

**SUPER SOLDIERS**  
How to build the  
ultimate army

**ONCE UPON A TIME**  
Storytelling's  
evolutionary origins

**EARTH HEART**  
The centre of our  
planet pulsates

# NewScientist

WEEKLY May 11-13, 2006

## Shadow of the invisible

Our closest view ever  
of a black hole



# Is this the dawn of the super-soldier?

What if science could ensure that recruits always think clearly and calmly under pressure

THE news that the US army is studying how neuroscience can “improve” its soldiers will once again raise the spectre of amoral scientists using any means at their disposal – drugs, genetic profiling, brain stimulation, cybernetic implants, brainwashing – to vault ethical boundaries in the pursuit of military aims.

The army-backed report from the US National Academies of Sciences anticipates a day when troops will be monitored by biosensors, selected by gene tests, stimulated with magnetic tweaks to the brain and enhanced with pills (see page 6). This will inevitably spark discussions about the rise of cold-eyed super-soldiers who kill without emotion, and we should certainly be vigilant about the potential for “enhancement” to dehumanise troops, let alone the wider implications of this work for civilian life.

But by the same token, “improving” soldiers is about more than making them efficient and lethal. The depressingly routine atrocities committed by servicemen are the result of confusion, exhaustion, and the trauma of seeing comrades killed by bullet, booby trap and bloody dismemberment. These are

soldiers in extreme circumstances equipped with extreme weaponry and driven to violence by violence. Or they may be veterans returning from duty to hurt their family or take their own lives. How much better if science could ensure that recruits think clearly and calmly under extraordinary pressure.

After all, modern armies exist because of a need to prevent and control violence: soldiers are trained to use force only in well-prescribed situations, and are subject to the rules of war and military law.

That doesn’t mean there is no danger of neurotechnologies being abused by the military. There is a tradition of driving

**“‘Improving’ soldiers is about much more than making them efficient and lethal”**

warriors berserk with drugs, alcohol and magic mushrooms. Governments should think long and hard about the ethics of engaging in such research. A *Terminator*-style soldier would be a liability, not an asset.

But let’s not lose sight of the potential for science to rid armies of the trigger-happy, the vengeful and the deranged. Remember that the greatest challenge that forces face today is avoiding the use of violence unless absolutely necessary.

Nor should we forget how research can intervene in the war that rages off the battlefield. Veterans there are crippled by mental health problems, from stress disorders to depression to self-medication with drugs and alcohol. It would be a crime not to use neuroscience to cut this toll of suffering, if we possibly can. ■

# Ignoring swine flu won’t make it go away

H1N1 flu is still spreading. In North America, the number of cases may have passed the 100,000 mark; and cases in Japan may tip us into a pandemic. Yet Europe claims it doesn’t have evidence of “sustained transmission” of the virus.

That’s hardly surprising, as Europe isn’t doing the relevant tests (see page 10). Do governments fear that if they discover the virus is spreading, people with sniffles will swallow antivirals unnecessarily and spawn a drug-resistant strain? Whatever the reason, mad cows taught the UK that refusing to see – and tell – the truth about disease is unwise. If H1N1 is spreading elsewhere, it is unlikely to peter out in Europe. The authorities have had years to draw up pandemic plans. Yet they appear as ill-prepared to track the spread of this virus as they are to make a vaccine for it. ■

# Holey grail

AT A time when financial black holes loom on all sides, it will be a relief to get a glimpse of the genuine article. Astronomers hope soon to have an image of the giant black hole at the heart of the galaxy (see page 28), so anyone still sceptical of the existence of these gravitational monsters should make the most of the next few months. It may be your last chance to doubt. Unless, of course, the thing fails to show up. To find that the only real black holes are of the financial kind would be doubly depressing. ■

## What’s hot on NewScientist.com

**BLOG When Scientology met psychiatry** What happened when Scientologists protesting the American Psychiatric Association’s annual meeting ran into a counter-demo organised by the anti-Scientology group called Anonymous

**SPACE Stealth solar storm erupts** Images of the sun have revealed a burp of ionised gas that blasted into space without warning, confirming that the sun can spew out matter even when its surface looks tranquil

**SPORTS SCIENCE Dedication turns pathological** Elite athletes sometimes believe they must follow strict rituals – and these superstitions can keep them training after others call it a day. But when does such behaviour tip over into pathology? We report on the athletes suffering from obsessive-compulsive disorder

**COMPUTERS Nine games at which computers can outplay humans** Computers can now defeat the rest of us at a wide

range of games, from chess to rock-paper-scissors. *New Scientist* is honoured to salute our electronic game-playing masters

**CONSERVATION Whale avoidance** A new sonic alarm could warn off whales and manatees threatened by approaching ships. Our video shows what happens

**TECH How phones can alter reality** Smartphones are taking virtual reality to the streets – making it

possible, for example, for us to see the world with relevant information pulled from online data sources laid on top of objects nearby

**ENVIRONMENT Oil road turns Amazon Indians into meat traders** A new road and free bus rides for local people have created an unwelcome new trade in bushmeat, conservationists claim

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## Fight for a quiet canyon

YOU might think the depths of the Grand Canyon would be a place of restful quiet. But with well over 100 helicopter and light-plane flights passing low overhead every day, calm is often in short supply. Now the Sierra Club, a US environmental organisation, is calling on Congress to end a two-decade fight over the Arizona landmark's airspace and to curb the flights.

The issue was meant to be resolved by a 1987 act that required the Federal Aviation Administration (FAA) and other agencies to restore quiet to the canyon, so that visitors could contemplate its wonders in peace. Yet sightseeing aircraft now make around 50,000 flights every year. For walkers on the canyon rims, the noise can be deafening, says

Dick Hingson of the Sierra Club.

"The Grand Canyon may look the same, but it surely doesn't sound the same any more," he says.

Implementation of the law has been stalled by protests from flight operators and debate over how to measure the noise from planes and helicopters. A 1994 National Parks Service "road map" intended to smooth the process called for the act's aims to be realised by the end of 2009.

At the annual meeting of the Acoustical Society of America, held in Portland, Oregon, this week, Hingson will be calling on the new US administration to push the FAA and others to meet the parks service deadline and ensure that the canyon's natural soundscape is restored.



IAN DIGNALL/ALAMY

Looks great, sounds awful

## NASA's new boss

DOES NASA's probable new boss have the right stuff to put the agency back on track?

Former space shuttle pilot Charles Bolden was this week expected to be nominated as NASA administrator, with a résumé that combines advocacy for the agency's scientific work with experience as an astronaut.

He will take over an organisation in trouble on two fronts. Future US human space exploration will rely on the Ares 1

Houston, Texas. Bolden seems to agree. Three years ago, he told a Senate subcommittee that working within NASA's budget was "like trying to fit 15 pounds of stuff into a 5-pound sack".

He called for more money to avoid proposed cuts in science spending. "Human exploration and science research are necessarily parallel endeavours," he said. Bolden also served on a panel that in 2004 urged NASA to send a repair mission to the Hubble telescope (see right).

Bolden is well connected with the aerospace establishment and has held various posts in industry. Yet these ties might be a hindrance when deciding whether to ditch Ares 1 in favour of privately developed launchers, suggests aerospace analyst Charles Lurio.

Bolden has also served briefly as assistant deputy administrator of NASA. "Charlie Bolden is a good guy – friendly, outgoing, well-liked and respected," says John Logsdon of the National Air and Space Museum in Washington DC. "He will do well on Capitol Hill and with the public."

## Going for green

THE first serious attempt to rein in US greenhouse gas emissions is taking shape.

A House of Representatives committee is expected to pass a bill this week that will require US emissions to fall to 17 per cent below 2005 levels by 2020. The bill will make companies pay for at least some of their emissions, with 5 per cent of the money going to reforestation projects worldwide.

Henry Waxman, the bill's author and a Democrat from

California, has faced opposition from Republicans and some in his own party. Representatives from coal-exporting states have fought particularly hard, leading Waxman and his allies to retreat from attempts to impose a 20 per cent cut by 2020.

That the bill is even being debated is a huge step forward, as George W. Bush opposed all emissions controls and such measures stood no chance of being passed. US industry had better start thinking hard about how it will limit emissions.

## "Human exploration and science research are necessarily parallel endeavours"

rocket, which is meant to replace the shuttle, but Ares is dogged by technical problems. Meanwhile NASA's science programme is suffering from cuts made two years ago to pay for Ares.

NASA is trying to do too much with a budget so tight that "little or nothing can be done well", warns Eugene Levy, a space scientist at Rice University in

## It takes more than rocket science

IF YOU'VE ever been frustrated by home repairs and were tempted to "just whack it", you're not alone. The astronauts sprucing up the Hubble space telescope had to resort to brute force in repairs that ended this week.

On 14 May, installation of Wide Field Camera 3 almost failed when a bolt holding the existing camera refused to budge. When none of their tools could shift it, the spacewalkers were authorised to use as much force as possible. After a tense wait,

astronaut Drew Feustel cheered: "Woo-hoo, it's moving out!"

Then on 17 May, a handle blocking access to the Space Telescope Imaging Spectrograph wouldn't come loose. This camera has lain idle since 1990, when one of its two power converters failed. The astronauts struggled with it for 90 minutes, but Mike Massimino eventually had to yank the handle until it broke off.

The telescope was released into space once more on 19 May.



## Hard times

FREE Viagra for the unemployed! Pharmaceutical company Pfizer earned this catchy headline this week with its plans to make 70 products free to US residents

**"We all know people who have been laid off, making it difficult for them to pay for healthcare"**

who have lost their job.

Anybody who has been taking one of the 70 drugs for at least three months and became unemployed after 1 January this year can apply.

"We all know people who have been laid off recently and have lost their health insurance, making it difficult for them to pay for healthcare," says company executive Jorge Puente.

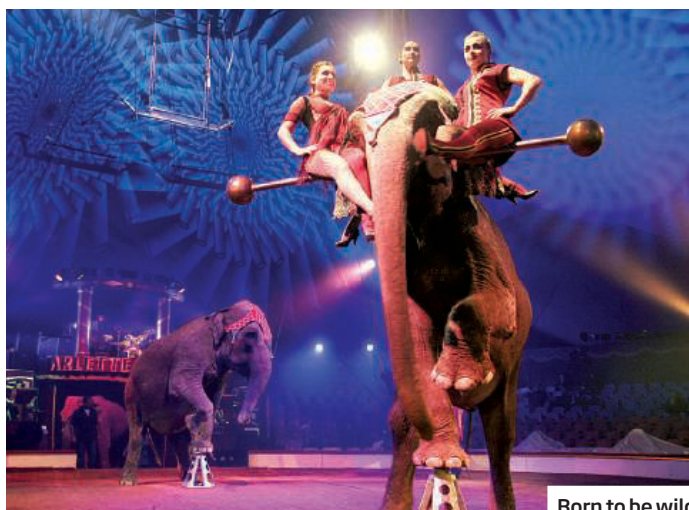
The decision is not all about patients, however. It also reflects Pfizer's concern for the bottom line: people cut costs when they lose their job, which may involve switching to a competitor's drugs.

Many of the drugs on the list, including painkiller Celebrex, face competition from rival products. A generic version of another Pfizer top-earner, the cholesterol medicine Lipitor, is set to be introduced in 2011.

By giving away some drugs for a limited period, market analysts say Pfizer will keep patients loyal to its brand during hard times.



Give it a good kick



Born to be wild

## Beastly acts

STARS of the show they may be, but circus acts featuring elephants, lions and tigers should end, the first global study of animal welfare in circuses concludes.

"Whether it's lack of space and exercise, or lack of social contact, all factors combined show it's a poor quality of life compared with the wild," says lead researcher Stephen Harris of the University of Bristol, UK.

On average, circus animals

**"Circus animals spend most of their time confined to cages or enclosures far smaller than those in zoos"**

were found to spend just 1 to 9 per cent of their time training, and the rest confined to cages or enclosures typically covering a quarter of the area recommended for zoos. While domesticated animals such as dogs or horses can adapt to these conditions, species such as elephants, lions, tigers and bears cannot, the researchers say.

Many of the confined animals exhibit stress behaviours such as pacing up and down for hours on end. "Even if they are in a larger circus pen, there's no enrichment such as logs to play with, in case they use them to break the fence and escape," says Harris, whose

team's results appear in *Animal Welfare* (vol 18, p 129).

Some countries, including Austria, have already banned wild animals from circuses, but they still feature prominently in the US and much of Europe. While elephants were not seen in UK circuses for 10 years, three have been performing since February in the Great British Circus.

## Germany's DNA law

SECRETLY obtaining someone's DNA to settle paternity disputes was banned in Germany last week. The UK passed a similar law in 2006, and Australia is considering following suit.

The new law allows paternity disputes to be settled using DNA evidence only if all parties consent. "People can still do it secretly using companies outside Germany, but the result would have no legal status within Germany," says Carston Proff of LCG Forensics in Cologne.

The law bans sex determination of fetuses and testing for predisposition to diseases that may or may not develop in adulthood. It also forbids employers and insurance companies from demanding gene tests except in special circumstances, such as to identify individuals who might be allergic to chemicals used in a particular job.

## 60 SECONDS

### Primate ancestor

A 47-million-year-old primate fossil could be the common ancestor of monkeys and apes, including humans. The find may suggest that we evolved not from precursors of the tarsier, as generally thought, but from a primate group that led to today's lemurs. The pristine skeleton was unveiled by New York mayor Michael Bloomberg on 19 May (*PLoS One*, DOI: 10.1371/journal.pone.0005723).

### Health job filled

President Barack Obama has named Thomas Frieden, New York's health commissioner, as director of the US Centers for Disease Control and Prevention. Frieden is best known for spearheading a ban on smoking in public places and boosting the number of New Yorkers getting tested for HIV.

### Park of peace

Sierra Leone and Liberia have announced plans to create a transboundary "Peace Park" to protect one of the biggest surviving areas of intact forest in west Africa. The park will include Sierra Leone's Gola reserve and Liberia's Lofa and Foya reserves, as well as wildlife corridors to link them.

### Nuclear waste on top

We shouldn't rush to bury nuclear waste as it's perfectly safe to store it in dry casks for 60 to 70 years. That was the unanimous verdict of scientists at a meeting in Boston this week. Money would be better spent on improving waste reprocessing technology, they concluded.

### Back to black bees

The UK's forgotten black honeybee could restore declining populations. Beekeepers ousted the native species a century ago in favour of bees from Italy and eastern Europe, but the larger, hairier black bees may be hardier. On 18 May the Co-op Group announced a £10,000 fund to map remaining native populations and set up a breeding programme.

# The universal soldiers

Advances in neuroscience are helping the US army create the blueprints for future super-soldiers

Linda Geddes

BATTALIONS of super-soldiers could be selected for specific duties on the basis of their genetic make-up and then constantly monitored for signs of weakness. So says a report by the US National Academies of Science (NAS).

If a soldier is struggling, a digital “buddy” might step in and warn them about nearby threats, or advise comrades to zap them with an electromagnet to increase their alertness. If the whole unit is falling apart, biosensors could warn central commanders to send in a replacement team.

As advances in neuroscience bring all this into the realms of reality, there are ethical issues to consider. Last week, the NAS released a report assessing the military potential of neuroscience, providing a rare insight into how the military might invest its money to create future armies.

Sponsored by the US army and written by a panel of 14 prominent neuroscientists, the report focuses on those areas with “high-potential” – where the

science is sufficiently reliable to turn into useful technologies (see “Where should the money go?”).

“A growing understanding of neuroscience offers huge scope for improving soldiers’ performance and effectiveness on the battlefield,” says the report.

Within five years, biomarkers might be used to assess how well a soldier’s brain is functioning, and within 10 years, it should be possible to predict how individuals are likely to respond to environmental stresses like extreme heat and cold, or endurance exercises.

Genetic testing might also enable recruitment officers to determine which soldiers are best for specialist jobs. For example, by combining psychological testing with genetic tests for levels of brain chemicals, a clearer picture of a soldier’s competencies might shine through. “We might say that given this person’s high levels of brain serotonin, they’re going to be calmer under pressure, so they might make a good sniper,” says Paul Zak of Claremont Graduate University in California, who was

on the NAS panel. Alternatively, someone with low dopamine might be less likely to take risks, he says, and therefore be better suited as a commanding officer in a civilian area.

Selection by genotype could be fraught with difficulty – applicants rejected for certain jobs might try to sue on the grounds of genetic discrimination, say. Anders Sandberg, a neuroscientist at the University of Oxford’s Future of Humanity Institute, says the military also needs to choose the traits it wants to optimise with care. “The battlefield is changing quite a lot right now. Wars are becoming more like computer games, which means that in the future having the genes that make you a good physical fighter might not be so important as having excellent hand-eye coordination.”

