

GALLIPOLI THE BRUTAL FACTS

What war was REALLY like for our Australian Diggers



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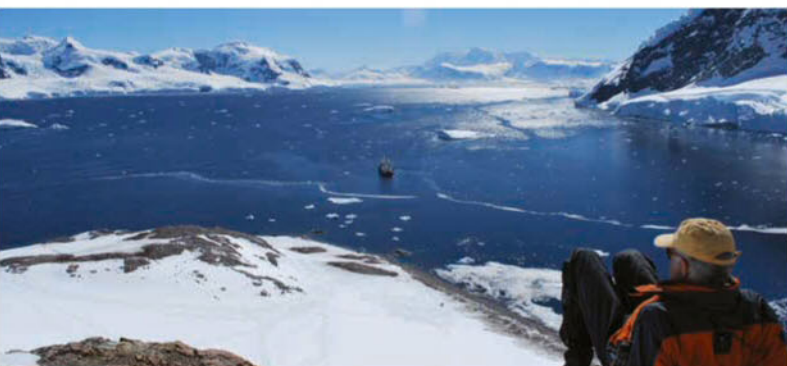
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WELCOME FROM THE EDITOR

Blindly obvious observation: it's easier to remember things that happened two minutes ago than two years ago. Little events and conversations that stick today will start peeling from your memory like cheap wallpaper come tomorrow. Only the big-ticket recollections will survive.

A similar law generally applies to history. More magazine columns, book shelves and docos are devoted to, say, Hitler than Genghis Khan. Not because one genocidal maniac is intrinsically more interesting than the other, but simply because the German's reign of terror played out more recently.

Certain cultural biases come into the mix, but in layman's terms, the more distant an historical event, the less we're interested. Older stories feel less relevant to our lives.

Still, it feels inconceivable that one day in the future – when you and I are no longer on this mortal coil – the events of the Gallipoli campaign (see p12) will fade from our collective memory, to be replaced by another war, another bloody conflict.

As we reach its 100-year anniversary, there's still something about Gallipoli that tugs at Australian hearts and minds. The battles formed the modern Aussie character, becoming a symbol of achievement and existence as a nation. And men and women died so that could happen.

If you remember just one thing about today, let it be that...

Vince Jackson, Editor



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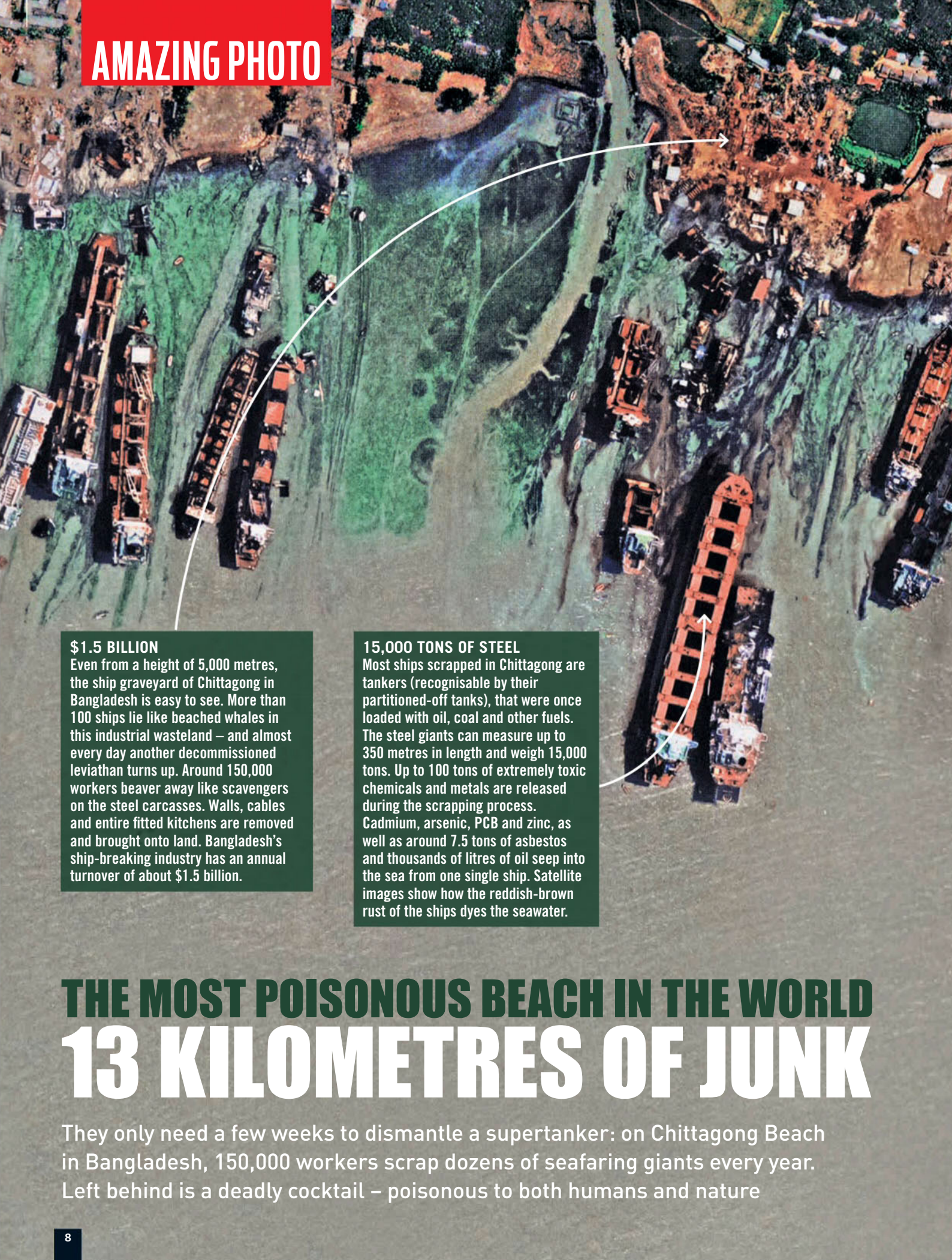
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An aerial photograph showing a vast area of water and land in Chittagong, Bangladesh, filled with hundreds of rusted, decommissioned ships. The ships are mostly orange-brown from rust, with some green patches of vegetation visible. A white curved arrow points from the top left towards the center of the image, and another white curved arrow points from the bottom right towards the center. The water is a murky, reddish-brown color, likely due to rust from the ships.

AMAZING PHOTO

\$1.5 BILLION

Even from a height of 5,000 metres, the ship graveyard of Chittagong in Bangladesh is easy to see. More than 100 ships lie like beached whales in this industrial wasteland – and almost every day another decommissioned leviathan turns up. Around 150,000 workers beaver away like scavengers on the steel carcasses. Walls, cables and entire fitted kitchens are removed and brought onto land. Bangladesh's ship-breaking industry has an annual turnover of about \$1.5 billion.

15,000 TONS OF STEEL

Most ships scrapped in Chittagong are tankers (recognisable by their partitioned-off tanks), that were once loaded with oil, coal and other fuels. The steel giants can measure up to 350 metres in length and weigh 15,000 tons. Up to 100 tons of extremely toxic chemicals and metals are released during the scrapping process. Cadmium, arsenic, PCB and zinc, as well as around 7.5 tons of asbestos and thousands of litres of oil seep into the sea from one single ship. Satellite images show how the reddish-brown rust of the ships dyes the seawater.

THE MOST POISONOUS BEACH IN THE WORLD

13 KILOMETRES OF JUNK

They only need a few weeks to dismantle a supertanker: on Chittagong Beach in Bangladesh, 150,000 workers scrap dozens of seafaring giants every year. Left behind is a deadly cocktail – poisonous to both humans and nature



ONE DEATH PER WEEK

Barefoot and without protective clothing, workers break down the ship's massive steel walls using welding torches and sledgehammers. For each 14-hour shift spent sweating, hammering and hauling stuff around, a so-called 'iron-eater' earns roughly \$1. On average, between one and three workers die here every month – crushed, struck by or buried alive beneath falling debris. **w**

LIFE EXPECTANCY: 40 YEARS

Liquefied natural gas carriers (those with domed containers on the deck) release especially large quantities of chemicals during the scrapping process. These toxins get under the workers' skin; many contract severe respiratory illnesses or become blind. The consequence: very few of the people who work here for years will live beyond the age of 40. That is, on average, 15 years longer than most of the tankers. After 25 years in corrosive saltwater, they are ready for the scrapyard.

INVISIBLE POISON

The pH value of the seawater here is markedly higher today than it was 20 years ago. Biologists have confirmed an increased concentration of toxic substances in fish and crustaceans in the region, while the groundwater in Chittagong is also contaminated with toxic substances from the ships.

AMAZING PHOTO



1600 KM/H MODEL KIT

This is the Bloodhound SSC. In this picture are 3,500 unique components – including driver Andy Green – which, when assembled, should be able to blast past the current land speed record, all the way to 1,600km/h



Looking like the world's biggest model kit, the Bloodhound Supersonic Car sits in pieces at the headquarters of the UK team who are determined to set a new land speed record, and ultimately break the magical 1,000mph (1,600km/h) barrier.

Led by project director Richard Noble, who was in charge of Thrust SSC when it set the current record of 1,228km/h in 1997, the aim is to set a new high of 1,287km/h this year, then hit 1,600km/h in 2016. Ahead of the team lie months of testing, both here and at the proposed record-breaking site in South Africa, but the mind-boggling statistics surrounding this car suggests that they are well equipped to reach their target.

The Bloodhound SSC is powered by three 'engines'. Primary thrust comes from a Rolls-Royce EJ200 jet engine from a Eurofighter Typhoon, while extra boost

is provided by a cluster of Nammo hybrid rockets. The car also has a 410Nm supercharged V8 Jaguar engine, simply to drive the rocket oxidiser pump. All of this adds up to the kind of astonishing thrust horsepower that's equivalent to 180 Formula 1 cars.

And what that amount of power equals is speed – and lots of it. In order to complete its record-breaking run, Bloodhound SSC requires 19km of completely flat desert track. Operating at full power, Bloodhound SSC covers a mile (1.7km) every 3.6 seconds. And that's equal to four-and-a-half football pitches, every second.

Dealing with the stresses caused by such speeds is a titanium-skinned upper chassis and a carbon fibre monocoque with a 50mm-thick windscreen, all held together by 22,500 aerospace-grade rivets. This particular model kit is only for the big boys. **W**

UPHILL BATTLE

ANZAC soldiers move toward Turkish trenches at Gallipoli. The terrain around Anzac Cove meant many charges were done uphill.

GALLIPOLI LIFE

What was it really like being a soldier at Gallipoli? To honour the 100th anniversary of the ANZAC landing, we delve into the historical archives and tell the story of the campaign through the eyes of the average Digger



E OF A DIGGER

Not for the first time during the journey, 21-year-old Private Mick Allen* is lying on his bunk, staring at the black-and-white photo of his wife. She was there to wave him

off in Sydney, one of thousands of women bidding farewell to their husbands that day, their vision blurred by tears. They were married on August 4th 1913. How could he forget that date? Exactly a year to the day that, on the other side of the world, Great Britain declared war on the German Empire and its allies.

On a normal Sunday before that turning point in history, Mick would have spent a quiet day with Elizabeth, doing odd jobs around the house. Or taken a stroll to his parents' place for lunch. But Mick is committed to another family now. He's one of

20,000 Australian troops the Federal Government promised to the British, on one of the first convoys of transport ships to leave for the Great War.

Without warning, there's a bellowing call from his senior officer. Other men in the 4th Battalion rise from their bunks. It's time to disembark. Emotions swirl in Mick's stomach, a strange cocktail of excitement and fear. He puts Elizabeth's picture in the chest pocket of his tunic, next to his rapidly beating heart, and says a quick prayer in his head.

He looks out of his porthole. Wisps of smoke are streaking from the cliffs behind the beach, where thousands of Turkish soldiers have taken positions on ridges, firing on the infantrymen of the 3rd Brigade who are already trying to land. It's Sunday morning, April 25, 1915. The assault on the Gallipoli peninsula is under way. >

THE JOURNEY TO TURKEY

Private Mick Allen and the other members of the 1st Brigade, 4th Battalion, expected to be trained in England. But the powers-that-be decided the mother country's already crowded camps and cold winter weather would not sit well with 30,000 men from the Southern Hemisphere (20,000 from Australia, 10,000 from New Zealand). Not that conditions on the troop ships were ideal. Living quarters were cramped and cold. Sickness was rife. Army doctors encouraged men to have their teeth forcibly pulled out, as a way of avoiding dental problems on the battlefield.

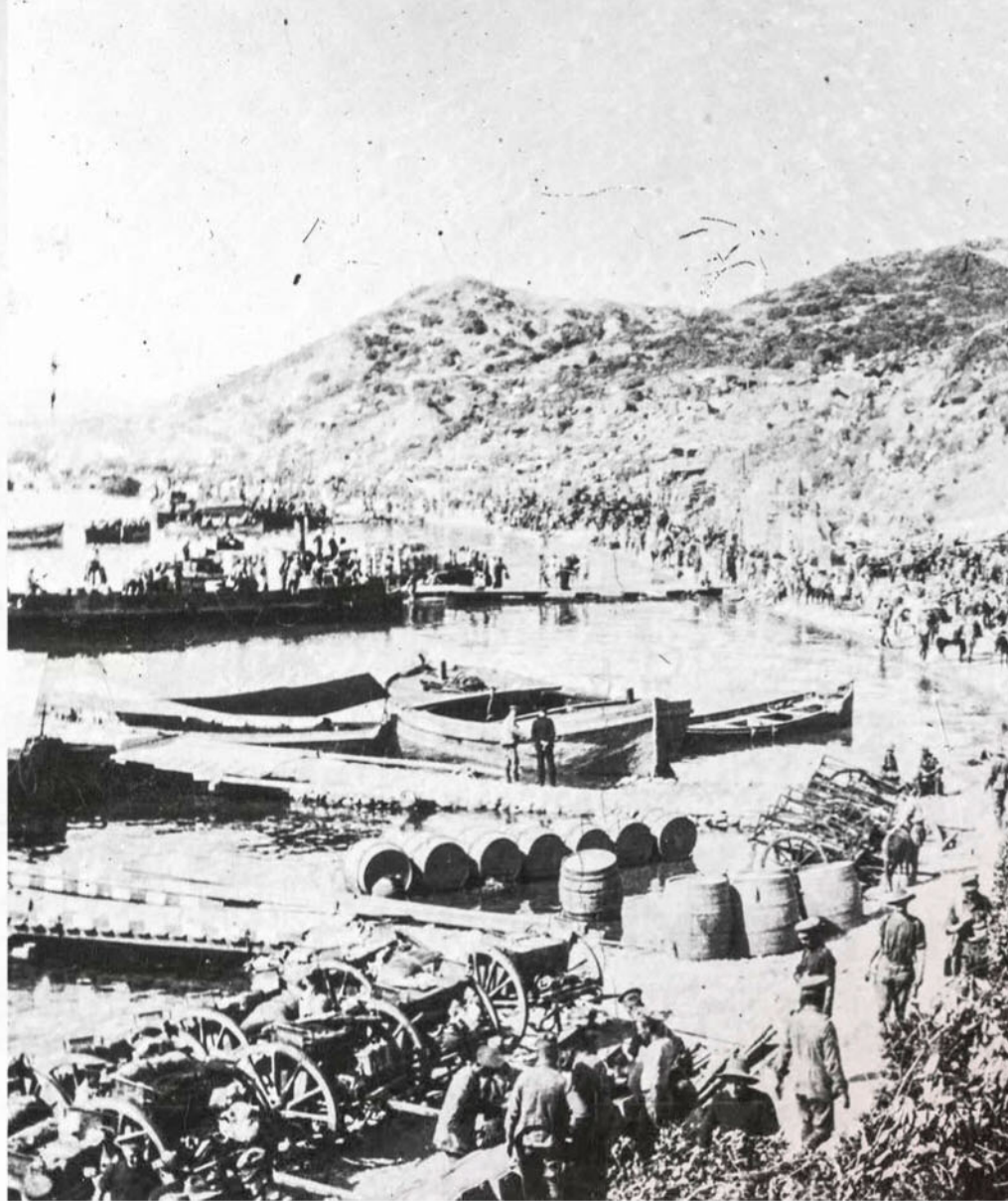
During the journey, it's decided that ships will be rerouted to Egypt. It's here the Australian and New Zealand divisions are formed into the Australian and New Zealand Army Corps, and given a name that will always stick: ANZACs.

In Cairo, Mick and the rest of the ANZACs train from 9am to midday, then spend the next few hours resting, avoiding the harsh Egyptian sun. Although most of his fellow soldiers are solid, decent men – volunteers who enlisted to fight for their country and defend its values – Mick notices a ruffian element among the troops. As the journalist C. E. W. Bean reported at the time, it was “obvious that there had also been enlisted a certain number of criminals, some of whom had entered the force with the intention of running gambling schools or escaping punishment in Australia.”

On April 2nd, less than a month before they would fight for their lives in Turkey, 2,500 ANZACs are embroiled in the Wasser Riots, smashing up bars and brothels, brawling with staff and owners.

THE LANDING AT GALLIPOLI

By late-1914, fighting on Europe's Western Front was approaching stalemate. Attempts by commanders on both sides



“THE 4TH BATTALION CLIMB DOWN ROPE LADDERS INTO ROWING BOATS, ABOUT 25 MEN TO EACH CRAFT. A STEAMER FERRIES THEM TO WITHIN 100 METRES OF THE BEACH.”

to outmanoeuvre or outflank the enemy had failed. More than one million Allied troops had died. The British War Council decided, therefore, that the best way to weaken the Germans was to attack its allies.

The assault on the Turks of the Ottoman Empire was originally conceived as a naval mission, but after several failed attempts in February and March 1915 to take the Dardanelles – the narrow strip of

water off the Aegean Sea, which included the Gallipoli peninsula – the British Cabinet sanctioned the use of land forces, assembled under the command of British General Sir Ian Hamilton.

Hamilton planned a three-pronged raid [see map, opposite page]; the ANZACs, under the leadership of General William Birdwood, would land at Gaba Tepe ■, the area later named Anzac Cove; the British Royal Navy's 29th Division would



[This photo] Allied troops after Gaba Tepe (Anzac Cove) is secured. [Below] An ANZAC Digger rests on the beach. [Bottom] Aussie infantrymen on their way to the Gallipoli landing



take Cape Helles to the south ²; French forces would make a diversionary landing at the headland of Kum Kale ³. Once the Turks were banished from their defensive positions along the Dardanelles, the Allies planned to continue to the Sea of Marmara and take the city of Constantinople (now Istanbul).

Private Mick Allen's transport ship is stationed around three kilometres off Anzac Cove. He's standing on deck in the morning light, petrified to his core, but eager to move and shake off the nerves. In the distance, he can see other platoons already close to shore, and hear the crack of Turkish machine guns and rifles. There are no special landing vessels. Mick and the rest of the 4th battalion climb down rope ladders into simple rowing boats, about 25 men to each craft, 10 boats in all. A steamer ferries them to within 100 metres of the beach. They must row the rest of the way.

The closer to shore Mick gets, the nearer he is to a living hell. Shells are exploding in the water. Shrapnel is pinging off the rowing boat. Men are being killed around him. His vessel runs aground about

WAS THE ANZAC COVE LANDING A TACTICAL FAILURE?

It's a common belief that the first wave of ANZAC troops landed in the wrong place, about 1.7 kilometres north of the original target area. Military historian Professor Peter Stanley of the University of NSW claims there was never a precise landing spot, just a range of a kilometre or two. "For decades people have tried to explain the failure at Gallipoli by blaming it on the Royal Navy," he told the ABC last year. "But the Royal Navy did land the troops in approximately the right spot. It was what happened after the landing where things went wrong." Stanley also suggests that landing at Anzac Cove may have been preferable; there were fewer Turkish soldiers compared to other locations.





[This photo] An iconic image of an Aussie soldier carrying a wounded comrade. [Below] Colourised photo of Australian artillery troops fighting Turkish forces.

30 metres from land. He jumps out, landing in shoulder-deep water. Turkish machine guns stationed up in the cliffs are peppering the length of the beach as Mick creeps towards the sand. The order to line up on the beach is now meaningless. Enemy fire is an incessant diagonal shower of lead; lifeless bodies are slumped across the sand. Mick can't believe he's still alive. He runs up beyond the beach into dense bush and scrub, shrapnel still fizzing around him. In the chaos, many of the battalions are mixed up with each other.

Mick and more than 8,000 ANZACs bravely fight on until evening, gradually pushing back the Turks, taking a slice of land about two kilometres long, and one kilometre at its widest point. Mick can't shake the feeling that this will be a long campaign.

LIFE IN GALLIPOLI

By nightfall on April 25, 1915, 860 Australians had died; more than 2,000 were wounded. In the months and years that followed, many historians would claim the assault was a tactical failure [see

WHY DID GALLIPOLI BECOME KNOWN AS AN ANZAC-ONLY CAMPAIGN?

"The most widely believed myth [about the Gallipoli campaign] is that it was mainly an ANZAC affair," says academic Dr Geoffrey Partington. "In reality, the ANZACs were an important but relatively small part of the entirety." Estimates vary, but some figures put the British dead at 34,000, out of 468,000 soldiers who fought. Of 42,000 French troops in Gallipoli, around 9,800 perished. Australian fatalities numbered 8,709 out of a total of 20,000. The Turks, however, fared worse of all during the seven-month campaign; some estimates put their casualties as high as 470,000.



box, previous page]. For now, Mick and the rest of the 4th Battalion are only concerned with one thing: survival. And survival at Gallipoli means digging endless trenches.

Mick feels like fighting is the easiest part of daily life. Conditions are beyond grim. He sleeps on the stony trench floor, fully clothed, with only a single blanket for warmth. That's if he *can* sleep. The human traffic constantly traipsing up and down the trenches means Diggers – as they will now forever be known – are lucky to catch a few minutes' slumber. Just being able to close their eyes is good enough.

Water is in perilously short supply. Mick stores his rations in his mess tin, which holds enough water to make two cups of tea. Problem is, Mick has to use the same water to bathe in, clean his teeth and shave with. Because his skin is caked with grime from all the digging, those cups of tea taste like lukewarm mud.



WHAT WAS IN A DIGGER'S KIT?



Bayonet

Mark 1 Lee
Enfield .303 rifle

Wool or
rabbit-fur felt
slouch hat

150 rounds of
ammunition

Wool tunic,
a.k.a. the jacket
service dress.
Loose fit enables
free movement
and superior
circulation of air

'Marching order'
harness. Holds
rations, water
bottle, mess tin,
soap, toothbrush,
respirator, gas
mask, and more

Tan leather ankle
boots, fitted
large to allow for
swelling during
prolonged
marching

Mick's food rations consist of small amounts of bully beef, bacon, cheese, biscuits and apricot jam – all of which become virtually inedible in the escalating heat. The beef is overly salty, making Mick even thirstier. The biscuits are tough enough to break his teeth. And he has competition

for the food, too. The flies are descending in plague proportions. It's not uncommon for Mick to swallow mouthfuls of the insects whenever he eats.

