botnets to be unwittingly used in bringing down large targets.

Let's take a look at the NHS ransomware attack as an example. It was carried out using tools leaked online by nefarious group the Shadow Brokers. The tools were recognised by the international security community as hailing from the NSA's Equation Group cyberwarfare team. They contained a number of 'zero-day' exploits, which could be used to gain access to computers running Microsoft operating systems from Windows 2000 to Windows 8. The toolkit – known as Eternal Blue – exposed a multitude of vulnerabilities and made it child's play for the perpetrators to spread the WannaCry ransomware around the world.

Where it gets murkier is when you start to consider the motive for the WannaCry attack. It would seem to be financial, yet relatively little cash was paid out – just \$1,26,000 worldwide (this was easy to track, thanks to

Hackers targeted Emmanuel Macron just 48 hours before French voters were due to go to the polls – he still beat his rival Marine Le Pen to become president of France

PHOTOS: GETTY X2



Stolen user data is bundled up and traded on the dark web, while compromised machines join sprawling botnets to be unwittingly used in bringing down large targets

TYPES OF HACK

Do not know your Trojan from your worm? Brush up on your hacker lingo here



VIRUSES AND WORMS

Most malware tends to be either a virus or a worm. The difference comes down to the software's ability to propagate. Like their biological namesakes, computer viruses require a host body, whereas worms can spread from one machine to the next unaided.



DDOS

Short for distributed denial of service, a DDOS attack is basic yet effective.

It works on the principle that, if a website's DNS server can be overwhelmed by traffic requests, the site will crash. Hackers run botnets – networks of zombie computers or devices – to besiege a server from multiple fronts simultaneously.



There are allegations that Russian hackers interfered with the US electoral system. Some claim this led to the defeat of Hillary Clinton in 2016's election

the open nature of the Bitcoin transactions that were used for payments). And the attack was relatively easily halted by a security researcher who inadvertently realised that by registering a domain name found within the malware, he activated a built-in 'kill switch'. This doesn't tally with the sophistication of the tools that were used in the attack, or the capabilities of those alleged to be behind it (some have pointed the finger at North Korea).

So how did we get to a point where hackers can rob and extort with impunity, and – if analysis is to be believed – nations such as Russia or North Korea can interfere in political campaigns? Russian president Vladimir Putin came close to conceding that Russian elements could be behind recent ›



TROJANS

As its name suggests, a Trojan is a form of malware that sneaks into your computer under an innocuous guise (like an email attachment). Its cargo can be any form of malware. A Trojan's specific ability is getting in, then leaving a backdoor open for others to follow undetected.



RANSOMWARE

This subset of malware made the headlines for the WannaCry attack, but has been around since at least 2012. It searches for important files, encrypts them and demands a ransom (usually paid in Bitcoin) for their safe return. In some cases, the ransomware can lock down a machine rather than specific files.



SPEAR-PHISHING

An evolution of phishing (the spelling harks right back to early phone-based hacking, or 'phreaking'), spear-phishing is more direct, and consists of targeted campaigns, usually over email, to spread malware in a particular network or company. The messages sent out would be laden with Trojans.

/THE BIGGEST HACKS IN RECENT MEMORY



MACRON EMAIL LEAK

Just 48 hours before the run-off poll between Emmanuel Macron and Marine Le Pen, a 9GB cache of emails from Macron's En Marche! party was posted on PasteBin, a filesharing platform. They were spread to WikiLeaks. "The attacks were so simple and generic that it could have been practically anyone," France's cybersecurity chief said.

BANGLADESH BANK HEIST

In February 2016, hackers got the login credentials used by Bangladesh Central Bank for the international banking transfer system SWIFT. They tried to transfer \$951m to accounts in Sri Lanka and the Philippines. Most transactions were flagged, but \$101m was removed. A Trojan known as Dridex was used, which hides in MS Word or Excel attachments.



WANNACRY ATTACK

On May 12, 2017, a global ransomware attack affected more than 2,30,000 computers, including PCs in the NHS, FedEx and Deutsche Bahn. The malware was leaked from the NSA, and targeted machines running Windows XP and Windows 2003. The attack yielded just over \$1,26,000 in payments and caused considerable upheaval.



YAHOO! BREACH

In 2016, Yahoo! was forced to confirm that its systems had been breached twice, in 2013 and 2014, resulting in the loss of more than a billion users' personal information, including passwords. The hackers used fake browser cookies that allowed them to dupe the site's login systems. To date, it is the largest loss of customer data by any single company.



CHIPOTLE ATTACK

The Mexican restaurant chain, which has more than 2,250 outlets in the USA, reported that, if you paid with a credit card between March 24 and April 17, 2017, your credit card details had almost certainly been obtained by hackers. The attack vector has not been confirmed, but the malware involved allegedly read the card data directly from the machines as they took payment.



political hacks. "If hackers are patriotically minded, they start to make their own contribution to what they believe is the good fight against those who speak badly about Russia," he said in a recent interview. (Those with longer memories will point out that interfering in the elections of satellite states was a favourite activity of the US during the 1980s – it just wasn't done online.)

One side of the answer is the exposure of people to the internet. As the Internet of Things grows, we are adding 'attack vectors' to our lives. We are opening more and more doors for hackers to walk through. "Smart home technology has not yet been universally adopted, so attackers don't have much to gain from it other than nuisance value," explains Emms. But that may soon change when smart home technology reaches a tipping point, and the weaknesses are there to be exploited.

"Companies who have never had to think about internet security in the context of standalone products wake up to the need for security when they add Internet of Things functionality," says David Harley, a security consultant and chief operations officer for the Anti-Virus Information Exchange Network. Although, he adds, the smart home's sheer scale could also act in its favour.

"Because of the wide diversification of brands, technologies and devices, the scope of an individual attack may be comparatively

When I started, it really was the Wild West out there. And there was an innocence to it. When groups of us met in chatrooms, we did not realise we were creating criminal gangs



'Hactivist' group Anonymous tend to attack religious and political groups, and large corporations. Many members opt to wear the stylised Guy Fawkes mask

restricted." Restricted or not, there is the potential for some creatively unpleasant hacking. "Imagine a ransomware attack linked to your heating system!" says Emms.

So, you don't have to worry about someone hacking into your smart kettle – yet. But that's only because there are easier ways for criminals to get what they want, whether that's by simply buying leaked data, sending out a few thousand phishing emails, or exploiting existing vulnerabilities that go unfixed by users who neglect to update their software.

BLAME GAME

But we can't place all the blame on lazy individuals or companies. The majority of security researchers concur that, without punishment, crime is allowed to flourish.

"It is a myth to think criminals have some magical edge," says Stephen Cobb, senior security researcher at antivirus specialists ESET. "Right now, it appears that way with cyber criminals because of the massive failure of governments to mobilise international law enforcement. How many culprits involved in watershed breaches have been brought to justice? Clearly, not enough to deter new

entrants to the field."

But who are these hackers anyway? The security community is generally cagey about attributing attacks to certain groups or countries, seeing it as the responsibility of law enforcement to act on their pure analysis of the code. Nonetheless, the anonymity offered by the internet makes it hard to be certain. The few major hacking groups that are known to security researchers are the exception, not the rule, and their actual membership can be even harder to pin down.

Cal Leeming gained notoriety as the UK's youngest convicted hacker in 2007. According to Leeming, his natural talent was "given a bit too much freedom." He was carrying out illegal attacks at the age of 12, then, in 2006, he was sentenced for using stolen credit card data to buy £750,000 worth of goods. Now running his own security consultancy for high net worth individuals, he laughs when asked if hackers really fit people's image of them.

"Stereotypes do generally exist for a reason," he says. Still, he doesn't quite live up to these stereotypes, as his childhood hacking was borne of a need to support his family rather than a desire for mischief. "Back when I started, it really was the Wild West out there. And there was an innocence to it. When groups of us met in chatrooms, we didn't really realise we were creating criminal gangs. I used to think the internet should be totally free, no rules, everything goes," he explains. "But we have got to a point where the internet, and anonymity in particular, has brought out the very worst in our culture. It has brought out the best too, but we have become desensitised,

THE BIG PLAYERS

Who are the most notorious hacking groups out there and what do they want?