Perhaps more sinister is the possibility of neuroscientists creating cognitively manipulated

## “Neuroscience offers huge scope for improving soldiers’ performance on the battlefield”

warriors, whose emotions have been blunted, for example.

Zak emphasises that the panel was not asked how to turn soldiers into better “killing machines”, although “the whole purpose of maximising and sustaining battlefield capacity is to gain superiority over opponents”, admits Floyd Bloom of the Scripps Research Institute in La Jolla, California, who chaired the panel.

That’s not to say someone won’t try it, though. Zak’s own work focuses on the role of the hormone oxytocin in trust and empathy. If drugs were developed to block oxytocin, the effect might be to reduce a soldier’s ability to empathise with enemy combatants or civilians.

“There are lots of stories of soldiers who refuse to shoot other soldiers,” says Zak. “If you could get rid of that empathy response you might create a soldier that’s

## Ready for battle?

Battalions of super-soldiers could result from the US army’s relationship with novel neurotechnology research

### NUTRITION AND STRESS

Supplements supply neurons with the energy they need and rebalance brain chemicals disrupted by tiredness or stress

### WEAPON AIM POINT

Illuminated on headgear display. Optoelectronic algorithms highlight the arrival of new people or objects on a scene

### UNIFORM

Sensors assess physiological measures and provide information about health and ability to perform a job.

Commanders use information to predict how well a unit is likely to perform, or choose to send in a different team

### TRIAGE SYSTEM

Enables immediate assessment of injuries and ballistic impact

## WHERE SHOULD THE MONEY GO?

### NEAR TERM (within 5 years)

- Immersive virtual reality
- Heartbeat variability
- Galvanic skin response

### MEDIUM TERM (5-10 years)

- In-helmet EEG for brain-machine interface
- Head and torso impact protection
- Biomarkers for predicting soldier response to environmental stress

### FAR TERM (10-20 years)

- In-vehicle deployment of transcranial magnetic stimulation
- Brain scanning to assess physiology

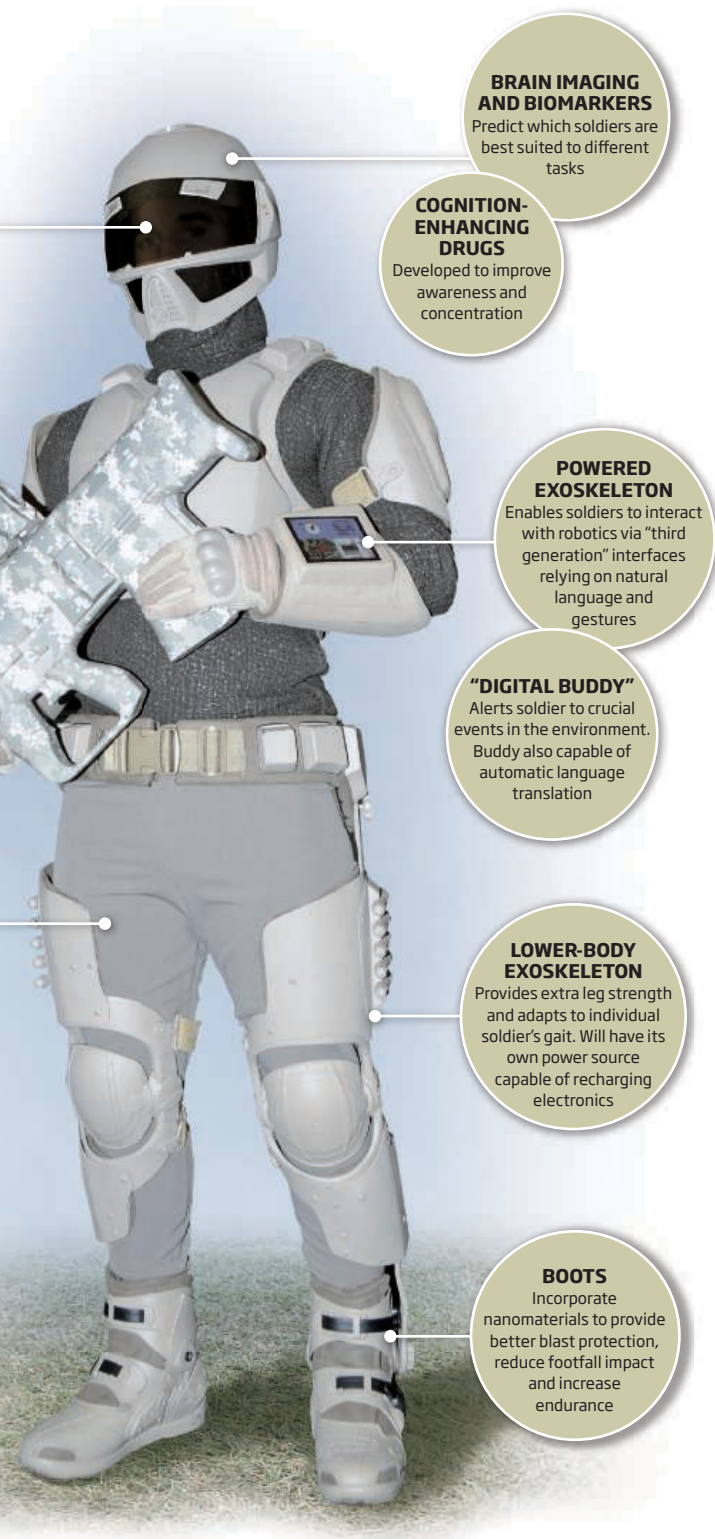
### ONGOING (within 5 years with continued updating)

- Field-deployable biomarkers of neural state
- Biomarkers for sleep levels



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- Bid to restore French cave art backfires, page 12



### BRAIN IMAGING AND BIOMARKERS

Predict which soldiers are best suited to different tasks

### COGNITION-ENHANCING DRUGS

Developed to improve awareness and concentration

### POWERED EXOSKELETON

Enables soldiers to interact with robotics via "third generation" interfaces relying on natural language and gestures

### "DIGITAL BUDDY"

Alerts soldier to crucial events in the environment. Buddy also capable of automatic language translation

### LOWER-BODY EXOSKELETON

Provides extra leg strength and adapts to individual soldier's gait. Will have its own power source capable of recharging electronics

### BOOTS

Incorporate nanomaterials to provide better blast protection, reduce footfall impact and increase endurance

more prepared to engage in battle and risk their life."

The panel recognised that such ethical dilemmas might be an inevitable consequence of their work. For this reason, they recommended that the US military should recruit ethicists to examine the ramifications of such developments before they occur. "They need to be explored because at some point someone's going to do them," says Zak. "Controls have to be put in place."

Neuroscience could also help to save lives in a military context. If you could predict which soldiers were particularly susceptible to stress, for example, it might help prevent a tragedy. Last week US army sergeant John Russell was charged with shooting five of his colleagues dead. Russell had completed a 15-month tour of Iraq and was being treated for stress.

Other research has suggested that navy recruits whose hypothalamo-pituitary axes (an area of the brain involved in the stress response) are highly reactive to stress are less likely to complete navy SEAL training. Robert Ursano at the Uniformed Services University in Bethesda, Maryland, and his colleagues have hinted that you might be able to predict individual responses to stress by looking at numbers of serotonin receptors, and levels of p11, a protein linked to depression (*Progress in Brain Research*, DOI: 10.1016/S0079-6123(07)67014-9).

The difficulty is finding predictive markers that are reliable enough, says Simon Wessely at the King's Centre for Military Health Research in London, who was not involved in the report. "Current predictors are too weak, and while they may work statistically in large groups, they cannot say that Private A is vulnerable and Private B isn't." Moreover, "if you wrongly label someone as vulnerable to breakdown, you are damaging his career and robbing the army of much-needed manpower".

A more likely short-term prospect is monitoring whether an individual soldier's mental performance is deteriorating because of stress or tiredness.

Many errors involve lapses of attention, so finding ways to monitor attentiveness could have big benefits. Recent studies have

**"You could get rid of empathy to create a soldier that's more prepared to engage in battle"**

linked variations in blood flow and oxygenation with occasions when observers miss signals, says the report, so sensors in helmets to monitor these variations could alert the soldier and his unit that his attention was fading.

Another possibility might be to use brain imaging to work out which recruits have understood new training concepts. In a recent study, fMRI was used to compare the brain activity of physics students and other students when they watched film clips of two different-sized balls falling at either the same or different rates.

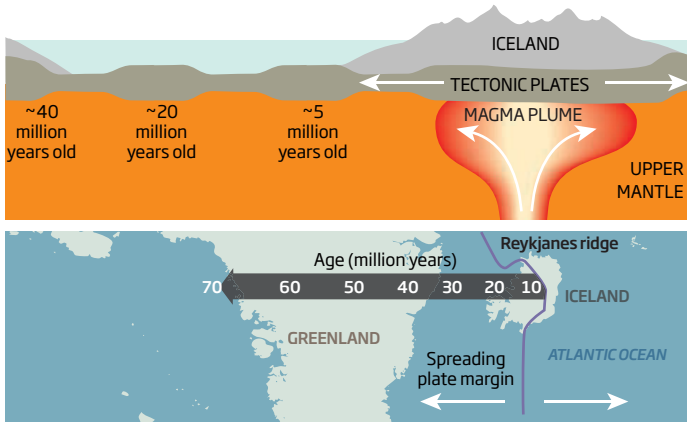
The students were asked if the film they viewed was consistent with their expectations of how the balls should fall. In the non-physics students, an area of the brain associated with error detection lit up when the large and small balls fell at the same rate. For the physics students, the same area lit up when they fell at different rates – suggesting that they had fully grasped the Newtonian concept that different balls should fall at the same rate, regardless of their size.

Bloom emphasises that while all technologies have the potential to be misused, this is not necessarily a reason for ignoring them. Indeed, military investment could even reap benefits for the wider society. "Investment in such opportunities will be of benefit to the public by improving ways we educate our children and understand ourselves," he says. ■

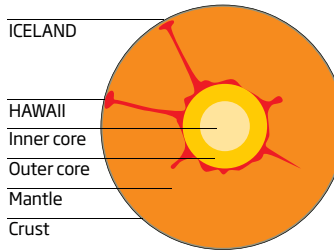
SOURCE: RICHARD MATTIOLUS/US ARMY

### History on a plate

Periodic thickening of the tectonic plate stretching outward from the Mid-Atlantic Ridge suggests that there is a 15-million-year pulse in the magma plume thought to be driving it



Magma plumes in Hawaii and Iceland have strengthened in sync with each other, suggesting a shared origin at the core



## Have we taken Earth's pulse?

Catherine Brahic

EARTH may have a heartbeat. Evidence from Hawaii and Iceland hints that the planet's core may be dispatching simultaneous plumes of magma towards the surface every 15 million years or so.

If the hypothesis is true, it would revolutionise our ideas of what's happening far below our feet. Independent scientists contacted by *New Scientist* were split, with some scornful and others intrigued.

Rolf Mjelde of the University of Bergen and Jan Inge Faleide of the University of Oslo, both in Norway, used seismological data to measure the thickness of Earth's crust between Iceland and Greenland (see map). Iceland is on the Mid-Atlantic Ridge, where magma wells up to form fresh crust.

The measurements allowed Mjelde and Faleide to infer the past flow of magma in the plume generally thought to rise beneath Iceland. When this plume is strong, it thickens the crust that it forms at the surface. They found that the crust has thickened

roughly every 15 million years, suggesting the plume pulses at around that frequency.

Regular pulsing of plumes is not a new idea, but when the pair compared their results with similar pulsing in Hawaii, which also sits on a plume, they found a surprising correlation. Data collected by Emily Van Ark and Jian Lin of the Woods Hole Oceanographic Institution, Massachusetts, suggests that Hawaii's plume pulses have

**"The synchrony must relate to the core somehow. I can't see any other possibility"**

coincided with Iceland's (*Marine Geophysical Research*, DOI: 10.1007/s11001-009-9066-0).

"These two are on very different parts of the Earth, so I don't think the synchrony could be related to something in the mantle," says Mjelde. "It must relate to the core somehow. I can't see any other possibility." This would mean that the Earth's core periodically heats up the overlying mantle,

generating synchronised plumes that rise to the surface at widely separated spots.

"If correct, it would be a significant alteration from our current thoughts," says Rhodri Davies of Imperial College London. Most geologists who believe that mantle plumes exist think that pulsing can be explained by processes in the mantle alone, such as magma build-up in regions of different viscosity. "A new way of thinking would be needed," agrees Mjelde. However, several geologists contacted by *New Scientist* said they could not explain how the enormous pulses of heat required could be generated in the core.

There could be other explanations for the synchronicity. More detailed measurements may reveal the timings of the two plumes' pulses are close but not synchronous. Furthermore, Mike Coffin of the National Oceanography Centre in Southampton, UK, points out that the mantle is not homogeneous, so plumes leaving the core at the same time might not reach the crust at the same time.

"I am sceptical that they are co-pulsing from the evidence presented," says Huw Davies of Cardiff University, UK. Still, the idea is "potentially very exciting", he adds. ■

### SOUNDBITES

"There are two countries that the world blames for doing nothing, and they have a better story to tell."

China and the US might be climate villains in many people's eyes, but the two have actually come close to joint action on emissions cuts, says **Terry Tamminen**, an environmental adviser to California, who attended secret talks between the nations in the last days of the Bush administration (*The Guardian*, London, 19 May)

"We want the spacesuits that the lab workers are going to have. That's the only way we'll be safe."

Campaigner and Boston resident **Klare Allen** expresses fears over a biodefence laboratory built near her home. Lawsuits from residents have blocked its opening until at least next year (*Los Angeles Times*, 17 May)

"Sweaty, stomach-churningly tinny... the worst wines I have tasted so far this year."

Wine critic **Jane MacQuitty's** verdict on some of the industry's "wine in a can" products - an effort to reduce its carbon footprint by using lighter packaging (*The Times*, London, 18 May)

"We still live in a world where if you have nuclear weapons, you are buying power."

International Atomic Energy Agency head **Mohamed ElBaradei** predicts that up to 30 countries will soon either acquire nuclear weapons or become "virtual nuclear states", with the materials and know-how needed to build them (AFP, 16 May)

"King and Paco will get some extra tuna tonight, that's for sure."

Trainer **Simone Arrigoni** celebrates after breaking the "foot pushing" world record by riding 450 metres on his dolphins' noses (*The Sun*, London, 19 May)

## Alarm raised on plight of world's shellfish

GLOBALLY, 85 per cent of reefs have been lost. Destructive fishing practices, disease and coastal development threaten many of the survivors. What sounds like an apocalyptic vision of the future for the world's tropical corals is in fact a chilling assessment of the current state of reefs built in cooler waters by oysters and other bivalve shellfish.

According to a report from The Nature Conservancy (TNC), released this week at the International Marine Conservation Congress in Washington DC, shellfish reefs are the world's most imperilled marine habitats – faring worse than coral reefs and mangrove forests.

“Shellfish like oysters, cockles and mussels have been feeding people

for millennia,” says co-author Robert Brumbaugh, a member of TNC's global marine team based in Summerland Key, Florida. “But there is very little appreciation for their plight.” Shellfish biologists hope that TNC's global survey will galvanise conservation efforts in a similar way to the 1998 report of the Global Coral Reef Monitoring Network, which raised the alarm on tropical reefs.

Shellfish reefs protect shores from erosion and provide shelter for other animals, while bivalves also filter out suspended organic matter, clearing waters for plants such as seagrass. Because shellfish have been thought of almost exclusively as a human food source, little thought has been given to their role as “ecosystem engineers”.

TNC's team scoured the literature, surveyed scientists and analysed fisheries statistics to assess the health of reefs in 144 bays and estuaries in 44 “ecoregions” across the globe. In most bays, shellfish reefs are down to around 10 per cent of their historical abundance. In many former strongholds – such as in North America, Europe and Australia – they are all but extinct. Reasons for the decline vary, but include overfishing,

**“Shellfish reefs are the most imperilled marine habitat – faring worse than coral reefs or mangroves”**

introduction of exotic species, and disturbance from human activities.

In Europe, Pacific oysters introduced for aquaculture are now moving from southern latitudes into the North Sea, where they are outcompeting native mussels – with

knock-on effects for other wildlife. In the Gulf of Mexico off the south-eastern US, meanwhile, the water demands of Atlanta and other cities mean river flows are down, making estuaries more salty and allowing invading marine predators to feast on native oysters.