"I had biscuits and a tin of jam," said Ion L. Idriess in the book *The Anzacs At Gallipoli: A Story For Anzac Day*. "But immediately

when I opened the tin the flies rushed the jam. They buzzed like swarming bees... of all the bastards of places this is the greatest bastard in the world."

The flies aren't only attracted to the food. A month of intensive fighting has resulted in a pile-up of dead bodies. The hotter it gets, the worse the smell becomes. During a 24-hour truce called on May 24, the Turks are allowed to bury the rotting corpses festering in the no-man's land between trenches.

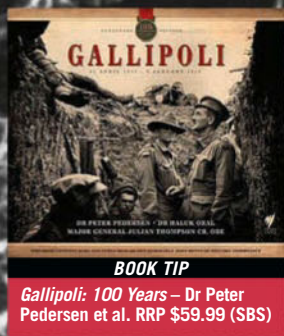
Owing to contaminated food and water supplies, dysentery is sweeping through the trenches, felling thousands of ANZACs, including Mick. Over three stinking hot days, he's bent over with severe abdominal pain and foul diarrhoea. It's so bad he forgets about the lice making his body itch all day long.

Among the horror stories, though, there are occasional pockets of humanity. In the gaps between fighting, men can be seen cooking small dinners in the trenches, writing love letters to women back home, and even swimming together in the gin-clear waters. And the war experience is building a strong sense of camaraderie. Some of these men will remain lifelong friends. If they make it back alive.

COUNTING THE CASUALTIES

The Turks consider the area of Lone Pine, situated on a plateau above Anzac Cove, relatively easy to defend. Spread in front of their lines is a flat, 120-metre slab of no-man's land. Their initial deployment of 1,000 men – of which 500 are in trenches – should be able to pick off the Australian and New Zealand forces. What the Turkish fighters don't know is that the ANZACs have secretly dug an underground line, reducing the distance that needs to be charged. The raid's objective will be to distract the Turks from the main assaults on other sections of the Gallipoli peninsula.

THE BIG FREEZE
Snow settles on the Dardanelles. Freezing conditions as winter approached ultimately signalled the end of the Gallipoli campaign.



At 5.30pm on August 6th, the first wave of 1,800 men from the Australian 1st Brigade (2nd, 3rd and 4th Battalions) swarm from their trenches, attacking the Turks. Each ANZAC soldier is carrying 200 rounds of ammo and a gas mask. Mick storms across the no-man's land, grenades exploding around him.

But return fire is lighter than expected; a few hours earlier, Turkish positions had been bombarded with ANZAC artillery, and naval gunfire from a British cruiser off-shore. The land charge takes the Turks by surprise.

Reaching the enemy trenches, Mick finds them covered with pine logs, too heavy to lift, and must slip inside gaps inside this roofing. Some ANZACs are hit at point-blank range through special holes the Turks have drilled in the logs.

When Mick jumps into the enemy trenches, there's chaos. The pits are maze-like, dark and cramped. Earth has collapsed in some sections. Men are fighting hand-to-hand, stabbing each other with bayonets. In the confusion, it's difficult to tell who's friend and who's foe.

Some of the Gallipoli campaign's bloodiest fighting occurs over the

next few days in these trenches, as the Turks launch counter-offensives. Hand grenades are a defining feature of the Battle of Lone Pine. Mick witnesses the small bombs travelling back and forth three times between trenches before exploding. So many are being used, around 50 ANZACs are deployed back down in Anzac Cove to produce makeshift grenades from jam tins.

A total of 150 metres of ground is captured by the ANZACs when the fighting subsides on August 9th, with both sides consolidating their positions. The human cost of the so-called August Offensive amounts



DID EVENTS AT GALLIPOLI OVERSHADOW HEROICS ON THE WESTERN FRONT?

While Gallipoli grabs the headlines, five times as many ANZACs fought on Europe's Western Front – a 700-kilometre-line stretching from the Belgian coast to the Swiss border. Five times more people were killed there (46,000), and five times as many Aussies were awarded Victoria Crosses. Historian Jonathan King says: "Let's use the centenary to redefine Anzac Day for what it was and upgrade our recognition of Remembrance Day – that victorious end to the battles fought by our ANZACs on the real killing fields of the Western Front, which should at least rank as equal favourite alongside Anzac Day."

to more than 2,000 Australians, and 6,000 Turks. Later, Captain Harold Jacobs of the 1st Battalion would observe, "the trench is so full of our dead that the only respect that we could show them was not to tread on their faces, the floor of the trench was just one carpet of them, this in addition to the ones we piled into Turkish dugouts." In all, seven of Mick's countrymen are awarded the Victoria Cross for bravery.

**"THE TRENCH IS SO FULL OF OUR DEAD THAT
THE ONLY RESPECT THAT WE COULD SHOW
THEM WAS NOT TO TREAD ON THEIR FACES."
– CAPTAIN HAROLD JACOBS**

THE CASE FOR WITHDRAWAL

The tips of Private Mick Allen's fingers are numb. He can't control the shivering. He can't feel his nose. How did this happen? Why hadn't his winter uniform arrived when the first blizzard struck in late November? A few months ago, his fellow ANZACs were catching sunstroke; now they're dying from frostbite. He's heard there have been nearly 3,000 cases in the area around Anzac Cove alone; at another location, 30 British soldiers were found frozen to death in a single trench. To make matters worse, heavy seas are making it even more difficult to bring in supplies. The first big winter storm destroyed the pier at Anzac Cove.

With shivering hands, Mick reaches into his tunic pocket. The picture of Elizabeth is still there, damp and more wrinkled than before. Every day he wonders whether he'll see her again. Every day he wonders for how long he'll have to endure this nightmare in Gallipoli.

Behind the scenes, in the corridors of power, decisions had already been made that will seal his

fate. A few months previously, General Sir Ian Hamilton ruffled feathers in London by demanding another 95,000 troops, to continue the Turkish offensive. But news of the terrible conditions in Gallipoli had reached the British government. Hamilton is eventually replaced by Sir Charles Monro. The new General is quick to assess the situation in Gallipoli, deciding that Anzac Cove is too small to be safely held, and

that the Turkish defences are too strong at other positions on the peninsula, particularly Helles and Suvla. A total of 16,000 troops had been forced to leave the battlefield because of frostbite and exposure.

And so, between December 8th and 20th, 125,000 Allied troops, 14,000 animals and 400 large guns are evacuated from the area around Anzac Cove, Suvla and Helles. Monro calculates the withdrawal will cost about a third of the force, but the final figure is 164 men, all British.

Mick bristles with tense excitement during those final hours on Turkish soil. He leaves for his assigned jetty just before midnight, with sandbags wrapped over his boots to muffle any sound. He ties his equipment with string to stop it rattling. The path to the beach has been sprinkled with rice and flour so troops don't get lost. Without haste or panic, Mick and hundreds of other men just like him walk silently, almost peacefully, towards the sea, away from Gallipoli. **W**

*Important footnote

Although the character in this feature is fictitious, a range of sources have been used to ensure historical accuracy, including first-person accounts. With thanks to: the Australian Government, the Australian War Memorial, anzacsofgallipoli.com, diggerhistory.info, *Gallipoli: 100 Years* – Dr Peter Pedersen et al

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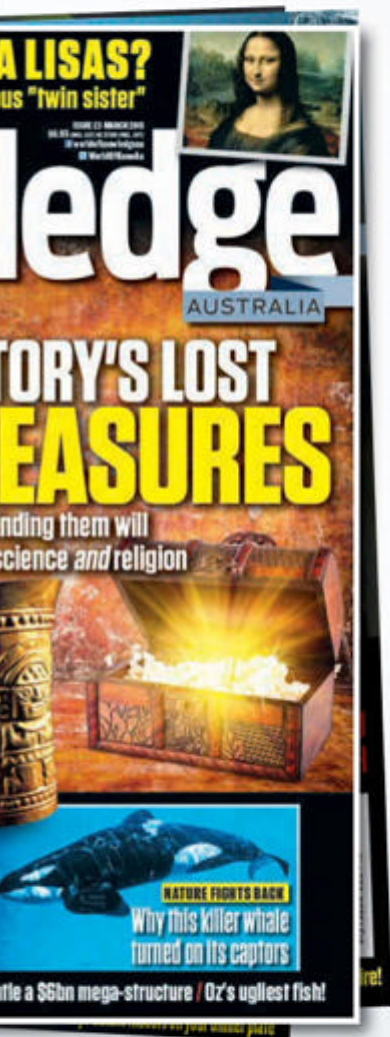
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WHAT WOULD HAPPEN IF...

What effect would a nuclear bomb have on a cyclone? What if you lost your DNA? What if all the world's lightning struck one place? Over the following pages, these and other fascinating scientific scenarios are put to the test



... the Earth suddenly stopped spinning?

A person standing still on the equator is actually moving at a speed of over 1,600km/h because of the Earth's rotation. As you get nearer to the poles, the speed decreases until it finally reaches zero. But people in Amsterdam are still zooming around at an almost ultrasonic speed. If the Earth suddenly stopped spinning, these people – as well as buildings and oceans – would continue to move in an easterly direction. Even if everything else somehow

succeeded in staying put, the air in the atmosphere would continue to rotate and would immediately transform into the strongest storm ever measured. As a result of friction, the air would be heated to such an extent that a wall of fire would be created. And after the Earth finally comes to a standstill, there would only be one sunrise per year: six months of blisteringly hot daytime, followed by six months of ice-cold night – even at the equator.

WHAT WOULD HAPPEN IF...



... the DNA disappeared from every human cell?

The entire genome of a human being weighs just 150 grams, laid down as DNA in every single one of the roughly 100 trillion cells in the body. If it were somehow to go missing, you'd start by losing this exact amount of weight. But at first nothing more than a tiny twitch would be discernible, due to the loss of volume in the cells – even though death is now inevitable. That's because without DNA, without the genetic blueprint of the cells, the body cannot produce any more 'replacement parts'. That's particularly serious for the body's high-performance factories: the digestive tract will digest itself, and without replenishment of white blood cells from the bone marrow, the body will be flooded with bacteria. The consequences are similar to that of severe radioactive contamination, which also damages the genome. Within hours, the body would completely collapse.



... you fired a ball at the speed of light?

If you could shoot a penalty at close to the speed of light, accelerating the ball to over 1 billion km/h, the consequences would be fatal: the ball would be so fast that there would be no time for the air molecules to move out of the way. Instead, individual oxygen or nitrogen atoms would fuse with hydrogen or carbon atoms on the surface of the ball. Along the trajectory, a permanent thermonuclear explosion would develop, releasing high-energy gamma rays. Starting from where the free kick was taken, a bubble of blisteringly hot plasma would form. The bubble would reach the goalkeeper within 50 nanoseconds and burn him to death. He would never see the kick, because the light containing this information would already be on its way at the same speed. But stopping it would also be impossible: the ball would have already dissolved into a projectile-shaped cloud of plasma.

... humans tried to eradicate the common cold?

It is primarily viruses, known as rhinoviruses, that cause the common cold. These are annoying, but generally not too serious. That's because our immune system destroys the invader within a few days – by which time you will have infected at least one other person, on average. Were you to try to stop its circulation by separating the entire land surface of Earth into individual quarantine stations, each human would have an area of a little over two hectares and around 77 metres of space between them and their neighbours. As the virus would not be able to find any new victims, it could theoretically be eradicated within a few weeks. The problem: for one thing, the costs of a cold-free world would spiral into the quadrillions. And what's more, there would still be a strong chance of a few viruses surviving: in people with compromised immune systems, rhinoviruses could persist for years. And these few hosts would be enough to infect the entire world all over again.

WHAT WOULD HAPPEN IF...



... a person fell into a spent fuel pool with radioactive fuel elements?

As long as you stay swimming on the surface, nothing will happen. The typically 30°C water offers excellent protection from the radioactive materials at a depth of several metres. But don't dive in! Why? Well, the risk increases the nearer you get to the sealed containers of fuel at the bottom of the pool. The intensity of the radiation doubles every seven centimetres and, a metre from the bottom, the death zone begins. And just brushing your shoulder once against the pool could result in death from radiation within hours – hence the extreme caution exercised by the divers who maintain the spent fuel pools. But on the water's surface the divers are actually safer than when dry: the water protects them from the tiny amounts of natural radiation.





... we aimed billions of lasers at the moon?

It would be fiendishly expensive to light up the moon from the Earth, but is cost the only reason why its surface is not used as a giant billboard? It seems not. Billions of ordinary five-milliwatt laser pointers and even illegal one-watt devices wouldn't make any noticeable change in its brightness. The light ray of a laser would scatter along the 380,000-km journey and eventually cover about 10% of the moon's surface. But the light from the sun would outshine the spot by a factor of more than a thousand. To achieve even the most minimal illumination of the moon, you'd need billions of 30,000-watt water-cooled lamps from the IMAX cinema system. And to negate the brightness of the sunlight, you'd need the same amount of one-megawatt lasers. But all the energy reserves on Earth wouldn't be enough to keep this light show up for very long.

... an atomic bomb was detonated in the eye of a cyclone?

A fully developed cyclone has a power rating of up to 200 terrawatts, of which roughly one tenth is transformed into mechanical energy as wind. This is equivalent to the detonation of a large ten-megaton nuclear bomb every 20 minutes. In comparison, the energy from Hiroshima was about 1,000 times weaker. So a cyclone wouldn't be affected by a nuclear bomb at all. That is also due to its mode of operation. It takes its destructive power from a massive shockwave, which moves from its centre at supersonic speed. Our theoretical explosion wouldn't change anything, due to the massive pressure differences from which a cyclone gets its strength. To weaken it you would have to blow at least half a billion tons of air into the 19-kilometre eye of the storm.

WHAT WOULD HAPPEN IF...



BLOW YOUR MIND!

Tap here to watch more mind-blowing 'what if' scenarios.

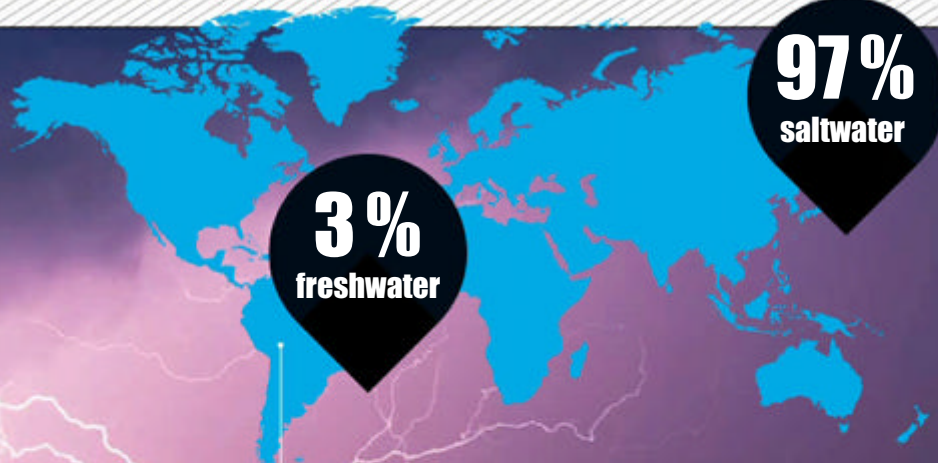


BOOK TIP

You'll find answers to more fascinating questions in the book *"What If? Serious Scientific Answers to Absurd Hypothetical Questions"* by Randall Munroe (\$27.99, John Murray)

... all the
lightning in
the world
struck the
same place at
the same time?

Around the world there are approximately 100 lightning strikes every second, which equates to roughly 10 million lightning strikes per day. A group of one million lightning strikes – that's roughly the amount that actually reaches the ground every day – would have a diameter of about six metres. But in striking the ground it would leave a crater at least four times that diameter. The amount of energy released in the air and under the ground as a result is equivalent to two small nuclear bombs – and the destructive power would be similar. The heat and the expansion of the plasma forming in the air would fell trees over distances of several kilometres and destroy buildings. Heat and light would set all flammable items in the area on fire. Only a metre-thick copper cable would be able to take this mega lightning in its stride – but only until the ground was reached, because then it would no longer conduct electricity very well and would simply explode.



97%
saltwater

3%
freshwater

... the radius of the Earth increased at a rate of one centimetre every second?

If the Earth began stretching out, while still maintaining its same density, we would feel nothing on the first day – except for a gentle tug, like riding on an escalator. Exactly 864 metres in the direction of outer space, a person travels at a speed of one centimetre per second every 24 hours. The increase in the Earth's circumference, which would have grown by 5.3 kilometres on the first day, would not be enough to pull down any buildings. Gravity increases in tandem with the mass of Earth so an adult would weigh ten grams more after day one. After a year, gravity would have increased by a (still bearable) 5%. But after 40 years, gravity would be three times as high, and only the strongest among us would be able to cope with that. After 100 years, and with six times the original amount of gravity, humans would only be able to exist in pressure chambers under water. And after 300 years the gravitational pull of the Earth would crush the moon and for a short time our planet would have rings like Saturn.

... we pumped all of the oceans dry?

The Challenger Deep in the Pacific is the deepest point in all the world's oceans, at a depth of 10,994 metres. If we were to install a 30-metre-wide drain there and the water could shoot downwards into a fictitious pool, the worldwide sea level would only decrease by one centimetre during the first day. It would take more than 100,000 years to drain all the oceans on Earth. If the sea level sunk by 3,000 metres, Papua New Guinea would be part of the Australian continent; elsewhere, a huge mountain massif, the Mid-Ocean Ridge, would rise out of the Atlantic; the UK would be absorbed into mainland Europe. On this scale, the oceans would no longer connect with one another, all that remained would be small inland waters, like giant lakes. At its deepest point, the water would still be around five kilometres deep. This amount would not be enough for the phytoplankton in the oceans to continue to be able to produce 80% of all oxygen on Earth. As a result, the human race would suffocate. 



THE **WILDEST** SHOW ON EARTH

Frozen in spectacular motion or simply captured in contemplation, we've sifted through the world's most spectacular nature photography to bring you wildlife like you've never seen it before...



POLAR PADDLE!

Tap here to watch Go Pro footage of a polar bear swimming. And more!



THE WATERPROOF WONDER

➔ Weighing up to 800 kilograms, over two metres in length, and covered in thick fur, the polar bear is the biggest land-based predator on Earth. Impressive is not the word. When in the water, like this one here, you'd expect it to act like a sponge – soaking up water before sinking like a stone. But you'd be wrong. In reality, *Ursus maritimus* is well-prepared for the melting of ice floes during the Arctic spring. Due to global warming, the polar bear is getting used to swimming ever greater distances to reach its food sources. Researchers from Alaska tagged a number of female bears with GPS transmitters and stretches of 50 to 145km were not uncommon. One even managed 350 kilometres, without stopping! Using a doggie-paddle action, the bears can reach speeds of 10km/h, with their back legs acting as a rudder. This technique can be seen in this photo taken in Canada's Hudson Bay. An 11cm-thick layer of blubber provides the necessary buoyancy and warmth. And when the polar bear finally reaches land again, a clever waterproofing trick comes into play: its coat is oily and water-repellant – just one quick shake and the bear is free of every last drop of water.



PUBLIC ENEMY NUMBER ONE

➔ Sometimes a spectacular nature photo draws your attention to a species of animal that you're not familiar with. This is one such shot. Admittedly the deer mouse, here illuminated by the setting sun, is very well known in its home environment. And no, it doesn't normally spend its time eyeing up small spiders. *Peromyscus maniculatus* is the most common and most widely distributed mammal in North America, where it can be found scrabbling around in householders' basements, attics and garages. And no wonder: females are capable of giving birth

to an astonishing 14 litters a year, each consisting of up to 11 young – potentially, that's 154 deer mouse siblings *every year*. No surprise, then, that if you type 'deer mouse' into an internet search engine you'll come across numerous deer mouse control sites. It all seems pretty clearcut: the rodent is a pest, fit only for the exterminator. And as well as annoying the urban population, studies have shown that the deer mouse is responsible for ongoing changes to the rural landscape, too. Its foraging activities and taste for seeds has devastated the toadshade wildflower in the forests of southwest Oregon. And we bet you didn't know any of that before we showed you this photograph, right?



THE CLOUD- WHISPERERS

➔ You're never alone if you're a wildebeest. For days, weeks even, an African wildebeest sees nothing but the rear end of the animal directly in front of it, so closely packed are the 1.5 million that thunder across the plains every year. This gigantic steamroller only obeys two traffic regulations, though. Rule number one: the convoy's speed limit is roughly 80km/h, and is only brought to a halt when crossing bodies of water. Rivers, particularly the powerful Mara river between Kenya and Tanzania pictured here, frequently transform the

rampaging herd into a panicked throng of flailing horns and hoofs. Undaunted by death, the members of this group eventually pluck up the courage to tumble down an almost vertical river bank, into deep white water, all the while hoping that the long object that has suddenly appeared from the bubbling depths is a piece of driftwood and not a crocodile snout. And the point of this arduous trek and all its risks to life and limb? Well, this is where wildebeest rule number two comes in: follow the clouds. Over there, in the distance, the smallest rain cloud can just about be made out. That's where the delicious, lush grasslands lie – and that's where the herd is heading...





WHO DO YOU THINK YOU ARE?

→ Springtime in the Northern Hemisphere will once again see such harmonious scenes between the animal and plant worlds as this one here. But this ground squirrel investigating the berries is probably a little confused, as every time it awakes from its eight-month winter hibernation, the rodent suffers from amnesia. For days it wanders around in a stupor, unable to make head nor tail of its surroundings. Tests have shown that the animal actually loses a large part of its previous knowledge during its winter dormancy – presumably because its brain has to make do with an insufficient supply of oxygen for months on end. The effects are almost identical to the symptoms of Alzheimer's, with one difference: members of the *Spermophilus* species possess a protein that completely repairs the damage within days – its dementia is only temporary. Until next spring arrives, that is...