FANCY BEAR

Also known by a myriad of aliases including Sofacy, APT28 and Pawn Storm, this highly capable group is widely believed to operate with at least the tacit approval of the Russian government. It has claimed responsibility for attacks on NATO, the White House, the French election, the DNC and the German parliament.



EQUATION GROUP

Classed as one of the most advanced threats by security companies, the Equation Group (named for the complexity of its encryption) is commonly believed to be affiliated to the NSA and has been particularly involved in cyber attacks across the Middle East. One such attack was the Stuxnet worm, which destabilised Iranian nuclear centrifuges.



LAZARUS GROUP

This group is known for the attacks on Sony Pictures and the Bangladesh Central Bank in 2014 and 2016, respectively. The Lazarus Group is also thought to have attacked the South Korean government between 2007 and 2013. Specialising in financial attacks and espionage, the group has been linked by researchers and the media to the North Korean regime, albeit not conclusively.



UNITED CYBER CALIPHATE

The UCC, also referred to as the Islamic State Hacking Division, refers loosely to all groups claiming to further the ideology of ISIS. Yet it is not known how coordinated it is with others, such as the Tunisian group that claimed responsibility for an attack on the NHS in February. The group has attacked American, British and Australian targets.



SHADOW BROKERS

One of the newest groups to emerge, Shadow Brokers published leaked hacking tools from the NSA in summer 2016, with the possible assistance of a former military contractor at Booz Allen Hamilton. Little is known about the group's identity or motives, but there is speculation that the leak's main purpose is to send a message of mutually-assured destruction if the US were to retaliate for the group's hacks on the Democratic National Committee in 2015 and 2016.

**FIND
MORE
FREE
MAGAZINES**

FREEMAGS.CC

to how awfully we're treating each other." As an emerging hacker, Leeming lacked guidance but also felt that the law was too heavy-handed. "It has criminalised schoolkid mischief," he says. He cites the tendency of small crimes to turn into bigger ones. "We need people who can interact with those kind of young adults – people who otherwise develop no grasp of ethics or personal responsibility."

However, the general consensus among experts is that hackers and hacking are something we need to accept will never disappear, yet that doesn't mean we have to give up the fight.

"There will always be some level of criminal hacking, but it is possible to improve human behaviour. For example, there's a lot less crime in America and the UK today than there was 25 years ago, and not because all the criminals have gone online," says Cobb.

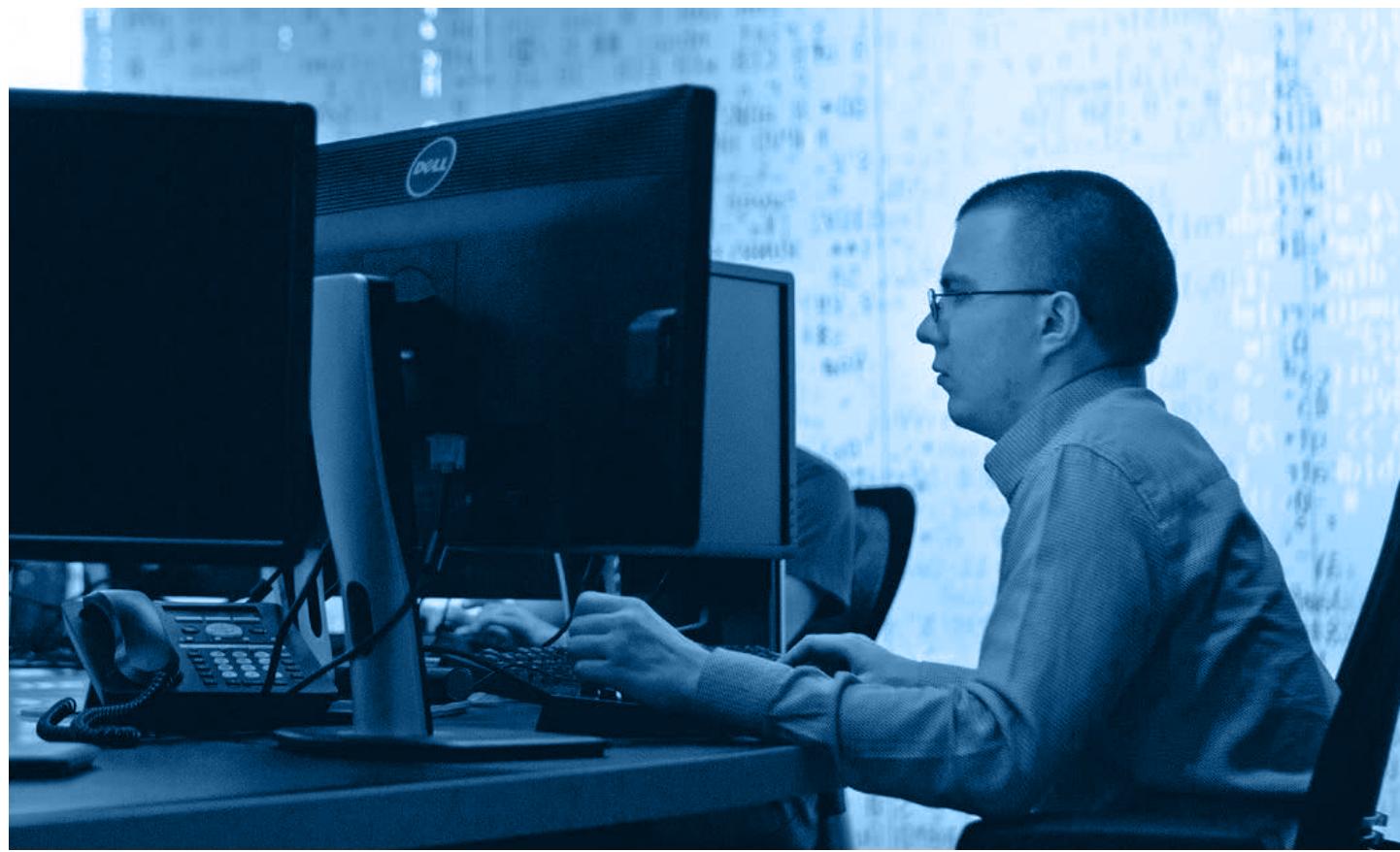
When the diagnosis is as all-encompassing as a global issue like cybercrime, so the prescriptions are going to be pretty far-reaching. For David Emms at Kaspersky, it's an education issue. "Cyber attacks are so often reliant on humans and their mistakes, so big businesses could go a long way towards dealing with the problem by focusing more on a culture of awareness and developing education," he says. "It's like parenting, you can't expect to tell your kids to do something once and they'll never do it again. It's a longer-term process."

However, there's no question that serious vulnerabilities remain. "I think the big tech companies need to take a step back and realise that their future profits are in serious jeopardy if we don't improve cybersecurity across the board," says Cobb. "There are massive tech companies sitting on billions in cash and I would argue a chunk of that cash came from the corner-cutting we have done so far."

But that doesn't mean it's all doom and gloom. It's a glorifying myth, says Harley, to think of it as "genius hackers versus plodding security companies". Instead, if we think of hackers like ordinary criminals and guard against them in the same way, there's no reason why society, including the public, the media, companies and governments, cannot keep cybercrime under control. 