The good news is that oyster reefs can bounce back, if managed with care. On the east coast of Florida, years of disturbance from boat wakes have created “dead margins” of dislodged oyster shells. Volunteers led by Linda Walters of the University of Central Florida in Orlando use an amphibious mechanical digger to remove the debris, then lay down mesh mats with empty shells tied on. These encourage larvae to settle, and after 18 months the mats host the same density of oysters as a pristine reef. The team has laid 8500 mats and will set 3500 more in the next few months. Peter Aldhous ■

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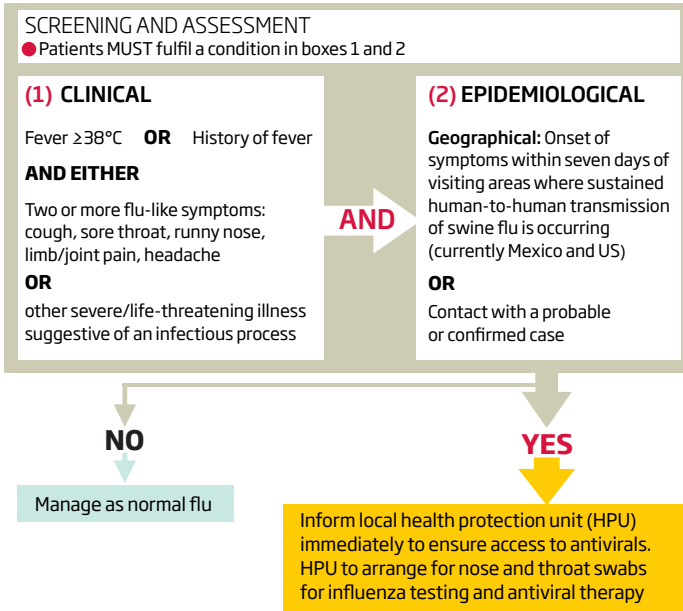
## BAE SYSTEMS

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**Do you have H1N1 swine flu?**

This is the algorithm for doctors for the management of suspected cases of swine influenza, taken from the UK Health Protection Agency



# Europe may be blind to swine flu cases

Debora MacKenzie

EUROPE might have more H1N1 swine flu than it knows. The virus could be circulating widely but not being spotted simply because people are not being tested.

As *New Scientist* went to press, the World Health Organization was still undecided about declaring a full-blown pandemic, despite a surge in swine flu cases in Japan. To do this it needs evidence of "sustained transmission" outside the Americas, where the virus originated. This means finding cases in the general population that have not had known contact with places or people confirmed to have the virus. Japan found H1N1 this week in over 100 people, many without known contact.

But European countries are using a case definition from the European Centre for Disease Prevention and Control (ECDC) in Stockholm, Sweden, that virtually precludes discovering such cases. It recommends testing people with symptoms only if they have been to affected countries or had contact with a known or suspected case in the past seven days.

"We can't test every mild case of flu symptoms," says Johan Giesecke, chief scientist at ECDC.

**"A *New Scientist* reader had flu symptoms on returning from New York but was not tested for H1N1"**

"But it's true, we might not be seeing community spread because we aren't looking." On 18 May, the UK had 101 confirmed cases of H1N1, of which only three fell outside the case definition.

The UK Health Protection Agency's criteria are similar (see diagram, left). Doctors "are

encouraged to use this algorithm", an HPA spokesperson told *New Scientist*, but they can "use their clinical discretion" to test anyone.

An anonymous UK *New Scientist* reader, and two family members, had flu symptoms after one returned ill from New York on 10 April. They were not tested for H1N1. "My general practitioner is horrified that I am not even eligible for a test because I have not returned from Mexico in the last seven days, nor been in contact with someone who has been diagnosed."

Tests may simply be unavailable. "I was given only two swabs [for H1N1] initially," says Laurence Buckman, head of the GP committee of the British Medical Association. More are available now, "but if you can't do many tests you save them for people who meet the case definition".

Any others, says Buckman, will be picked up by "sentinel" clinics that compile weekly statistics. The ECDC claims this system "would detect circulation of the new H1N1 virus before any major outbreaks occur".

However, such sentinel systems are designed to track ordinary flu, not to detect a new infection that is initially highly localised. "It may take weeks before the numbers indicate an epidemic," warns Dick Wenzel of Virginia Commonwealth University in Richmond, past president of the International Society for Infectious Diseases. He advises testing clusters of flu and all severe cases.

Hong Kong is testing all hospitalised cases of flu and pneumonia. Belgium, departing from ECDC advice, is testing flu-like clusters and deaths. But without more tests, Europe may be missing an epidemic. ■

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## The new biology of ageing

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University College London

Research into ageing has been rejuvenated by the discovery of mutations in single genes and signalling pathways that extend the lifespan of laboratory animals. As well as a prolongation of healthy lifespan, with a broad spectrum improvement in function during middle and old age, there is a delay or amelioration of a range of ageing-related diseases. These findings have led to an intensive wave of research directed at understanding the mechanisms at work, which this lecture will address.

Linda Partridge holds the Weldon Chair of Biometry at UCL and is director of the UCL Institute of Healthy Ageing. She is the recipient of many awards, most recently she has been selected to take part in the 2009 Women of Outstanding Achievement in SET Photographic Exhibition by the UK Resource Centre for Women in SET.

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# Mars robots in the frame for destroying evidence

HAVE Mars landers been destroying signs of life? Instead of identifying chemicals that could point to life, NASA's robot explorers may have been toasting them by mistake.

In 1976, many people's hopes of finding life on Mars collapsed when the twin Viking landers failed to detect even minute quantities of organic compounds – the complex, carbon-containing molecules that are central to life as we know it. "It contributed, in my opinion, to the fact that there were no additional [US lander] missions to Mars for 20 years," says Jeff Moore of NASA's Ames Research Center in Moffett Field, California.

The result also created a puzzle. Even if Mars has never had life, comets and asteroids that have struck the planet should have scattered at least some organic molecules – though not produced by life – over its surface.

Some have suggested that organics were cleansed from the surface by naturally occurring, highly reactive chemicals such as hydrogen peroxide. Then last year, NASA's Phoenix lander, which also failed to detect organics on Mars, stumbled

on something in the Martian soil that may have, in effect, been hiding the organics: a class of chemicals called perchlorates.

At low temperatures, perchlorates are relatively harmless. But when heated to hundreds of degrees Celsius they release a lot of oxygen, which tends to cause any nearby combustible material to burn. For that very reason, perchlorates are used in rocket propulsion.

The Phoenix and Viking landers looked for organic molecules by heating soil samples to similarly high temperatures to evaporate them and analyse them in gas form. When Douglas Ming of NASA's Johnson Space Center in Houston, Texas, and colleagues tried heating organics and perchlorates like this on Earth, the resulting combustion left no trace of organics behind. Ming's team presented their results at the recent Lunar and Planetary Science Conference in Houston.

Iron oxides have also been suspected of interfering with the detection of organics, but perchlorates are probably far more effective, says Chris McKay of Ames. Even if organics make up a few parts per thousand of



NASA/JPL/CALTECH/UNIVERSITY OF ARIZONA/TEXAS A&M UNIVERSITY

Burn first, ask questions later

the soil, Viking or Phoenix could have missed them, he adds, so it is too soon to conclude that these materials are not there. "We haven't looked the right way," he says.

Jeffrey Bada of the University of California, San Diego, agrees that a new approach is needed. He is leading work on a new instrument

called Urey for the European Space Agency's ExoMars rover, due to launch in 2016, which will be able to detect organic material at concentrations as low as a few parts per trillion. The good news is that, although Urey heats its samples, it does so in water, so the organics cannot burn up. David Shiga ■

## MYSTERY OF THE MISSING SALT

Organic chemicals are not the only substance that we may have missed on the Red Planet (see above). We should have seen carbonate salts littering the surface.

Weathering breaks down basalt, the dominant rock in the planet's crust, into a clay plus positive ions. These ions should react with carbon dioxide in the Martian atmosphere to form carbonate salts, explains Ralph Milliken at NASA's Jet Propulsion Laboratory in Pasadena, California.

Orbiters have spotted clay on Mars but few carbonates or other salts. We shouldn't assume that they aren't there, however, Milliken says.

Milliken and his colleagues have

calculated that weathered Mars basalt should produce equal amounts of clay and salt. Thus in the planet's southern highlands, where thousands of clay deposits have been identified, there should be at least as much salt (*Geophysical Research Letters*, DOI: 10.1029/2009gl038558). "Chemistry has shown that you can't draw conclusions from observations alone, because you are still missing pieces of the puzzle," says Milliken.

Some argue that the lack of known carbonate salt deposits points to a different atmospheric composition in the past, but Milliken says we should study the rocks directly before making any conclusions. Jessica Griggs



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# Cave art rescue bid creates new threats

Andy Coghlan

HISTORIC cave paintings in France partially saved from attack by a black fungus face a new threat: bacteria that moved in following four years of spraying with fungicide.

The Lascaux cave in south-west France houses invaluable animal paintings that are between 16,000 and 17,000 years old, making them among the oldest examples of cave art ever found. Now conservationists must deal with the twin threats of the *Fusarium solani* fungus and the new bacterial populations.

The latest invasion came to light when a team of Spanish and French microbiologists analysed 11 swabs from the cave walls, comparing the profile of species found in Lascaux with those in undisturbed caves in Spain. Almost all the bacteria and protozoa found in Lascaux were associated with human activity.

"The Lascaux cave is now a reservoir of potential pathogenic bacteria and protozoa similar to those found in disease outbreaks linked to contaminated air-conditioning systems and cooling towers in hospitals and public buildings," says team member Cesareo Saiz-Jimenez of the Spanish Institute of Natural and Agrobiological Research in Seville.

The team conclude that a benzalkonium chloride spray applied between 2001 and 2004 to kill the fungus is to blame, as it allowed bacteria brought in by human visitors to thrive (*Naturwissenschaften*, DOI: 10.1007/s00114-009-0540-y). "It produced a drastic change in the cave biodiversity," says Saiz-Jimenez.

According to the researchers' analysis, Lascaux's management history is a catalogue of errors. The team think the bacteria started to arrive in 1940, when the caves were discovered and opened



Facing a biological attack

to the public. Over 1800 people visited each day, and their breath would have permanently altered the atmosphere and microbiology of the site. New air conditioning systems and lighting only added to the problem, and the caves were closed to the public in 1963. Arrival of the fungus in 2001 and subsequent antifungal spraying accelerated the destruction of the environment that had kept the paintings largely

unharmful for 16,000 years.

There is hope for the paintings, however. Saiz-Jimenez and his colleagues have been testing conservation techniques in Spanish caves that avoid fungicides, relying instead on meticulous control of the cave microclimate. They are also examining whether hydrogen peroxide can destroy the organic matter that the fungi and bacteria feed on. ■

# Muscle 'immunity' weighs in against monkey HIV

HOW do you deal with a virus which attacks the immune system that is trying to fight it off? It's a question HIV researchers have been trying to solve for years, and now they may have come up with a solution: bypass the immune system altogether.

Nine macaques have been protected against the monkey version of HIV with a novel vaccine that sidesteps the monkey immune system. Instead, the vaccine turns monkey muscles into factories for churning out antibodies which kill simian immunodeficiency virus (SIV) - the monkey equivalent of HIV.

The vaccine is a departure from the

usual approach, which is to prime the body's immune system for attack by exposing it to a harmless version of the real pathogen. Thus primed, the immune system prepares for a real invasion by building its own stockpile of antibodies that target the pathogen.

Instead, Philip Johnson of the Children's Hospital of Philadelphia in Pennsylvania and his colleagues injected the monkeys' muscles with a harmless virus carrying genes for making immunoadhesins, antibody-like molecules pre-selected to attack SIV.

The viruses load the genes into the

nuclei of muscle cells, which produce and churn out the immunoadhesins, potentially indefinitely. "Instead of expecting the person's own immune system to do the job, we're giving them their own supply of 'off-the-peg' antibodies," Johnson says.

"It is now 85 weeks since all nine macaques received their jabs, followed by injections of SIV, and they still haven't suffered any infections,"

**"Instead of using their own immune system, we're giving them a supply of 'off-the-peg' antibodies"**

he says. "By contrast, four of six unvaccinated animals died of monkey AIDS" (*Nature Medicine*, DOI: 10.1038/nm.1967).

Johnson says the approach is

especially suitable for combating HIV, which overwhelms the immune system that is supposed to fight it. With all conventional vaccines so far "the virus always wins in the end", he says.

Given such a strong proof of principle, the team is already gearing up for clinical trials, with four potential "superantibodies" from people who are HIV-resistant.

"Within two to three years, we would hope to have this in the clinic," says Wayne Koff, senior vice-president of research and development at the International AIDS Vaccine Initiative, which is collaborating with Johnson on this next phase. "It will be a tremendous test of the concept to see if what has protected the monkeys pans out into people," he says. Andy Coghlan ■





## Komodo dragons have a secret weapon - poison

HUGE, ugly, now add venomous to the list of the Komodo dragon's awful charms. The Komodo's reputation for hosting toxic bacteria in its mouth is undeserved: in fact they produce a deadly venom from glands in their jaws.

For decades, wildlife documentaries have promoted the idea that Komodo dragons owe their success as predators to a mouthful of toxic bacteria - a claim bolstered by a 2002 study reporting deaths among lab mice injected with saliva. Now a team led by Bryan Fry of the University of Melbourne, Australia, has carried out MRI scans on a preserved Komodo head and found a

simpler explanation: huge venom glands (*Proceedings of the National Academy of Sciences*, DOI: 10.1073/pnas.0810883106). The team confirmed the finding by removing the glands from a terminally ill Komodo.

The venom contains substances that prevent blood clotting and widen blood vessels, which would cause a dramatic drop in blood pressure. The dragons have sharp teeth but a weak bite, so "it's the venom that nails it", Fry says. "Prey goes into shock and can't even struggle." He compares previous ignorance of the Komodo dragon's venomous capabilities to "missing the teeth on great white sharks and saying they are plankton eaters".

The study also suggests that the largest venomous creature ever was a 5.5-metre-long ancestor of the Komodo, the extinct *Megalania* lizard.

## Extra gene fights cancer in Down's

AN EXTRA copy of a gene on chromosome 21 may explain why people with Down's syndrome are less likely to get breast and lung cancer than the rest of the population.

People with Down's have three copies of chromosome 21 instead of two. A gene on chromosome 21 called *DSCR1* is involved in controlling tumour growth. So Sandra Ryeom at the Children's

Hospital in Boston and colleagues bred mice with three genes to find out if an extra copy gave them extra protection against cancer.

Tumours in these mice grew 50 per cent more slowly than those in healthy mice, indicating that one extra copy of the gene has a significant effect on tumour growth (*Nature*, DOI: 10.1038/nature08062).

To see whether this also applies

to humans, the team engineered stem cells from people with and without Down's syndrome and injected them into mice.

They found 60 per cent fewer blood vessels surrounding tumour-like tissue grown from Down's stem cells than those from other volunteers.

Ryeom suggests that the extra copy of *DSCR1* blocks signals from the tumour that recruit vital blood vessels, and could be a potential drug target.

## Plants thriving despite Chernobyl

MORE than two decades after the world's worst nuclear accident, wildlife near Chernobyl in Ukraine seems surprisingly normal. "There are no dogs with two heads or interesting plant species," says Martin Hajduch of the Institute of Plant Genetics and Biotechnology in Nitra, Slovakia.

To see how plants are able to adapt to the radiation, Hajduch compared soya in radioactive plots near Chernobyl with plants grown in uncontaminated soil. The Chernobyl soya produced different amounts of dozens of proteins, including some that aid seed production and some that defend cells from heavy metal and radiation damage (*Journal of Proteome Research*, DOI: 10.1021/pr900034u). One also protects human blood from radiation.

The results could help geneticists engineer plants that can withstand radiation in space, which may be vital for interplanetary travellers.

## Mockingbirds can tell people apart

EVER felt that your backyard birds know who you are? Some may well do, as it seems mockingbirds can recognise individual people.

Doug Levey of the University of Florida in Gainesville devised a test in which one person briefly touched a northern mockingbird's nest four days in a row, followed by a different person on the fifth day.

The birds were quicker each day at recognising the first person as a threat, but were as slow to respond to the new person approaching their nest as they had been on the first day (*Proceedings of the National Academy of Sciences*, DOI: 10.1073/pnas.0811422106). This ability to distinguish passers-by from potential threats may have aided the species' success in urban areas, Levey says.

## How to grow a frost garden

NOT much grows in the icy polar regions, but for the fern-like clusters of ice crystals called frost flowers this is the perfect environment, especially when it's still and dry.

Frost flowers bloom on fresh, thin sea ice, which makes it difficult to get close enough to study them. It was assumed that these salty structures were similar to hoar frosts, which form when water from supersaturated air – perhaps in the form of freezing fog – is deposited as ice crystals on a surface.

However, Grae Worster and Robert Style of the University of Cambridge found that frost flowers form mostly in still, dry air. The key factor is air that is much colder – by around 20 °C – than the water below the ice, they say in a paper to appear in *Geophysical Research Letters*.