ANGRY BIRDS

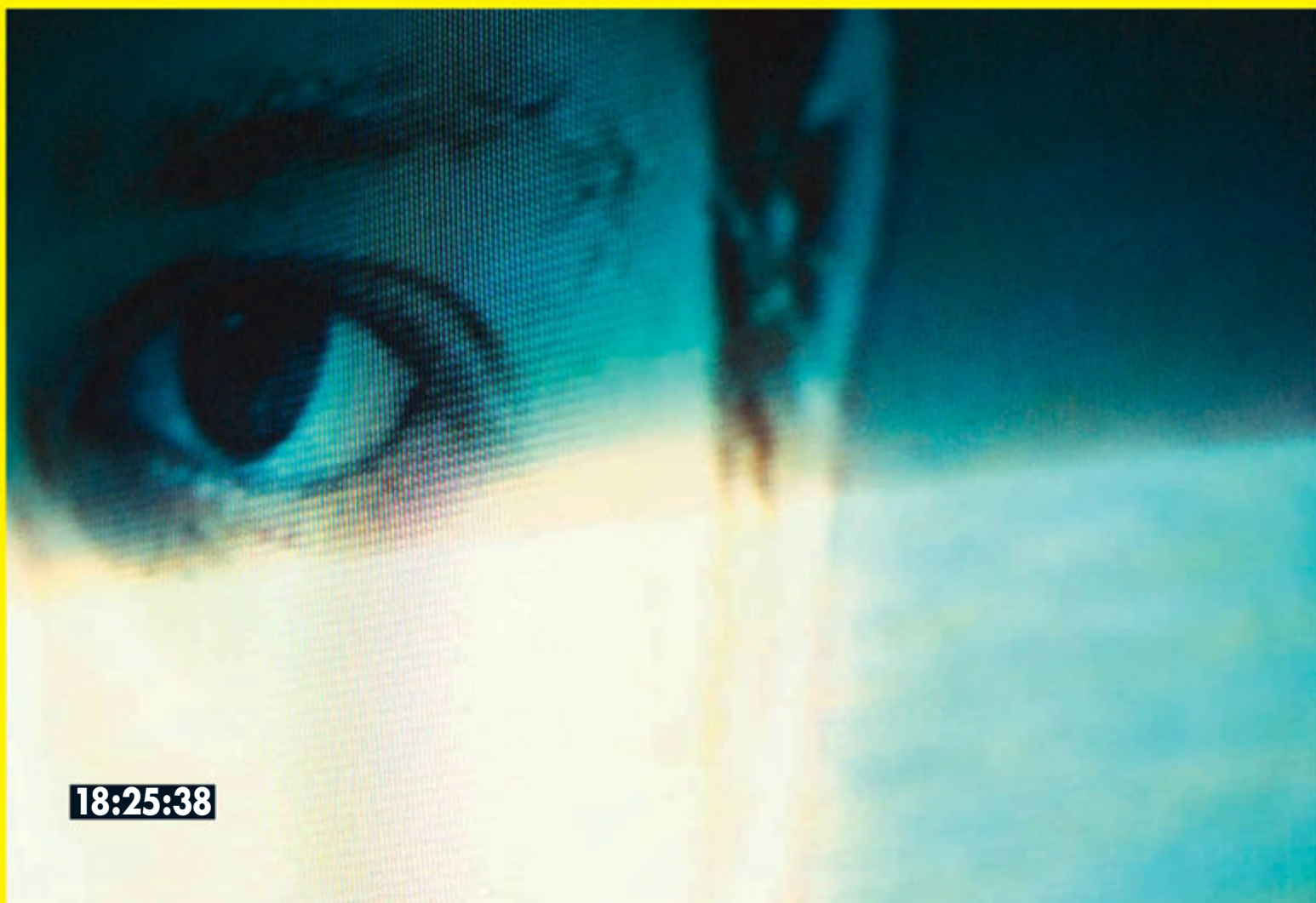
➡ This photo of a group of mallards is taken from a piece of bread's perspective. Ducks tend to create pandemonium whenever bread is thrown their way. But if they have to, they can fly long distances to a new food source, without having to resort to a

squabble over the remnants of someone's bread bin. Scientists have now proved the presence of the hormone leptin in both mallards and other birds. Leptin regulates the metabolism and ensures that migratory birds can survive for long periods of time without food. This discovery could encourage us to stop throwing our leftover crumbs to the hungry ducks. They don't need them! ☑

THE INVASION OF **WEBCAM PIRATES**

WE CAN SEE YOU

An internet connection is all that's needed to spy on thousands of people. 'Ratters' intrude on the most intimate aspects of your life by hacking into webcams, tablets and smart TVs. They watch your every move, spying on you while you sleep and even during your most private moments – without you ever realising





23:41:15



21:14:56

P

ing! Amy Wright loves this noise. She's just received a chat message on her laptop. The 20-year-old clicks on the chat window. "Will you go on a date with me?" a stranger with the username 'mistahxxxrightme' asks. "Stupid teenagers messing about," the student thinks and closes the window. Ping! A second chat message appears onscreen. It reads: "I like your white curtains and

"THEY THINK THEY'RE ALONE IN THE HOUSE AND HAVE NO IDEA WE'RE WATCHING."

your four-poster bed... and I'm counting the diamonds on your duvet." The sender? Mistah X. Amy looks at her bed and feels her hair standing on end. Her hands tremble. Panicking, she closes the chat window, but immediately receives an email with an image attachment.

IS THERE A LIVESTREAM FOR VOYEURS?

Until it was closed down at the end of 2014, a website called Insecam gave anyone access to 70,000 live streams from security cameras, many in people's homes... while the subjects remained completely oblivious to the fact.



WEBCAM PIRATES ARE SELLING OUR PRIVACY

Billions of dollars change hands on hacker forums every year. \$1.20 buys access to a woman's computer. For the same amount, you can connect to the computers of 100 men.

She opens it and finds a picture of herself staring back at her, a picture that she has never taken...

HOW DO YOU BECOME A SLAVE TO YOUR WEBCAM?

Amy Wright is one of thousands of victims targeted by webcam pirates. Known as ratters, their name is derived from the software they use: a remote access Trojan, or 'RAT' for

malware by tricking the 'slave' into visiting a specific webpage, usually by emailing them an infected link. Often this will claim to offer free music downloads. When the victim clicks on it, a covert download begins. The Trojan installs itself – without the user's knowledge. From then on, the online spies have complete access to the computer.

On one hacking forum, a ratter boasts: "I got loads of female 'slaves' using an infected *Sims 3* server." Another posts: "They think they're alone and have no idea that we're watching." Security expert Dr Ruby A. Rouse agrees. According to her, teenagers and young women are most at risk: "It is alarming that so many people don't know their webcams can be easily hacked," she says. Once the victim realises what's going on, the damage has usually already been done. Which was certainly the case with Amy Wright...

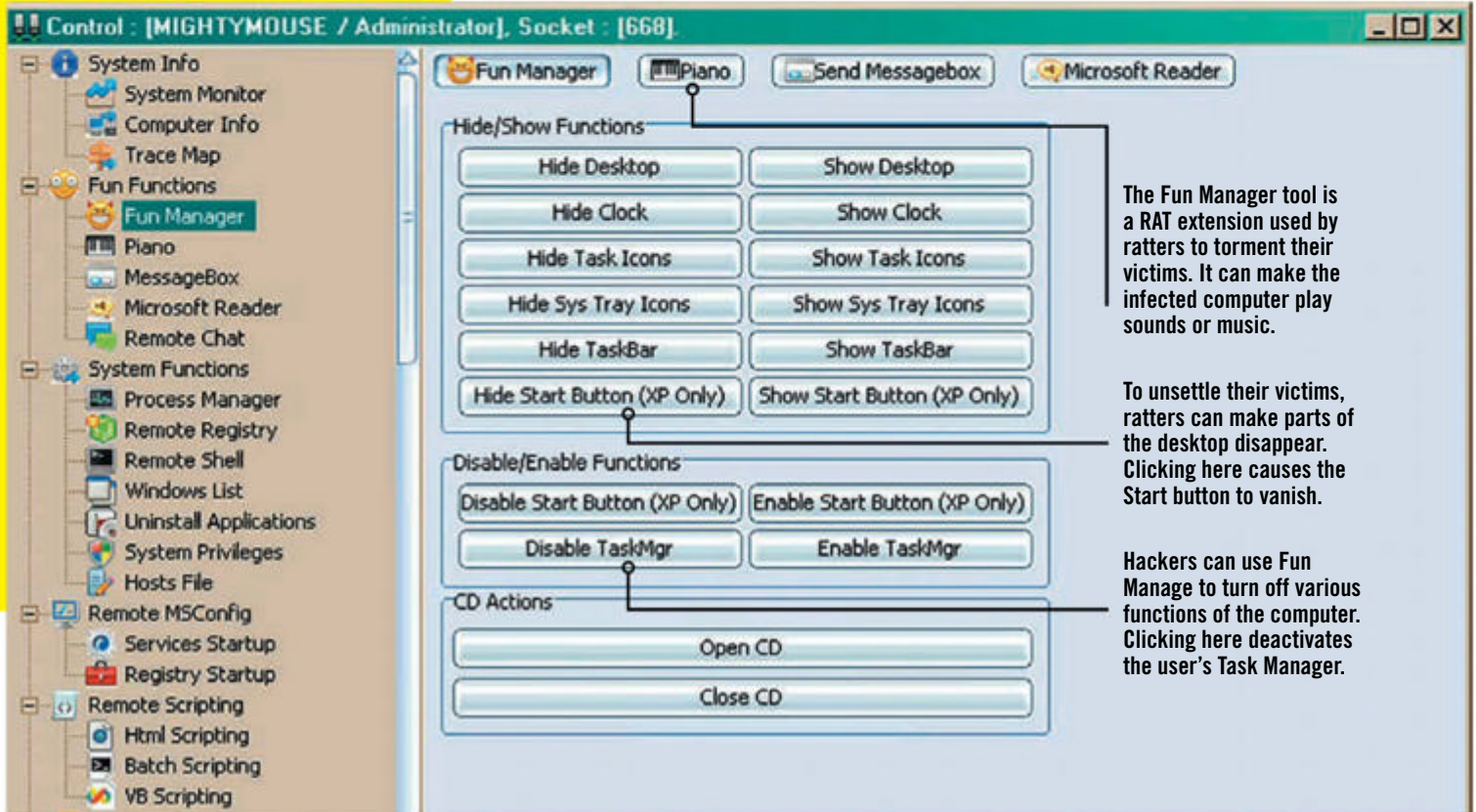
When the student sees the photo of her sitting naked on her bed, she calls her boyfriend. "What should I do?" she asks, her voice shaking. Ping! Almost immediately, the messaging app opens itself on her boyfriend's laptop – and a message from Mistah X appears, as if he can hear them. "I know you're talking to each other," writes Mistah X. Amy tells her boyfriend she's going to call the police, but before she can, another message appears on both



THE SECRET TOOLBOX OF WEBCAM PIRATES

Webcam hackers require spyware called remote access Trojans (RATs) to actively manipulate computers. The online market for these programs is booming, with webcam pirates paying up to \$250 for their tools. There are also extensions for RATs that

can cost between \$20 and \$50, depending on their content. The advantage of this level of 'customisation'? It makes it extremely difficult to track using anti-virus software. One of these extensions, shown below, is known as Fun Manager.



The Fun Manager tool is a RAT extension used by ratters to torment their victims. It can make the infected computer play sounds or music.

To unsettle their victims, ratters can make parts of the desktop disappear. Clicking here causes the Start button to vanish.

Hackers can use Fun Manager to turn off various functions of the computer. Clicking here deactivates the user's Task Manager.

of their screens. "I know you're calling the police," the hacker types, revealing that he can access the microphone as well as the camera. The 20-year-old locks herself in the bathroom and turns on the shower, worried that the stranger can hear her. She calls the police. Unfortunately, there's nothing they can do. They have no idea how Mistah X managed it...

HOW DO YOU CONTROL THE LIFE OF A STRANGER?

Ratters aren't merely Peeping Toms or spies; many are entrepreneurs. They trade access details for other computers on internet forums and sell access to webcams on dedicated file-sharing sites online. Connection to a woman's webcam costs \$1.20, and the same amount

could purchase access to 100 computers owned by men. The transactions take place on forums or secure chat servers, run by the hackers. Experts say the industry is already worth several billion dollars per year. "I don't care who gets access, as long as they pay me," one Finnish hacker says.

It's not only webcams that are vulnerable. Hackers can also take over smartphones, smart TVs and security cameras. Edward Snowden's leaks revealed that the NSA have developed software to infiltrate iPhones. Called DROPOUTJEEP, the program allows the controller to gain access to caller lists, text messaging history – even a phone's camera and microphone. Internet-enabled smart TVs, meanwhile, are a godsend for hackers. Using a transmitter, they are able to generate their own content

HOW CAN I PROTECT MY HOUSE?



SMARTPHONE

Delete text messages as soon as you read them. Hackers often use infected text messages to take control of smartphones.



SMART TV

The best protection method is to stop using the internet function on your smart TV because no anti-virus programs for these devices exist yet.



PC WEBCAM

Your anti-virus software should always be up to date. Files should only be downloaded from secure websites. Never click on unfamiliar links and always cover the webcam when it is not being used.

LUIS MIJANGOS HAD THE COMPUTERS OF 230 WOMEN UNDER HIS CONTROL



on individual televisions. In dense urban areas, up to 20,000 TV devices can be targeted in a single attack.

It is similarly straightforward for a professional hacker to access CCTV cameras. A 2014 study revealed that the three largest manufacturers of security systems pre-program their products with simple, default passwords like '1234' for use during initial setup, instructing users to change the password later. Many never do, meaning there are whole catalogues of camera models with easy-to-crack passwords available online. Once a hacker infiltrates the system, he has access to all current and archived recordings and can even control the cameras remotely. Police cameras are just as easy to hack. In one test, security researcher Paul McMillan discovered 30,000 susceptible systems in 16 minutes.

HOW CAN I PROTECT MYSELF AGAINST WEBCAM ATTACKS?

The invasion of our private sphere is the most disturbing element of a webcam hack. It's not just an attack on a home's technology – it's an assault on privacy. In fact, people

 Luis Mijangos [seated, left] began hacking after an accident left him paralysed. Using instructions he found online, he learnt how to use a RAT. Mijangos offered services as a spy for hire on forums: for \$150, he would

hack the computer of an unfaithful spouse and then forward the link to his clients. He also acquired a collection of 230 female 'slaves' as well as around 15,000 videos, 13,000 screenshots and 900 sound recordings.

who fall victim to ratters – and have their private photos, videos or emails published online – are three times more likely to develop psychological disorders like depression. "Knowing that the culprit is always there, but not who they are, results in a psychological burden," explains psychologist Lynne Roberts. "The victim sees how vulnerable they are. The damage is made worse by the distribution of the images on the web. The offender can reach a much larger audience online."

Thankfully, there are precautions you can take to reduce the risk of being hacked. The most obvious is to make sure your computer is equipped with the latest anti-virus software. "There are 100,000 new virus threats created every day so it's vital to keep your security up to date," says Graham Cluley, an expert on computer viruses. "Anti-virus software should protect you against most of these." According to Joss Wright from the Oxford Internet Institute, the second precaution is even simpler: "The idea of sticking a piece of paper over your webcam is reasonably common among the more paranoid corners of the internet. But it's not necessarily paranoid, it's useful to be aware."

SEXTORTION – THE HUNT FOR RATTERS

When the police investigation into Amy Wright's case turns up no leads, the files land on the desk of the FBI's cybercrime unit. After a

week of research, there is a breakthrough: some of the internet domains are registered under the name Luis Mijangos. Investigators begin to monitor his house, but don't see anything unusual. Then, one morning, Mijangos hears a sudden loud noise. A commotion. It's his 31st birthday and he thinks it's his friends, throwing him a surprise party. But this is no ordinary surprise: instead, heavily armed FBI agents storm his house and arrest him. In Mijangos' room, they find four laptops and a scattered collection of hard drives and memory sticks. Mistah X and Mijangos are the same person.

Mijango's library contained 15,000 videos, 900 audio files and 13,000 images – including hundreds of Amy Wright. In total, he spied on 230 victims and reprogrammed spyware so he could spy on 600 computers simultaneously. As soon as one of his 'slaves' logged on to a social network, Mijangos gained access to a new set of targets by scanning the victim's account and selecting new prey: "Facebook is like gold when it comes to hackers," he confesses.

Eighteen months later, the ratter is sentenced to six years in prison for 'sextortion' – sexual exploitation on the internet. But both Mijangos and the FBI know that thousands of ratters are still operating around the world, observing millions of unsuspecting victims during their most private moments. Perhaps including you...

SMARTER IN 60 SECONDS...

4 FASCINATING QUESTIONS ABOUT **WEBCAMS**

WHERE WAS THE FIRST WEBCAM?



The first webcam was attached to a coffee machine and began streaming in 1991. Famously known as the Trojan Room coffee pot, it was set up to save researchers from a Cambridge University laboratory an unnecessary trip to an empty coffee pot. At the time, the images were low resolution and only streamed in greyscale, but by 1993 live images could be viewed online. It was finally decommissioned in 2001, but went down in technological history.



COULD A HACKER TURN MY **SMARTPHONE** INTO A **WEBCAM**?



The smartphone malware PlaceRaider uses a smartphone's camera to record images. The stealthy app works by silencing the user's phone so that the user can no longer hear the telltale click of the smartphone's camera. Then, still in the device, the program analyses the images and discards any blurred or shaky ones. All useful photos are uploaded to the host's server by the app. Secret photos are taken of wherever you leave your device – in effect, your own phone is turned against you...

WHAT IS A **DASHCAM**?



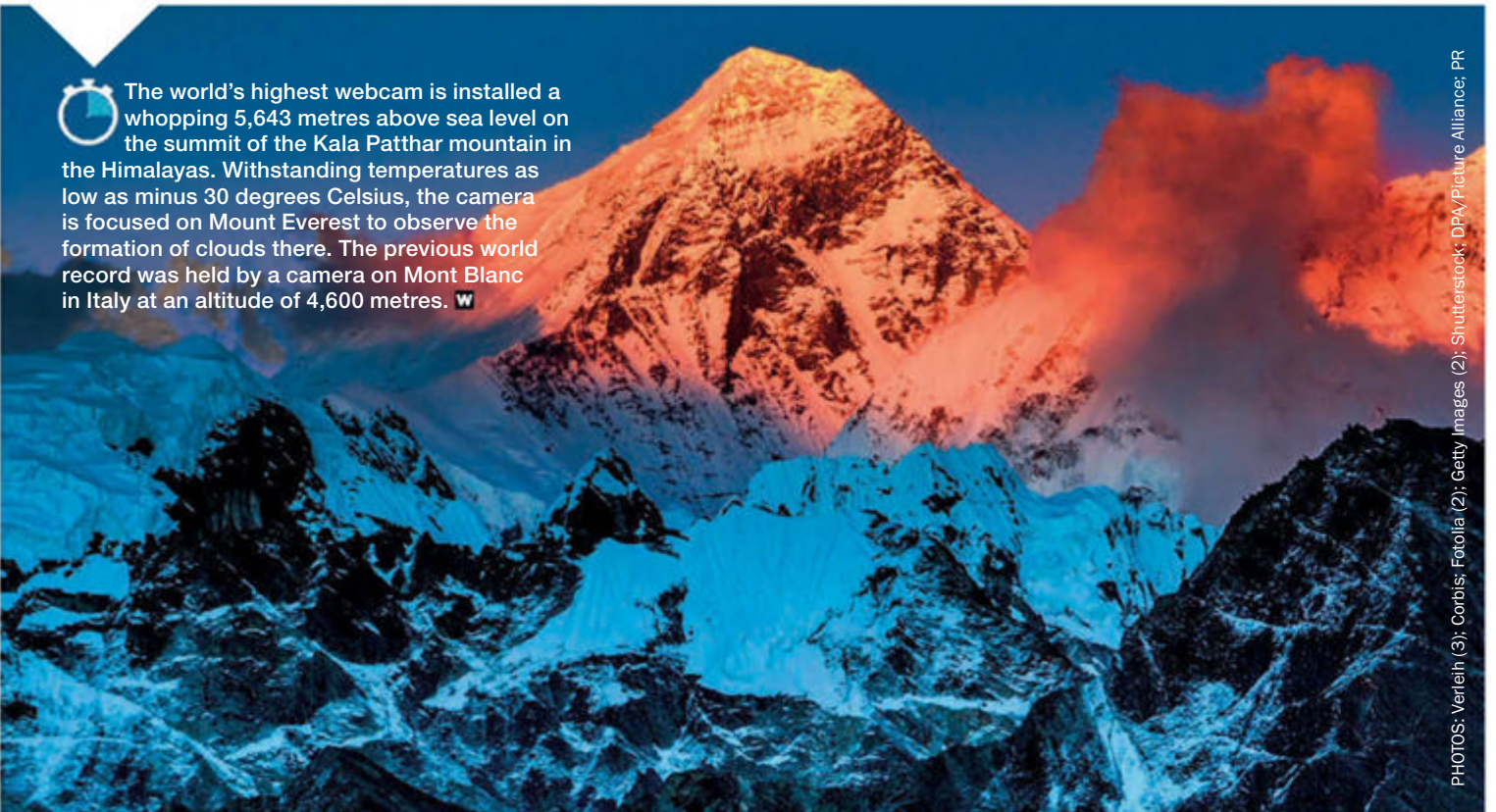
Dashcams, or dashboard cameras, are devices that continuously record the traffic in front of the car.

Everything is saved on a small hard drive – if it's full, then it's automatically overwritten. Depending on the model, dashcams can record acceleration and the distance travelled. Some cameras also have a night mode. The dashcam is supplied with electricity by a battery or cable.

WHERE IS THE HIGHEST **WEBCAM** IN THE WORLD?



The world's highest webcam is installed a whopping 5,643 metres above sea level on the summit of the Kala Patthar mountain in the Himalayas. Withstanding temperatures as low as minus 30 degrees Celsius, the camera is focused on Mount Everest to observe the formation of clouds there. The previous world record was held by a camera on Mont Blanc in Italy at an altitude of 4,600 metres. **W**



PHOTOS: Verleith (3); Corbis; Fotolia (2); Getty Images (2); Shutterstock; DPA/Picture Alliance; PR

THE BACK-YARD PLANET HUNTERS

Professional astronomers have already discovered around 2,000 planets outside of our solar system – but so far, Earth's twin has not been found among them. Now, legions of amateur planet hunters are taking up the search, too. And some of them are outperforming NASA's super-computers!

**POLAR PADDLE!**

Tap here to watch Go Pro footage of a polar bear swimming. And more!



KIAN JIN JEK

No formal training in astronomy but did what NASA super-computers couldn't...



ROBERT GAGLIANO

With Jek, found the first planet in the galaxy to orbit a solar system with four stars...



THE SWAN THAT CREATED THE SOLAR SYSTEM

The Cygnus constellation is considered one of the most productive and active regions in our home galaxy, the Milky Way. In contrast to the relatively calm spots that we call home, many new stars and planets develop there. That's down to the large amount of 'raw materials' required for the construction of solar systems that are present there – and it is a key reason for keeping the Kepler space telescope directed at this area.

WHERE IS EARTH'S TWIN HIDDEN?

The search area lies about 1,000 light years from Earth, equivalent to about 60 million times the distance between Earth and the sun. Using the Kepler telescope, researchers are discovering more and more unusual planetary systems there.

Seen with the naked eye, the shadow that sent Robert Gagliano into such a flurry of excitement is barely

discernible. Momentarily, the double star system KIC 4862625, located around 50 billion kilometres away, darkens. The light is only dimmed by one per cent, but it happens regularly, every 138 days. So what is behind this mysterious darkening?

Gagliano describes his discovery in a chat forum. There he meets Kian Jek, who has also stumbled upon irregularities. Neither man has formal training in astronomy, nor owns a telescope to help them look into outer space. Indeed, 70-year-old Gagliano only has an ancient computer – he's even blind in one eye. Yet despite this, both hobby astronomers have succeeded where the massive supercomputer and a team of NASA experts at the world's best universities failed: Gagliano and Jek have discovered the first

planet in the galaxy which orbits a solar system composed of not one sun, but four.

DO PLANETS EXIST THAT REALLY SHOULDN'T BE THERE?

This new world is so bizarre that it is proving hard for the astronomical establishment to accept it – because there is no theoretical explanation for how planets could form if they are being influenced by the gravity of four suns at once. By rights, they should simply tear apart under the pressure. But Kepler 64b is keeping the truth about its origin a secret.