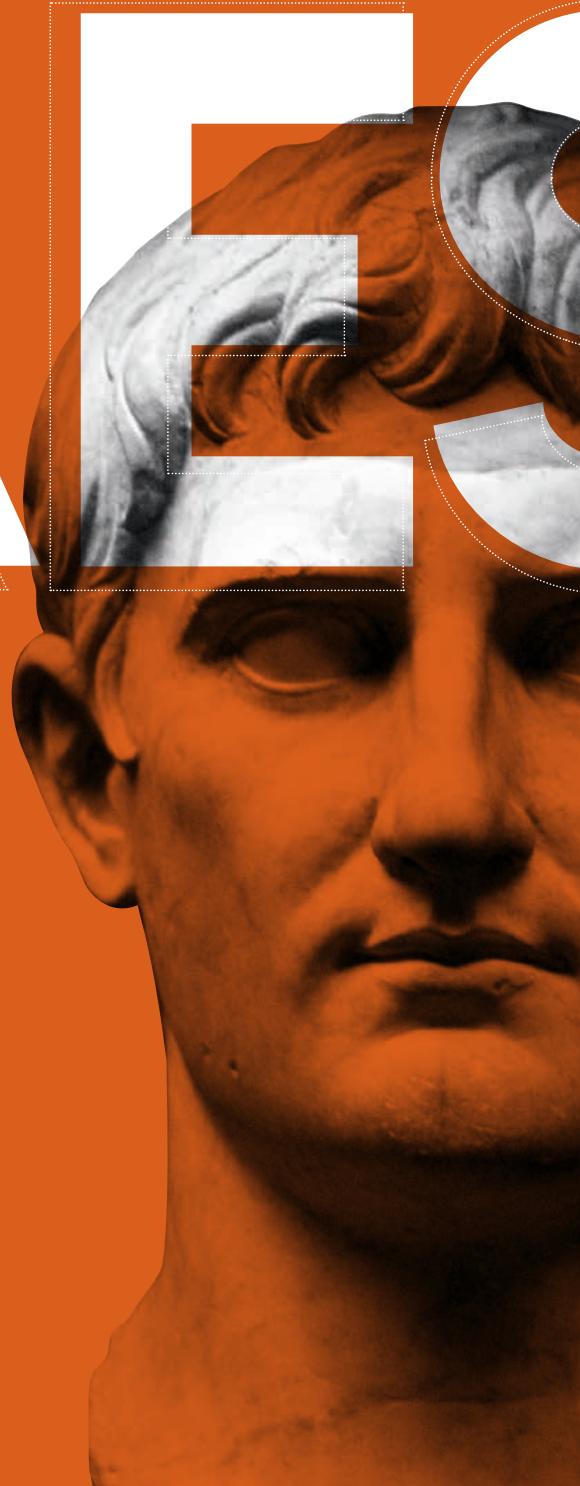
The big tech companies need to take a step back and realise that their future profits are in serious jeopardy if we do not improve cybersecurity across the board

CHRIS HALL is a science and technology journalist who has written for *Esquire*, *Men's Health* and *CQ*.



THE GLORIOUS CAESARS

Rome's first emperors are often decried as tyrannical, sex-mad monsters – but, as **Tom Holland** explains, the likes of Augustus, Caligula and Nero brought peace and stability to the Roman world



Augustus, Caligula and Tiberius, depicted (left to right) in contemporary busts. For all their despotism, Romans thanked their first three emperors for delivering them from the curse of civil war



GETTY/AKG-IMAGES

A

LMOST 2,000 years after his death, Gaius Julius Caesar Augustus Germanicus remains the archetype of a monstrous leader. Caligula, as he is better known, is one of the few characters from ancient history to be as familiar to pornographers as to classicists.

The scandalous details of his reign have always provoked prurient fascination. "But enough of the emperor; now to the monster." So wrote Gaius Suetonius Tranquillus, an archivist in the imperial palace who doubled in his spare time as a biographer of the Caesars, and whose life of Caligula is the oldest extant account that we possess. Written almost a century after the emperor's death, it catalogues a quite sensational array of depravities and crimes. He slept with his sisters! He dressed up as the goddess Venus! He planned to award his horse the highest magistracy in Rome! So appalling were his stunts that they seemed to shade into lunacy. Suetonius certainly had no doubt about this when explaining Caligula's behaviour: "He was ill in both body and mind."

But, if Caligula was sick then, so, too, was his city. The powers of life and death wielded by an emperor would have been abhorrent to an earlier generation. Almost a century before Caligula came to power, his great-great-great-uncle had been the first of his dynasty to establish an autocracy in Rome. The exploits of Gaius Julius Caesar were as spectacular as any in his city's history: the permanent annexation of Gaul, as the Romans called what today is France, and invasions of Britain and Germany. He achieved his feats, though, as a citizen of a republic – one in which it was taken for granted by most that death was the only conceivable alternative to liberty.

When Julius Caesar, trampling this presumption, laid claim to a primacy over his fellow citizens, it resulted first in civil war and then, after he had crushed his domestic foes as he had earlier crushed the Gauls, in his assassination. Only after two more murderous bouts of slaughtering one another were the Roman people finally inured to their servitude. Submission to the rule of a single man had redeemed their city and its empire from self-destruction – but the cure itself was a kind of disease.



Bottom left: A detail from the Ara Pacis, an altar dedicated to the goddess of peace. It was built under Augustus who, having butchered his way to power, recast himself as a prince of peace

Below:
A first-century BC coin shows Augustus wearing a laurel wreath – symbol of military victory. "No sooner had he seized control of the world," says Tom Holland, "than his face was being minted everywhere"

Their new master called himself Augustus: the 'Divinely Favoured One'. The great-nephew of Julius Caesar, he had waded through blood to secure the command of Rome and her empire – and then, once his rivals had been dispatched, had coolly posed as a prince of peace. As cunning as he was ruthless, as patient as he was decisive, Augustus managed to maintain his supremacy for decades, and then to die in his bed. Key to this achievement was his ability to rule with, rather than against the grain of, Roman tradition. By pretending that he was not an autocrat, he licensed his fellow citizens to pretend that they were still free. A veil of shimmering and seductive subtlety was draped over the brute contours of his dominance.

Over time, though, this veil became increasingly threadbare. On Augustus's death in AD 14, the powers that he had accumulated over the course of his long and mendacious career stood revealed, not as temporary expediencies but rather as a package to be handed down to an heir. His choice of successor was a man raised since childhood in his own household, an aristocrat by the name of Tiberius. The many qualities of the new Caesar, which ranged from exemplary aristocratic pedigree to a track record as Rome's finest general, had counted for less than his status as Augustus's adopted son – and everyone knew it.

A DISEASED AGE

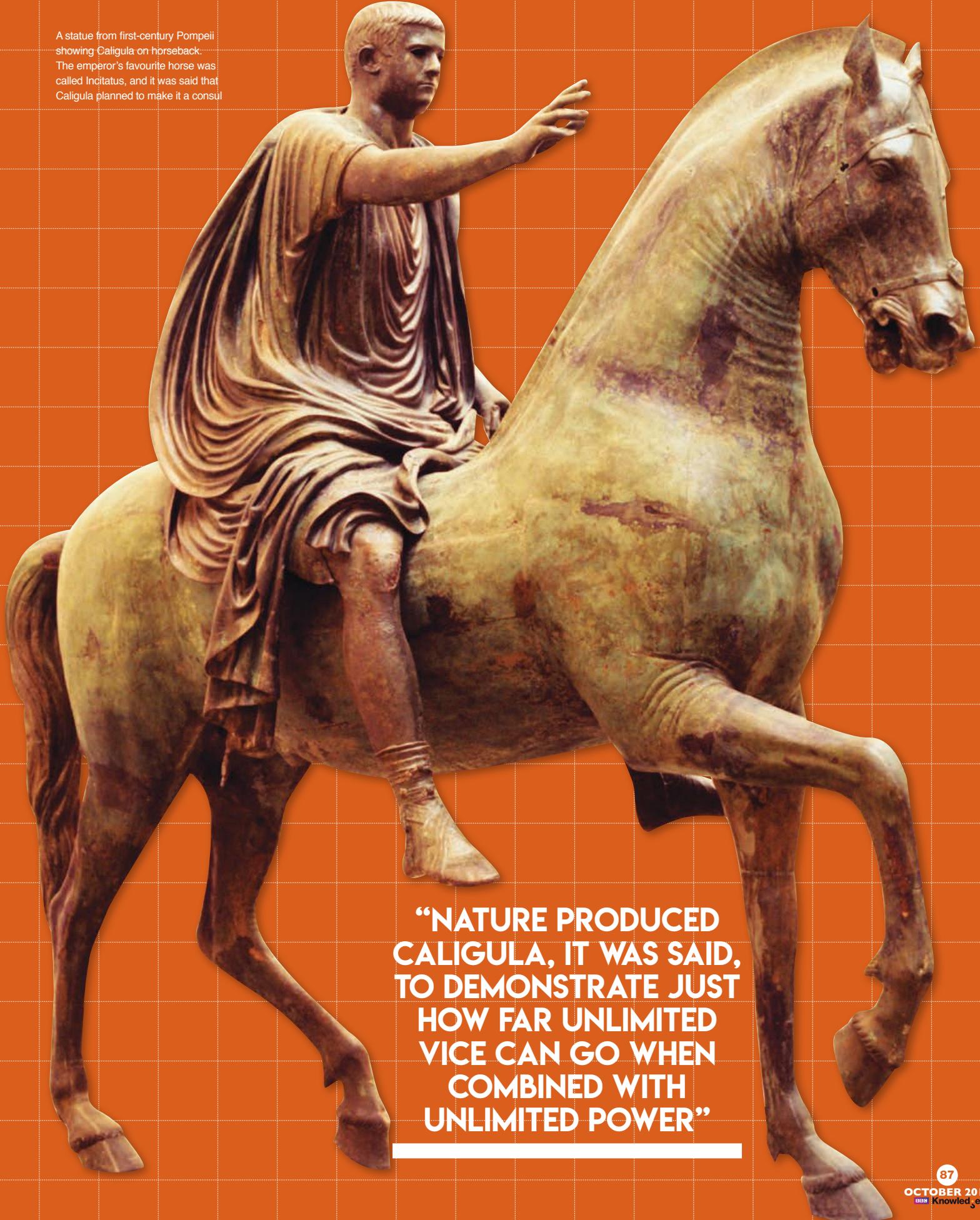
Tiberius, a man who, all his life, had been wedded to the virtues of the vanished republic, made an unhappy monarch; but Caligula, who succeeded Tiberius after a reign of 23 years, was unembarrassed.