Under these extreme circumstances ice vaporises into the dry air and then refreezes in the form of a frost flower. The pair confirmed this by recreating such conditions in the laboratory. They grew frost flowers from fresh water at 0 °C by cooling the surrounding air to around –25 °C.

The finding could change the way past climate is inferred from ice cores. High levels of salt in frost flowers have been assumed to come from sea spray kicked up by storms, but it now seems that these flowers can bloom in calm conditions.



## Genes for timing of puberty and menopause found

IT HAS long been known that some women's biological clocks tick faster than others. Now several gene variants that control when an individual has her first and last period have been identified.

Groups from the US, UK, Iceland and the Netherlands, working independently, scanned the genomes of thousands of women and then compared the results with their age when menstruation began. All four teams found that variations near a gene called *LIN28B* were associated with the timing of

a girl's first period. Two of the teams also identified several gene variants associated with advanced or delayed menopause. Each team's research will be published in this week's issue of *Nature Genetics*.

*LIN28B* is also involved in determining a person's height. This may help to explain why girls whose first period occurs later end up taller than those who start menstruating younger, says André Uitterlinden at the Erasmus Medical Center in Rotterdam, the Netherlands.

This points to a more general

role for *LIN28B* in development, says Ken Ong at the UK's Medical Research Council Epidemiology Unit in Cambridge. His team found a variant associated with earlier breast development in girls and earlier voice-breaking in boys. "Showing it in boys means [*LIN28B*] is fundamental, not just to menstruation, but to the timing of growth as well," he says.

The findings could lead to treatments for diseases linked to prolonged or shortened fertility, such as breast cancer and osteoporosis.

## Frozen islands may remain in Antarctic

SOME of the West Antarctic ice sheet may survive as the climate warms – although the parts most likely to float off could still raise sea levels globally by more than 3 metres.

Glaciologists had feared that when warmer water melts floating ice shelves, the entire sheet will be released into the ocean and will melt too, raising sea levels by up to 5 metres. A recent study found the ice sheet is probably doomed if the seas warm by more than 5 °C.

Now Jonathan Bamber at the University of Bristol, UK, says that one-third of the ice sheet might remain, mostly because it rests on bedrock that is above sea level (*Science*, DOI: 10.1126/science.1169335). The two-thirds lost, however, could still raise sea levels by 3.3 metres. The loss of Antarctic ice would also shift the Earth's gravitational pull, causing water to pile up in the northern hemisphere and boosting sea-level rise there.

In March, Bamber argued that the Greenland ice sheet is also more resistant to warming than previously thought. But most predictions still put global sea-level rise at around 1 metre by 2100 – with more to follow.



## Water falls faster than it oughta

RAINDROPS have been seen falling from the sky faster than thought possible. The finding suggests that forecasters could be miscalculating how much it rains.

Conventional wisdom holds that all raindrops fall at their terminal velocity – a freely falling object's maximum speed – and that larger drops fall faster than smaller ones. To test this, Fernando García-García of the National Autonomous University of Mexico in Mexico City and his colleagues traced the shadows of raindrops. In a paper to appear in *Geophysical Research Letters*, they

report that up to half exceeded their expected terminal velocity, and some fell 10 times as fast.

"Others had detected this before, but everybody disregarded it," says García-García. The drops may fall at "super-terminal" speeds if they are fragments of speedy larger drops.

Forecasters estimate the volume of rainfall by using radar to measure the speed at which raindrops fall – and hence deducing their size. By getting this wrong they may be overestimating rainfall by up to 20 per cent, the team says, and so overstating risks of flooding.





Didn't hear it coming

## Warned off by a sea siren

TRAFFIC accidents are taking a heavy toll on marine mammals. At least one-third of the north Atlantic right whales that died in the past decade were killed by ship strikes. Now whales and manatees could be saved by an underwater siren that drives them out of harm's way.

Many collisions occur because marine mammals in the path of a ship cannot hear its propellers, according to researchers at Florida Atlantic University in Boca Raton. "The sound of the propellers is deflected to the sides," says Edmund Gerstein, who presents his team's findings this week at a meeting of the Acoustical Society of America in Portland, Oregon.

The animals do not seem able to learn from painful experience, either. Some manatees in Florida have been hit 50 times, Gerstein says. "They seem to seek out the quieter zone

in front of the ship as a refuge."

His team's solution is a small device fitted on the bow of a ship below the waterline that emits a narrow beam of sound. Gerstein says that when the siren was tested, manatees always got out of the way.

But the device has not yet been

**"Marine mammals in the path of a ship cannot hear its propellers. The sound is deflected to the sides"**

tested on whales, and a whale siren tested in 2003 failed to work. "There is a very long way to go before this can be proclaimed as a way to prevent ship strikes in right whales," says Scott Kraus of the New England Aquarium in Boston. Gerstein says that sea tests of a larger whale-warning system will start next year.

## Robot insect spies to get their eyes

A MICROCHIP-sized digital camera patented by the California Institute of Technology could provide vision for the US military's insect-sized aircraft. It is light enough to be carried by these tiny surveillance drones and also uses very little power.

In today's minicams, the image sensors and support circuitry are on separate microchips, and most of the power goes on communication between the chips. Now with Pentagon and NASA funding, Caltech's Jet Propulsion Lab in Pasadena has squeezed all the components of a camera onto one low-power chip, revealed in a US patent filed last week ([www.tinyurl.com/ojwmdq](http://www.tinyurl.com/ojwmdq)).

The gadget can be radio-controlled via a secure frequency-hopping link from up to a kilometre away, say its inventors.

# 489

**The number of pirate radio transmitters seized by UK regulator Ofcom in 2008. Many were on the air again within weeks**

## Greedy gadgets must learn to diet

COME 2030, electronic gadgets will gobble three times as much electricity as they do today, requiring 280 gigawatts of new generating capacity, unless we do something about it.

A new study by the International Energy Agency (IEA) reports that devices from cellphones to personal computers consume 15 per cent of all household power, and that figure is climbing rapidly.

Energy consumption could, however, be reined in using existing technologies. "If we were to use the most efficient technology available, instead

of doubling or tripling energy consumption we could hold it almost flat," says Paul Waide of the IEA.

The efficiency of cellphones could be improved by updating the way that chargers convert power from AC to DC, for instance. But such devices cost slightly more to make, so government regulation or incentives will be required to bring them onto the market, the IEA says.

One suggestion is that the law should limit standby power to 1 watt for all electronic devices. A 2007 study by the IEA found that 20 per cent of US televisions used more than 2 watts and one model drew 50 watts while on standby.



**"I haven't seen any good come out of the internet"**

**Michael Lynton**, chief executive of Sony Pictures, tells an audience at Syracuse University in New York that the internet has had a consistently negative impact on the film business. Stronger copyright protection is the answer, he says (*The Hollywood Reporter*, 16 May)



# Pandemic flu is now boarding at gate 5

Can fever detectors and microphones that listen for suspect coughs identify sick air passengers and stop diseases racing round the world?

Paul Marks

WHEN aviation officials chose Mexico City for a meeting to discuss their response to pandemic outbreaks, they could scarcely have predicted swine flu would intervene. "The irony was amazing," says Tony Evans of the International Civil Aviation Organization (ICAO) in Montreal, Canada. "The meeting will probably go ahead in June unless we get another wave of H1N1."

Future pandemics will almost certainly be spread via air travel, with flights capable of carrying a pathogen across the world in hours. The UN's Convention on International Civil Aviation requires nations to "prevent the

spread of communicable diseases by means of air navigation". That is easier said than done, especially in poorer regions.

Enter CAPSCA – the Cooperative Arrangement for the Prevention of the Spread of Communicable diseases by Air travel. CAPSCA aims to help airports in developing nations prepare for a pandemic, and its schemes are now getting off the ground in the Americas, Asia-Pacific and Africa.

"When an aircraft arrives with a suspected disease case on board, CAPSCA will make sure you've thought about where you are going to park the plane, how you will deal with the luggage and how are you going to keep in touch with the passengers that haven't

got any symptoms," Evans says. You also have to work out which people on the plane are most likely to be infected and whether they need prophylactic treatment or admission to hospital. How will you protect customs officers? Careful planning is crucial and CAPSCA will promote that, Evans explains.

At present these plans rely on aircrew identifying any sick passengers by their symptoms. It would be far better to have an automatic system that can detect infected people as they pass through a gate or wander around an airport, but there is still no reliable technology to do that.

Since the SARS scare in 2003, some airports have used infrared



Hotbeds of infection

cameras to pinpoint passengers with high temperatures, Turkey spotted its first swine flu case this way. It is an imperfect solution, however, because different viruses are infectious at different stages: flu is infectious about a day before fever arrives, whereas with SARS the two coincide. "So cameras were better at picking up SARS cases before an infected person got on a plane," Evans says.

Ideally, he'd like to see a test that reveals when somebody is infected before they even develop symptoms – perhaps based on a breath test. But such technology remains far-off.

One infection-spotting technique that might be practical in the near future is the cough detector. Biorics, a spin-off from the Catholic University of Leuven in Belgium, is hoping to use cheap networks of microphones in airports to detect and locate people with persistent coughs. The firm has developed software that by analysing the pattern of

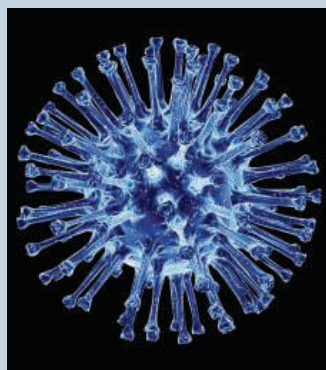
## Ceramic coating makes short work of viruses

Viruses lurking on solid surfaces could be killed by a new coating based on ceramic nanoparticles, which is undergoing trials in the US.

The technology follows from work by virologist John Oxford and his colleagues at Queen Mary, University of London. The team discovered that certain silicon and metal carbide ceramics destroy any viruses they came into contact with, as long as the substances are in the form of fine particles no more than 100 nanometres across.

"It kills 99.9 per cent of viruses in less than an hour. It's better than wiping the surface with acetic acid," says Joseph Rugaso of Intrinsic Materials in Farnborough, UK, which is now developing the coating.

No one is yet sure how it works, however. Originally, it was thought that the nanoparticles physically damaged surface proteins on the virus, but the researchers now suspect the particles have a chemical



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effect akin to that of an acid.

Intrinsic makes its coating by mixing a plasma of silicon and carbon ions and condensing them as carbide nanoparticles. Backed by defence company Qinetiq, also in Farnborough, Intrinsic is working to build its antiviral material into aviation air filters, face masks, shopping cart handles, cash machines and even banknotes.

"Most available face masks work by filtering out virus particles based on their size, but don't deactivate the virus," says Rugaso. "Our masks, and cabin air filters will provide the added benefit of virus deactivation." After all, he says, a face mask or filter that has merely trapped viruses is still a biohazard. Paul Marks ■



JUNG YEON-JE/AP/PRESS ASSOCIATION

frequencies can tell the difference between someone merely clearing their throat and a sickly cough. Once a cough has been detected, the microphone array can then be used to triangulate their position and identify them, perhaps with the aid of CCTV, so they can then be checked for infection.

"It is not clear for which human infections the technique will be reliable. That needs more research," says Biorics director Daniel Berckmans. The firm also believes its acoustic cough

within 3 hours of infection.

Beyond the realm of aviation, pandemic detection could harness the distributed sound and location sensors we all carry: cellphones. Biorics says its algorithms could be built into phones, alerting health authorities when a suspect cough is sensed, even revealing whether it is the phone user who is sick or if somebody else is coughing in the background.

Last week, the Japanese government kicked off a 2000-person trial based on GPS-enabled phones. Cellphone users will receive a warning text if their GPS history suggests they may have been in contact with another user later diagnosed with flu.

Both these ideas have the potential to infringe privacy. But in the face of a 1918-style potential pandemic, health authorities are likely to echo the words of Sun Microsystems boss Scott McNealy, when faced with the onslaught of the internet: "Forget privacy." ■

### "Software can tell the difference between someone clearing their throat and a sickly cough"

detector can monitor animal health on the kind of massive pig farms where the new H1N1 flu is thought to have emerged. In tests with seven microphones in pens of 100 pigs, the Biorics system was able to identify sick pigs 82 per cent of the time

## Sperm-like nanopropeller is smallest swimmer ever

REMOTE-CONTROLLED nano-devices that look like sperm but mimic the corkscrew motion of flagella may one day deliver drugs to where they are needed in the body.

Flagella are the structures some bacteria use to swim through water. Because water is syrupy at small scales, ordinary swimming motions don't work well. "Picture trying to swim in a pool of asphalt on a hot summer's day," says Peer Fischer of The Rowland Institute at Harvard University. Instead, flagella use a corkscrew motion to drive bacteria through the water.

The motion of flagella inspired Fischer and his colleague Ambarish Ghosh to create their nanopropellers. Made of glass, each has a spherical head 200 to 300 nanometres across and a corkscrew-shaped tail 1 to 2 micrometres long - less than one-tenth the length of a human sperm.

To make their propellers, Ghosh and Fischer covered a silicon wafer with glass beads, before depositing a vapour of silicon dioxide onto them. While doing so they spun the wafer, causing the silicon dioxide to form corkscrew-shaped tails on each bead. Finally, once the silicon dioxide had solidified they covered one side of the nanopropellers with cobalt.

Cobalt is magnetic, so when an external magnetic field is applied

the propellers line up with the field. By making the field rotate, Ghosh and Fischer were able to make the propellers rotate with it, corkscrewing through the water at up to 40 micrometres per second (*Nano Letters*, DOI: 10.1021/nl900186w).

The nanopropellers can also be steered precisely. "We control the coils that give rise to the magnetic field," says Fischer. "By changing the magnetic field in three dimensions we can steer and propel the propellers." The team were able to get a single nanopropeller to trace out various characters, including an "R" and an "@".

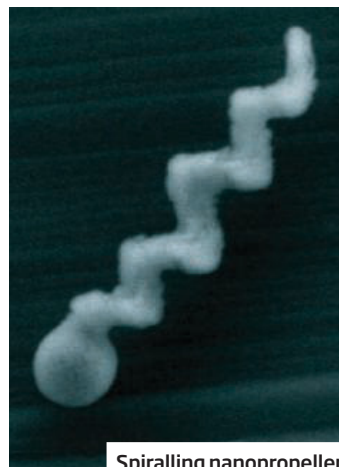
Another benefit to using an external magnetic field to move the propellers is that the swimmers aren't limited by internal energy

### "By changing the magnetic field in three dimensions the propellers can be precisely steered"

sources. It also means that the nanopropeller has no moving parts, unlike microbots.

Ghosh and Fischer have shown that a nanopropeller can push a silica bead over 1000 times larger than itself. Along with the propellers' size and controllability, that opens up a range of possible applications. Most exciting would be using them to deliver drugs to specific areas of the body via the bloodstream, or even to conduct surgery.

While a group at the Swiss Federal Institute of Technology in Zurich had previously produced corkscrew-shaped artificial swimmers, these new nanopropellers are more steerable and much smaller, says David Gracias, a nanobiotechnology researcher at Johns Hopkins University in Baltimore, Maryland. In fact, they are the smallest artificial swimmers yet. "It is an important step towards the creation of artificial mobile micro and nanoscale devices," says Gracias. Jon Evans ■



2005-AMERICAN CHEMICAL SOCIETY

Spiralling nanopropeller



## Space flight companies push for greater freedom

CIVILIAN space flight companies are this week pressing the US government to change strict arms-control rules that could cripple their nascent industry.

At issue are the International Traffic in Arms Regulations (ITAR), which are supposed to prevent technological secrets ending up in the hands of 21 proscribed nations, including China, Iran and North Korea. If a technology appears on a document called the US Munitions List, companies need a licence to export it or to reveal details to a foreign national. Even if granted, the licence often forces the firm to mount a security guard on the system while it is in another country.

The list contains very broad definitions of what should be kept secret, and even includes spacecraft hatches and windows. "That list is written for a cold war world," says Mike Gold of Bigelow Aerospace in Washington DC, which plans to fly crewed inflatable habitats in Earth orbit. "Any space technology, no matter how benign, such as a solar panel

or the table you support a craft on in the workshop, is covered by it."

Gold speaks from experience. In 2006, Bigelow launched a model habitat called Genesis 1 on a Russian ballistic missile. ITAR requirements cost the firm \$1 million, including \$220,000 for two American guards to watch over a support stand no more advanced than a coffee table.