The planet's mundane-sounding name – all objects identified by the Kepler space telescope are

numbered chronologically according to when they were found – doesn't hint at the explosiveness of the finding. "The discovery of these systems is forcing us to go back to the drawing board,"

'The next Columbus of star research could be a child'

explains the astronomer Meg Schwamb, from Yale University in Connecticut, USA.

The scientists have checked the data from Gagliano and Jek over and

ALPHA CENTAURI

4.37 ly

The third-brightest star in our night sky is actually a triple system. It is the sun's nearest neighbour.

1 ly

1 light year = 9.5 trillion km

5 ly

10 ly

OORT CLOUD

0.79 ly

This supposed cloud of tiny pieces of ice orbits the sun at the edge of the solar system. It is between 2,000 and 5,000 times further from the sun than the Earth.

SIRIUS

8.6 ly

Sirius is the brightest star in the night sky and also a neighbour. Exactly twice the size of the sun, it is 25 times brighter than our star.

5 PER CENT

of all stars **are orbited by**
a copy of the Earth.

over again, but there is no doubt: at least one planet the size of Neptune is orbiting two stars simultaneously – one star is one and a half times the size of our sun, the other is about half the size. Meanwhile, a second pair of stars orbits all three – a model that nobody thought possible before now. Its discoverers imagine a spectacular world: from the surface of the planet, you would have a perfect view of four suns in the sky – all at the same time!

It seems almost unbelievable that the experts could miss such a finding. But how did amateurs like Gagliano and Jek manage to outdo the professionals and surpass the elaborate algorithms of a super-computer? The pair belong to a global task force – the planet hunters – which currently has about 170,000 members. The team trawl

through the publicly available data and photos from space authorities like NASA, whose Kepler Space Telescope was launched in 2009.

Kepler was sent into outer space in order to search for extrasolar planets, but the resultant flood of data overwhelmed the community of astronomers: until an accident put it out of action, Kepler took a photo of around 160,000 stars every half hour. This amounted to millions of images over the course of several years, each with a resolution of 95 megapixels. No human would live long enough to analyse such a mass of data in detail.

What the astronomers hope to find is the equivalent of a stellar blink. Now and then a star turns dark for a very brief moment – sometimes it's just the flickering of an eruption on the star,

sometimes a fluctuation in the surface temperature, but others it's a planet passing in front, which, like a mini solar eclipse, shields a small section of the radiation and leaves behind a distinctive fingerprint in the star's light pattern. And this is where planet hunters like Jek and Gagliano come into play. Like detectives, they look for these traces, analyse them and search for further clues.

"Computers can quickly search large amounts of data according to specific parameters, but that's all," explains the astronomer Ji Wang from Yale University. But what if nobody can tell the computers what they should be searching

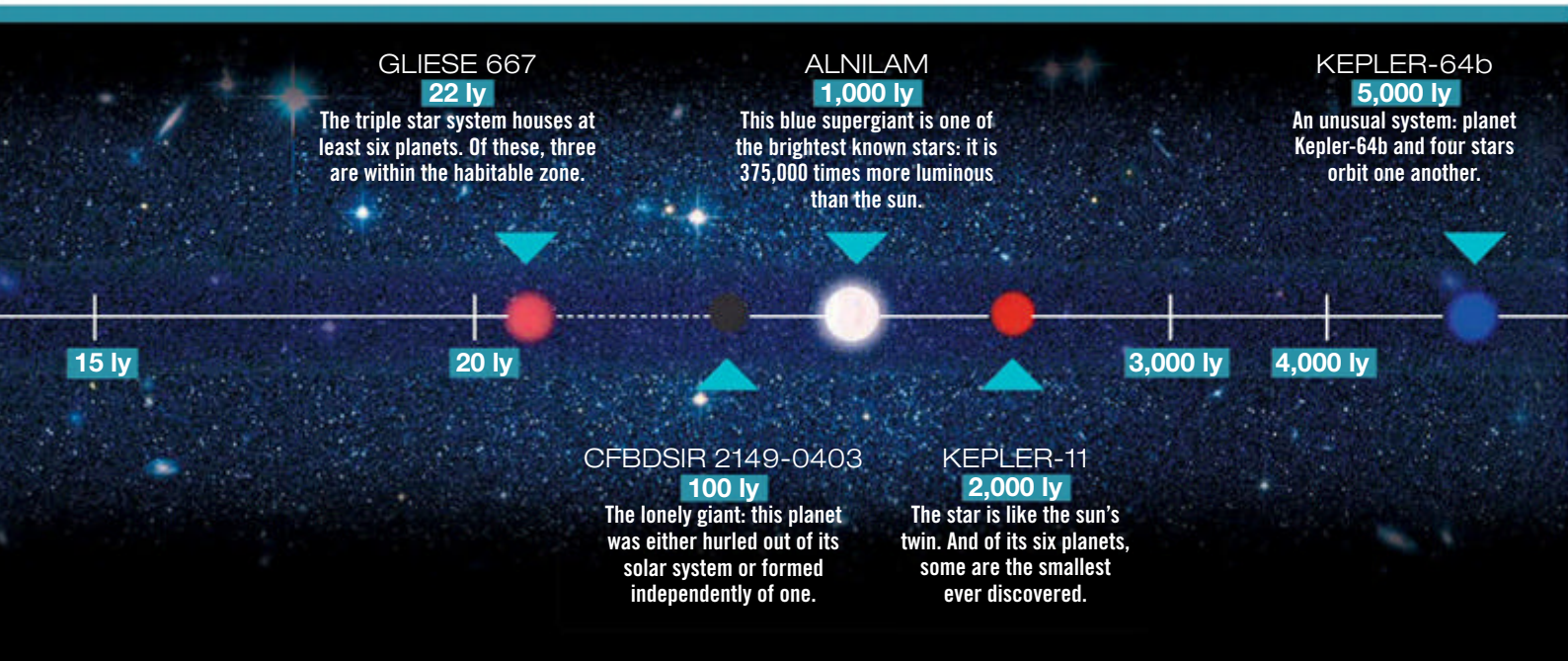
PLANET HUNTER

KIAN JIN JEK
still likes to use his
backyard telescope
– but his passion is for
extrasolar planets.



for? Only the human brain can recognise unknown patterns. For this reason, planet hunters composed of flesh and blood will always trump digital ones.

Planet hunters are especially important in the search for Earth's galactic twin. Copies of uninhabitable gas giants like Jupiter >



HOW DOES A BREAKDOWN SERVICE IN SPACE WORK?

Harnessing the power of the sun to rescue the telescope //////////////////////////////////////

MISSION PROFILE

'SECOND LIGHT'

ORIGINAL START:

7 March 2009

FAILURE DATE:

15 August 2013

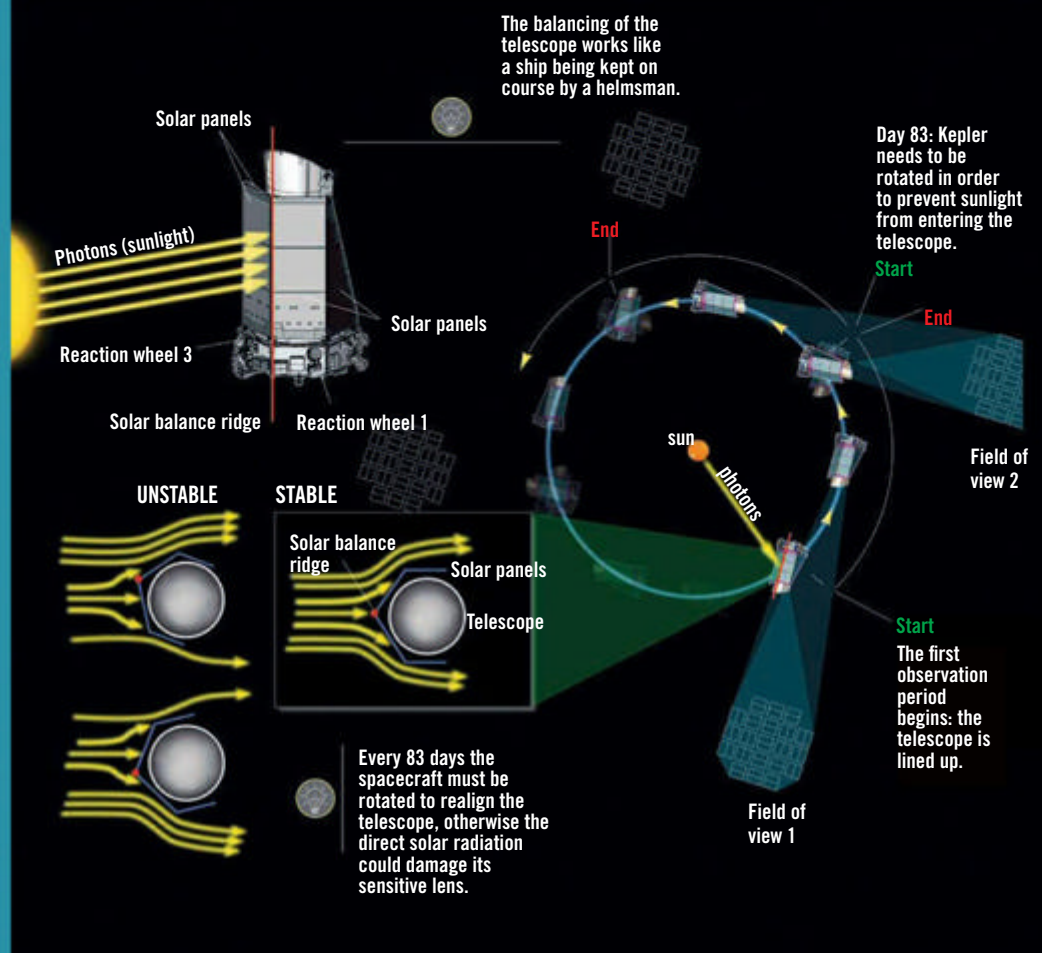
NEW MISSION DATE:

Spring 2015

INSTRUMENT MASS:

1,052 kg

The Kepler space telescope uses four gyroscope-like reaction wheels to help in its search for planets outside of our solar system – but an accident has put half of these out of action. This means the telescope can no longer be aligned. The technicians taking part in the NASA mission 'Second Light' are now considering whether it's possible to use the energy pressure from the sun as a kind of third steering wheel to stabilise the telescope like a sail. And while the pressure of a single photon of light from the sun is infinitely small – under the conditions of weightlessness and with enough photons, it could be enough.



and Saturn take a lot of the star's luminosity during transit on account of their relative size, which makes finding them a piece of cake. But what about the comparatively tiny, rocky planets like Earth, quadrillions of kilometres away, which only pass



PLANET HUNTER
ROBERT GAGLIANO
needs only one eye,
his brain and a bit
of imagination to
outdo NASA.

by their home star once a year or even less frequently? A planet hunter at the other end of the galaxy

would have to catch the 0.01% decrease in light which our Earth triggers every 365 days when it passes by the sun.

Astronomers estimate that roughly 5% of all stars are orbited by an exact copy of the Earth. But of the 2,000 verified exoplanets found to date, none of them have been a candidate for a second Earth: a sphere of the same size and mass, which orbits a star like our sun at a similar distance.

"We have reason to believe that planet hunters in particular are discovering the slow-orbiting and potentially habitable planets," says Wang. The fascinating thing is that

the discoverer of a potential second Earth doesn't need any technical knowledge or training. What's required above all is imagination, creativity and access to the internet. It's enough to observe the light curve of a star over the passage of time and to recognise distinctive patterns within it. The next great explorer – like a modern-day Christopher Columbus – could make the breakthrough discovery from their childhood bedroom. Planet hunter Robert Gagliano has been back at his machine for some time – and encourages others to do the same: "If I can discover a planet," he says, "then so can everyone else."

PHOTOS: Corbis; NASA (3)

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THE VAN GOGH CONSPIRACY

For decades the official line has been that Vincent van Gogh took his own life. Now a team of historians and forensic scientists has taken a closer look, questioning the painter's premature death

HOW DID 'THE GENIUS' REALLY DIE?



Vincent van Gogh gazes across the vast, carpet-like cornfields of Auvers-sur-Oise, France, one last time. Plagued for months by hallucinations and bouts of depression, the 37-year-old reaches into his bag, pulls out a revolver, holds it to his body and pulls the trigger.

On 27th July 1890, one of the most famous painters in the world takes his own life.

Suicide. That's the result of the autopsy which took place just days after the tragedy, and what is repeated in timelines and books many years later. Even now, more than a century later, the internet reports the same thing.

But one team of historians and forensic scientists believe the incident never happened that way. After

years of studying official documents, witness statements and ballistic reports, they're convinced of one thing: the story of Vincent van Gogh's death needs to be rewritten. So what exactly *did* happen in the last hour of his life?

'WOULD YOU
REALLY TRY TO KILL
YOURSELF **WITH
A BULLET TO
THE STOMACH?**'

In May 1890, three months before his death, Vincent van Gogh moved from Paris to Auvers-sur-Oise, a small town 30 kilometres north of the French capital. Once there, the artist rents a room in the Auberge Ravoux guesthouse and engages in a true creative frenzy. Over the following 68 days he completes more than 80 paintings and 60 drawings set among the



THE MOST FAMOUS SELFIE IN ART HISTORY

Very few artists painted as many self-portraits as Vincent van Gogh. His most famous – and last – one was painted in 1889, just a year before his death. Today it hangs in the Musée d'Orsay in Paris.





i THE GENIUS
Dutch painter Vincent van Gogh (1853-1890) is considered the founder of modern painting. In his short career, he completed 864 paintings and more than 1,000 drawings. For years Van Gogh suffered from depression and hallucinations. Whether it was Van Gogh himself or his companion and fellow painter Paul Gauguin who famously cut off part of his left ear has never been ascertained.

The picture above is the work of photographer Tadao Cern. Using a model and Photoshop, Cern has mimicked the famous self-portrait of Vincent van Gogh [see previous page].

cornfields and in the small village streets. Then came 27th July 1890. On this day, Van Gogh returns to his lodgings without his easel, severely injured by a gunshot wound to the stomach. He drags himself to his room where, 29 hours later, he dies.

Allegedly, shortly before his death, a policemen asked him if he had been trying to kill himself. "I think so," Van Gogh is said to have groaned in reply. But why would you take an easel with you if you were planning to commit suicide? Why would you shoot yourself in the stomach? And why didn't Van Gogh try to end his misery with a second shot, instead of dragging himself back to his guesthouse and suffering in agony for hours?

It's precisely these questions that historians Steven Naifeh and Gregory White Smith asked when they began researching their biography of Vincent van Gogh. Today, 13 years later, both Pulitzer Prize winners are convinced: Vincent van Gogh was murdered. In their opinion, the historic descriptions of the gunshot wounds in particular don't allow for any other conclusion. To allay any possible doubt, the historians contacted

'FROM A FORENSICS ANGLE, IT'S UNLIKELY THAT VAN GOGH SHOT HIMSELF'

a leading expert on handguns, Dr Vincent Di Maio. He's a coroner who has testified in numerous court cases, including that of gunned-down US teenager Trayvon Martin. His conclusion: "From a forensics angle, it's unlikely that Van Gogh inflicted his deadly wounds himself. He did not shoot himself." Di Maio based his findings on the fact that no traces of gunpowder were found on the artist's hands. This is difficult to explain away because weapons at the time were still loaded with gunpowder.

"Wounds inflicted by a weapon loaded with gunpowder fired at close range are extremely dirty," explains Di Maio. The forensic scientist also thinks it unlikely that Van Gogh, as a left hander, would have been able to shoot himself



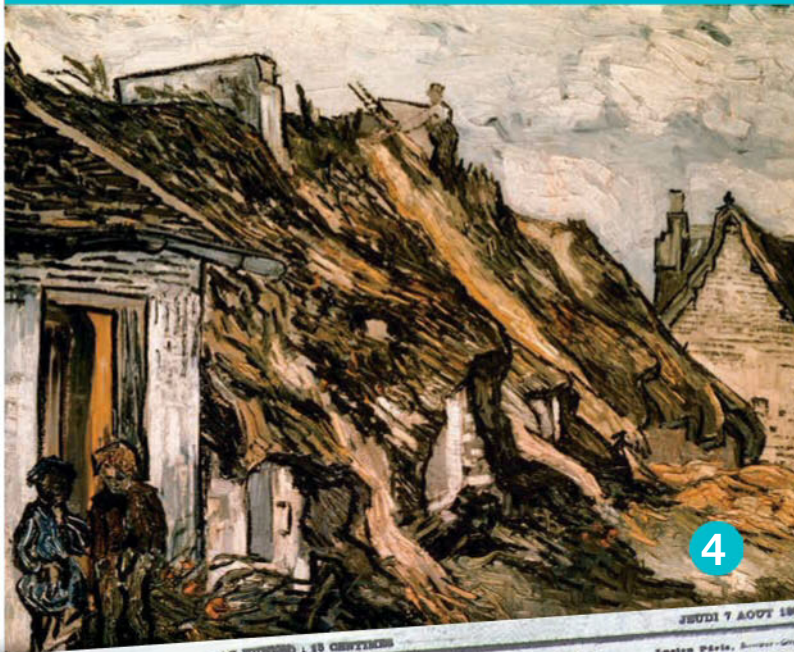
HIS MASTERPIECES AND THE LAST NIGHT BEFORE HIS DEATH

- 1 On 20th May 1890, Vincent van Gogh moved into a room in the Auberge Ravoux guesthouse in the French town of Auvers-sur-Oise. There he lived, together with other artists, until 27th July 1890 when he returned from a trip to a cornfield with a gunshot wound, laid down in his bed and died two days later. As a result, the Auberge Ravoux has become known as Van Gogh's place of death and is a popular tourist destination. Van Gogh's room remains unchanged to this day.
- 2 This portrait of a young woman shows Adeline Ravoux, the landlord's 12-year-old daughter, who saw Van Gogh return to the guesthouse. The painter however went straight to his room.
- 3 'Starry Night' is one of Van Gogh's most famous paintings. It was painted in 1889 in Saint-Rémy-de-Provence.
- 4 Shortly before his death he completed the painting 'Thatched Sandstone Cottages in Chaponval'.

in the stomach from such an angle. Last but not least, the lack of powder traces – certified in the autopsy report – seems to indicate that the shot must have been fired from a distance of at least half a metre. Under these conditions, it is extremely difficult to shoot yourself. But if it wasn't Van Gogh himself, who was it that shot one of the founders of modern painting?

In an attempt to answer this, Naifeh and Smith have collected some interesting evidence. For example, on the day of his death, Van Gogh was seen by eyewitnesses outside the house of Rene Secretan – a 16-year-old youth who had been bullying the artist and who also owned a small-calibre weapon, which often misfired. Almost 125 years later, the boy remains the two historians' prime suspect. **W**

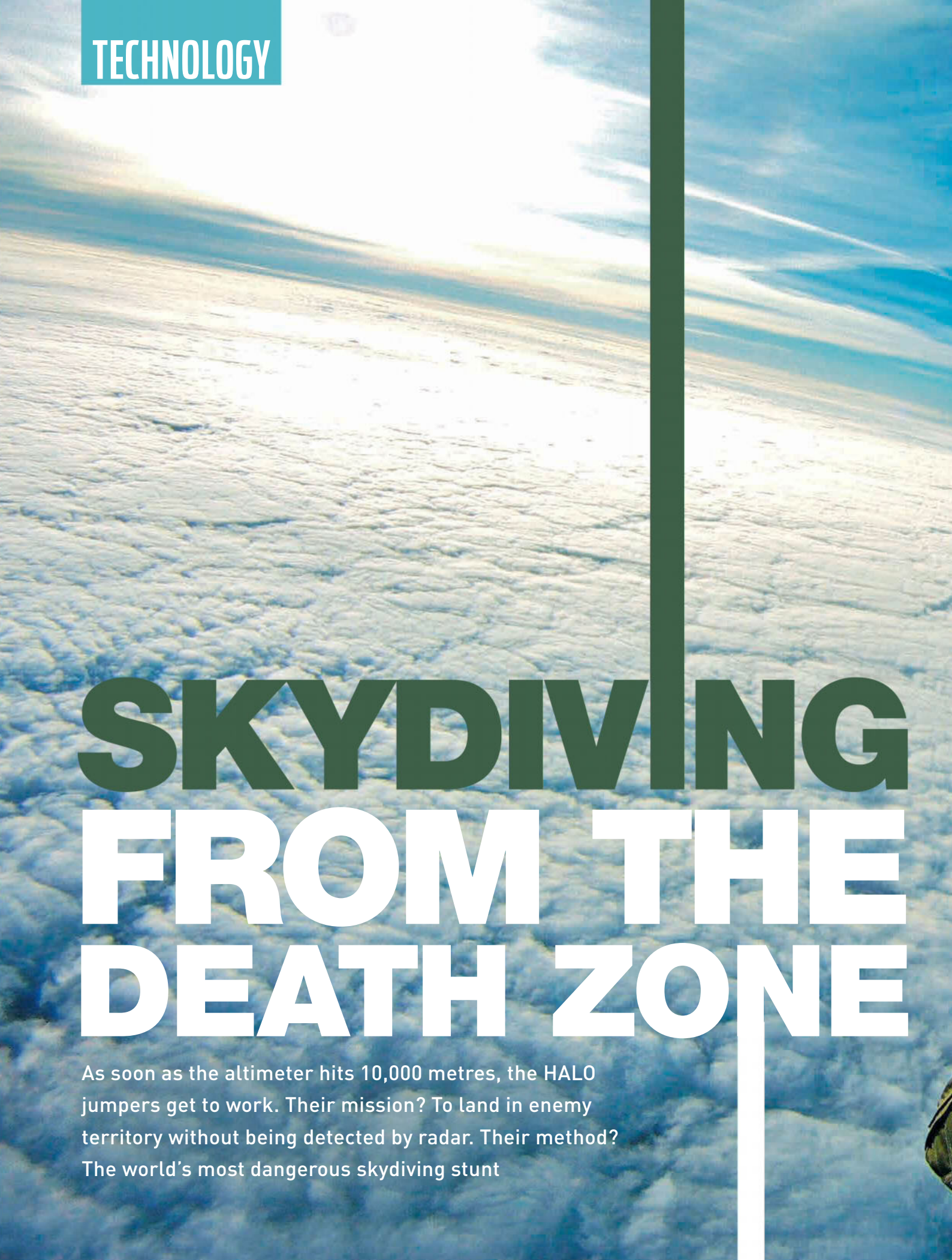
PHOTOS: Getty Images; Corbis; AKG/DPA/Picture Alliance (3); Tadao Cerri; PR



THE BIRTH OF A MYTH

On 7th August 1890, French newspaper *L'Echo Pontoisien* published an article about the death of Van Gogh. It stated that the Dutch painter had turned a weapon on himself, pulled the trigger and then returned to his lodgings severely wounded, where he died the following night.





TECHNOLOGY

SKYDIVING FROM THE DEATH ZONE

As soon as the altimeter hits 10,000 metres, the HALO jumpers get to work. Their mission? To land in enemy territory without being detected by radar. Their method? The world's most dangerous skydiving stunt



10,000 METRES, TWO OPTIONS

The military use two different techniques when parachuting from 10,000 metres: in a HAHO jump (high altitude, high opening), the soldier deploys his parachute immediately after jumping out of the aircraft and travels for several kilometres before landing [this photo]. In a HALO jump (high altitude, low opening), the soldier freefalls for about two minutes before deploying his parachute – just 700 metres above the ground [see next page].