That he ruled the Roman world by virtue neither of age nor of experience but as the great-grandson of Augustus

bothered him not the slightest. "Nature produced him, in my opinion, to demonstrate just how far unlimited vice can go when combined with unlimited power." Such was the obituary delivered on Caligula by Seneca, a philosopher who had known him well. The judgement, though, was not just on Caligula, but also on Seneca's own peers, who had cringed and grovelled before the emperor while he was alive, and on the Roman people as a whole. The age was a rotten one: diseased, debased, degraded.

Or so many believed. Not everyone agreed. The regime established by Augustus would never have endured had it failed to offer what the Roman people had come so desperately to crave after decades of civil war: peace and order. The vast agglomeration of provinces ruled from Rome, stretching from the North Sea to the Sahara and from the Atlantic to the Fertile Crescent, reaped the benefits as well. Three centuries on, when the nativity of the most

A statue from first-century Pompeii showing Caligula on horseback. The emperor's favourite horse was called Incitatus, and it was said that Caligula planned to make it a consul



**“NATURE PRODUCED
CALIGULA, IT WAS SAID,
TO DEMONSTRATE JUST
HOW FAR UNLIMITED
VICE CAN GO WHEN
COMBINED WITH
UNLIMITED POWER”**

celebrated man born in Augustus's reign – Jesus – stood in infinitely clearer focus than it had done at the time, a bishop named Eusebius could see in the emperor's achievements the very guiding hand of God. "It was not just as a consequence of human action," he declared, "that the greater part of the world should have come under Roman rule at the precise moment Jesus was born. The coincidence that saw our Saviour begin his mission against such a backdrop was undeniably arranged by divine agency. After all, had the world still been at war, and not united under a single form of government, how much more difficult would it have been for the disciples to undertake their travels?"

THE PRICE OF PEACE

Eusebius could see, with the perspective provided by distance, just how startling the feat of globalisation brought to fulfilment under Augustus and his successors was. Though the methods deployed to uphold it were brutal, the sheer immensity of the regions pacified by Roman arms was unprecedented.

"To accept a gift," went an ancient saying, "is to sell your liberty." Rome held her conquests in fee, but the peace that she bestowed upon them in exchange was not necessarily to be sniffed at. Whether in the suburbs of the capital itself – booming under the Caesars to become the largest city the world had ever seen – or across the span of the Mediterranean, united now for the first time under a single power, or in the furthermost corners of an empire, the *pax Romana* brought benefits to millions.

Provincials might well be grateful. "He cleared the sea of pirates, and filled it with merchant shipping." So enthused a Jew from the Egyptian metropolis of Alexandria, writing in praise of Augustus. "He gave freedom to every city, brought order where there had been chaos, and civilised savage peoples." Similar hymns of praise could be – and were – addressed to Tiberius and Caligula. The depravities for which these men would become notorious rarely had much impact on the wider world. In the provinces, it mattered little who ruled as emperor – so long as the centre held.

Yet, even in the empire's farthest reaches, Caesar was a constant presence. How could he not be? "In the whole wide world, there is not a single thing that escapes him." An exaggeration, of course – yet a due reflection of the fear and awe that an emperor could hardly help but inspire in his subjects. He alone had command of

Top right: An etching shows the emperors Claudius (left) and Tiberius, with their wives Agrippina and Livia, respectively

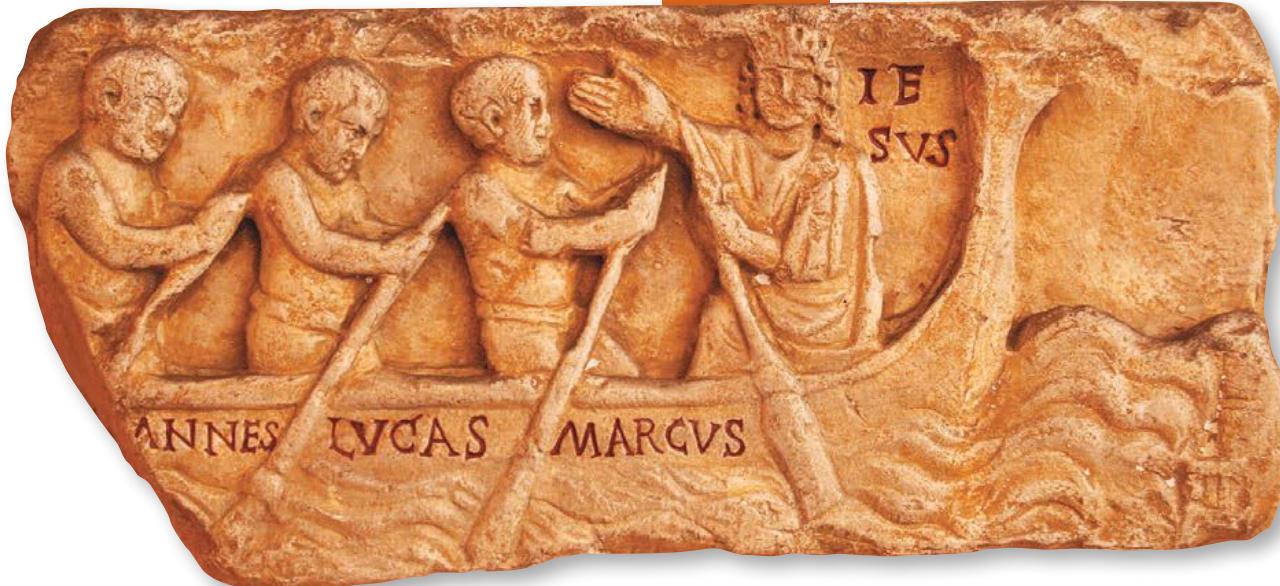
Below:
A fourth-century relief shows Jesus with three apostles. One bishop of that era claimed that the Augustinian peace hastened the spread of Christianity



Rome's monopoly of violence: the legions and the menacing apparatus of provincial government that ensured that taxes were paid, rebels slaughtered and malefactors thrown to beasts or nailed up on crosses. An emperor did not constantly need to be showing his hand for dread of his arbitrary power to be universal across the world.

Small wonder that the face of Caesar should have become, for millions of his subjects, the face of Rome. Rare was the town that did not boast some image of him: a statue, a portrait bust, a frieze. Even in the most provincial backwater, to handle money was to be familiar with Caesar's profile. Within Augustus's own lifetime, no living citizen had ever appeared on a Roman coin – but no sooner had he seized control of the world than his face was being minted everywhere, stamped on gold, silver and bronze. "Whose likeness and inscription is this?" Even an itinerant street-preacher in the wilds of Galilee, holding up a coin and demanding to know whose face it portrayed, could be confident of the answer: "Caesar's."