On 21 May, Gold will chair a

meeting of the commercial space transportation advisory committee of the Federal Aviation Administration. Alongside specialists from fellow firms such as Virgin Galactic and Space X, he hopes to thrash out exactly what revisions the Munitions List needs. "There are limited government resources for monitoring sensitive technology exports in any case," says Gold. "This will

**"Meeting the requirements included paying \$220,000 for two guards to watch over a support stand"**

allow the government to spend more time on the truly sensitive stuff, like the rocket technology."

Bigelow has already scored a success. The US Department of State has waived the need for the company's technology to have separate licences for every non-American passenger on its space habitat – a move expected to benefit other space firms.

"It makes sense," says Gold. "Passengers are not exposed to detailed technical data in a Bigelow hab or a Virgin Galactic spaceship. I fly frequently but I still can't build a Boeing 737." Paul Marks ■



MARC GREENBERG/VIRGIN GALACTIC

Time to change the rules for craft like WhiteKnightTwo?

## Secret messages can be buried in fake internet traffic

THE internet's underlying technology can be harnessed to let people exchange secret messages, perhaps allowing free speech an outlet in oppressive regimes.

So says a team of steganographers at the Institute of Telecommunications in Warsaw, Poland. Steganography is the art of hiding a message in an openly available medium. For example, you can subtly change the pixels in an image in a way that is undetectable to the eye but carries meaning to anyone who knows the pre-arranged coding scheme.

Wojciech Mazurczyk and his colleagues have already worked out how to sneak messages into internet phone calls, and now the Warsaw team have turned their attention to the internet's transmission control protocol (TCP).

Web, file transfer, email and peer-to-peer networks all use TCP, which ensures that data packets are received securely by making the sender wait until the receiver returns a "got it" message. If no such acknowledgement arrives (on average 1 in 1000 packets gets lost or

corrupted), the sender's computer sends the packet again. This scheme is known as TCP's retransmission mechanism – and it can be bent to the steganographer's whim, says Mazurczyk.

His system, dubbed retransmission steganography (RSTEG), relies on sender and receiver using software that deliberately asks for retransmission even when email data packets are received successfully. "The receiver intentionally signals that a loss has occurred. The sender then retransmits the packet but with some secret data inserted in it," he says in a preliminary research paper ([www.arxiv.org/abs/0905.0363](http://www.arxiv.org/abs/0905.0363)). So the message is hidden among the teeming network traffic.

Could a careful eavesdropper spot that RSTEG is being used because the first sent packet is different from the one containing the secret message? As long as the system is not over-used, apparently not, because if a packet is corrupted the original packet and the retransmitted one will differ from each other anyway, masking the use of RSTEG.

The Warsaw team hope RSTEG can be used by dissidents in totalitarian regimes. They plan to demonstrate it at a workshop on network steganography in Wuhan, China, this November. "We are aware that organising this event in China may be not only a scientific challenge but also a political one," says Mazurczyk. Paul Marks ■



# Get real, drug czars

International drug policy has become absurd. It's time world leaders abandoned their futile pursuit of a drug-free world, says **Robin Room**

ELEVEN years ago, the UN pledged to win the war on drugs within a decade. It has failed.

At this year's meeting of the UN Commission on Narcotic Drugs, held in Vienna in March, there was a two-day session to evaluate the progress since 1998. In his opening remarks, the head of the UN Office on Drugs and Crime, Antonio Maria Costa, claimed "measurable progress". The drug problem has been "contained", he said, and drug use has "stabilised".

Costa's position flies in the face of the evidence, and by the end of the meeting he was on the defensive. But he said the goal remains the same, and he reiterated the UN's position: that the choice for the world's nations is either to apply strict prohibition or concede to total legalisation.

Soon after the meeting, the US special envoy for Afghanistan and



Pakistan, Richard Holbrooke, acknowledged the failure to stamp out poppy farming in Afghanistan. Of the US expenditure of over \$800 million a year on counter-narcotics, Holbrooke said: "We have gotten nothing out of it, nothing."

Those in charge of the world's drug control system seem more committed to maintaining the existing policy than to addressing its failures. International discussions on the subject have become absurd, and nowhere is this more apparent than with cannabis. Although cannabis amounts to perhaps 80 per cent of total global illicit drug use, there was scarcely any mention of it in Vienna.

International prohibition of cannabis was established in 1961 under the UN's Single Convention on Narcotic Drugs, a document drafted in a wholly different era when cannabis use was confined largely to small subcultures. Though huge changes since then have rendered it outdated, the status of cannabis remains unchanged and is apparently not up for negotiation.

In Vienna, the only action on cannabis was a resolution from ultra-prohibitionist Japan on cannabis seeds. Its aim was to clamp down on the growing trend

## Who wants to be a millionaire?

Scientists are winning just rewards for their role in creating blockbusters, says **Nicholas Jones**

IT HAS been a long time coming. Back in 1987, Ray Chiu and Duncan Kelly were research scientists at UK medical diagnostics company Amersham International, which later became part of the US multinational General Electric. Today they are jointly more

than £1.5 million richer after the high court in London awarded them retrospective compensation from GE for their part in an invention that was used in a blockbuster product.

Chiu and Kelly were involved in the development of a compound

called P53, a key component in an imaging agent called Myoview which went on to generate global sales in excess of £1.3 billion.

They are the first UK-based scientists to win compensation from a former employer through the courts for their contribution to a patent that brought "outstanding benefit". Similar claims have been brought before, and though some may have been settled out of court, this is the first to result in an award.

Scientists in other parts of the world have enjoyed similar successes. In Japan, for example, compensation awards have been made to employee inventors, including an award in 2004 of

over £100 million from Nichia Corporation to the inventor of the blue light-emitting diode (later reduced to around £6 million on appeal). Some countries, such as Germany, have formulae for

**"A recent amendment to the law makes it easier to win claims of retrospective compensation"**

calculating compensation for employee inventors. In the US the position is less clear because such claims are governed by the terms of employment contracts.

In the UK, a recent amendment to patent law appears to make it easier for research scientists to win

of cannabis cultivation in private homes, which Japan claimed was “a global threat”.

It doesn't have to be this way. Last year, the UK-based Beckley Foundation published its Global Cannabis Commission Report, of which I was an author. The report sets out how countries might move to fairer and more effective systems of cannabis control. It offers tools for policy-makers to break the stalemate, such as decriminalisation and depenalisation, and evidence on what happens if they are adopted. As the report points out, “that which is prohibited cannot easily be regulated”.

A regulated cannabis market offers more options than prohibition for acting to limit harms from use. We need to move beyond the deadlock on drug policy, to transcend the polarisation, and to give serious consideration to the options for change. Cannabis would be a good place to start. ■

Robin Room is professor of social alcohol research at the School of Population Health, University of Melbourne, Australia, and director of the AER Centre for Alcohol Policy Research at the Turning Point Alcohol and Drug Centre in Melbourne

such claims. The change clarifies that compensation is payable when an invention or patent has been of “outstanding benefit”. The definition of “outstanding benefit” is not entirely clear, but the judge in Chiu and Kelly's case defined it as something “out of the ordinary” or “special”, rather than merely “significant” or “substantial”.

Scientists around the world will no doubt want to keep an even closer eye on what happens to their inventions and patents. Where there's innovation, there may well be brass! ■

Nicholas Jones is a life sciences specialist at patent and trade mark attorneys Withers & Rogers in London

## Viewfinder

Opinions from around the world

“We as consumers have been completely unaware of the complex chain of events tying widespread sexual violence in [the Democratic Republic of the] Congo to the minerals that help power our cellphones, laptops, MP3 players, video games and digital cameras.”

Singer **Sheryl Crow** and campaigner **John Prendergast** in *The Christian Science Monitor* on how demand for tin, tungsten and tantalum is fuelling rape

“If Darwin had been dependent on a grant from a British research council, he would never have set sail.”

**George Monbiot** in *The Guardian*, London, arguing that university research is becoming too commercially oriented

“Bad information in the medical literature leads doctors to make irrational prescribing decisions, which ultimately can cost lives.”

**Ben Goldacre** comments in his *Guardian* “Bad Science” column on drug company Merck paying publisher Elsevier (a sister company of *New Scientist*) to produce a promotional magazine in the style of a peer-reviewed journal



LYNSEY ADDARIO/CORBIS

## Horizon scanner

Expect controversy over the status of Pluto to reignite, following a decision by the International Astronomical Union to reopen the issue. Some astronomers hope to reinstate Pluto to full planetary status and promote a host of other “plutoids” for good measure. There will be blood.

### Good week for...

**Astrophysics** The European Space Agency successfully launched its Herschel and Planck telescopes, which are expected to revolutionise our understanding of the universe

### Bad week for...

**Particle physics** Austria intends to withdraw its €17 million annual funding from the CERN laboratory in Geneva, prompting fears that other contributors will follow suit

## Wells maintained

From Ross Allan, *WellWishers*  
Your article reporting on the poor state of maintenance of wells in Ghana and Mali gives the erroneous impression that these problems are typical of other areas in Africa (28 March, p 4).

WellWishers, a group dedicated to funding wells in Ethiopia, has constructed 141 wells in that country over its seven-year lifetime. Apart from two that are suffering from overuse, all but one of them are still working.

The Relief Society of Tigray (REST) has been digging wells in Ethiopia for more than 20 years, and has built more than 1000 wells in conjunction with Oxfam Australia, an organisation well known for its thorough monitoring processes and transparency of operation. Of the more than 5000 wells that have been built, only 2.5 per cent have failed, according to the executive director of REST, Teklewoini Assefa.

A balanced article on wells in Africa should include the good news about what has been achieved in Ethiopia. I am concerned that your article's

narrow reporting of breakdowns in a particular area may cause people to have second thoughts about supporting the important work of organisations building wells in Africa.

*Mullumbimby, New South Wales, Australia*

## Track down the truth

From Richard Leakey

Robert Adler reports that ancient footprints discovered near Ileret in northern Kenya could provide information on important questions about human evolution (7 March, p 10). My first reaction was to question how the findings passed muster to be published in the first place as a report in *Science*, and secondly how *New Scientist* could be equally uncritical.

One of my many questions is: how do the authors reach their conclusion that the footprints were made by *Homo erectus*? At the time they were laid down, 1.5 million years ago, we know from fossil material that there were two or three distinct taxa of bipedal hominins living in the same ecosystem. The footprints

could have belonged to *Paranthropus boisei*, *Homo erectus* or *Homo habilis*.

The authors make comparisons with the 3.75-million-year-old Laetoli footprints. But are they



sure that the Laetoli prints were made by *Australopithecus afarensis*? There was at least one other hominin taxon that we know existed at the time of the Laetoli ashfall, though no specimen has yet been discovered in the vicinity.

An almost complete set of foot bones, known as OH 8, dated to 1.8 million years ago – and therefore pre-dating *H. erectus* – were discovered in 1961 in Tanzania. This set shows remarkable features similar to our own feet today. The rather poor prints from Ileret are of limited value compared to fossil bones for the understanding of bipedalism.

The value of the Ileret footprints is being overstated, as is the confidence in determining the creature that made them.  
*Nairobi, Kenya*

## Carbon economy

From Martin Harvey

Andrew Simms is right to highlight the inadequacies of the carbon trading system, which seems to be yet another way for the financial sector to try to make large sums of money, rather than a serious attempt to stave off global catastrophe (18 April, p 22).

There are more effective alternatives. For example, any

manufacturer using a natural resource in making their product should have to buy a token for every tonne of carbon that will be released when the product is consumed. In this way, the product's environmental cost will be built into the price the consumer pays, so there is no need to monitor and regulate who is doing the final polluting.

Conversely, permanent extraction of carbon from the atmosphere – by allowing rainforest to regrow on cleared land, for example – will earn tokens that can be sold on to those wishing to extract more resources from the Earth.

With sensible regulation of the resulting market for these carbon-offset tokens, the only remaining problem might be the global nature of the system. But then, any serious approach to saving the planet will require worldwide cooperation.  
*Wotton-under-Edge, Gloucestershire, UK*

From Peter Wood

It is important to put a price on carbon emissions, otherwise polluters will continue to emit greenhouse gases for free. But as Andrew Simms points out, problems arise under a cap-and-trade scheme if estimates for future allowable emissions are set too high, or a recession drives down emissions below expected levels. In that case, the price of carbon-emission permits will fall so far that they no longer provide any economic incentive to decarbonise economies.

A carbon tax has a related problem. If the economy grows by more than expected, the tax will not reduce emissions as much as it should.

A solution to these problems would be to combine emissions trading with a price floor. This would be implemented by imposing a flat fee when anyone wants to surrender their permits. The fee would be set at a level that matched the expected social cost

## Enigma Number 1546

### Mini-tangram

BOB WALKER

Joe cut out a cardboard rectangle 12.5 cm by 8 cm. He asked Penny to cut it into two pieces with one straight cut and then, with a second straight cut, to cut one of the pieces into two. Her problem was to work out where to make the cuts so that the three pieces could be arranged to form a square.

Penny found it quite easy once she realised that in each case one of the two cut pieces was a triangle.

What will be the area of the largest of the three pieces?

**WIN** £15 will be awarded to the sender of the first correct answer opened on Wednesday 24 June. The Editor's decision is final. Please send entries to Enigma 1546, *New Scientist*, Lacon House, 84 Theobald's Road, London WC1X 8NS, or to [enigma@newscientist.com](mailto:enigma@newscientist.com) (please include your postal address).

**Answer to 1540** On the run: The years were (a) 2000 (b) 2005

**The winner** Jae Eon Lee of Surbiton, Surrey, UK



of emitting the amount of carbon allowed by the permit. The permits then would be auctioned off, resulting in a price for carbon equal to the permit price and the extra fee.

Canberra, ACT, Australia

## Precious rubbish

From Mark Glover, *Eco Waste Pty*  
Phil McKenna's suggestion that gasifying trash could solve the energy crisis was simplistic (25 April, p 33). The materials that we now simply discard represent a problem and an opportunity at the same time.

While recovering energy efficiently is probably an improvement on sending it to landfill, it would be even better to recover resources from trash in a systematic way. Organic materials, for instance, are a valuable source of carbon, and represent a valuable resource at a time when fossil fuels are running out or are being taxed out of reach to address climate change.

The increasing scarcity of many metals, detailed in a report by *New Scientist* two years ago (26 May 2007, p 34), means that they too need to be recovered systematically from materials we would normally discard.

When considering how to deal with these materials, words like "waste", "getting rid of" and "disposal" ought to be removed from the lexicon.

Randwick, New South Wales, Australia



## Confused over ME

From Jennifer Wilson

Tony Waldron's comments on research into treatments for myalgic encephalomyelitis (ME) fail to address the effect on these studies of confusion over the definition of ME (25 April, p 24).

In most studies into the efficacy of cognitive behavioural therapy (CBT) and graded exercise therapy (GET), the people who report in favour of the treatments most likely do not have, nor ever had, ME. They are likely to be suffering from psychological chronic fatigue, which is very different.

The inclusion of people with chronic fatigue in research into ME muddies the waters. ME sufferers cannot undertake exercise – not even graded exercise – without worsening their illness. Some of the criteria for including people in studies on CBT/GET exclude the very markers that show someone has ME, such as the very distinctive symptom of post-exertional malaise.

Reported success stories highlight not those with ME, but sufferers of the entirely different illness, chronic fatigue.

Pontardawe, Swansea, UK

## Improbability theory

From Crispin Piney

There seems to me to be a fundamental flaw in Saibal Mitra's idea for saving the world by applying an interpretation of the "many worlds" idea, reported in your recent news story (18 April, p 11).

The mistake is to try to apply the concepts of probability theory to an infinite set – in this case, the putative branching set of all possible futures.

Although a subset of such an infinite set may superficially seem smaller, it too is infinite. To illustrate the point: one would intuitively think that the set of all

even numbers would be half the size of the set of all integers. The latter is, however, countably infinite, so you can match each even number to the integer half its size, and you will never run out of either.

Similarly, you could take only half of the set of even numbers, say those that are multiples of 4, and match them, one to one, with the set of integers, leaving unused half of your original set of even numbers.

Your article warns that Mitra's claim "defies our natural instincts". However, it appears that he too has been taken in by "common sense" assumptions. David Deutsch is quoted as saying "probability is not yet sufficiently well understood". Trying to apply it in this way makes it seem very unlikely that there is any universe in which this idea would ever be credible.

Valbonne, Alpes-Maritimes, France

## Patently difficult



From Tony Holkham

I suspect that James Dyson's space-saving kitchen gadgets you describe (2 May, p 20) will fail to be popular, for several reasons.

For instance, very few people will ever want to replace all their equipment at the same time, and when a new appliance is needed, supermarkets sell kitchen gadgets at ludicrously low prices.

More importantly, many gadgets have to be pulled out into a free space before they are used, to avoid damage to their

surroundings or to the units themselves. Toasters, for example, can produce enough heat to melt work surfaces.