A full-page background image of a HALO jumper in freefall. The jumper is wearing a dark flight suit, a helmet with goggles, and a complex harness with various equipment. They are positioned diagonally across the frame, with arms outstretched. The background is a deep blue sky filled with stars and some wispy clouds near the bottom. A vertical white line runs down the left side of the image, separating the text area from the main visual.

A WORKPLACE IN THE SKY

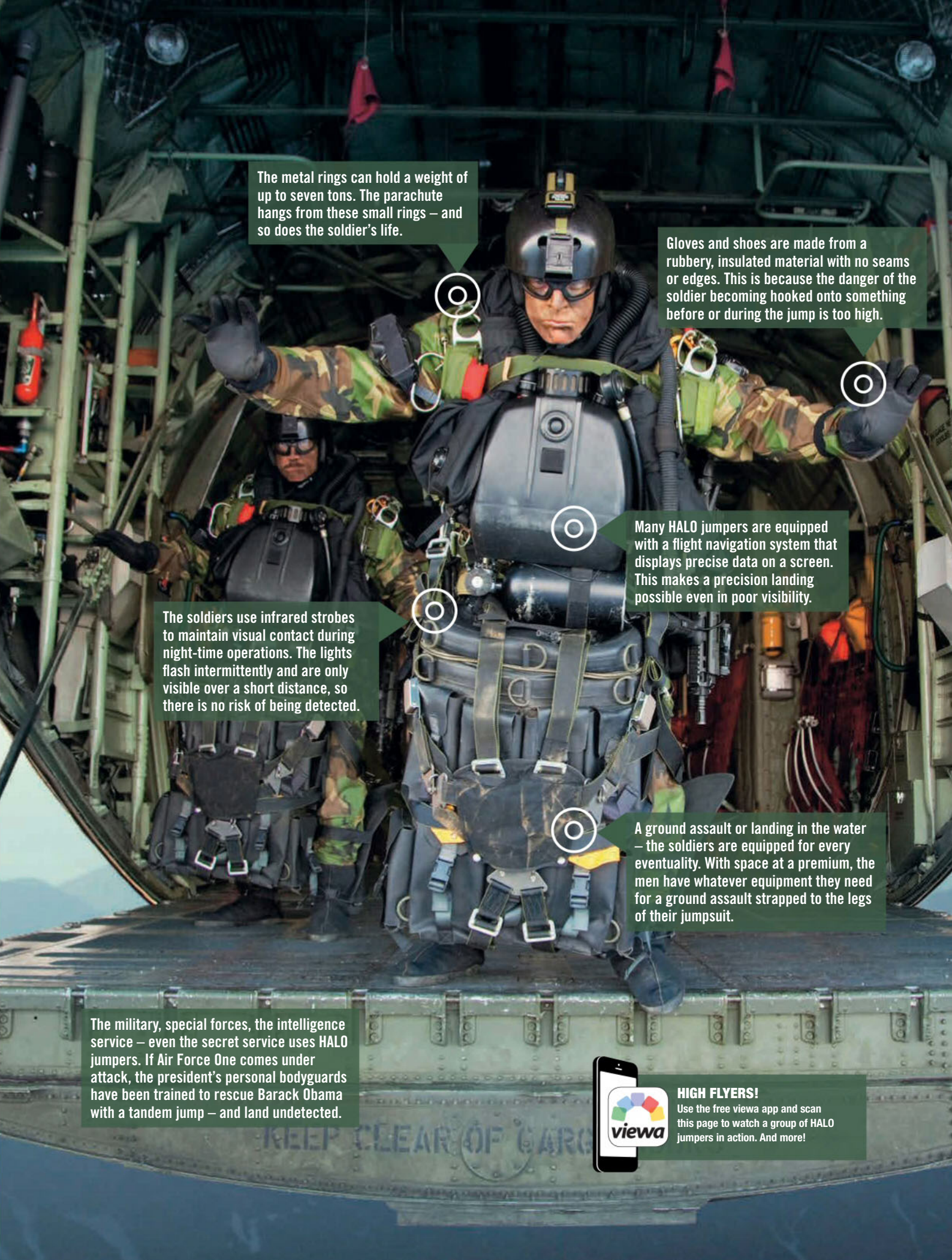
There are no official statistics on the number of HALO jumpers operating in the world. What we do know is that every year only a few hundred men obtain a prized place in the Military Freefall School in Arizona, USA. Most will learn not only the HALO technique, but also how HAHO jumps work. The training covers theoretical instruction, ground exercises and training missions in heavy rain and thunderstorms – anyone who completes the course will be prepared for even the most demanding jump.



TEAM SPIRIT

Candidates have to pass several health tests and psychological evaluations before they become HALO jumpers – not least to prevent them from endangering their fellow soldiers.



A HALO jumper is shown inside the cargo bay of a military aircraft, preparing for a jump. The jumper is wearing a full-body jumpsuit with camouflage patterns on the sleeves and legs, a helmet with a night vision device, and a large parachute pack on their back. They are standing on a metal platform, and their arms are raised, showing the metal rings used for the parachute. Another jumper is visible in the background, also in the cargo bay.

The metal rings can hold a weight of up to seven tons. The parachute hangs from these small rings – and so does the soldier's life.

Gloves and shoes are made from a rubbery, insulated material with no seams or edges. This is because the danger of the soldier becoming hooked onto something before or during the jump is too high.

The soldiers use infrared strobes to maintain visual contact during night-time operations. The lights flash intermittently and are only visible over a short distance, so there is no risk of being detected.

Many HALO jumpers are equipped with a flight navigation system that displays precise data on a screen. This makes a precision landing possible even in poor visibility.

A ground assault or landing in the water – the soldiers are equipped for every eventuality. With space at a premium, the men have whatever equipment they need for a ground assault strapped to the legs of their jumpsuit.

The military, special forces, the intelligence service – even the secret service uses HALO jumpers. If Air Force One comes under attack, the president's personal bodyguards have been trained to rescue Barack Obama with a tandem jump – and land undetected.



HIGH FLYERS!

Use the free viewa app and scan this page to watch a group of HALO jumpers in action. And more!



SKYDIVING OVER THE ENEMY

Pilots can limit the information a military aircraft sends to the enemy's radar system. Turning off the transponder, a device that emits an identifying signal to the radar, is a favourite technique used in military operations over enemy territory. The radar then only identifies the aircraft as a cargo plane and not as a military threat. That gives the flight crew time to deliver the soldiers to the drop zone and return to base.

High up above the clouds, the sky is pitch black. Twelve heavily armed men are flying through the darkness. One of them keeps checking the illuminated display of the altimeter on his wrist. When it reaches 7,300 metres, a voice crackles over the headset: "We are entering the death zone." And still the number on the altimeter keeps climbing...

The 12 men in the aircraft belong to the elite unit of the US Navy SEALs. Their mission: to land undetected in Iraq. Their method: a HALO jump out of a military aircraft. HALO stands for high altitude, low opening – the men in this unit jump from altitudes in excess of 10,000 metres, and don't deploy their parachutes until the very last minute when they're 700 metres above the ground. It's an extremely risky jump. And the reason why they receive specialist, in-depth training.

HALO jumpers are generally deployed when the mission is to hit a target with no advanced warning. Tonight the target is a terrorist cell in southern Iraq. The SEALs want to catch the suspects off guard and with no chance to destroy key evidence, which is why they chose a surprise, precision attack from the air. Using the HALO technique means the men will not show up on



READY FOR ANYTHING

HALO jumpers carry equipment weighing up to 65kg. Their kit contains the following: helmet with an integrated night vision camera, an inflatable UDT life jacket, oxygen tanks and mask, gloves with an altimeter on each wrist, special boots, an audible altimeter, a hook knife and a thermal jumpsuit. The soldiers also have to carry full combat gear – weapons, waterproof body armour and ammunition – as well as a radio unit and provisions for the ground assault.

The MC-5 parachute was developed for use in military freefall operations. It is important for it to be oversized, so that it can support a soldier and all of his equipment.

The soldiers get used to jumping with an oxygen supply during training. A hose connects the oxygen mask to the two tanks harnessed to the jumpsuit.

Two wrist-mounted altimeters display the current altitude. They are connected to an automatic activation device that deploys the parachute if the jumper is still in freefall at 225 metres.



enemy radar screens and trigger the early warning system. In terms of surface area on a radar screen, a person falling through the sky looks just like a bird. And to make radar detection even less likely, the men have high-tech jumpsuits made with a radar-absorbent material. And yet a HALO jump from 10,000 metres is still an extremely dangerous exercise, even for highly trained paratroopers. The slightest loss of concentration could lead to death.

A DEATH ZONE ABOVE THE EARTH

The aircraft carrying the SEALs continues its climb into the death zone. Temperatures outside have plummeted to minus 50 degrees Celsius and the air pressure has dropped dramatically. It's down to about a quarter of the normal air pressure on the ground, creating a huge strain on the lungs. The air is too thin to breathe. You'd lose consciousness after a couple of minutes, and after six minutes you'd be dead – that's why the soldiers wear oxygen masks.

The jumpers' equipment, which is secured to the legs of the jumpsuit with extra-strong metal rings, can weigh as much as 65kg. Every item has to be in the right place – when

soldiers are hurtling towards the ground at 320km/h, nothing can be allowed to move around. A dangling weapon or an oxygen tank that hasn't been properly secured can become a deadly weapon in the air.

JUMPING FROM PASSENGER PLANES

HALO jumpers will leap from any aircraft that can take them to an altitude of up to 10,000 metres – including passenger planes. This is a strategy not uncommon to Navy SEALs. Passenger planes are authorised to fly just about anywhere in the world and no one suspects them of carrying out military missions. Unlike with military aircraft, it's also practically impossible to close off air space to civilian planes. The only problem with them is the cabin pressure, which, at cruising altitude, is about four times higher than the air pressure outside the aircraft. At 10,000 metres, the atmosphere exerts six tons of pressure on every square metre. Before jumping, the pressure is equalised and all of the soldiers breathe through oxygen masks. Only then, do they open the hatch and jump out of the aircraft.

The Navy SEAL HALO team has been in the death zone now for 15 minutes. The altimeter reads nearly 10,300 metres. Finally, they get the signal to jump. Without hesitation, the soldiers leap out of the aircraft into the night air. And the air can be a rather unpredictable foe, which is why the soldiers receive special training for jumps from the stratosphere, the layer of the Earth's atmosphere ten to 50 kilometres above the surface.

The men are in freefall for about two minutes, accelerating at a rate of about 9.81 metres per second. That means they hit a top speed of 320km/h – about as fast as a Formula 1 car – after only 9.3 seconds. At this pace, the most important thing is to keep your

back straight. Without this simple trick, they could start spinning uncontrollably. Every one of the 12 SEALs is acutely aware: when you go into a flat spin, it rarely ends well. If the upper part of your body is the centre of rotation, blood races to your feet and you can lose consciousness. If the rotation is in the lower part, blood races to your head which can lead to a so-called redout. That can result in anything from a bad headache to blood vessels bursting in the eyes and brain. The longer the spin lasts, the more dangerous it becomes.

But today everything goes smoothly. After freefalling 9,600 metres from the death zone, the paratroopers pull their ripcords 700 metres above the ground. Even though the night sky was clear and cloudless when they jumped, down below the fog is getting thicker. Air navigation systems indicate where the men need to go. Suddenly they see the target through the fog: an isolated wooden house. The same men that were hurtling towards the ground just a few seconds ago, now glide silently through the night and make a precision landing after one of the world's most dangerous skydiving jumps. The impact of the landing is about the same as you'd experience jumping from a height of three metres.

When all of the men are assembled on the ground, they bury their jump equipment and continue on in full combat gear. They storm the house, taking the sleeping terrorists by surprise – after only ten minutes they have the whole situation under complete control. Twenty-four minutes later, and ground assault troops take over from the SEALs. The men recover their equipment before a S70 Blackhawk helicopter picks them up and takes them back to base. Time to unwind – at least until their next surprise attack from the death zone. **W**

“Jumping out of a plane at night... it's like stepping out into a black void.”

Ryan Zinke,
Former Navy SEAL

THE SHADY WORLD OF CORPORATE TRICKS

The use of tricks to deceive millions of people is ingrained in big business; corporations are now the least-trusted entities in the world. Over the following pages, we reveal how to spot their most common strategies

W

Who can you trust? That's the question leading market research group GfK asks 28,000 people across 25 countries every year. The annual survey shows which institutions the public views as honest – and which are seen as being shifty and underhand. According to the latest results, 81% of the public trust the police, 65% trust the law and 43% trust the media.

What's surprising, however, is what's at the bottom of the list: only 26% of the people polled believed in the honesty of corporations. It's an opinion shared around the world and applies to almost all sectors of the economy. Whether it's the food industry, energy sector, banking or insurance companies – the distrust of big businesses has reached record levels. According to another study, the public also views them as being corrupt, with only

political parties faring worse. But why do so many people feel deceived by corporations? Do they lie as much as everyone thinks they do? And if so, how exactly do they do it?

“The industry has lied to and deceived us for 50 years – at the cost of our health.”

US District Court Judge Gladys Kessler

It's one of the most expensive advertising campaigns in the economic history of the USA: full-page ads are run in the Sunday editions of the leading 35 US newspapers for a whole year. Primetime TV adverts are aired five times a week on the biggest networks CBS, ABC and NBC. The text is always the same: “The tobacco industry has deliberately deceived the American public about the health effects of smoking.”

However, what's spectacular about this campaign is not its message or how that message is delivered, but who's paying for it – the four largest tobacco companies in the USA. For the first time, these companies have admitted that they knowingly lied to the public

for decades. It makes the campaign the biggest admission of guilt in the history of the tobacco industry. That said, the confession definitely wasn't voluntary. Instead, it was US District Court Judge Gladys Kessler who forced the tobacco companies' hands following a sensational trial. It was the first court-ordered confession in the history of capitalism. “The industry has lied to us and deceived us for 50 years – at the cost of our health,” says Gladys Kessler. It's time for payback.

But the uncovered lies of the tobacco cartels are just the tip of the iceberg: secret price-fixing by phone and energy companies, food scandals, illegal data-mining, insider trading and a multitude of banking scandals – a new corporation ends up in court every month. Despite this, many are still reporting record profits. For some sectors of industry, however, this could be about to change...

It's only one sentence – but it's a sentence that could end up costing corporations billions in the future. A French consumer law, passed in October 2014, states: “In future, manufacturers who deliberately shorten the lifespan of



Budget airlines prefer to use small regional airports to benefit from the lower fees they charge.

1

The destination trick

BOOK A TICKET TO MELBOURNE, AND YOU'LL LAND IN MELBOURNE

Paris, London, Melbourne – low-cost airlines hide their true destinations behind these city names. Even though the name suggests otherwise, in reality the airports are often miles away – and some don't even offer a fast connection to the city centre via public transport. In order to offer the lowest prices, budget carriers choose provincial airports that often have much lower landing fees. Good news for the airline's bottom line, not such good news for time-

sensitive holidaymakers. The situation is particularly bad in Europe. For example, those booking a weekend break from London Stansted to Frankfurt without first doing their homework might have a shock: the round trip from both airports to the actual cities adds up to nearly 570km. In total, the transfers waste a precious five hours holiday time. Typically, low-cost airlines will also work to less convenient timetables, meaning an early start or late arrival is often unavoidable.

i

AIRPORT
DISTANCES

M'BOURNE-AVALON

56 KM

FRANKFURT-HAHN

124 KM

MUNICH-MEMMINGEN

114 KM

LONDON-STANSTED

61 KM

PARIS-BEAUVAIS-TILLÉ

85 KM

OSLO-TORP

120 KM

TOKYO-NARITA

60 KM

their products will be guilty of fraud." The French government was responding to one of the oldest and most lucrative profit strategies of corporations – so-called obsolescence, also known as 'killing off' your products.

The obsolescence conspiracy can be traced back to 1924. In a Geneva backroom, the bosses of the world's largest light bulb manufacturers meet to set up an illegal cartel. The most important result of their meeting: the lifespan of a light bulb, which had previously been 2,500 operating hours, would be limited to a maximum of 1,000 hours. For the first time in history, a mass-produced item sold by a number of leading manufacturers is deliberately manipulated to make sure it breaks down

early – to sell more products, of course. The so-called Phoebus cartel of light bulb manufacturers is just the tip of a gigantic iceberg of industry conspiracy – one which still continues today...

"To be commercially viable, a product must generate as much profit as possible. If a printer lasts twice as long, the customer will take twice as long to come back."

Industrial engineer Christian Kreiss

The electronic appliance breaks just after the warranty period has expired? The battery of the MP3 player gives up the ghost after being charged 500 times? The smartphone's software

is obsolete after two years, meaning that no apps work? Experts are convinced: more and more companies are implanting a 'suicide code' into their products, reducing their lifespan and forcing people to buy a replacement. "To be commercially viable, a product must generate as much profit as possible. If a printer lasts twice as long, the customer will take twice as long to come back," says industrial engineer, Christian Kreiss.

However, planned obsolescence is still difficult to prove – mainly because the corporations don't rely on one process alone. This means that many companies reach a settlement with prospective claimants out of court.

The newly adopted law in France could



mean higher penalties for electronics manufacturers who deliberately limit the useful life of their products. The law states that this could be up to 10% of the company's annual turnover. For IT giants Apple, under fire by some who claim their multi-million-selling iPhone has a short useful shelf life, that would be a hefty \$18 billion. In reality, however, the justice and policy of the new law can't be relied upon, as the links between the corporations and the policy makers in the corridors of power are too close...

"The more money a company gives lobbyists, the higher their profits."

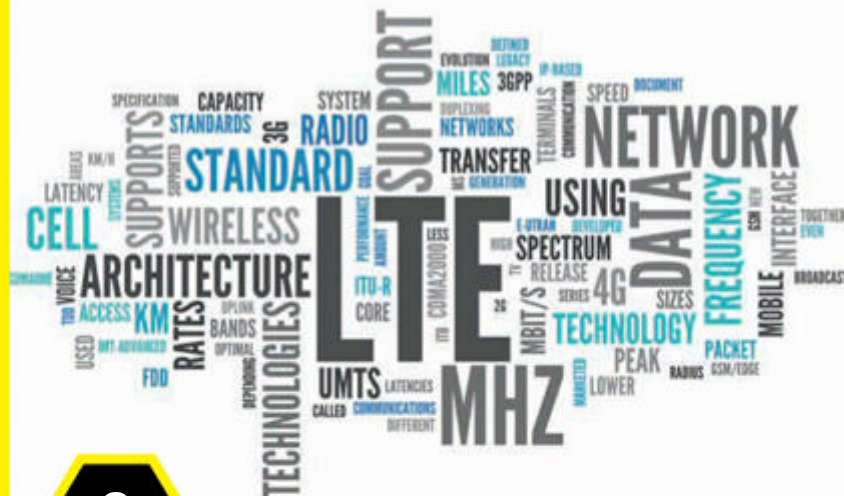
Daniel Clifton, Strategas Research Partners

The US consultancy firm Strategas Research Partners has investigated the link between a company's profits and its spending on lobbying. It revealed that the shares of companies that spend a lot of money influencing politicians do far better on the stock market than those that don't use lobbyists. According to them, each dollar spent on influence is worth \$200 in the long run.

"It's true today that lobbying generates higher profits than innovation," says Edmund Phelps, winner of the Nobel Prize in Economics and professor of economics at Columbia University.

In fact, lobbyists can influence politics to the extent that laws are passed to promote the sale of specific products, even though it only benefits one body: the company that paid for it. For example, it's been revealed that the government-funded insulation of thousands of buildings in some European countries had neither a positive effect on the environment nor was a money saver for the tenant or homeowner. Instead, the main beneficiaries of the process were the companies that sell the insulation materials, who have since reported record sales – suggesting that the people who really control government ministers' programmes sit in the boardrooms of big companies.

Here, *World of Knowledge* has collected some of the most shocking examples of lobby deals, cover-ups and lies...



2

The internet trick

THE BROADBAND SPEED YOU PAY FOR IS THE BROADBAND SPEED YOU GET

Australia has a very competitive broadband market. The big internet providers promise speeds of 10, 20 or even 100 Mbps (megabits per second), even though we rank 44th in the world when it comes to broadband speeds (an average of 6.9 Mbps at the end of 2014). And while it's reasonable to expect the speed you pay for will be the speed you achieve, this is rarely the case. Buried in the small print of your contract is probably a clause stating that a certain data transfer rate within the described bandwidth corridors not being guaranteed – or words to that effect. For most internet users,

though, there is no such thing as speed. There is only 'throughput'. The truth is that the internet providers have a pretty good idea of the capacity of each customer's line and the sorts of speed they should be able to achieve. This will vary depending on a number of factors such as how close you are to the nearest exchange (the nearer, the better) and the type of data cable used in the house. Throughput can also be affected by the number of people sharing your broadband connection, the particular website you are visiting and the time of day you are using the internet.

3

The make-up trick

NATURAL COSMETICS ARE NATURAL

Natural cosmetics are sustainable, healthy and natural – something all manufacturers legally claim, despite what's actually in their products. This is because the term 'natural cosmetics' is neither clearly defined nor properly regulated. A report by consulting firm Kline & Company found that the majority of natural cosmetics sold worldwide are merely 'natural-inspired' and mostly made up of synthetic products. Many contain ingredients grown using pesticides and herbicides. Thus, conventional cosmetic products can be labelled as 'natural' even if only a tiny percentage of the total

ingredients are from natural sources. There are currently no Australian standards defining natural cosmetics. But this could soon change, if we follow a lead from Europe. Cosmos, a six-year effort between national certification bodies, has created a Europe-wide standard for natural beauty products. The standard does not currently require a minimum of organic ingredients, but many commonly used ingredients such as parabens and GM ingredients cannot be used. And while this won't mean an end to all claims of products being 'natural', it should help consumers navigate the many products on offer.

**4***The petrol trick*

THIS CAR DOES 4.7 LITRES EVERY 100 KILOMETRES

Car manufacturers specify the exact fuel consumption of their models – and demonstrate it with tests. But how accurate are the manufacturers' 'official' figures? The answer is not very. The standard test procedures give the industry a lot of leeway and allow them to carry out all sorts of tricks to boost performance: cars are fitted with smooth-running wheels to reduce rolling resistance. At the same time, cracks around the doors and windows are

taped up to reduce wind resistance. The engine is also specially tuned and the car kept in a high gear for much of the test, further reducing consumption. A study by the International Council of Clean Transportation has analysed the data of more than 500,000 vehicles. The result? On average, new cars consume around a third more than is specified in their official description, costing drivers hundreds of dollars more per year.

Fuel for thought: manufacturer's fuel consumption figures are often wildly optimistic.