No surprise, then, that the character of an



emperor – his achievements, his relationships and his foibles – should have been topics of obsessive fascination to his subjects.

“Your destiny it is to live as in a theatre where your audience is the entire world.” This was the warning attributed by one Roman historian to Maecenas, a close confidant of Augustus. Whether or not he really said it, the sentiment was true to his master’s theatricality. Augustus, lying on his deathbed, was reported by Suetonius to have asked his friends whether he had played his part well in the comedy of life; assured that he had, he demanded their applause as he headed for the exit.

A good emperor had no choice but to be a good actor – as, too, did everyone else in the drama’s cast. Caesar, after all, was never alone on the stage. His potential successors were public figures by virtue of their relationship to him. Even the wife, the niece or the granddaughter of an emperor might have her role to play. Get it wrong and she was liable to pay a terrible price, but get it right and her face might appear on coins alongside Caesar’s own.

No household in history had ever before been so squarely in the public eye as that of Augustus. The fashions and hairstyles of its most prominent members, reproduced in exquisite detail by sculptors across the empire, set trends from Syria to Spain. Their achievements were celebrated with spectacularly showy monuments, their scandals repeated with relish from seaport to seaport. Propaganda and gossip, each feeding off the other, gave the dynasty of Augustus a celebrity that became, for the first time, continent-spanning. Time has barely dimmed it. Two millennia on, the west’s prime examples of tyranny continue to instruct and appal.

“PROPAGANDA AND GOSSIP, EACH FEEDING OFF THE OTHER, GAVE THE DYNASTY OF AUGUSTUS A CELEBRITY THAT BECAME CONTINENT-SPANNING”

THE FIRST FIVE ROMAN EMPERORS

AUGUSTUS

(63 BC–AD 14, emperor from 27 BC) Born Gaius Octavius, his adoption by his great-uncle Julius Caesar left him with a commanding name and fortune. By his mid 30s, he enjoyed an unprecedented dominance over the Roman world. In 27 BC, he took the title Augustus: ‘Divinely Favoured One’. By the time of his death, he had established an autocracy secure enough to survive as long as the empire itself.

CALIGULA

(AD 12–41, emperor from AD 37)

Called Gaius, as a young boy he was nicknamed ‘Caligula’ (‘little boots’) by soldiers serving under his father. “I am rearing a viper,” said Tiberius, and so it proved. On becoming emperor, Caligula’s tastes for theatricality and hurting people fuelled attacks on the authority of the Senate. Even so, when he was assassinated by his own guards in AD 41, his death was widely mourned.

CLAUDIUS

(10 BC–AD 54, emperor from AD 41)

Tiberius’s nephew was prone to twitching and stammering, which hindered his political progress. He became Caesar when his nephew Caligula was murdered. Though widely despised as being under the thumb of women and freedmen, he proved an effective emperor, invading Britain and commissioning a new port for Rome. His death was believed to have been caused by his wife (and niece), Agrippina.

NERO

(AD 37–68, emperor from AD 54)

Known initially as Domitius, the son of Agrippina was adopted by Claudius; he later had his mother and wife murdered. He refined Caligula’s policy of appealing over the heads of the senatorial elite to the mass of the people; the more murderous his regime became, the more his showmanship flourished. Faced with rebellion, he committed suicide in AD 68 – marking the end of the Julio-Claudian dynasty.

THE EXHAUSTION OF CRUELTY

“Nothing could be fainter than those torches which allow us not to pierce the darkness but to glimpse it.” So wrote Seneca, shortly before his death in AD 65. The context of his observation was a shortcut that he had recently taken while travelling along the Bay of Naples, down a gloomy and dust-choked tunnel. “What

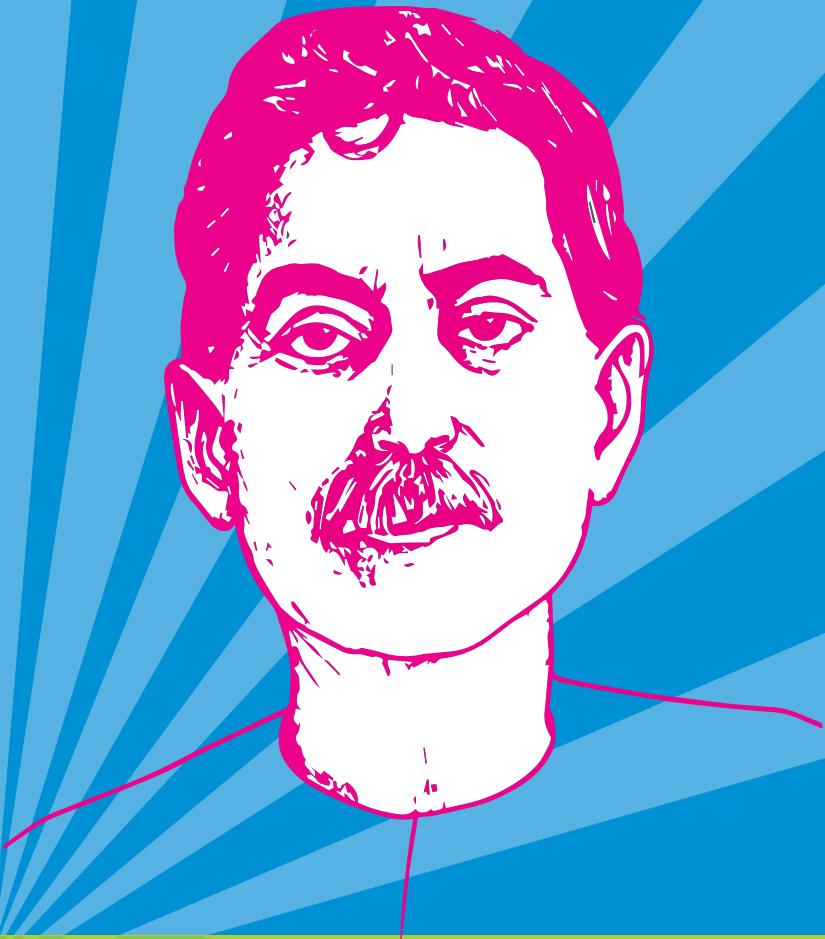
a prison it was, and how long. Nothing could compare with it.”

As a man who had spent many years observing the imperial court, Seneca knew all about darkness. He certainly had no illusions about the nature of the regime established by Augustus. Even the peace that it had brought the world, he declared, had ultimately been founded upon nothing more noble than “the exhaustion of cruelty.” Despotism had been implicit in the new order from its beginning.

Yet what he detested, Seneca also adored. Contempt for power did not inhibit him from revelling in it. The darkness of Rome was lit by gold. Looking back to Augustus and his heirs from 2,000 years on, we, too, can recognise – in their mingling of tyranny and achievement, sadism and glamour, power-lust and celebrity – an aureate quality such as no dynasty since has ever quite managed to match.

“Caesar is the state.” How this came to be so is a story no less compelling, no less remarkable and no less salutary than it has ever been these past 2,000 years.

TOM HOLLAND is a presenter on BBC Radio 4’s *Making History*.



Author and historian
URVASHI BUTALIA details
the life of one of India's
greatest writers

PREMCHAND

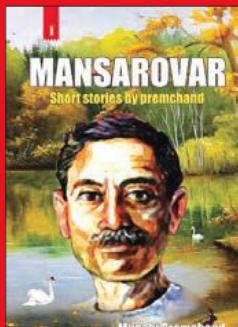
T was in school, many, many years ago, that I first came across Premchand. One of his books, *Gaban* (embezzlement), was on our syllabus, and I remember reading it and being filled with a great sympathy for Ramanath, the protagonist, and his wife Jalpa, and thinking about how societal pressure and expectations push people into taking what can be disastrous steps in their lives. I did not know at the time that I was reading a story by someone who is considered to be among India's top writers.

It also came as a discovery to me that Premchand's name wasn't really Premchand. Although this was the name he chose as his writerly pseudonym, his birth name was Dhanpat Rai and, later in life, an uncle of his gave him the nickname Nawab. In his early writing career, Premchand wrote under the name Nawab Rai and, later, he became Premchand, the name that was to stay with him all his life and beyond.