Petersfield, Hampshire, UK

## Universal science

From Frederick Blundun

Sebastian Hayes argues that science is relative, but religious attitude is universal (18 April, p 24), but he is wrong.

A sufficiently intelligent being on the other side of the galaxy would conclude that gravitational attraction between two bodies is inversely proportional to the square of the distance between them. This conclusion follows from experimental observation.

By contrast, religious attitude is not universal. Some religions are monotheistic, some are polytheistic: there is little common ground between the mythology of ancient Greece and Christianity, for example.

London, UK

## For the record

■ Hal Pashler, whose criticisms of interpretations of brain scans we reported (2 May, p 4), is at the University of California, San Diego.

■ We got the time it takes light to arrive from the Horsehead nebula wrong by a factor of a million: the light we see from it is a mere 1500 years old (9 May, p 46).

■ TCP/IP is a set of communications protocols, not a language (2 May, p 28); we should have recognised the clue in the two Ps.

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# Biofuelling the future

You can't grow biofuel without cutting down trees, right? Not so, says plant scientist **Marcos Buckeridge** who tells **Jan Rocha** how Brazil can supply the world with green ethanol



PAULO FIDMAN FOR NEW SCIENTIST

**Your aim is for Brazil to produce sustainable biofuel while preserving its rainforests. Isn't that close to having your cake and eating it?** It's true that those of us who think like this are in a minority, caught between those who don't worry about the environmental costs of bioethanol and those who claim it is impossible to produce biofuels sustainably. The answer to those who condemn all biofuels has to be to differentiate where these fuels are being produced: we must ensure that Brazil's biofuel is green and sustainable.

## How do you do make it sustainable?

A few years ago, when the search for fossil fuel replacements became more urgent, Brazil rediscovered the sugar cane ethanol programme it put into place in the 1970s because of the oil crisis. Back then, nobody worried about sustainability. Now we have to show why Brazil's sugar cane ethanol is

different from America's maize ethanol. It is unfair to lump the two together. Our bioethanol is produced by using less than 1 per cent of Brazil's total agricultural area. It does not destroy preserved areas or compete for land with food crops. In fact, Brazilian food production should increase in the next five years. People fear sugar cane will be planted in the Amazon rainforest, but it is too humid for sugar cane there. We want to supply the world with green ethanol without cutting down a single tree. That's the challenge.

## How much progress have you made?

At the moment only about one-third of the sugar cane biomass can be transformed into energy. It is an inefficient process. If we can make ethanol from the non-edible parts of the plant as well, we can double productivity. To achieve this, we need to know more about the plant's structure. That's where I come in. I've

spent 20 years as a plant cell-wall biologist. We've set up a virtual research institute, and expect that, within five years, this will lead to new technologies to produce fermentable sugars from the non-edible parts of the plant. It's an exciting time to be a plant biologist in Brazil. You could say it's our Manhattan Project. We're preparing the ethanol bomb!

## Are you concerned about the ecology of where sugar cane is grown?

I am determined to push for sugar cane to be grown in a sustainable way, conserving or regenerating forest areas in sugar cane fields. So instead of a sea of cane stretching as far as the eye can see, there would be areas of forest too. Things are changing. The government of São Paulo – where half of Brazil's bioethanol is produced – has just introduced more drastic laws requiring that 20 per cent of fields must be set aside as ecological corridors.

## How did you become so interested in plants?

It began when I was growing up in São Paulo, next to a community of Japanese immigrants. I walked to school through their market gardens with their rows of lettuces, tomatoes, peppers... I used to read a lot of science fiction, too, and my grandfather was an inventor, so that got me interested in science.

## I've heard that you think plants are intelligent. In what sense?

I don't mean they are more intelligent than us, but they do have intelligence. We put our brains to work for them, to look after them and water them. So who dominates who? Man or plant? ■

## PROFILE

Marcos Buckeridge has a doctorate in biology and molecular sciences from the University of Stirling, UK. After 20 years at São Paulo's Institute of Biology in his native Brazil, he moved to the University of São Paulo's botany department. He is coordinator of Bioen, the bioenergy programme of FAPESP, São Paulo state's research centre.





BRIAN STAUFFER

# The monster at the centre of the galaxy

No one has yet peered into the abyss of a black hole. But at last we are ready, says Stephen Battersby – and we may be in for some surprises





outrageous prediction of science, and even though we can paint fine theoretical pictures of them and point to evidence for many objects that seem to be black hole-ish, nobody has ever actually seen one.

All that could change in the next few months. Astronomers are working to tie together a network of microwave telescopes across the planet to make a single instrument with the most acute vision yet. They will turn this giant eye towards what they believe is a supermassive black hole at the centre of our galaxy, code name Sagittarius A\*.

Even part-built, the microwave eye has already produced a hazy picture of Sagittarius A\*. Last September, a team led by Shep Doleman of the Massachusetts Institute of Technology's Haystack Observatory in Westford published results that are almost good enough to show the reputed black hole (*Nature*, vol 455, p 78).

Soon, Doleman and his team hope to see the hole's dark silhouette. Then they want to watch matter falling into it in order to trace out the twisted space-time around the black hole. That could tell us how it formed and grew.

These observations will also be the sternest test yet of Einstein's general theory of relativity, which predicts the existence of black holes. If relativity breaks down, Doleman and his team might not see a black hole at all, but something even stranger.

What we do know for sure is that something big lurks at the centre of our galaxy – because its powerful gravity affects the motion of nearby stars and gas. That something is about 4.5 million times the mass of the sun and crammed into an area the size of the inner solar system. There are few obvious ways to pack stuff in so tightly. Four million suns would be a dead giveaway, for instance. A swarm of neutron stars or small black holes would be highly unstable. So our best bet is one massive black hole.

A supermassive black hole is thought to sit at the centre of most large galaxies. In some so-called active galaxies, enormous quantities of gas are swirling into the black hole, forming

a disc of hot matter around it that often outshines the billions of surrounding stars.

Our own galactic monster is less well fed, surviving on only a thin gruel of gas streaming out from nearby stars. As this gas falls towards the hole it also heats up and shines, though more faintly than the disc in an active galaxy. All kinds of electromagnetic radiation are emitted, ranging from radio to X-rays.

Of course, the black hole itself does not shine since it actually swallows light. That is how we hope to be able to see it: light from

**"We know for sure that something big lurks at the centre of the galaxy. Seeing it is not easy, though"**

gas swirling round the hole will be devoured, so the hole should show up as a shadow or silhouette against the background of hot, shining gas.

Seeing this shadow is not easy. It won't have sharp edges because we will still see light and other radiation from gas in front of the hole. It will also look very small. According to relativity, a black hole of 4.5 million solar masses should be 27 million kilometres across, and even though its gravity warps nearby light rays, making it appear about twice that size (see diagram, page 31) it will still seem very small. From our distant viewpoint halfway across the galaxy, that would cover an angle of only about 50 micro-arcseconds – the size a football would appear on the moon, or a small bacterium held at arm's length.

No ordinary telescope could see such a small dark smudge. Instead, Doleman is using a well-tested technique called very long baseline interferometry or VLBI. By combining the observations from widely separated dishes across the planet, radio astronomers can effectively reconstruct what would be seen by one enormous dish – even one as large as the Earth (see map, page 31). Because small dishes collect less light, a VLBI ►

**L**IKE a giant pale blue eye, the Earth stares at the centre of our galaxy. Through the glare and the fog it is trying to catch a glimpse of an indistinct something 30,000 light years away. Over there, within the sparkling starscape of the galaxy's core... no, not those giant suns or those colliding gas clouds; not the gamma-ray glow of annihilating antimatter. No, right there in the very centre, inside that swirling nebula of doomed matter, could that be just a hint of a shadow?

The shadow we're straining to see is that of a monstrous black hole, a place where gravity rules supreme, swallowing light and stretching the fabric of space to breaking point. Black holes are perhaps the most

image is less bright than the image from a real planet-sized dish would be, but it can reveal just as much detail.

Previous VLBI observations of the galactic centre have been far too fuzzy to see the black hole's shadow. For starters, we are peering right through the most crowded parts of the galaxy, where lots of gas scatters radio waves. "It is like dense fog blurring the image of a streetlight," says astrophysicist Avi Loeb of Harvard University.

Worse still, the gas swirling around the black hole is opaque to most wavelengths, throwing a veil over the shadow. And more fundamentally, the resolution depends on the wavelength of radiation being observed, with long waves giving us a vaguer picture than short waves.

Luckily, all of these problems go away if your telescope works at wavelengths of about 1 millimetre. Such short-wavelength radiation cuts through the interstellar fog and the inner veil of gas. Also, the resolution for a telescope with dishes separated by thousands of kilometres is just about fine enough, in theory, to see the shadow. In fact

the bigger the dish separation, the better.

Doeleman's team adapted VLBI to work at the ultra-short wavelength of 1.3 millimetres. In April 2007 they took their hardware to mountaintop telescopes in Arizona, California and Hawaii.

The result was frustrating. They did pick up emissions from the central region of Sagittarius A\*, but they don't quite have enough information to get an unambiguous

## "Giant balls of lightweight particles called boson stars are a theoretical alternative to black holes"

picture of it. "We have two models that fit the data," says Doeleman. In one, Sag A\* looks like a doughnut with a hole in the middle, which may be the supermassive black hole. Unfortunately their observations also fit a simple blob of bright emissions, with no apparent black hole shadow.

Even so, these early observations are

a strong sign that Sag A\* really is a black hole. According to Avery Broderick at the University of Toronto, Canada, the results indicate that it almost certainly has an event horizon, the defining feature of black holes.

An event horizon is an insubstantial boundary, within which nothing can escape the grip of the black hole's gravity. Matter crossing a horizon just gets quietly swallowed, emitting no radiation. Some theoretical alternatives to black holes, such as the giant balls of lightweight particles called boson stars, would have physical surfaces instead of horizons. These surfaces would be warmed by gas falling onto them, with the smallest ones heating up the most.

Along with Loeb and Ramesh Narayan at Harvard, Broderick has analysed Doeleman's results and argues that if Sag A\* had a surface it would be hot enough to glow with a steady emission of infrared light. In fact, no such glow has been detected ([www.arxiv.org/abs/0903.1105](http://www.arxiv.org/abs/0903.1105)). They conclude that an event horizon does cloak Sag A\*, cutting us and the rest of the universe off from whatever lies within.

Still, there may be loopholes in this argument so it would be better to actually see the hole for ourselves. In April, Doeleman returned to Hawaii. To try to boost sensitivity, he decided to try to use the signals from three telescopes rigged together on Mauna Kea instead of just one. "I think we've shown we can do that tonight," he told me from the summit on 3 April. After some months of processing, this latest set of observations ought to finally reveal the shadow of the monster.

## Black hole: the movie

That first faint smudge will only be a beginning. Doeleman wants to move to an even shorter, sharper wavelength of 0.87 millimetres. Meanwhile, more and more telescopes will be brought together to get a more revealing view of the black hole.

The centre of Earth's microwave eye will be in the mountain deserts of Chile, where the Atacama Large Millimeter/Submillimeter Array (ALMA) is being built. All of its 66 dishes should be up and running by 2012. "ALMA will be the new 800-pound gorilla on the block," says Doeleman. In concert with other scopes across the planet, it should provide a much sharper picture of Sag A\*, as well as revealing an even bigger black hole in the galaxy M87 (see "Other black holes worth viewing").

It could also give us "black hole: the movie".

## Other black holes worth viewing

Our galactic centre is not the only target for astronomers trying to image black holes. In a galaxy called M87 there is a truly vast black hole, more than 3 billion times the mass of the sun. Radio astronomers hope to be able to zoom in on this monster, not only to see the dark shadow of the hole's event horizon, but also to find the origin of a gigantic jet of matter squirting out of M87.

At about 60 million light years away, M87 is 2000 times as far away as Sagittarius A\*, the black hole in the centre of our galaxy. So even though it is several hundred times the diameter of Sag A\*, M87's black hole appears about one-third of the size. At the moment, that means we cannot see it clearly even with an astronomical technique called very long baseline interferometry (VLBI), which links many radio telescopes to create a giant virtual scope.

All that will change as the Atacama Large Millimeter/Submillimeter Array in Chile comes online over the next few

years. "That will bring M87 in range of our VLBI artillery," says astronomer Shep Doeleman of the Massachusetts Institute of Technology in Westford.

The next two black hole candidates are in the Sombrero galaxy and Centaurus A, 30 million and 12 million light years away respectively. Their shadows will appear even smaller than the hole in M87 and might be beyond the power of Earth-based radio astronomy to resolve.

One day a rather different instrument could give us sharp pictures of these black holes too. A proposed space mission called Black Hole Imager would use X-rays instead of radio waves. Two or more X-ray telescopes flying in formation could in theory provide sufficient resolution.

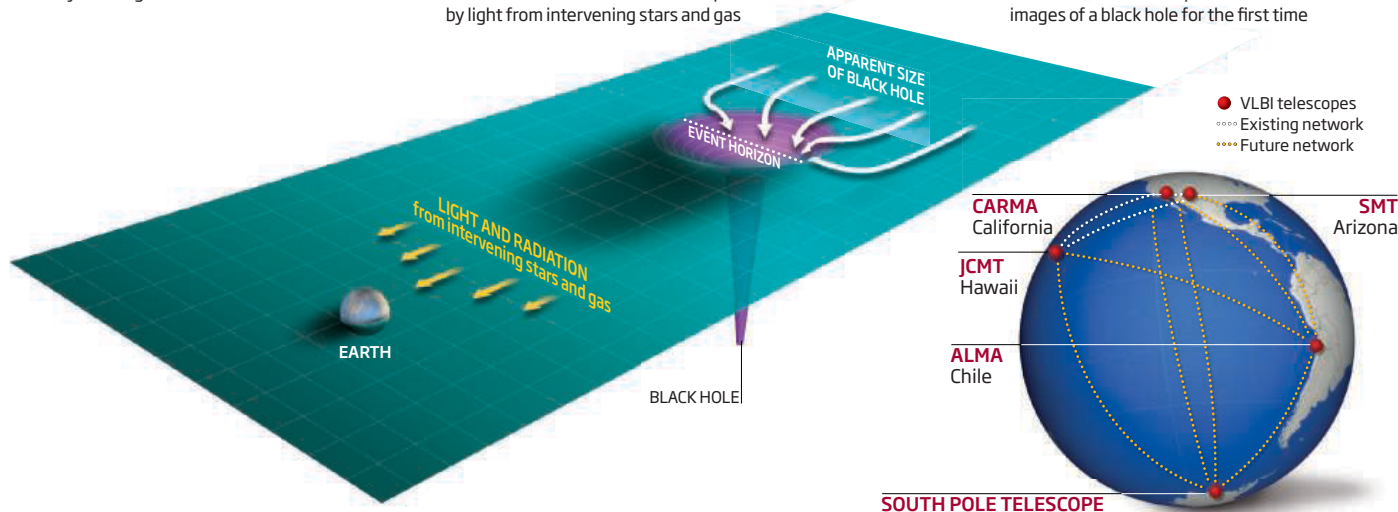
The mission is only in the early stages of discussion and won't fly for decades. "It is possible by 2030, but that requires an aggressive technology development programme," says astronomer Keith Gondreau of NASA's Goddard Space Flight Center in Greenbelt, Maryland.

# How to spot a black hole

Light and radiation crossing a black hole's event horizon never escapes, thereby creating a shadow

The black hole at the centre of the Milky Way is difficult to see because it is so distant and the shadow is swamped by light from intervening stars and gas

By linking together the signals from many short-wavelength telescopes around the world, astronomers hope to collect images of a black hole for the first time



“What I’m most excited about is that we can look for temporal variations,” says Doeleman. Observations made at many wavelengths have revealed sudden outbursts of radiation from the gas swirling around Sag A\*. Using VLBI, Doeleman wants to watch these small flares circling and being swallowed by the horizon in real time. “That’s the money-shot in this business,” he says.

It could reveal something researchers would dearly love to know about black holes: their spin. Relativity says that a spinning black hole will form a whirlpool in the fabric of space, a phenomenon known as frame dragging. Hotspots close to the hole would be caught in this whirlpool, so their motion will show how fast Sag A\* spins. That in turn will give us a hint about the black hole’s past life, because its spin depends on what it consumed to become the heavyweight it is today.

Emanuele Berti of the University of Mississippi in Oxford and Marta Volonteri of the University of Michigan in Ann Arbor have calculated the effects of a few different diets. Sag A\* might have grown up on a steady diet of galactic gas. Sharing the overall rotation of the galaxy, that gas would form a disc spiralling faster and faster as it approaches the hole, like water going down a plughole. When the gas is finally swallowed,

its spin would add to that of the hole. If Sag A\* put on most of its weight that way, its spin would be boosted close to the maximum possible value relativity allows.