5*The environment trick*

BIOGAS IS AN ENVIRONMENTALLY FRIENDLY ALTERNATIVE TO OIL

Biogas is produced from manure, sewage and plant material and protects the climate – at last we can use waste to generate electricity. This was the original idea behind using alternative energy sources. However, since the developed world has supported the production of biogas, the demand for energy crops like corn has increased – the need can no longer be satisfied by waste alone. Billions have been spent on implementing biogas programs, including subsidies for farmers making the switch to cultivating maize. For them, it's more lucrative to grow fields of crops for fuel rather than food. The rental prices of agricultural land have increased up to three times because of the biogas boom. But the actual environmental benefit is questionable: burning biogas is carbon-neutral and releases the carbon dioxide the plants previously drew from the air. However, it takes a lot of energy to grow thousands of tons of corn, fertilise it, protect it from pests, harvest it, transport it and sow the seeds over the fields again. Furthermore, biogas plants are not airtight: escaping methane, the most important energy source in biogas, has a greenhouse effect 25 times more powerful than carbon dioxide. Nitrous oxide, which is also released, has a 300 times larger greenhouse gas potential than carbon dioxide.

i

WHERE DOES BIOGAS COME FROM?

Biogas is produced wherever bacteria break down organic matter in the absence of oxygen. It can occur naturally, for example in swamps and compost heaps. Commercial production takes place in a biogas plant, where the process is controlled: in large steel or concrete airtight containers (called fermenters) bacteria are supplied with new food on an hourly basis. A separate heating system keeps the fermenters at a constant 35 to 40 degrees Celsius. The slurry is continuously stirred inside the building, allowing the gas to escape. The biogas then has to be dried and desulphurised, since water vapour and sulphur can inhibit combustion. The raw material, therefore, contains about 50-60% methane, with the rest being carbon dioxide.

6*The fitness trick*

FUNCTIONAL FOOD STOPS ME GETTING ILL

Functional food is what the food industry calls products that have a potentially positive effect on health beyond basic nutrition. Many consumers are willing to pay a premium to achieve the extra benefits promised in advertisements. But, in truth, these quasi-medications may even be harmful. According to a study by the University Hospital of Saarland, for example, cholesterol-lowering margarine may even trigger cardiovascular disease in people without elevated cholesterol levels. There is evidence that the cholesterol-lowering phytosterols in the margarine can themselves trigger deposits in the blood vessels. Dr Aseem Malhotra of the National Obesity Forum advises her patients to stay clear of it, claiming that it is an artificial product full of unnatural ingredients.

Then there's probiotic yoghurt, which aims to strengthen the body's defences and aid intestinal flora. That's actually true, but it achieves much the same results as normal yoghurt. Added vitamins, meanwhile, are good in moderation, but too many can have the opposite effect. Vitamin A, beta carotene and vitamin E can shorten your life if taken in large quantities. Those who neck too much vitamin C and E can forget about ever running a marathon as the substances suppress the health-promoting effect of sport, while men who overdo it on vitamin E or selenium are also increasing their risk of cancer.





7

The dirt trick

A NEW PAIR OF TROUSERS ONLY CONTAINS LEGAL MATERIALS

A brand new, never-before-worn piece of clothing, straight from the shop. It should be spotless, completely clean. But, in truth, countless pairs of trousers, coats and shoes are dirty – with chemicals. Some goods manufactured in the Far East have been found to contain dimethyl fumarate, a chemical used to prevent mould growth in leather goods. Banned in the EU but not in Australia, the biocide can cause allergies, skin irritation and acute respiratory difficulty. Carcinogenic azo dyes and the allergen chromium trioxide were also discovered. Cotton clothes

can be especially at risk as producing a textile from the plants often involves using a variety of chemicals in the process of bleaching, shrink reduction and stain resistance. Some of these chemicals are applied with heat, thus bonding them to the cotton fibres. Just last year, research by Greenpeace found residues of toxic chemicals in clothes made by major brands. Though there was no evidence to suggest the levels of chemicals were high enough to cause harm, to minimise the risk you should always wash brand new clothes before wearing them.

i

PENTACHLOROPHENOL is a chlorinated hydrocarbon used as a fungicide to protect textiles in transit. This means the clothes don't get mouldy as they're transported from Asia to Europe. The chemical can cause acne, severe nerve damage and is carcinogenic.

TRICLOSAN is mainly used in functional clothing. It inhibits bacteria growth and the development of body odour. However, the substance also attacks the natural microbiomes on our skin. The result? Antibiotic resistant strains of bacteria can develop due to triclosan.

FORMALDEHYDE is used to give non-iron shirts an unwrinkled appearance. It can cause skin and respiratory irritation and has been classified as a carcinogen by the International Agency for Research on Cancer. Even 300mg/kg can cause a wearer health problems. Nevertheless, only garments with a concentration of 1,500mg/kg or above need to carry a 'contains formaldehyde' label.

AZO DYES are synthetic compounds used for colouring garments. These carcinogenic chemicals are banned in the EU, but not Australia. Tests by the ACCC (Australian Competition and Consumer Commission) found that 3% of all clothes, sheets and pillow cases contained traces of the dyes. Experts recommend that you wash new clothes several times before wearing them.

8

The contents trick

CHICKEN NUGGETS ARE MADE OF CHICKEN MEAT

Is it unreasonable to expect chicken nuggets to be made of chicken? Apparently so – when some fast-food nuggets were tested, less than half of each one consisted of this ingredient. The rest was made of scraps: cartilage, bone, blood vessels, fat and nerve tissue. The crispy coating was particularly bad, containing substances like gluten, salt, sodium carbonate and calcium phosphate. It means that this chicken snack is 20% fat.



**9***The energy-saving trick*

LIGHT BULBS ARE BAD FOR THE ENVIRONMENT

Energy-saving light bulbs last up to ten times longer than traditional incandescent or filament bulbs and consume 80% less power, thus reducing environmentally harmful carbon dioxide emissions – but at what cost? European environmental laws mean that incandescent bulbs cannot contain illegal substances, but fluorescent bulbs are not covered by the legislation: break one of these and you could contaminate your whole house. Researchers with the US Environmental Protection Agency conducted

an experiment and found that a single broken energy-saving bulb can release up to 50,000 nanograms (ng) of mercury per cubic metre. The maximum permitted level is 300ng. Energy-saving lamps can also contain a number of cancer-causing substances like phenol, naphthalene, styrene and toluene. And while you can throw away broken light bulbs, energy-saving bulbs are considered hazardous waste. But, according to estimates, one in two people throw these poison bombs straight in the kitchen bin...

i

HOW DOES AN
ENERGY-SAVING
BULB WORK?

So-called compact fluorescent lamps don't have a filament like light bulbs, but are filled with mercury gas. They begin to illuminate when a voltage is applied and the electrons charged. While light bulbs convert 97% of their energy into heat radiation, fluorescent lamps remain cold – saving electricity. Incidentally, LED lamps also save energy, but do not contain mercury.

11*The ingredients trick*

IF IT SAYS CONTAINS LEMONS, IT CONTAINS LEMON

Lemons on the packaging, lemon in its name – but lemonade often contains no trace of lemon. Instead, it contains additives and citric acid, industrially produced from raw materials like corn and molasses. The process is completely legal and extends to other products. According to Food Standards Australia New Zealand, sausages only need to contain 50% fat-free meat flesh, while it's entirely legal for your meat pie to only contain 25% meat flesh. And what does 'meat flesh' mean? According to the standard, 'The skeletal muscle of the carcass of any buffalo, camel, cattle, deer, goat, hare, pig, poultry, rabbit or sheep, slaughtered other than in a wild state (i.e. not bush meat), plus any attached animal rind, fat, connective tissue, nerve, blood and blood vessels.'

10*The organic trick*

'ORGANIC' MEANS FREE FROM ADDITIVES

The term 'organic' still seems to confuse shoppers. Many believe that there are no pesticides, fertilisers or additives in organic food, but this is not necessarily the case. In 2013, Australian company Green Cow Organics was caught selling sausages as 'organic', when they in fact contained high levels of

sulphur dioxide, a forbidden ingredient in organic food. And while the land used to grow correctly labelled organic food may *currently* be pesticide-free, there's no guarantee that the previous farmer used organic methods – the soil may still contain chemical residues, albeit at lower levels than other 'regular' foods.



ONLINE BANKING IS SECURE

The simple and secure transfer of money via the internet to anywhere in the world – almost every major bank now offers this service. But online banking is still far from safe, despite what banks themselves might say: cybercriminals make \$1 billion a year in Australia through 'phishing', though the real figure is thought to be even higher. Australia is the most 'phished' country in the world according to a recent study, accounting for 24% of all attacks. Globally, the cost of cybercrime to individuals and companies is estimated at \$300 billion a year. The solution? There isn't one: officials say no form of online banking is 100% safe – all are vulnerable to hacking. The attackers operate by posing as real firms in emails or online communications, directing users to contaminated sites almost identical to online banking login pages. If the user enters their personal data on the imitation site, the internet predator gains immediate access to the funds and can drain the account. Firewalls and anti-virus software can help to dilute the threat, but it is increasingly easy for hackers to circumvent such security measures. The biggest risk is posed by mobile banking. Sim cards were long thought 'unhackable', but researchers recently discovered a flaw in the card technology that puts millions at risk of being hacked. Whether compensation will be offered after a successful hijacking attempt varies from provider to provider.

Smartphones are increasingly the target of attacks: the mini computers offer cybercriminals a wealth of opportunities to hack into and empty a bank account.

PERSONAL DATA IS SECURE IN THE CLOUD

Gigabytes of space for your photos, videos and personal documents – and encrypted access wherever you are in the world. Data is protected and isn't disclosed to third parties – this is how cloud storage providers like to advertise their online storage systems. But there's good reason not to trust the cloud with your sensitive documents: as last year's hacking of Apple's iCloud proved, cybercriminals can still gain access despite sophisticated security measures. Secondly, there's ambiguity over whether the NSA and similar intelligence agencies have access to the online storage medium. Experts are now warning users that no cloud is completely secure. In response to the Apple hack, Google now triple encrypts all data stored on its cloud service.



THIS PACKET CONTAINS 30% EXTRA



More product for less cash? It sounds like a bargain, but it's really a clever trick used by manufacturers to save money. Multipack items are one of the worst offenders. Look at the back of the packet: while the larger packet might lead you to assume you're getting more for your money, the contents inside are often proportionately smaller than if you bought the items individually. A single chocolate bar, for example, weighs 42 grams. If you buy the same bar in a multipack of six, the manufacturer often reduces the weight from 42 to 30 grams. More air is forced into the

plastic packaging, which also suggests a greater amount to the customer. The same trick is used to cover up price rises: a box of chocolates stays the same size, but the number of truffles inside has decreased. This cunning trick isn't just used on food items, either: if the amount of detergent in a bottle has increased, it's probably been diluted with water. The clue's in the instructions: the smaller bottle says to put 3ml in the sink, while the larger bottle says 5ml. The same is true of washing powder, so it's useful to compare wash loads rather than the total weight of the box.

i

HOW DO COMPANIES CHANGE THEIR PRODUCTS?

Filled with air, 'false' bases, larger lids – customers are often tricked into thinking there is more content, but companies are rarely prosecuted. Cadburys caused an uproar in Australia when it reduced the size of its standard

Dairy Milk block from 220g to 200g, while keeping the price the same. The size of a Vegemite jar has shrunk from 400g to 380g, while a pack of Red Rock Deli chips is down from 185g to 165g after a recent rebrand.

ANTI-AGEING CREAMS STOP WRINKLES



Forever young: anti-wrinkle creams claim to tighten the skin and stop the ageing process in its tracks. However, a study by UK consumer organisation Which? tested 12 anti-wrinkle eye products on volunteers between the ages of 35 and 65 and found none that significantly reduced wrinkles. Much of the ageing process is down to genetics and sun exposure, with diet, pollution, alcohol and nicotine consumption contributing too. Hydrating the skin does make it look firmer for a while, but you don't need any anti-ageing products, which are just a mixture of fat and water – the basis of all skin creams. **W**

PROJECT WIND TURBINE

WORLD-SAVING WIND MACHINE!

Seven hundred metres above the ground, the wind is so strong that it could provide the answer to humanity's energy needs. But there has been no way of harnessing this power – until now



MOBILE POWER PLANT

A circular helium balloon with wings, a rotor in the middle, a handful of cables and a mobile station on the ground – these are the components that make up the most effective wind turbine in the world.

Denmark, October 2014: a generator pumps 1,000 cubic metres of helium into the grey shell of the BAT, or Buoyant Air Turbine. Developed by US company Altaeros, the BAT has a diameter of 10.7 metres when fully inflated. Engineers watch on as it fills with air before slowly beginning its ascent into the sky.

These floating wind turbines have massive potential. "Enough energy exists in high-altitude winds to provide us with 100 times the power we need," says Ken Caldeira, a professor at the Carnegie Institute for Science at Stanford University in California. But to harness this

potential, Altaeros need the prototype of the BAT to be a success and then go into production.

Before the floating power station has even reached its target altitude, its three rotor blades start to turn – and generate electricity. On the ground, three mooring ropes not only fix the BAT in place, they position it in the optimum direction to generate electricity. The energy is then transferred to a mobile station on the ground.

In early 2014, during an experiment in Alaska, a smaller version of the BAT was hoisted to a height of 150 metres and consistently generated 30 kilowatts of electricity per hour. Back in Denmark, the newest model of the buoyant turbine is expected to rise to 700 metres and generate 200 kilowatts of electricity per hour from the wind. In comparison, a modern

fixed wind turbine produces around 2,000 kilowatts per hour. Granted, that's about ten times as much as the BAT, but with a rotor diameter of 130 metres, an ordinary wind turbine is 12 times the size of the BAT. It sits on a massive concrete foundation – and only produces electricity when the wind's blowing. At an altitude of 700 metres the wind never stops, so on average, a BAT can produce four times more electricity than a stationary turbine per year.

The biggest advantage of the BAT is its practicality and flexibility. It can be used anywhere – and that's good news for communities located off the main grid. Undeveloped regions or disaster areas could also benefit. Today, such locations rely on diesel generators to produce electricity. But with a single BAT, 250,000 litres of diesel could be saved per year. **W**

Photos: Altaeros Energies (3)



CHASING THE WIND

Thanks to its mobile wheels, the power station can be set up anywhere – even in places without an electricity grid.



700 METRES

GENERATING POWER AT RECORD HEIGHTS

The wind turbine has a diameter of 10.7 metres and will rise to a height of 700 metres in a few minutes. Three double-braided steel cables anchored to the ground will keep the balloon in place.

"The BAT will bring renewable energy to the most remote places on Earth."

Adam Rein, co-owner of BAT manufacturer Altaeros

UP AND AWAY

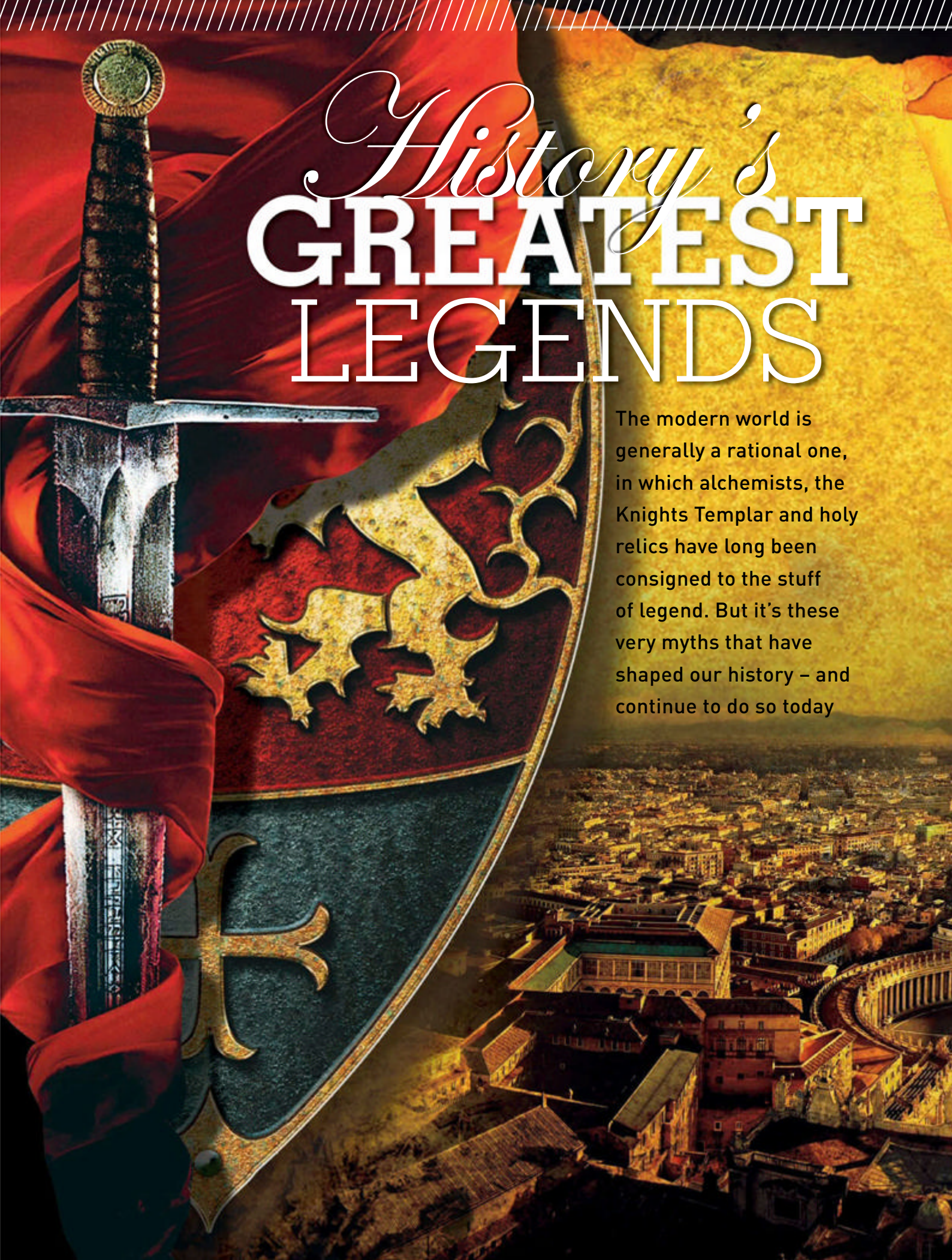
1,000 cubic metres of helium will drive the balloon 700 metres into the sky. The winds there are five to eight times stronger than those at ground level.

150 METRES

COMPARISON:

A fixed wind turbine is, on average, 150 metres tall and runs at full speed for approximately 2,000 hours a year. At 700 metres, the wind blows for up to 8,000 hours.

GROUND LEVEL



History's **GREATEST LEGENDS**

The modern world is generally a rational one, in which alchemists, the Knights Templar and holy relics have long been consigned to the stuff of legend. But it's these very myths that have shaped our history – and continue to do so today

DID THE KNIGHTS TEMPLAR HAVE A SECRET SOURCE OF POWER?

How a smuggled treasure
changed the course of history

SYMBOL OF POWER

The Eye of Providence is the symbol of the Freemasons. It became the most powerful secret society in the world when the surviving members of the Knights Templar joined its ranks.

It is 1204. Crusaders are currently destroying Constantinople, the capital of the Byzantine Empire. Amidst the chaos, a troop of knights succeeds in smuggling a small packet out of the city unnoticed – a packet containing one of humanity's greatest treasures, cloaked in mystery and of infinite value. For more than a century, it provides its robbers with tremendous power. The thieves belong to an organisation from the European Middle Ages more steeped in legend than any other: the Knights Templar. But what exactly was the treasure that allowed a small order to become so powerful?

After Constantinople is destroyed, the Knights begin making financial transactions. Although Christians are banned from charging interest at this time, the Vatican turns a blind eye. The reason? The small packet from that night in 1204 contains the blanket in which Jesus was said to have been buried after his crucifixion and displays the face of Christ.

The shroud, now displayed in Turin, is Christianity's greatest relic. In the Middle Ages, its value was even higher: the shroud was thought to allow the viewer to establish direct contact with God. In 1204, the shroud was an immensely valuable artefact that bestowed the Templars with enormous power. In the 13th century, they became Europe's most furtive rulers – until a catastrophic error of judgement put paid to their reign. They give the shroud to Pope Clement V, hoping to win him over as a coalition partner against the French King Philip VI, whom the Knights wish to overthrow. Rome, however, sees no further reason to support the actions of the Templar – the order is attacked and destroyed. In Portugal, some knights survive and found the Order of Christ. Under their symbol, known as the cross pattée, they discover the New World. Other knights escape to Scotland, affiliate themselves with the Freemasons and turn it into the most powerful secret society on Earth. Almost 500 years later, Freemason George Washington becomes the first president of the USA.

WHY WAS HITLER HUNTING FOR THE HOLY GRAIL?

How the Nazis wanted to found their own religion

It is meant to be the creation of a new world religion – with Hitler as saviour and the Holy Grail as a symbol. The symbol of a new Aryan order. Mythical strength, power and immortality – that's what the legend promises to those who find the Holy Grail. It is rumoured to contain the blood of Christ, shed when he died on the cross.



UNHOLY GRAIL HUNTERS

Top photo: SS leader Heinrich Himmler [pictured right] with his architect for Wewelsburg, Hermann Bartels. Below: Himmler and Bartels en route to the fortress [in the background].



Were they serious? Hitler as the Messiah? Incredibly, that's what some Nazis hoped for, which is why top Third Reich officials enlisted Grail specialist Otto Rahn to help with the search.

Rahn discovers some caves in Rennes-le-Chateau in southern France where a priest claims to have found the Holy Grail. But in 1939, before Rahn can find out any more, he dies in mysterious circumstances. Undeterred, the Nazis plough on. So convinced are they that they'll find the Grail, they make plans for a fortress to house it – Wewelsburg castle is earmarked for renovation and will become the biggest castle complex in Europe. It is an undertaking on a grand scale and Hitler gives SS leader Heinrich Himmler huge financial backing to turn the palace into the 'Centre of the World'. Hitler's template is the Catholic Church, whose power and influence has long fascinated him.

He envisions Wewelsburg as the SS's Vatican and includes a temple to house the Holy Grail. Meanwhile, the search continues...

For many historians today, Hitler's search for the Grail was nothing more than a scam. For the Nazi regime it would have been the ultimate propaganda coup to present the Holy Grail to the world – whether it was genuine or not. Most believe Hitler wasn't interested in the Holy Grail itself, but in the idea that it represented. He wanted to reinterpret the myth as an instrument of power that would accord him the status of an immortal legend. In the end, all that was left of the self-appointed Messiah was a charred body in his bunker in Berlin. And today the Holy Grail remains what it has always been – a myth.

A HOME FOR THE GRAIL

Below the north turret of Wewelsburg, concentration camp inmates were forced to excavate this vault. It was built to enshrine the cult of the Holy Grail.

DID JESUS SURVIVE THE CRUCIFIXION?

The length of time he spent on the cross is arousing suspicion among forensic scientists

It is one of the boldest questions of the past century – did Jesus survive the crucifixion? Modern-day scientists know that a person on the cross can survive for several days – but Jesus is said to have died after just a few hours. Is one of the best known stories in the world actually a fake? Suzanne Olsson has been researching this for years. Her conclusion: "Pontius Pilate warns his soldiers to be careful with Jesus. They were instructed to inflict external injuries on someone so it looked like they had been crucified without injuring them too severely." Olsson is certain that Jesus survived the crucifixion. Some oral histories from eyewitnesses confirm this belief. While on the cross, some scholars believe that Jesus was given opium – a narcotic that induces a deep sleep. To bystanders he could have appeared to have been dead, so there would have been time to get him to safety. But where would Jesus have gone if he had survived? Experts have discovered a mysterious grave in the Indian city of Srinagar. "Jesus's walking stick had been placed in the coffin. Next to the grave there is a plaque with illustrations of feet with crucifixion wounds," says Olsson. Locals are opposed to it, but her ultimate aim is to take DNA samples from the grave and finally solve the mystery of the crucifixion.