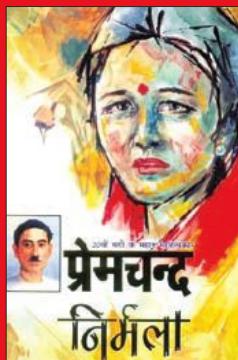
EARLY LIFE & INFLUENCES

Premchand, who wrote initially in Urdu and then turned to Hindi, did not come from a literary family. His father was a post office clerk and he lost his mother early on in life, something that affected him deeply. Premchand began his education in a *madrasa* in Lalpur, a village near his birthplace Lamahi, and it was here that he learnt Urdu and Persian from a *maulvi*. This early influence was to stay with him throughout his writing life, and echoes of these two languages resonate through much of his work. Later, he went to a missionary school where he added English to his repertoire of languages. During his writing life, he wrote some 250 short stories and several novels and also translated some foreign books he had read into Hindi. One or two of his early works have been lost, and many critics of his work feel he really came into his own as a writer with his later works, in particular some of his novels (*Nirmala*, *Sevasadan*, *Godaan*) that have, over time, come to acquire the status of classics.

As a young boy, Premchand led a somewhat lonely life. Some time after his mother's death, his father remarried, and he remained greatly preoccupied with his work. Premchand's sister, too, was married early, so, for much of his young life, he was left to his own devices. Over time, he developed an interest in and love for stories. It is said that, at the local shop, he would often listen to people recounting stories from *Tilisme Hoshruba*, a collection of fantastic and fantasy stories that were told and retold to much appreciation and applause in the towns and cities of Uttar Pradesh in the early 20th century. In order to earn money, Premchand worked for a bookseller, and this increased his exposure to and familiarity with books.



WITHOUT PREMCHAND'S WORK, OUR UNDERSTANDING OF SOCIAL ISSUES IN NORTHERN INDIA, IN PARTICULAR IN UTTAR PRADESH, OR THE UNITED PROVINCES, AT THE TIME, WOULD HAVE BEEN INCOMPLETE



Like many young men at the time, Premchand was married early – when he was only 15. It is said that he was not too happy in the marriage – we know very little of what his wife felt – and was more interested in pursuing his studies. This was not easy – after his father's death, he wasn't able to get admission to the college of his choice in Varanasi. After trying for an alternative, and not succeeding, he had to break off his studies for a while. Later in life, he remarried, this time marrying a young widow, something that made him the target of much criticism.

Although it must have been quite a blow to him to not be able to continue his studies, he did not lose hope, and, soon after, took up jobs here and there to earn an income. He lived very simply, and even sent some money from his earnings to his family but, over time, he was unable to stay out of debt. The story goes that he went to a bookshop to sell some books in order to get some money and, there, met the headmaster of a school, who offered him a job. Later, he moved on to teaching in a government school. Throughout, his interest in reading continued and he also began to write, producing short novels and stories.

MIRRORING THE MILIEU

Much of his young life was spent in moving around from place to place, with his family or in search of work or education. In this way, Premchand came into contact with the world of rural and semi-urban Uttar Pradesh. It was a heady and exciting moment in India's history at the time. Nationalism was very much in the air, and the movement for independence from the British was gathering strength. Premchand became very invested in these political developments, and much of this is reflected in his writing.

But there were also other things that disturbed him as a writer. He was concerned about the situation of women and their suppression by the forces of patriarchy, and this concern is evident in the way he creates his women characters. He was angry at the ways in which temple priests, using religion as a cover, sexually exploited women, and his first novella, *Asrar-e-Mahabid*, addresses this issue. This work was also serialised in a local magazine, *Avaz-e-khalk*, in Kanpur, the city in which he was living when he wrote it. It was during this time that he also began writing for another local magazine, *Zamana*. He wrote articles and stories, several of which showed his commitment to the nationalist cause and his criticism of what he felt were political strategies that were too moderate.

Zamana also published Premchand's first collection of short stories, *Saz-e-Watan*. As the title indicates, the stories in this

collection – there were four in all – were nationalistic in tone, and supported the struggle for independence. Because of this, the British rulers banned the book, something they often did to stifle criticism and to prevent nationalistic voices from reaching the public. The collector of Hamirpur district, where Premchand was at the time, had a raid conducted on his house and copies of the book found there were seized and later burned. Until this time, Premchand had been writing under the name of Nawab Rai, and it was now that he turned to what became the name he is now recognised by – Premchand.

THE LANGUAGE OF LITERATURE

Language was a major issue for Premchand. Writers often say that they do not choose the language they write in, it is the language that chooses them. Because of his early education in Persian, and because Urdu was the literary language of the time, especially in the towns and cities of Uttar Pradesh in which Premchand spent much of his life, this was the language he chose to write in. But, in the early 20th century, as Urdu came to be increasingly associated with Muslims and pressure mounted for Hindi to be used as the language of north India, Premchand began to write in Hindi. Historian Sumit Sarkar, who has chronicled many historical developments in the making of modern India, suggests that this switch could have been because of the difficulty of finding publishers in Urdu.

Premchand's new work, then, was in Hindi, but he also rendered some of his existing writings into Hindi. *Sevasadan*, one of his major works, a large, sprawling social novel, was originally written in Urdu as *Husn-e-Bazar*, but was published first in Hindi and then in Urdu (it is said to have been inspired by Thackeray's *Vanity Fair*).

AN IMPRESSIVE REPERTOIRE OF WORK

By this time, sometime in the 1920s, his writing was in full flow. Although he worked full time, he also managed to write alongside, building up what was to become a formidable repertoire of work. Women figured prominently in his work, and several of them can be seen trying to build their own lives, fighting circumstances and taking bold steps that were unusual for the time. The protagonist in *Sevasadan*, for example, is a housewife who goes on to become a courtesan, turning the sexual slavery of marriage into a different kind of sexual slavery but one for which she is paid. Throughout his work, women

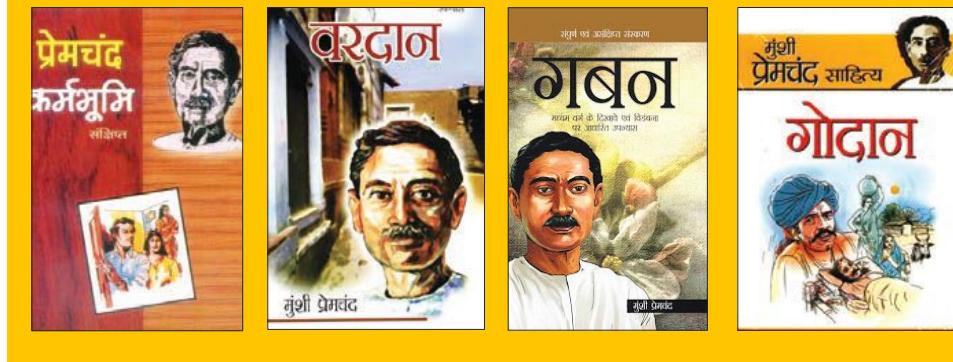
living more 'traditional' lives provide a mirror to those attempting to escape those lives – both effectively being shown as two sides of the same coin.

Equally much of Premchand's work focused on the social conditions of rural and small town India. His last complete work, and his most important one, *Godaan* (The Gift of a Cow) tells the story of Hori, a poor, honest peasant who wishes to have a cow and who falls repeatedly into debt in his attempt to fulfill this wish of his. *Godaan* is a story that reflects the social realities of the time, its focus on caste and on issues such as

incomplete.

Premchand did not only confine himself to writing short stories and novels and articles. In many ways he was as much of a writer as an editor. He set up a publishing house called Saraswati Press in Varanasi and also edited two magazines, *Hans* and *Jagaran*. While neither of them made any money, *Hans* went on to become a much respected space where new writers were privileged to be published. Later it died out, but was then revived by other, more contemporary writers. Premchand's interests were wide, and he also dabbled in cinema, travelling to Mumbai to work in Hindi cinema. He wrote a script for a film about the labouring classes, its release was stayed by the courts, and it was then banned because factory owners protested that it would encourage the labouring classes to revolt. This aspect of his career was short-lived though and he soon returned to the world of writing, which is what he loved most.