Or perhaps Sag A\* grew up by snacking on gas from a host of nearby sources in random orbits. The randomly oriented spins of those snacks would mainly cancel each other out, so the spin of Sag A\* would probably be low.

Another possibility is that Sag A\* grew hierarchically, as smaller galaxies merged to form the Milky Way. Each galaxy would have

**“Einstein’s general theory of relativity has never been tested in the super-strong gravity near a black hole”**

brought its own massive black hole and they would all have merged together to form Sag A\*. In Berti and Volonteri’s simulation, that usually adds up to a hole with moderate spin.

Of course, all of this assumes that Einstein’s general theory of relativity holds true. Almost a century after he devised it, general relativity remains our best theory of gravity and matches precise observations of planetary orbits and gravitational lensing. “It’s almost

embarrassing how good general relativity is,” says Broderick. But the theory has never been tested in the super-strong gravity near a black hole, where its predictions are most extreme. Broderick wants to make amends by following the motion of hotspots through this warped and twisted space. “The best way would be to place an undergraduate at the galactic centre with a laser pointer,” he says. “But if these flares do happen we can use them instead.”

By mapping out the exact shape of space-time near the hole, the flare movie could distinguish between relativity and some competing theories developed to explain the anomalous motions of stars and galaxies more commonly attributed to dark matter and dark energy. Among them are complex theoretical schemes known as scalar-tensor-vector gravity and  $f(R)$  gravity.

And what if Doeleman’s latest observations, made last month, show something odd? Could the horizon be a strange shape? Or not show up at all? “Then we would have a problem,” says Broderick. It could mean the relativity is radically wrong when it comes to super-strong gravity. And the monster at the centre of the galaxy will be even more shadowy than we thought. ■

Stephen Battersby is a writer based in London



What happens when humans catch fire?  
Linda Geddes meets a team whose  
macabre mission is to find out

# The body burners

**T**HE fire started with a match held under a cotton blanket close to the man's waist. Within 2 minutes, the flames had spread across the single bed he was lying on and were consuming his cotton sweatshirt and trousers.

Around a dozen onlookers were at the scene – including police, fire investigators and death investigators – yet all they did was watch. That was, after all, their job. The “victim” had in fact died some time ago, having previously donated his remains to medical research.

His body had reached a unique team led by Elayne Pope, a forensic scientist at the University of West Florida in Pensacola. Her group spends its time setting fire to corpses in a range of different circumstances, to work out exactly how the human body burns. They seem to be the only group carrying out such systematic studies in this area, and are certainly the only ones publishing their work.

Until now, scientific knowledge about burned remains has been limited. Anything that wasn't based on speculation has come either from post-hoc examination of burnt corpses – where the exact circumstances of the fire are usually unclear – or from the deliberate burning of pig corpses, which have key differences to humans. “There wasn't much literature,” says Pope. “The science is young.”

Pope formerly worked at a medical examiner's office – similar to a UK coroner's – where she saw how often burned bodies were surrounded by unanswered questions. Many people die in house fires, car fires, or as a result of arson, and sometimes the bodies of murder victims are burned to destroy evidence. “Fire

deaths by their nature are very confusing to look at,” says Pope.

The million-dollar question is whether a fire death was accidental or deliberate. As with other areas of forensic science, some textbook dogmas have never been tested. That can lead to a fire being labelled as accidental when it has a more sinister cause. Worse, it can lead to innocent people being convicted on the basis of unsound evidence (*New Scientist*, 28 February, p 6).

Eight years ago, a medical institute in Memphis, Tennessee, agreed to provide Pope with some of its donated bodies and she began her unusual mission. To date she has made use of about 30 whole corpses and various additional body parts.

Sometimes the team burns a single body set up in a commonly encountered situation, such as sitting in a car. Depending on her resources and the questions she needs to answer, she may also burn bodies in batches, in several variations on a theme or in a range of different situations.

So what happens after they light the fire? “A human limb burns a little like a tree branch,” says John DeHaan, a fire investigator at Fire-Ex Forensics in Vallejo, California, who works with Pope. First, he says, the thin outer layers of skin fry and begin to peel off as the flames dance across their surface. Then, after around 5 minutes, the thicker dermal layer of skin shrinks and begins to split, allowing the underlying yellow fat to leak out. ➤

Bodies found after house fires are often surrounded by unanswered questions







## Vanishing hands and other myths

### **MYTH** Hands and feet burn away, leaving the arms and legs as stumps

Fingers and hands curl and contract as they are heated, but once all of the supporting soft tissues burn away, many of the small bones in the fingers, hands and wrists simply fragment and fall off, according to studies by Elayne Pope at the University of West Florida in Pensacola, and colleagues. Because they are often buried in ash and debris, these bones may be overlooked, but hands are often used to fend off an attacker, so they may hold vital clues as to what happened to a victim.

### **MYTH** Fluid-filled blisters on the skin mean the person was alive at the time of burning

Pope's team has shown this is not true. Higher temperatures or a longer exposure to heat is needed to form blisters on dead skin - but it does happen. Post-mortem blisters are created from moisture drawn out of the tissue through heat exposure.

### **MYTH** Complete destruction of a body means flammable liquids were used

It is sometimes assumed that, outside of professional cremations, if a body or body parts have been completely destroyed by fire then a flammable liquid must have been used - potentially turning an accidental fire into a murder scene. In fact, a variety of everyday materials can generate extreme temperatures.

A related misconception is that flammable liquids alone are sufficient to destroy a body. "If you dump gasoline on someone, it will burn for about a minute," says Pope's colleague John DeHaan of Fire-Ex Forensics in Vallejo, California. "That's enough to cause localised burns, but not enough that the skin will split and the body fat gets involved." The body needs to be exposed to fire for about 5 minutes for that to happen.

### **MYTH** Bodies usually sit up as they burn

This is a myth prevalent in crematoria. Pope's team has found that limbs may flex and move during burning (see "Body of evidence", p 34) but bodies don't actually sit upright.

GENE BLEVINS/LA DAILY NEWS/CORBIS

"It is the most revolting odour and it stays with you forever"

"That's when the fire gets most interesting," says DeHaan. Body fat can make a good fuel source, but it needs material such as clothing or charred wood to act as a wick. Like that in a wax candle, a wick absorbs the fat and pulls it into the flame, where it is vapourised, so enabling it to burn.

Assuming there is sufficient wick material, the body can sustain its own fire for around 7 hours. During this time, the heat causes muscles to dry out and contract, making the limbs move and sometimes adopt characteristic postures (see illustrations, left). Bone takes longer to burn, so by the end the skeleton is usually laid bare like a charred anatomical model, coated in the greasy residue of burned flesh.

That is unless someone agitates the bones (which have become brittle though heating) to break them up, which helps them continue burning. Still, there is usually something left – often teeth or fragments of bone – that gives the game away. "In most cases something survives," says DeHaan.

One thing DeHaan can't describe is the odour, because he has no sense of smell. For this reason, he pays particular attention to other people's descriptions: "There's a complete range, from 'it smells just like barbecuing pork ribs', to 'it is the most revolting odour and it stays with you forever'." DeHaan suspects that it is decaying bodies that smell worse when they burn, although he hasn't tested this theory.

"Each environment is unique and produces very distinct burn patterns on the body," says Pope. If a body burns in the front seat of a car, for example, it will remain suspended on the wire frame of the seat, where it is exposed to flames from the upholstery. A body on the back seat, by contrast, will be somewhat protected by the metal bench that lies beneath the upholstery.

A body can be completely destroyed if it is put in the trunk of a car, especially if it lies on a rubber tyre. While the rubber burns, the body is suspended on the metal rim and so exposed to the intense heat. "I've been able to get complete bone destruction after a body has been in the trunk for 4 to 5 hours," says Pope. "It's like a mini-crematorium."

## Exploding skulls

Some of the group's studies tested common beliefs about how bodies burn. For example, many textbooks state that if a skull is initially intact, the brains will boil and cause the skull to explode into small fragments. Investigators may therefore see the lack of such an explosion as a sign of foul play. Pope's team tested this theory by systematically burning 40 human



The upper skull is usually the most charred because it has little overlying soft tissue

heads – some injured, others intact. They found that skulls do not explode, burning in broadly the same way regardless of trauma. The team also showed that a skull may look like it has exploded if debris falls on it once the heat has made it brittle (*Journal of Forensic Sciences*, vol 49, p 431).

The group has refuted several other beliefs about how bodies burn (see "Vanishing hands and other myths", page 33). It is also establishing new axioms to help guide fire investigators in future. The question of foul play is most difficult to establish if a body is so badly burned that only a charred skeleton remains. In the same paper, Pope's team showed that if someone is shot or stabbed, the wound opens up early during the fire, exposing that part of the skeleton to more heat and leaving a permanent record in the bones. "What I look for is whether there are heavily burned-out injuries," says Pope.

Often, the team is asked to help with specific investigations. In one, a man had been arrested on suspicion of murdering his wife, burning her body in a metal barrel and dumping the ashes over a cliff. The team tried to replicate the cremation to see if it was physically possible. "We wanted to see how much time, how much heat, how much fuel, how much agitation was needed," says Pope. "If you just start a fire and walk away it's going to go out [before the bones are destroyed]."

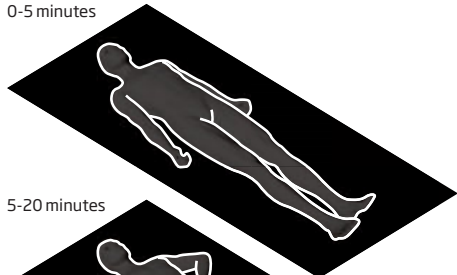
The researchers proved that in the suspect's

Accident or arson? Common misconceptions among fire investigators can lead them astray

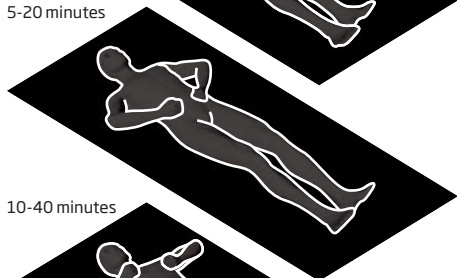
## Body of evidence

A prolonged fire causes the muscles to dry out and contract, sometimes moving the limbs into characteristic postures

0-5 minutes



5-20 minutes



10-40 minutes



30 minutes to an hour



The arms may be raised as if warding off an attacker, sometimes causing investigators to suspect foul play



# Spontaneous human combustion

IN 1998, a girl's burned body was found in the undergrowth of a forest in Oregon. Her head and torso were charred almost beyond recognition, suggesting an intense heat, yet her surroundings – and even her shoes – appeared untouched. How could she burn without igniting anything around her?

When John DeHaan of Fire-Ex Forensics in Vallejo, California, was called in, the local police suggested the unevenly burned remains bore the classic hallmarks of spontaneous human combustion.

With cases of SHC found indoors, there is often little or no sign of fire elsewhere in the room, aside from a greasy residue occasionally left on furniture and walls. The victim may seem to have just dropped where

they stood, suggesting a sudden and intense conflagration.

Various non-supernatural explanations have been put forward for such cases, yet according to DeHaan, "some trained fire investigators still believe in SHC". So his team have carried out a series of experiments using pigs, and more recently a human body, which are helping to finally nail the myth.

The best explanation for the unevenly burned remains has long been the wick effect. Once the skin burns enough to split open, the underlying fat gets involved, with clothing or other charred materials absorbing the fat and holding it close to the flames so it heats enough to vapourise and burn. Since in people most fat is stored around the torso

and thighs, it is hardly surprising that these are the areas most badly burned. "One argument is that it is unusual to be left with hands and feet – but that's what happens when bodies burn," says Elayne Pope of the University of West Florida in Pensacola.

Another misconception is that a human body cannot burn in a confined space without igniting its surroundings or running out of oxygen. DeHaan's team has shown that a fire fuelled solely by body fat typically releases just 40 to 80 kilowatts of heat – no more than a large wastebasket fire – which would not necessarily ignite nearby objects. "Most rooms are going to have enough oxygen," says DeHaan.

Another feature of many supposed

cases of SHC is lack of an ignition source. In one recent case, a woman's charred body was found by her front door, while the rest of the room was untouched. But closer inspection revealed a tiny trail of burned plastic and clothing leading to the kitchen, where the stove was still on. DeHaan believes that the victim's food caught fire, she grabbed it and made for the front door, setting her blouse alight along the way. If she had inhaled the flames, this would have caused her to collapse and succumb.

"Because the scene was perfectly preserved, you could see the connection," says DeHaan. "But most scenes aren't that pristine, so you have an ignition source in one room, and the body somewhere else, and people don't understand it."



window of opportunity, he could have rendered down the body completely by returning to agitate the burning remains. They do not know if the suspect was ultimately convicted.

A big problem is that forensic evidence is often lost in the life-threatening drama of the crime scene. "When firefighters get to the fire, the goal is always to get the victim out," says Steven Symes, a forensic anthropologist at Mercyhurst College in Erie, Pennsylvania, who is a former teacher of Pope's. Of course this is crucial if the victim still has a chance, but it sometimes happens even if they are obviously long dead.

Symes is overseeing a study investigating how much more information could be gleaned if burned bodies are examined in situ, instead of being moved to the medical examiner's office. He also hopes to start similar burning experiments to Pope's later this year.

As their work becomes more widely known, Pope hopes that more bodies will be made available so that she and her colleagues can carry out more ambitious reconstructions. One of her more macabre plans is to set fire to a bus with several corpses in different seats. Next month they plan to stage a body burning in a light aircraft.

As word spreads, Pope and DeHaan hope fire investigation will become more evidence-based. "We can't do it halfway and say 'this is what I was taught'," says Pope. "We need a more scientific approach and to actually get the facts. People's lives are at stake here." ■

Linda Geddes is a *New Scientist* reporter

# Your life, sold for

**H**OW curious. Early this year my bank sent me a replacement credit card. I hadn't asked for one, and the bank did not elaborate except to refer vaguely to "security" issues.

I still don't know why my card was replaced, but I have a hunch: a massive electronic heist at a New Jersey-based company called Heartland Payment Systems. Heartland acts as a middleman between retailers and credit card companies, and processes about 100 million transactions every month. At some point in March 2008, a group of hackers is believed to have broken through the firm's cyber-defences. They installed software that, for about four months, secretly relayed credit and debit card details to an external computer. It is likely that tens of millions of cards were hacked.

Like many other people, I initially missed the news about Heartland – perhaps because it was announced on the day of Barack Obama's inauguration. But my belated discovery made me wonder what would have happened to my credit card details if they had been stolen. So I called internet security company Team Cymru, based in Burr Ridge, Illinois. A few weeks later, cybercrime experts Steve Santorelli and Levi Gundert introduced me to a sprawling criminal underworld so large and pervasive that no one can control it.

This underworld is surprisingly easy to access. It consists of a network of online chatrooms and web forums where stolen information is openly traded, along with off-the-shelf software tools needed to pull off just about every kind of online scam going.

"This is an economy that is worth billions of dollars," says Dean Turner of the security company Symantec in Calgary, Canada. "It's highly organised. Everything that criminals need is available for sale."

It was not always like this. In the early days, criminal hacking required advanced technical skills. But organised crime has moved in and the black market has become a service economy where anybody can buy a career in cybercrime.

As soon as Santorelli and Gundert log me onto a chatroom, messages start to appear.

## <cinch>

I got fresh hacked UK cvv2's

My guides explain. This means that a criminal by the name of "cinch"\* is selling stolen British credit card details. "CVV2" means he or she has the full credit card numbers, expiry dates, billing addresses and the three-digit security codes on the back of the cards – all the details you need to make a purchase at most online retailers. These will cost you anything from about 50 cents to \$12 depending on the card's credit limit, where it comes from and how many you want to buy.

Gundert says that cinch or an associate probably obtained these details by hacking an online retailer or an intermediary like Heartland. Web retailers routinely employ tough electronic protection, but hackers are

\* The names of all traders have been changed, and some of the messages edited for clarity



MICHELLE THOMPSON



# \$15

Hacked bank details, credit card numbers, IDs and email passwords are trading online in shocking numbers. **Jim Giles** visits the cyber-underworld



frighteningly adept at finding and exploiting holes in their defences. Once hackers are in, they can scoop up credit card details and start selling them. The retailer may never know its defences have been breached.

Symantec estimates that almost a third of all adverts in the underground economy are for credit card information of some type, (see diagram, page 39). While I've been talking to Santorelli and Gundert, a new, more sinister message has appeared:

## <loopz>

### Uk US Dump Track 1 Track 2

Loopz is selling "dumps" – CVV2s plus all the information encoded in the card's magnetic stripe, known as Track 1, or that stored in the chip that is built into many European cards, which is called Track 2.