THE GRAVE OF JESUS?

The grave of Yuz Asaf is inside this building in Srinagar. Researcher Suzanne Olsson is certain: "Yuz Asaf means 'son of Joseph'."

WHO WERE THE INFAMOUS 'ASSASSINS' OF THE MIDDLE EAST?

How the ruthless secret society became to be so feared

The beggar approaches Nizam al-Mulk, vizier to the Persian sultan. "In the name of Allah, accept the greetings of Hassan-i Sabbah." A curved dagger suddenly appears. Then the beggar thrusts the blade into the vizier's throat. It is the morning of 14th October 1092 and Nizam al-Mulk is the first victim of a

new sect: the Assassins. From his mountain fortress Alamut in the north-west of modern-day Iran, Hassan i-Sabbah sends his messengers of death in all directions over the course of the next 34 years.

Further leaders of the Assassins succeed him, the most famous – and feared – of whom is Rashid ad-Din Sinan, also known as the 'Old Man of the Mountain'. Under his leadership the Assassins rule over parts of the Middle East – and kill hundreds of people.

In popular culture, like in the *Assassin's Creed* series of video games, the Assassins are portrayed as fierce enemies of the Christian Knights Templar. But in reality only five Christians counted among their victims, and the Crusaders and Assassins often worked together.

It's rumoured that England's King Richard the Lionheart contracted the Assassins to murder Christian Konrad von Montferrat, who was, for a short while, the *de facto* King of Jerusalem.

THE SOLDIERS OF DEATH
In many films (like here in *Prince Of Persia: The Sands Of Time*) the Assassins are presented as simple hitmen. In reality Assassins could be purchased like mercenaries.

Most victims of the messengers of death are Muslim regents and religious leaders who belong to the Sunni tribe. The Assassins are one of the splinter groups of the Shiites and belong to the Ishmaelite Nizaris, who interpret the Qur'an more loosely than other groups.

But what were their ultimate aims? Well, the Assassins wanted to create their own theocratic state and trained suicide attackers for that purpose. No assassin escapes from the crime scene – everyone should know who carried out the murder.

The widespread fear of this secret society is also used as a weapon. The Assassins are guaranteed a place in the afterlife for their actions. The successors of the Assassins, the Nizaris, today live mainly in Pakistan and India – and are considered one of the most tolerant and liberal Muslim groups.



WHICH PROPHECY DESTROYED A WORLD EMPIRE?

How a misinterpretation reshaped the world

Coincidences, predictions, false instructions – many factors can decide the outcome of a war. But there's actually a prophecy in the history of the world that destroyed a sprawling empire entirely and, in so doing, totally reshaped the future. "Shall I attack the Persian Empire?" Croesus, King of Lydia [the area located in modern-day Turkey], asks the oracle of Delphi. For around 1,200 years the prophecies of the oracle priests decided between war and peace, life and death. As usual they answer the king in a cryptic fashion: "If Croesus steps over the border river, a huge empire will be destroyed." Emboldened by this prophecy, Croesus attacks the powerful Persian Empire in 547 BC. But when the war comes to an end, it isn't Croesus who emerges the victor: it is the Persians. And that's how, as the prophecy predicted, a great empire was destroyed – just not the Persian one. Croesus' Lydian Empire, which rose to affluence when its people invented coins as money, and with it a previously non-existent freedom of movement, disintegrates. What sort of heights might the wealthy state have reached if Croesus had not acted upon the oracle? How would we live today if this country had left its mark on humanity? We'll never know, because a mighty empire was destroyed by a prophecy.

SURVIVING ARTEFACT

Croesus, King of Lydia (located in modern-day Turkey), was immortalised in paintings and ceramics [right] and also in Leo Tolstoy's 1886 short story *Croesus and Fate*.

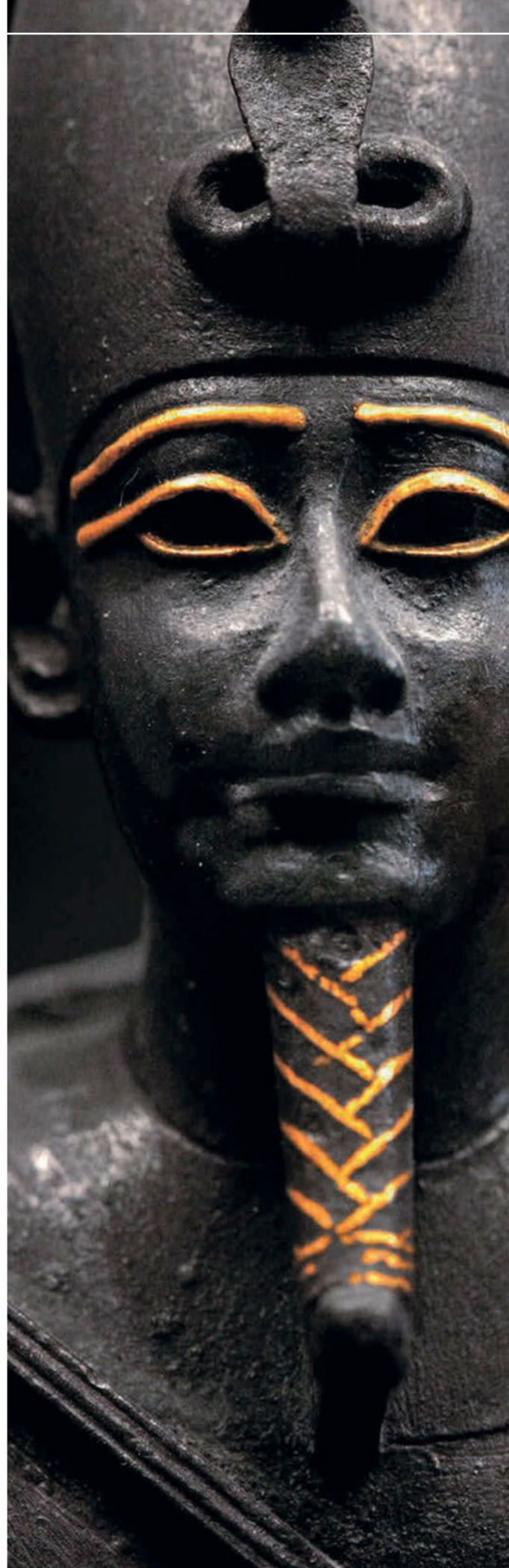


WHAT DID THE **ALCHEMISTS** REALLY **DISCOVER?**

How the mysterious scientists ushered
in a new era of research

It is perhaps mankind's biggest and oldest dream: the transformation of non-precious metals like lead into gold. The alchemists of the Middle Ages never achieved their biggest ambition, but in the course of their experiments they succeeded in creating different, far more useful treasures – even if they didn't realise it.

Back then, the secret scientists of the kings and princes can be found in every royal household in Europe. They spend their days experimenting with sulphur, mercury and lead. All with one aim: transmutation – the creation of gold. To make their knowledge inaccessible to other researchers, many alchemists summarised their findings and recipes in a secret language. As many of them met their deaths during their experiments, their findings remained unknown for a long time. Only recently have historians been able to decode the encrypted results. They discovered that even if the alchemists' experiments didn't create gold, they laid the foundations for modern scientific disciplines like chemistry and medicine. Along the way they cracked the chemical secrets of ethanol (alcohol in its pure form), porcelain and phosphorus. These discoveries catapulted humanity into a new, more progressive era. The alchemists knew nothing of this: because they failed in the quest to create gold, many were hanged from gilded gallows by their employers...



WHAT DID THE ANCIENT EGYPTIANS KNOW ABOUT THE AFTERLIFE?

Ghosts, death judges, soul-eating monsters;
the Egyptians believed in a dangerous afterlife

RULER OF THE AFTERLIFE

Osiris, the Egyptian god of the dead, and a tribunal of 42 deities decide whether the deceased lived well.

No other society was so completely obsessed with life after death as the ancient Egyptians. Nearly 3,000 years later, what do we know about their beliefs concerning the afterlife?

According to ancient Egyptian culture, a person had two souls that left their body after death. The desired aim was to return the soul to the body through religious rituals. Even handling the body incorrectly could endanger the process of reincarnation. For this reason, dying far from one's home presented a great risk. Cleopatra evaded capture and execution by taking her own life: being put to death could have proved an obstacle in her journey on to eternal life.

The Egyptians had no fear of dying; they were much more concerned with the dangers of the underworld. They feared attacks by soul-eating monsters and judgment before the Eye of Providence. To see if a soul was worthy of entering the afterlife, the deceased's heart had to be weighed before the god Osiris and his 42 judges. The heart was placed on one side of the Scales of Truth, with a feather placed on the other. If the scales balanced, the deceased was judged to have led a good life and could continue on to eternal life.

If it sank, he was declared a sinner and his heart was devoured by the crocodile monster Ammut.

For this reason, the symbolism of death was present in all Egyptians temples, so believers knew how to achieve eternal life. The Book of the Dead, a holy script, included many spells to minimise the danger of the trip through the underworld. Magic was seen as the only effective weapon against the demons of the underworld. It was the only way for the deceased to escape from an armed god and reach the Hall of Two Truths unharmed. For centuries, researchers have been trying to unlock the secrets of death from the temples. But in spite of their work, questions remain unanswered...

A SYMBOLIC METAL

Gold was a symbol of immortality. Until 60 AD, 32,000 tons of gold were said to have been found by the Egyptians. That's more than all the central banks in the world possess today.



WHO REALLY BUILT THE SPHINX?

The most well-known statue in the world
is thought to be 7,000 years old

Since ancient times the Sphinx has been a symbol for the superhuman wisdom acquired by the ancient Egyptians. But was the gigantic construction really built by the pharaohs? Or does the statue hail from a time long before the Egyptian civilisation? The geologist Robert M. Schoch believes that the Sphinx was actually carved more than 7,000 years ago – in

the late Stone Age. His proof comes from the results of examinations of its erosion channels, which make it appear as if large amounts of rainwater flowed over the stone. During the age of the pharaohs, it did not rain enough to produce such marks. And this means that the statue can only have been built earlier – 7,000 years ago, when plenty of rain fell in the region. Egyptologist John Anthony West is a supporter of this theory: “The head is too small for the statue. Earlier it must have depicted something else.” The head is also darker, harder and heavier than the rest of the statue. West is convinced that a mystical advanced civilisation ruled Egypt in the past. Further studies could help substantiate this theory, but the Egyptian government refuses to allow any further investigation. The truth is, the myth surrounding the Sphinx fills the coffers of those who write about it. Whether that’s historians, researchers or the Egyptian government. **W**

EGYPTIAN STATUE?

73.5 metres long, six metres wide, and 20.2 metres in height – the main part of the Sphinx of Giza was carved from one piece and stands on the rocky plateau of Giza. Several temple complexes are found in the vicinity.

PHOTOS: Corbis (3); Archiv RZB (2); Jungbold/Laif; Keystone; Fotolia; Bridgeman; "National Treasure"; Bildagentur Huber; Getty Images; Action Press



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WORLD RULER

Only about one to five per cent of the different species of bacteria that exist on Earth are known to science. There are 1,300 billion tons of bacteria in the world's oceans alone.

ARE ANTIBIOTICS BAD FOR YOUR HEALTH?

In total, 100 trillion bacteria inhabit a single human, with the majority making sure that we remain healthy. But we're becoming increasingly powerless against a growing number that are developing antibiotic resistance – something that could have devastating consequences in the future



TINY CREATURES

The average size of a bacterium is 0.001 millimetres. The largest so far discovered had a diameter of 0.7 millimetres and could even be seen without a microscope.

Bacteria are capable of far more than anything else in the natural world – they exist everywhere, even in places hostile to other life forms. Every 20 minutes these microscopically small organisms can double in number. They possess an incredible affinity for learning: in the space of just 30 minutes, bacteria can interchange your entire DNA and incorporate the new abilities into their genome. In this way, bacteria written off as harmless can become unpredictable killers.

For example, the bacterium *Escherichia coli* (*E. coli*) plays an important role in the intestines of healthy people and animals. In its original form it produces Vitamin K in the body. However, if it mutates, it can become deadly. As a result of genetic transfers, *E. coli* receives from one bacterium the ability to release toxins, from another the ability to cling stubbornly to the intestinal cells, and from a third the ability to resist antibiotics.

The real-life consequences could be seen in May 2011 when a harmless, useful *E. coli* transformed into a virulent

bacterium *Enterohaemorrhagic Escherichia coli*, or EHEC for short. In humans, this causes bleeding in the intestinal wall, damages the kidneys and triggers disturbances in the brain. An outbreak in 2011 claimed lives in Germany and Sweden after people ate food contaminated with EHEC. The last Australian outbreak was in 1995.

Antibiotics are useless against the pathogen – as they are against many others. Indeed, many scientists now believe the age of antibiotics is already on its way out. Remedies that once saved thousands of lives are now powerless against pathogens that continue to upgrade themselves in order to survive.

THE JOURNEY OF AN ANTIBIOTIC THROUGH THE BODY

So what actually happens when a bacterial pathogen enters our system? Harmful bacteria produce toxins in the body which lead to cells dying off. As a general rule, the immune system is able to fight off these foreign bodies by itself. But if the immune system is weakened, then the attack by the body's white blood

"Bacteria have survived so many natural disasters throughout the world that it was stupid to assume that antibiotics could stop them."

Professor Stuart Levy,
microbiologist from Tufts
University in Boston, USA

cells alone will not suffice. External help is needed, in the form of an antibiotic. Antibiotics are enzymes which inhibit the growth of the bacteria by preventing them from multiplying or by killing them off directly, for example by damaging their cell wall.

In order to see how an antibiotic works more precisely, let's accompany one on its journey through the body. Many antibiotics are taken orally. This means they must first travel through the mouth where they come into contact with saliva. Orodispersible tablets (those designed to melt on the tongue) will dissolve in seconds, but most antibiotics have a long road ahead of them. For these, the saliva only acts as a lubricant, transporting them smoothly along the esophagus to the stomach. Because of the acidic conditions found there, some antibiotics disintegrate into thousands of tiny pellets. Thanks to their small size,



PLASMA BRIDGE FOR DNA

The transfer of genes between bacteria takes about 30 minutes. Simply by making contact (circled above) they exchange their entire DNA and pass on their resistance.

these then reach the intestine very quickly, where they dissolve and release the antibiotic agent evenly.

Other antibiotics are armed against the aggressive stomach acid and reach the small intestine undamaged.

HOW DOES AN ANTIBIOTIC FIND THE PATHOGEN?

Once the antibiotic passes through the intestinal wall, it finds its way into the portal vein, which branches out into an intricate network of blood capillaries. These are the smallest blood vessels in the body. A continual exchange of substances takes place via these capillaries: they act like a kind of motorway, transporting the required nutrients to the organs and taking away any residues. Here, the medicines bind to the proteins in the blood plasma and travel with the blood to the liver.

In the liver the metabolism of the drug begins: one part is excreted via the gall bladder and the kidneys, the other passed on through the hepatic vein, where it is eventually absorbed into the body's circulatory system and distributed around the body – like an army of soldiers, fanning out in all directions. Released like this, the active ingredients of the antibiotic then begin to search for the bacteria they are programmed to fight against. They recognise the bacteria by the one thing that distinguishes them from all other living cells: the murein molecule in the bacteria's cell wall. Penicillin, the most well-known antibiotic, also reacts to this molecule – or to be more precise, as soon as it approaches a bacterium, it locks onto the bacterial cell wall. This is achieved by a complex process of interaction between the enzyme in the antibiotic and the molecules of the bacterial wall. If this binding

WHAT ARE BACTERIA MADE OF?

The bacteria cells in our body outnumber human cells ten to one. Unlike viruses, they have their own metabolism. Bacteria consist of a cell wall, the cytoplasm, the attached cytoplasmic membrane and ribosomes (a mix of proteins and ribonucleic acid).

CYTOPLASM

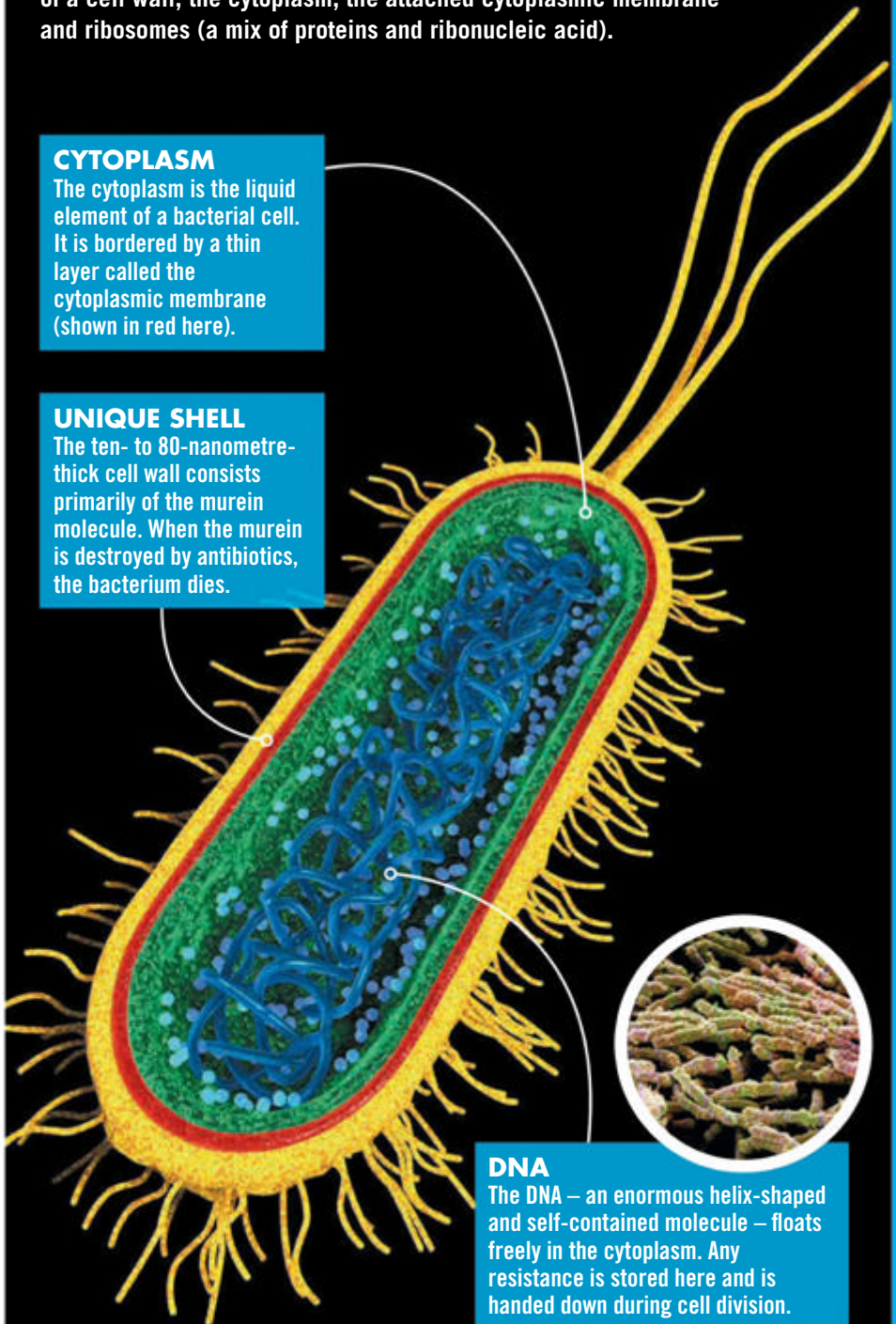
The cytoplasm is the liquid element of a bacterial cell. It is bordered by a thin layer called the cytoplasmic membrane (shown in red here).

UNIQUE SHELL

The ten- to 80-nanometre-thick cell wall consists primarily of the murein molecule. When the murein is destroyed by antibiotics, the bacterium dies.

DNA

The DNA – an enormous helix-shaped and self-contained molecule – floats freely in the cytoplasm. Any resistance is stored here and is handed down during cell division.



together is successful, the penicillin begins to act by interfering with the cell wall synthesis. The cell wall stops its supporting function and the cell bursts.

One of the drawbacks of antibiotics is that they don't distinguish between good and bad bacteria in the body and can also kill off the useful bacteria in the intestinal flora, without which harmful bacteria can multiply quickly. If healthy bacteria in the body is in short supply, fungi can spread on mucous membranes, and allergies or gastrointestinal disorders can develop – these and more are some of the many side effects of antibiotics.

WHY YOU SHOULDN'T STOP TAKING ANTIBIOTICS

Antibiotics are generally taken for between two and ten days – usually they take effect immediately after the first dose has been taken. Subsequently, the antibiotic agent remains in the body for two to 12 hours on average. The time until the onset of action depends on various factors – for example the biological processes in the body (metabolism, breakdown, etc.) or the concentration of the antibiotic agent.

The half-life of the drugs indicates when the amount of ingested active ingredient in the antibiotic has decreased by half – in the case of penicillin G, this is 30 minutes. For this reason, antibiotics must be taken several times a day, in order to restock the concentration of the antibiotic agent at regular intervals. If you stop taking it, small amounts of the dangerous bacteria in the body can survive and develop resistance against the antibiotic. This happens because the bacteria develop survival strategies during this

“We should not try to eradicate all bacteria, because we need them for our development.”

Professor Stuart Levy,
microbiologist from Tufts
University in Boston, USA

‘lull in action’ that allows them to resist the antibiotics. They either produce substances with which they can attack the antibiotic when they come into contact with it again, or they form a type of armour that the antibiotic is powerless to destroy. They then multiply further, passing the resistance to their offspring. This is why experts are now heralding the end of the antibiotic era.

HOW DO ANTIBIOTICS ACHIEVE RESISTANCE?

It sounds like a contradiction: the more antibiotics given out, the better the bacteria are able to arm themselves against them. Each of us ingests about 500 grams of antibiotics annually, via meat, medicine and vegetables. The consequences can be devastating. Without antibiotic contact, only one in ten million bacteria mutates. But when the bacteria come into contact with antibiotics, they activate their defence program – the amount of mutations multiplies and now one in a thousand bacteria mutates.

WILL BACTERIA SOON BE KILLED BY FAT?

Scientists across the globe are feverishly researching new antibiotics that could counteract resistance. One such pair are Eduard Babiychuk and Annette Draeger from the University of Bern in Switzerland, who are concentrating their research on liposomes. These nanoparticles are formed from the fatty layer of body cells and are used, among other things, to transport drugs inside the body. The scientists put together the liposomes in such a way that they draw the toxic bacterial substances together in the body and neutralise them. Without toxins, the bacteria are rendered defenceless and can be eliminated by the human immune system.