BOOKS BY PREMCHAND



widowhood, respectability for women, the village panchayat and more. In time, it was to become one of the great classics of Indian literature. In its reflection of the social realities of the time, *Godaan* acted as an essential part of the histories of that time, providing, through the realistic depiction of local life, the dimension that history, through its focus on documentation and evidence, was unable to show. Without Premchand's work, our understanding of social issues in northern India, in particular in Uttar Pradesh, or the United Provinces, at the time, would have been

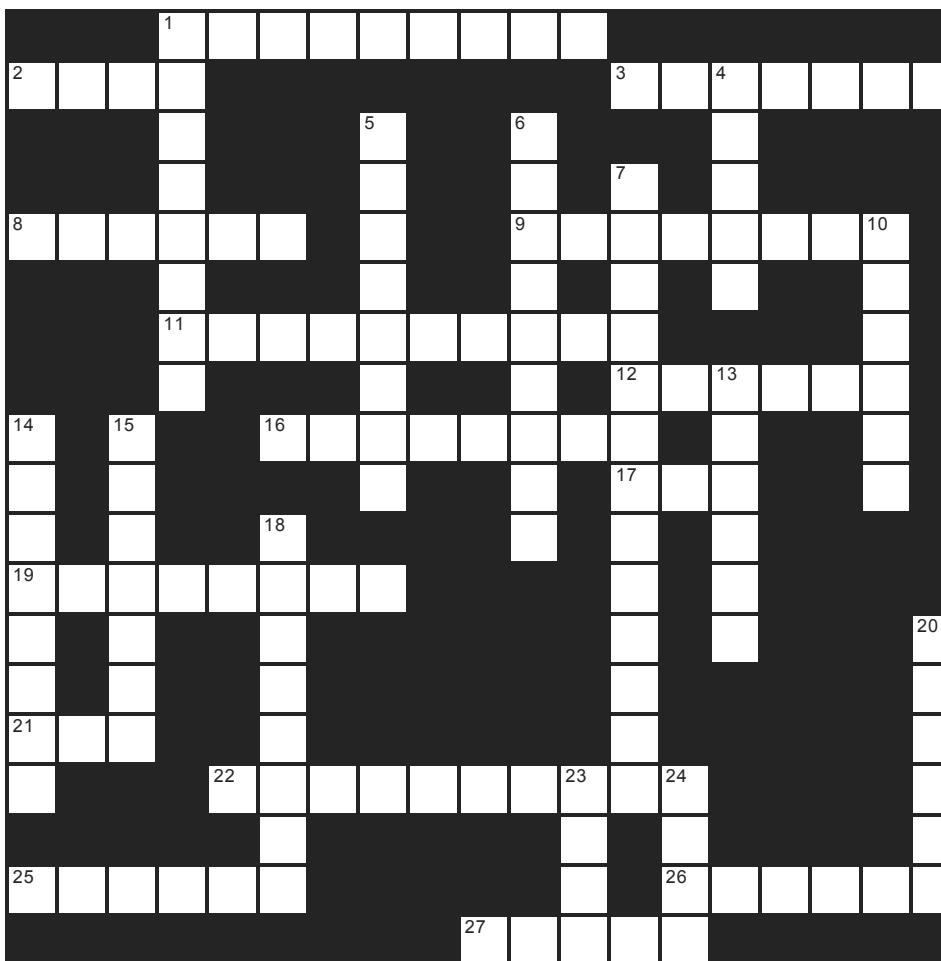
In time, Premchand came to be seen as one of the most important writers of our time. His contribution to literature in Hindi and Urdu is evident in the works of so many writers who came after him and continues to resonate in the many books that populate the world of literature in these two languages. Some members of his own family – his sons and his grandchildren – also took to writing, so the legacy was passed on through the generations. For a writer who began life in modest circumstances and who had to struggle to study, and then to be able to write, this is no mean achievement. ☺

URVASHI BUTALIA is the director and co-founder of Kali Women, India's first feminist publishing house. 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

CROSSWORD NO. 40



Across

- 1 See 10 Down
- 2 Captain of the Enterprise in the pilot of *Star Trek: The Original Series* (4)
- 3 Ac & 15 Dn She plays the roles of multiple clones in *Orphan Black* (7,7)
- 4 The main antagonist of the *Terminator* franchise (6)
- 5 Laurence Fishburne in *The Matrix* (8)
- 6 Jodie Whittaker will play the role of the ____ Doctor in *Doctor Who* (10)
- 7 Author who wrote the novelization based on *Fantastic Voyage*'s screenplay (6)
- 8 *Minority Report*'s specialized police department (8)
- 9 *Star Trek: Deep Space Nine*'s changeling (3)
- 10 In *Back to the Future* Dr Emmett Brown modifies this sports car to build his time machine (8)
- 11 Daisy Ridley's character's name in *Star Wars: The Force Awakens* (3)
- 12 Blade Runner's bioengineered beings (10)
- 13 Matthew McConaughey's character's name in *Interstellar* (2,4)
- 14 Alien race that appears in *Edge of Tomorrow* (6)
- 15 Alliance of species that attack Earth in *Star Trek: Enterprise* (5)

Down

- 1 Malcolm Reynolds' ship in *Firefly* (8)
- 2 Fred Johnson runs this station on *The Expanse* (5)
- 3 *Stranger Things* is set in this decade (8)
- 4 D in *Doctor Who*'s TARDIS (9)
- 5 Daniel Jackson's profession in *Stargate SG-1* (13)
- 6 Dn & 1 Ac Director of *E.T. the Extra-Terrestrial* (6,9)
- 7 Sci-fi film starring Will Smith loosely based on one of Asimov's short story collections (1,5)
- 8 Sci-fi sitcom created by Rob Grant and Doug Naylor (3,5)
- 9 See 3 Across
- 10 Farscape's Aeryn Sun is a member of this species (8)
- 11 Cybernetic race that appears in *Battlestar Galactica* (6)
- 12 G'kar's home planet and race on *Babylon 5* (4)
- 13 Darth Vader's mother (4)

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!

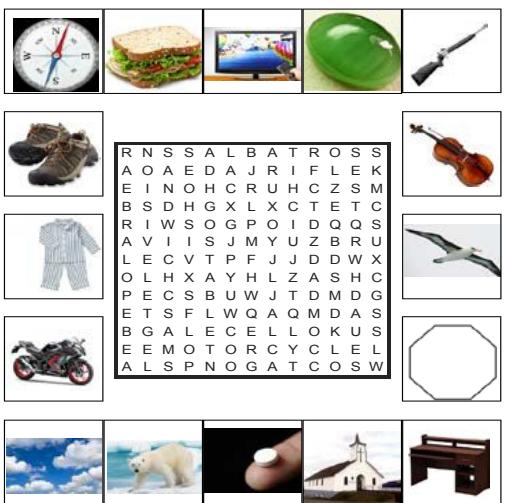
SOLUTION OF CROSSWORD NO. 38

A	K	R	P	C	C	T
A	D	H	E	R	E	N
H	E	R	E	N	T	O
V	E	R	N	A	C	U
R	E	N	A	C	U	L
G	E	T	S	O	N	A
E	T	S	O	N	M	I
E	D	Y	V	N	T	A
G	A	R	N	I	S	P
N	S	A	J	I	N	E
E	S	C	A	R	G	E
W	T	O	T	H	O	E
D	E	M	I	O	V	R
R	O	G	N	E	V	P
K	E	R	N	E	E	N
D	S	E	S	N	N	R

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.