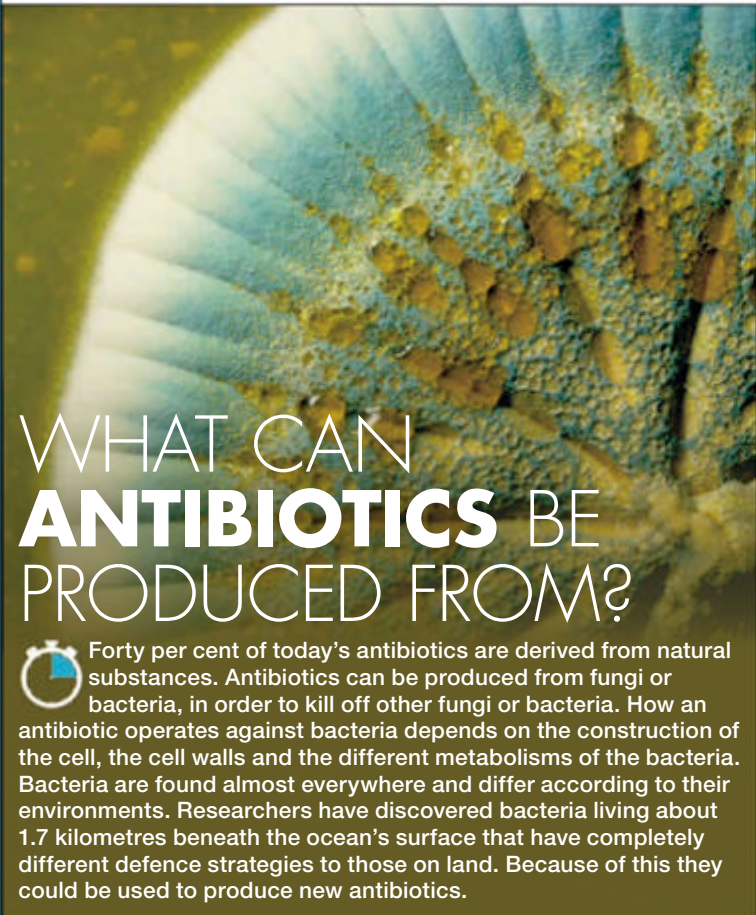
In extensive tests on animals, the drug has already achieved positive results: infected mice with life-threatening blood poisoning were cured as a direct result. When the drug CAL02, currently in the process of being patented, is approved it will be a milestone in the war against multiresistant bacteria.

“As the effect of the liposomes are not directed against the bacteria themselves, they are also not able to develop resistance,” says Draeger.

The American microbiologist Stuart Levy also wants to protect humans from bacteria without destroying microbes in the process. He hopes to do this through the simple deactivation of the proteins which cause the infection in the body. This will then allow the bacterium to develop normally – but cause the host no harm. “We should not try to eradicate all bacteria, because we need them for our development,” he says. “Conversely, bacteria don't need us to survive.”

SMARTER IN 60 SECONDS...

4 FASCINATING QUESTIONS ABOUT BACTERIA



WHAT CAN ANTIBIOTICS BE PRODUCED FROM?

Forty per cent of today's antibiotics are derived from natural substances. Antibiotics can be produced from fungi or bacteria, in order to kill off other fungi or bacteria. How an antibiotic operates against bacteria depends on the construction of the cell, the cell walls and the different metabolisms of the bacteria. Bacteria are found almost everywhere and differ according to their environments. Researchers have discovered bacteria living about 1.7 kilometres beneath the ocean's surface that have completely different defence strategies to those on land. Because of this they could be used to produce new antibiotics.

HOW OLD IS THE OLDEST BACTERIUM ON EARTH?



Bacillus permians was discovered in 2000 by researchers from the West Chester University in Pennsylvania. Salvaged during drilling in a salt mine in New Mexico, the bacteria had been trapped in the liquid of a salt crystal 609 metres underground. At an estimated 250 million years old, it is the oldest type of bacteria still in existence – and the oldest of all remaining living organisms.

WHY CAN'T ANTIBIOTICS CURE COLDS?



Antibiotics are only able to treat *bacterial* infections, whereas colds are caused by viruses, usually rhinoviruses. Therefore, you must rely on your body's immune system to beat a cold. Over-the-counter drugs and medicines merely help soothe the unpleasant symptoms. However, sometimes a bacterial infection such as bronchitis or pneumonia will follow a cold virus.



DO ALL BACTERIA LOOK THE SAME?



Bacteria come in all different shapes and sizes. For example, they can be spherical (Coccus), helix-shaped (Spirilla) or rod-shaped (Bacillus). Often bacteria bind themselves together in chains or across a surface. Their size also varies: the volume of the biggest bacteria is roughly ten billion times bigger than the smallest. **W**

PHOTOS: SPL/Agentur Focus (3); Ted Horowitz/Corbis (2); Shutterstock/Corbis



GIANT IN THE DEEP

A tunnel-boring machine (TBM) measuring almost 100 metres eats through a wall of lime and sand. Twenty-six hydraulic jacks slowly push the 8m-diameter TBM forwards.

8 metres

SILVER LINING

Vacuum erectors line the interior tunnel wall with precast concrete segments. Once in place, workers secure the segments with massive screws.

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HOW CAN MEXICO CITY BE SAVED FROM DROWNING?

■ Extending for 61km, the Emissor Oriente tunnel is the world's longest wastewater tunnel. If all goes to plan, it will save Mexico City from drowning. The city has subsided more than 13 metres over the last century – the same height as a four-storey apartment block. The region's 20 million inhabitants get 70% of their water supply from the reservoirs beneath the city, so there is more water being removed from the ground than rainfall can replace. This causes the soil to contract and the city sinks. It also changes the gradient of subterranean drainage canals. In a city surrounded by mountains, that means sewage can only be pumped out of the city at substantial cost. The sewage tunnels built in the 1960s have reached capacity and experts warn that the entire city could drown in its own sewage during the rainy season. The new tunnel, which will reach a depth of 150 metres, is designed to prevent that. It can transport 150 cubic metres of water per second. The \$1.1 billion project extends beneath the city and under the mountains to the north, where the sewage can be treated – saving the city from a watery grave.

A SNAPSHOT OF SINKING CITIES

1//VENICE



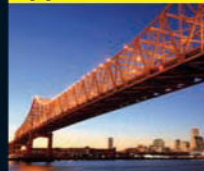
The 'Floating City' is constantly sinking. Calculations predict that the water level in Venice will rise by up to eight centimetres in the next two decades.

2//JAKARTA

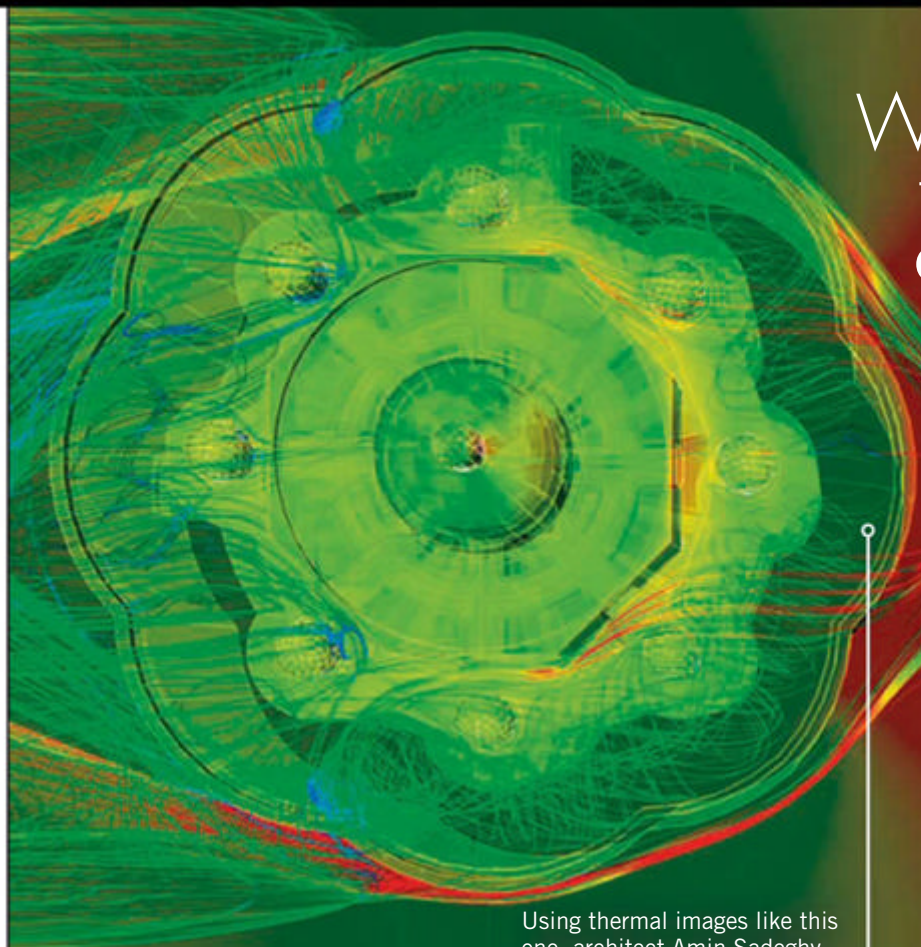


Jakarta sits on a swampy plain and is sinking at a rate of ten centimetres per year. Subsidence in the city is uneven, causing tilted houses and ruptured roads.

3//NEW ORLEANS



Could this be the next catastrophe after Hurricane Katrina? Scientists believe that New Orleans could be completely surrounded by water in 90 years.



Using thermal images like this one, architect Amin Sadeghy studies how buildings conduct heat and control wind flows.

What can we learn from **500-year-old buildings?**

Sustainability and energy saving – the eco-efficiency of ancient buildings trump modern construction hands down.

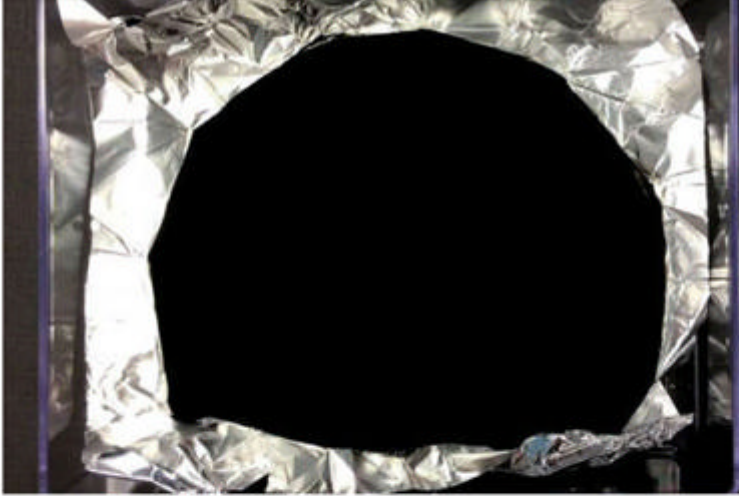
The architect Amin Sadeghy studied the secrets of 500-year-old buildings by analysing the geometry of the structures using thermal imaging and heat flows.

He discovered that the master builders of the day were able to use simple methods to achieve natural air conditioning. In the ancient Iranian ice houses, for example, perishable goods were kept cool even when external temperatures soared. The shape of the building and the relative height of its surrounding walls were designed to throw a shadow on a central pool of water, which stayed cool. The study report confirmed these findings: “Our thermal analysis showed that even when the building is at 50°C, the water remains at -10°C, making ice.”

Can music **cause car accidents?**

Choosing the wrong music can have fatal consequences, at least for car drivers. Some people focus better while listening to music, but your favourite tune is just as likely to have the opposite effect. Music psychologist Günther Roetter found that classical music caused more accidents than monotone pop music due to the fluctuations in tempo and volume. One surprise thrown up by the study: heavy metal music is not linked to aggression or a greater risk of an accident. Roetter recommends soft music that isn't too demanding.





What is the **darkest material in the world?**

Every surface reflects light, no matter how dark it appears. There is no such thing as absolute black. But now British scientists from the National Physical Laboratory have created a material that's as close as it gets: Vantablack. The substance reflects just 0.035% of visual light. In comparison, ordinary black paint generally reflects 5-10%. Thanks to its composition and structure, the thin layer of carbon nanotubes absorbs all but a fraction of visible light – which makes looking at this ultra-black coating a bit like staring into a black hole. Due to the lack of reflected light, it becomes impossible for the human eye to detect any shapes or contours formed from it. For all practical purposes, this makes Vantablack invisible. The scientists hope the 'paint' will be used in solar cells and telescopes as well as for military uses like stealth bombers.

WHY IS SCUBA DIVING SO **DANGEROUS?**

It's the most dangerous phenomenon known to scuba divers: nitrogen narcosis, also known as the 'rapture of the deep'. The condition is an alteration of consciousness that can occur at depths below 30 metres. The key culprit is the nitrogen in the air that divers breathe. At high pressure, which occurs underwater, the nitrogen directly affects the nervous system, effectively putting it under anaesthetic and slowing down neural transmissions – which then impacts cognitive processes. Overconfidence, disorientation, anxiety, panic – the symptoms can be grave. Divers have been known to start attacking one another underwater while others have tried to offer their breathing regulators to passing fish, because they are afraid the sea creatures might drown.

HOW **DANGEROUS** IS YOUR DAY?



07:00

The alarm beeps and you're ready to rise and shine – but is your day about to be over before it's begun? In the UK, for example, roughly 20 people die falling out of bed each year. But the statistics depict eating breakfast as an even more treacherous activity: 700 people around the world are electrocuted by their toasters annually – ten times the number attacked by sharks each year.

09:00

Driving to work is probably the riskiest thing you'll do all day: four people die on Australia's roads every 24 hours. Texting while driving inflates the risk – recent statistics show that mobile phone use has now overtaken not wearing seatbelts as the most common cause of road fatalities, accounting for more than 42% of all deaths.

13:00

Feeling peckish? Make sure you stay calm and collected – in the US, two irate customers are crushed by vending machines each year while attempting to tilt faulty dispensers. Eating a lunch you packed yourself is even riskier – choking on food is the cause of around 55 deaths in Australia every year.

17:00

Leaving work can be almost as dangerous as arriving. Car park barriers rarely malfunction, but when they do, the consequences can be fatal. In 2002, a Welsh man became one of the six unlucky souls in Britain to be killed by security barriers each year. He died instantly when the metal bar activated prematurely and smashed through his windscreen.

21:00

Home may be where the heart is, but it's also where most accidental poisonings occur. At the last count, 1,534 Australian adults aged between 25 and 44 lost their lives this way in a year, most commonly by ingesting cleaning products or medicines. This cause of death is beaten only by suicide in that age range.

HOW FAST IS THE WORLD'S FASTEST ELEVATOR?

In 2016, the new record holder is set to start servicing the 95 storeys of the CTF Finance Centre in the southern Chinese metropolis of Guangzhou. It will rocket up 530 metres in just 43 seconds – and reach a top speed of 72km/h. By comparison, Europe's fastest lift in Berlin crawls up at a leisurely 29km/h. Japanese multinational Hitachi built a 213-metre-high R&D tower for development work on the lift. Bespoke features include a permanent magnet synchronous motor, a system for emergency stops and extremely heat-resistant

brake pads. The lift even has a high-tech air pressure equalisation system so that the rapid change in altitude doesn't cause a painful popping in passengers' ears as they zoom up the building. Active guide rollers will also be installed in every corner of the elevator car to detect, and compensate for, minute warping in the guide rails and vibration due to wind pressure.

✕
1:500,000

Most lifts operate with up to eight steel cables. The probability of one of these cables breaking is one in 500,000. There has never been a case of all cables breaking simultaneously with fatal consequences.



PHOTOS: Corbis; Getty Images (5); Fotolia (3); Studio Integrate. Analyse sponsored by Thermoanalytics Radtherm and CEI Ensight; iStockphoto: Noah Fram-Schwartz/Nikon Instruments Inc.; Alamy; PR



HOW FAR CAN SPIDERS' EYES SEE?

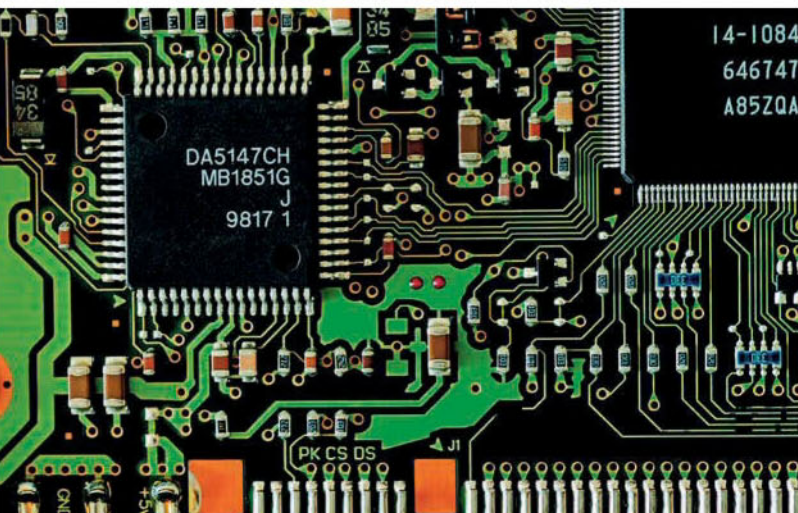
No, this isn't an image from Disney's latest animated film. It is a real photograph of a jumping spider's eyes at 20x magnification. Like a pair of giant spotlights, the eyes gaze off into the distance. But in this case, that distance is only 30 centimetres at the most. Despite this, these 50-millimetre jumping spiders have the best eyesight of all arachnid species. And they need it: instead of weaving webs, the

spiders hunt by pouncing on their prey. Three additional sets of eyes help enhance their peripheral vision. The main set of eyes have a sophisticated optical system with a corneal lens at the front and a second lens at the back focusing images onto a boomerang-shaped retina – operating just like a telescope. Unlike the eyes themselves, the retina has three pairs of muscles so it can move in any direction – providing a 270-degree panoramic view.



How much room does the internet take up?

Pretty much the same amount of space as an oil tanker, says research. But how was this comparison reached? In order to estimate the entire storage space of the internet, the physicist Randall Munroe imagined everything stored on hard drives. According to his calculations, the total amount of storage space so far has a volume of about 650 million litres. And as that's roughly equivalent to the storage capacity of an oil tanker we can now visualise the space we'd need to house the internet.



WHAT'S THE NEWEST ANIMAL?

So far, science has identified around two million species of animal, plant and microbes, and every year a few thousand are added to that list. One of the newest, most exciting debutants is the Atlantic Coast leopard frog. Unlike any other frog, the tiny *rana kauffeldi* has a call that's closer to a cough than a croak (check out the strange sound online at YouTube). Adult males have large vocals sacs on either side of their heads, which they deploy to make mating calls to females. But first, the amphibians – found in the north-east of the US – need their wingmen; they usually project these unusual 'coughs' in small groups of five frogs.

NAME:
Godiva sp.
SIZE:
4 centimetres



Cannibals, chemists, masters of disguise: sea slugs can transform into almost anything – as long as it's out of the ordinary. These water critters are some of the ocean's most outlandish characters

FREAKS FROM

Colourful, slow-moving and kind of cute: at first glance, sea slugs appear to be harmless ocean hippies. It's an assumption that has cost dozens of divers their lives. You see, these luminous creepy-crawlies are actually some of the most dangerous creatures on the planet. Many of the matchbox-sized slugs have poisonous skin and tentacles. The

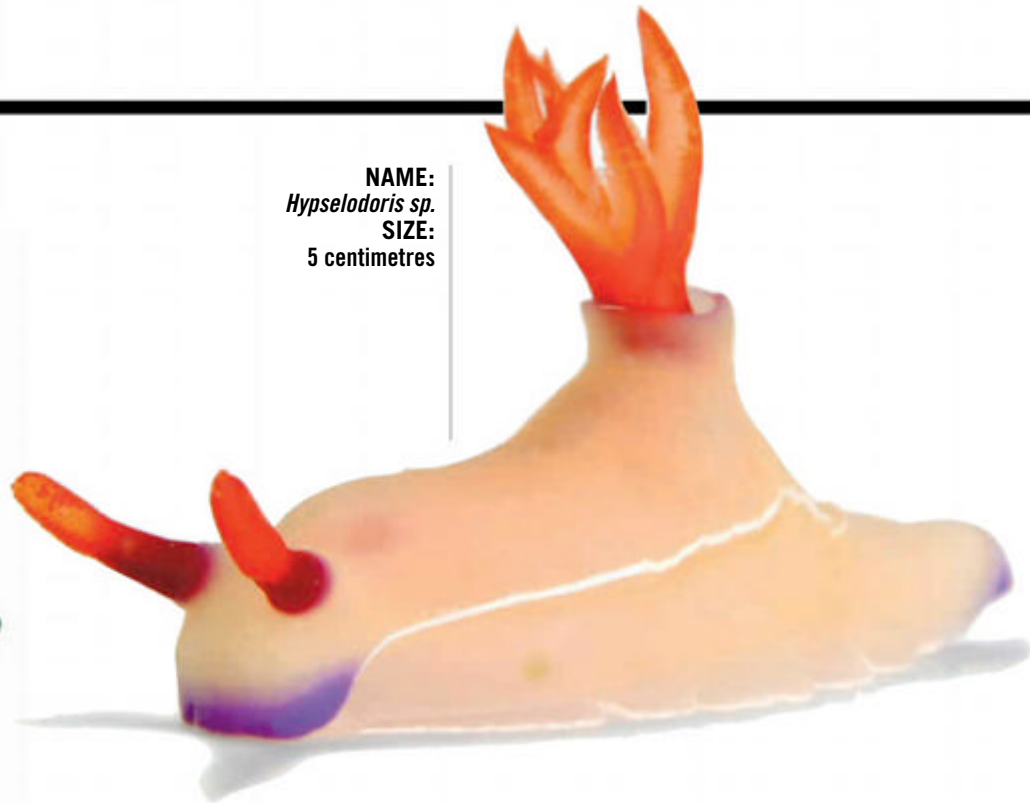
slightest touch can disable a victim's nervous system. Loaded with venomous barbs, they can penetrate the body in split seconds and some are potent enough to kill an adult. There's good reason why these marine gastropods carry such a highly toxic dose. After all, snails are more tortoise than hare – even underwater. So when they do manage to ambush a fish,

NAME:
Flabellina exoptata
SIZE:
3 centimetres





NAME:
Nembrotha cristata
SIZE:
12 centimetres



NAME:
Hypselodoris sp.
SIZE:
5 centimetres

THE DEEP

they need it to die very quickly. Remember, it would take our mollusc a whole day to travel a single metre – a distance their speedier victims can cover in seconds. Fortunately, not all sea snails can cause harm. Some are masters in deception, merely mimicking the psychedelic appearance of their toxic cousins. Unluckily for them, these quick-change artists

feature on the menu of the very same cannibalistic slugs they want to imitate, alongside fish, algae and coral. And it's not just their voracious appetite that sets these reef-dwellers apart. Scientists say only half of all sea slug species have been identified, which means there are still 3,000 ocean freaks just waiting to be discovered. 🐌



NAME:
Halgerda batangas
SIZE:
4 centimetres



NAME:
Nembrotha kubaryana
SIZE:
6 centimetres

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SIZE MATTERS

Lions? Sometimes the animal kingdom's smaller creatures are the real heroes



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