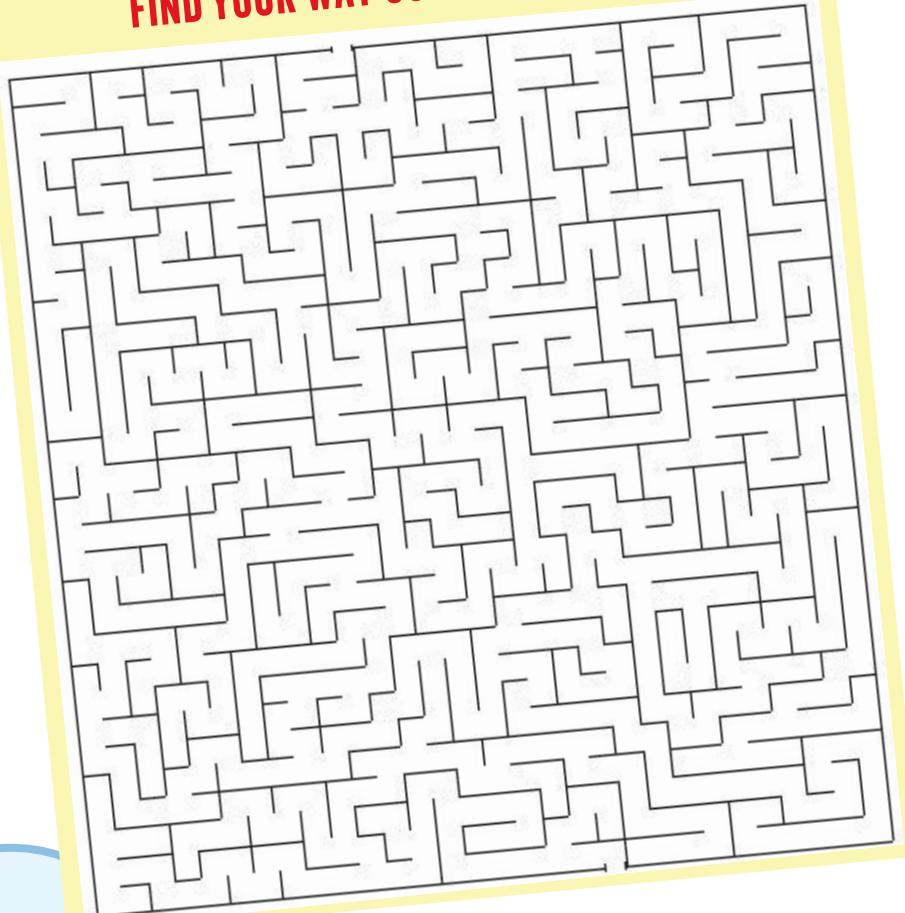
SCRAMBLE

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.

ESEGE	*	*	*	*
LAMER	*		*	
IMSULT	*		*	
EKTUBC	*		*	

Share our similarities, ___ our differences.
- M. Scott Peck (9)

FIND YOUR WAY OUT OF THE MAZE



HEAD & TAIL

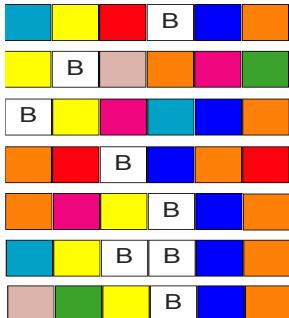
Look at the clue to fill the blank in the form of a compound word. The second part of the answer is the first part of the next answer, etc.

Tomato	Love
Fruity dessert	
Spend unwisely	
Sporting visitors	
Esprit de corps	
Carpenter's tool	
Utmost effort	Best

ENIGMA CODE

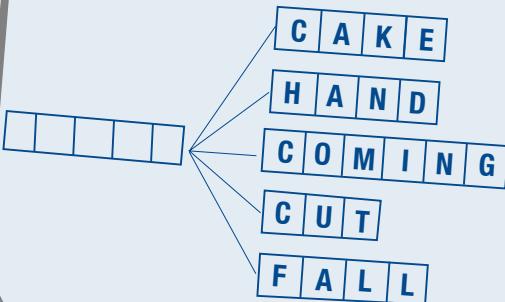
Each colour in our code represents a letter. When you have cracked the code, you will be able to make seven words. The clue to the first word is given to help you get started.

The clue: Take a chance



DOUBLE BARRELLED

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



BRAIN TEASERS

- 1) Can you decipher this dingbat ?
THOUGHTAN
- 2) It runs and runs but can never flee.
It is often watched, yet never sees.
When long it brings boredom,
When short it brings fear.
What is it?
- 3) $3, 3 = 3$
 $6, 2 = 5$
 $10, 5 = 4$
 $21, 3 = ?$
What is the missing number?
- 4) Solve the letter equation given below:
 $2 = H$ are $B T O$
(Hint: Proverb)
- 5) My shirt has 5 buttons, my cardigan has 2 buttons and my suit jacket has no buttons. How many buttons do my trousers have?

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. Card game similar to rummy

--	--	--

2. Overcharged or swindled

--	--

3. Evil-minded

--	--	--

4. Fruit of the oak tree

--	--

5. Public declaration

--	--	--

6. Ineffectual or pointless

--	--	--

FU	CAN	OL	ES	ORN	FLEE
LEV	LE	AS	IF	MA	TI
ENT	TA	TO	CED	MAN	AC

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) Who was the first Chairman of the Council of People's Commissars of the Soviet Union?
a) Stalin
b) Khrushchev
c) Lenin
- 2) How many Wimbledon titles has Roger Federer won till date?
a) Eight
b) Ten
c) Six
- 3) Who was the second person to set foot on the moon?
a) Buzz Aldrin
b) Rakesh Sharma
c) Neil Armstrong
- 4) In which Shakespeare play does the "All The World's a Stage" monologue appear?
a) Julius Caesar
b) Macbeth
c) As You Like It
- 5) What was Tokyo's old name?
a) Nippon
b) Edo
c) Kyoto
- 6) What is Google's video chat app called?
a) Allo
b) Plus
c) Duo
- 7) Which protein forms the main structural constituent of hair and nails?
a) Keratin
b) Opsin
c) Gluten

BBC Knowledge Quiz: 1. (a) Lemur, 2. (a) Egret, 3. (a) Duo, 4. (a) Buzz Aldrin, 5. (a) As You Like It, 6. (b) Edo, 7. (a) Kyoto

Pick & Choose: 1. Canasta, 2. Freed, 3. Malevolent, 4. Fuite, 5. Marifette, 6. Fuite

Brain Teasers: 1. An afterthought, 2. TIME, 3. 9 Divide the length of the word by the second number then add, 4. 2 = Heads first number are greater than One, 5. 2 buttons: 10 minus the length of the word.

Double Barrelled: Short

Enigma Code: Gamble, Absent, Banquet, Embroid, Enable,

Head & Tail: Love-Apple-Fritter-Away-Team-Spirit-Level-Best

Scramble: Geeze, realm, ilmus, boudet. Answer: Share our similarities, celebrate our differences. - M. Scott Peck

Picture Search: Allsorts, cell, church, clouds, compasses, desks, jade, motorcycle, octagon, polar bear, pajamas, rifle,

Solutions: Short

COMING WITHIN
1,012 MILES
of Saturn's clouds
(1,628 kilometres)

PASSING THROUGH A GAP
1,500 MILES WIDE
(2400 kilometres)

5 PASSES
THROUGH SATURN'S
UPPER ATMOSPHERE

ONE FINAL PLUNGE
INTO SATURN
(September 15, 2017)



22 ORBITS
IN TOTAL

MPH TOP SPEED
76,806
RELATIVE TO SATURN
(123,608 kph)

4 PASSES
THROUGH SATURN'S
intermost ring (D ring)

ONE MINUTE FROM
(atmosphere entry)
TO LOSS OF CONTACT

CASSINI

(October 15, 1997 – September 15, 2017)

WORDS: MOSHITA PRAJAPATI

Cassini, the exploratory spacecraft, is set to plunge to its death on September 15, 2017. Its demise will mark the end of one of the most successful space exploratory missions in human history.

The \$1.5bn machine will be seen hurtling at a speed of 113,000km/h onto Saturn's surface, where it will be broken into a million pieces, the frictional heat vaporizing its many components beyond recognition. Given its enduring significance in space exploration history, it seems a sad way to go. Cassini was introduced to the world on October 15, 1997, when it was launched into space to orbit around Saturn, one of the gaseous giants in our Universe. During its orbital period around Saturn and flybys around Jupiter and Venus, Cassini has clicked and sent back an astounding 400,000 photos – all of which have helped us better understand the planets in our little corner of the vast space that is the Universe.

The demise of Cassini was imminent. In service for more than 20 years, its rocket thrusters were running low on fuel, making it difficult to steer from Earth. This euthanisation was undertaken to prevent Cassini from crashing into one of Saturn's moons, Enceladus. Enceladus is one of the most promising environments in the Solar System for finding extra terrestrial life, and any alien microorganism could contaminate the environment for future explorations.



Knowledge