Dumps are more valuable. Access to these details allows criminals to print "cloned" credit cards and shop almost anywhere. The card-printing equipment costs \$20,000 to \$30,000, but is available legally. If that investment is too great, traders can email the details to criminal specialist printers who will run off cards and return them by mail for just a few dollars per card.

I send a message to loopz asking about price and availability. Minutes later I get a reply: he has 10 dumps and wants \$15 for each.

That seems ridiculously cheap for details that could potentially be "cashed out" for thousands of dollars. A few months back, loopz might have been asking several times that. But supply and demand shape this market, just like any other, and recently prices have slumped. It is impossible to say why, though the economic slowdown is probably not the cause: credit card fraud, says Turner, is a recession-proof business. Santorelli's guess is that the market has been flooded with information stolen from Heartland.

As in any transaction, however, let the buyer beware. Anyone who took loopz up on the offer would probably have come away empty-handed. Santorelli says that 9 out of 10



"Some chatrooms rate the traders' trustworthiness. I guess that's what they mean by honour among thieves"

traders in the chatroom are "rippers" – con artists who take the money and run. To combat this, many chatroom operators impose a ratings system not unlike the ones you find on eBay or Amazon. Most of the 340 people in the room are, like loopz, unrated, but a few have coloured dots next to their name which indicate that they have shown some level of trustworthiness in their previous transactions: the colour changes from yellow to blue to green to red as the trader's reputation grows. I guess that's what they mean by honour among thieves.

There are a handful of "reputable" traders in the room, including one called netter who has a blue dot next to his name.

## <netter>

**Selling USA Fulls Cvv2  
Info + SSN MMN DOB \$8 Per 1**

This marks netter out as an identity thief. "Fulls" is jargon for a collection of information that includes credit card details but also more personal details: SSN for social security number, MMN for mother's maiden name and DOB for date of birth. Criminals can use these details to apply for credit cards, take out loans or set up bank accounts to launder money.

Retail systems like Heartland's do not generally contain personal information, but hackers find it surprisingly easy to dupe people into handing it over. "Netter is almost certainly getting his information by phishing," says Gundert. He's referring to scams that direct users to websites that look almost identical to those operated by major banks. In reality, the sites are run by criminals, who use them to trick people into giving away the kind of information that netter is selling.

Phishing sounds like a complex operation, and five years ago it was. But like e-commerce in general the black economy has matured. Now a relatively unskilled criminal can buy

everything they need to go phishing. I saw several adverts for off-the-shelf phishing kits, and others for hacked access to internet servers, which phishers need to host their fake websites. Still others were hawking scanners – software that roams the internet looking for holes in servers' defences. I could also have bought hacked email logins, which can be used to squat on the web space that comes free with most internet accounts but which few people use.

Phishing is not the only way to steal logins. Hackers can also covertly install "keylogger" software, perhaps by attaching it to an email that appears to come from a friend. Once installed, the keylogger monitors every keystroke a user makes and relays details to a remote computer known as a dropzone.

Last year, Thorsten Holz at the University of Mannheim in Germany took a close look at keylogging. He and colleagues tracked down 240 dropzones and took a peek inside 70 of

them. They found usernames and passwords for around 5700 eBay accounts, login details for over 10,000 bank accounts and 5700 credit card numbers. Holz estimates that this information was worth \$16 million.

So if just 70 dropzones open the way to such a large sum of money, how much is the entire black economy worth? Since criminals do not file company reports, it is hard to be precise. In one of only a handful of independent studies, Vern Paxson of the International Computer Science Institute at the University of California, Berkeley, monitored chatroom trading over a seven-month period in 2006. He saw over 13 million messages sent under 100,000 different names. Every day, more than 400 credit card numbers were posted, and hacked access to bank accounts containing millions of dollars offered. Almost 4000 valid social security numbers were posted in total. All in all, Paxson observed trades worth \$93 million.

The underground economy is almost certainly much larger than that now. A year-long monitoring exercise run by Symantec in 2007 and 2008 identified credit card details, bank accounts and other stolen information worth \$276 million on just a small sample of underground chatrooms.

Not surprisingly, individual criminals can make a fortune. For example, the US government is currently trying to take possession of \$1,650,000 in cash, a condominium in Miami and a BMW owned by hacker Albert "CumbaJohnny" Gonzalez, who was charged last August along with 10 alleged accomplices from the US, China, Belarus, Ukraine and Estonia.

I found it unsettling to watch people like this doing business in the chatrooms. The fact that the conversation was public didn't stop me feeling that I was eavesdropping: it was as if I was overhearing a gang discussing plans for a bank robbery. But there is a crucial difference. In the real world, I could call the police and identify the plotters. Tracking down the people hiding behind usernames like netter and cinch is close to impossible.

The first layer of anonymity is provided by the servers running the chatrooms, which are programmed to mask the identity of traders. I asked the server to supply information on loopz. Here's what came back:



**loopz@xxxxxxx-6C3F616C.adsl-static.isp.belgacom.be**

Even to an expert eye, this means little except that the chatroom server is set up to hide the trader's identity. The last parts suggest that that loopz may be connected via Belgacom, a Brussels-based internet service provider, but there is no guarantee of that, as there are

## BEAT THE CYBERCROOKS

Online crime is not going to go away, but there is no reason to be a sitting target. Here's how you can stay one step ahead of the fraudsters:

- Use hard-to-guess passwords, not ones with obvious personal links, such as your birthday or the name of your street. Good passwords include a combination of upper and lower-case letters, numbers and other characters.
- Change your passwords often.
- Use an up-to-date browser, operating system and antivirus software. Turn your computer's firewall on and, if you are using Windows, set up your computer to automatically download new security patches from Microsoft.
- Never download email attachments from people you do not know or trust. Avoid attachments that you were not expecting, even if they are from a known source.

# Illicit goods

Over 12 months from July 2007, security firm Symantec monitored 45 million online messages offering to sell or buy illicit goods. Here is the breakdown of the most popular items – as a percentage of all “buy” or “sell” offers – along with their price range

## FULL BANK ACCOUNT DETAILS

18% of offers to sell   
14% of offers to buy   
price range: **\$10-\$1000**

Average balance of a hacked account is \$40,000

## CREDIT CARD DETAILS WITH CVV2 NUMBERS

16% of offers to sell   
13% of offers to buy   
price range: **\$0c-\$12**

The CVV2 is the 3-digit security number printed on the back of the card

## CREDIT CARD DETAILS WITHOUT CVV2 NUMBERS

13% of offers to sell   
8% of offers to buy   
price range: **10c-\$25**

Average credit limit on a stolen card is \$4000

## EMAIL ADDRESSES

6% of offers to sell   
7% of offers to buy   
price range: **10c-\$25**


Email addresses are used for spamming and phishing attacks

## EMAIL PASSWORDS

6% of offers to sell   
12% of offers to buy   
price range: **\$4-\$30**

Email passwords are useful for digging out valuable secret information, such as bank account details

## FULL IDENTITIES

5% of offers to sell   
3% of offers to buy   
price range: **90c-\$25**



A full identity can consist of name, address, date of birth, phone number, government-issued ID numbers, driving licence number, mother's maiden name, email addresses and “secret” Q&As for online ID verification

## CASH-OUT SERVICES

5% of offers to sell   
8% of offers to buy   
price range: **8-50%** of total value

Cash-out services are offers to convert stolen goods, such as bank account details, into hard cash

## ACCESS TO A PROXY SERVER TO MASK IP ADDRESSES

4% of offers to sell   
3% of offers to buy   
price range: **10c-\$25**

Proxy servers are essential for making yourself untraceable by law enforcement

## SCAMS SUCH AS PHISHING AND SPAM

3% of offers to sell   
6% of offers to buy   
**\$2.50-\$100** per week for hosting  
**\$5-\$20** for design

Phishing attacks cost US consumers and businesses around \$2.1 billion in 2007



● **Top 10 cybercrime countries**  
(Australia, Brazil, Canada, Germany, Netherlands, Romania, South Korea, Sweden, UK, US)

numerous ways for hackers to obscure the route they use to connect. Some rent time on legitimate servers and send their messages from them rather than their home computers. Others use bots – illegal software installed covertly on other computers – to relay messages for them. Either method makes it very difficult for law enforcement officers to identify the location of the sender.

Tracking down the chatroom servers is equally difficult. I ran a standard search, known as a “whois query”, to establish the internet address of the chatroom. It revealed only that the operators have an appreciation of irony: they had registered the server under the name and address of the New York State Division of Criminal Justice Services.

Law enforcement experts, such as the cyber-security team run by the FBI, have more sophisticated methods for locating chatroom servers, but the trail often leads to countries

such as China or Russia, where foreign agencies can find it time-consuming to collaborate with the police. Security experts say better international cooperation is producing results, such as last year's arrest of two prominent Turkish hackers. There will always be some governments, however, that will not work with authorities in the west, where most victims of cybercrime live.

With no technological fix, law enforcement has to rely on old-fashioned detective techniques, such as sting operations and the use of informants. The police can also work up the trading chain by catching criminals using stolen credit cards in stores and then tracing the traders who supplied the forged plastic.

All these techniques have played a part in the big police successes of recent years, including the September 2007 arrest of Max “Iceman” Butler, a trader from San Francisco who is alleged to have run a site known as

Cardersmarket and to have personally sold tens of thousands of credit card numbers. A month earlier, a US Secret Service investigation culminated in the arrest of 11 people in what federal officials said was the biggest ever identity-theft and hacking bust.

Victories like that are causes for celebration, and not just for card issuers and retailers. If somebody hacks your credit card, they pick up the bill. But both ultimately pass the cost onto consumers. So in the end, we all pay for the ill-gotten gains of cinch and netter.

The cost would be smaller if we all took steps to defend ourselves (see “Beat the cybercrooks”). But with so much money to be made, the threat is not going to go away. “There is never going to be a silver bullet,” says Santorelli. “We can make it harder for these criminals, but we’ll never stop them.” ■

Jim Giles is a writer based in San Francisco

We could learn a thing or two from ancient civilisations about how to cope with rising sea levels, says Catherine Brahic

# Saved by stilts and caves

**W**ITH rising seas lapping at coastal cities and threatening to engulf entire islands in the not-too-distant future, it's easy to assume our only option will be to abandon them and head for the hills. There may be another way, however. Archaeological sites in the Caribbean, dating back to 5000 BC, show that some ancient civilisations had it just as bad as anything we are expecting. Yet not only did they survive a changing coastline and more storm surges and hurricanes: they stayed put and successfully adapted to the changing world. Now archaeologists are working out how they managed it and finding ways that we might learn from their example.

The sea-level rise that our ancestors dealt with had nothing to do with human-induced climate change, of course: it was a hangover from the last ice age. As the massive ice sheet that lay on North America melted, the continent was buoyed upwards. As a result, the northern Caribbean, on the other end of the same tectonic plate, sank, making seas in the region rise up to 5 metres over 5000 years.

Although the cause of this rise was very different to what we face today, the effects were probably the same. Rising waters not only nibble away at coastlines, they also mean that hurricanes and storm surges reach further inland. Higher seas also mean that groundwater becomes contaminated with salt, and as the water table rises the waterlogged land becomes more likely to flood.

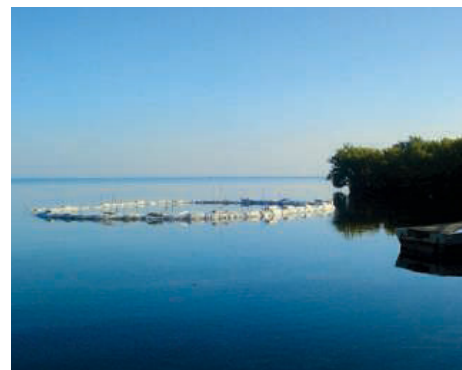
Despite these changes, excavations of ancient houses in what is now the province of Ciego de Avila in northern Cuba suggest that the region was inhabited between 5000 BC and just 300 years ago. One of the best-preserved ancient sites is the village of Los Buchillones, now 150 metres out to sea, which was inhabited from AD 1260 until the mid-1600s by people known as the Taino. For Jago Cooper, an archaeologist at the University of Leicester, UK, who studies the site and others across the Caribbean, the village provides a rare chance to study the pinnacle of Taino knowledge. "The people at Los Buchillones represent a way of living that capitalises on

hundreds or even thousands of years of experience of living in the area," he says.

So how did they survive as the waters rose? The first clue comes in the proverbial wisdom that every real estate agent knows: location, location, location. Palaeoclimatologist Matthew Peros of the University of Ottawa in Canada and his colleagues have taken sediment cores between the modern shore and the remains of the village, and these show that houses in Los Buchillones were built on stilts over a lagoon. The land barrier that lay between the lagoon and the ocean would have provided the village with some protection from storm surges. Other settlements in the area were in similarly protected pockets, or built on the leeward side of hills.

Building in sheltered spots may seem an obvious precaution, but Cooper argues it's a crucial bit of know-how that the region has since lost. Modern towns and cities, he says, tend to be in more vulnerable, exposed places.

Perhaps surprisingly, building over water may also have made the homes less at risk of



The remains of the village of Los Buchillones in northern Cuba is now 150 metres out to sea

JAGO COOPER



flooding. While living in the hills or on higher ground inland may seem a safer bet as the coast becomes less predictable, flood water rushing down hillsides during storms can destroy even the sturdiest house. Building over the lagoon meant that flood water, whether rushing in from the sea or down from the land, could pass underneath the house, minimising damage. This approach seemed to work: radiocarbon dating of Taino posts has shown that they were in place for hundreds of years. What's more, the bark is still on the posts, which tells Cooper that they had never been knocked over and reset. "Unless you're an archaeologist, you can't remove them from the mud without the bark coming off," he says. Older coastal sites elsewhere in the Caribbean have evidence of similar posts, suggesting that the locals may have developed stilted architecture over the centuries to deal with the fickle elements.

## "There is little doubt we will have to adapt to sea-level rise, and the Maya did it with wood and stone tools"

While the stilts were deliberately sturdy, the rest of the house was quite the opposite. In 1998, a team led by David Pendergast of the Royal Ontario Museum in Toronto, Canada, unearthed the remains of an entire Taino house, with beams, rafters, roof timber and the palm leaves that made up the house's thatch all collapsed on top of each other.

Living in flimsy, thatched, wooden houses may seem a bad choice, given the extreme weather the Taino were exposed to, but it could actually have been a sensible strategy. Before the arrival of Europeans, villages were often sited close to caves. Because the same caves are used as storm shelters today, archaeologists speculate that the ancient people abandoned their homes for the caves

when conditions got too dangerous to stay put. When the storm had passed, they could go home and rebuild, replacing lost thatch and beams within a couple of days, says Cooper. By contrast, modern houses in Cuba are made of concrete or brick, making them expensive and laborious to rebuild after a hurricane.

Clearly, convincing coastal populations to abandon their homes and possessions when a storm appears is unlikely to be popular today. Even so, there are lessons to learn from this style of building. Houses built on sturdy stilts could allow people to remain on the coast in spite of rising sea levels, provided that safe havens built further inland could house the entire population in a storm. This approach has begun to be used in the Maldives after the 2004 tsunami made 20 islands in the archipelago uninhabitable (*New Scientist*, 9 May, p 37). Using local materials to build houses would also make them cheaper and easier to rebuild.

Homes, of course, are only one part of what it takes to maintain a civilisation. People need food too. Cooper and his colleagues have found evidence that, along with growing crops, and collecting shellfish and other marine food, the Taino gradually diversified their diet, fishing in new areas and trading food with inland villages. Widening their food options in this way may have acted as insurance when times got tough.

Other civilisations in the region took a different approach. In Belize, rising sea levels meant that some regions were completely transformed. Pollen and ash remains show that 2000 years ago the Mayans were growing maize with slash-and-burn agriculture in some areas that over the course of later centuries became permanently flooded wetlands. Despite this, the people stuck around and, amazingly, continued to grow their crops. They did this by digging huge networks of drainage channels and raising their fields so that roots sat above intruding seawater. Some researchers



The Taino people consulted weather spirits to predict storms

speculate that they made the best of a bad situation by catching fish, and hunting turtles and waterfowl from the canals.

There are useful lessons here, says Tim Beach of Georgetown University in Washington DC, who has studied the Mayan channels. "There is little doubt we will have to adapt to sea-level rise, and the Maya did it with wood and stone tools," he says. "These are low-cost approaches that developing countries may want to use, where they cannot afford dams and dykes to keep out the sea."

Of course, we now have several advantages over these ancient communities. In place of stone tools we have industrial machinery. In place of the spirits the ancient Taino used to help forecast storms we have live satellite forecasts. But for all our modern technology, as the sea threatens to reclaim the coasts once again, we may have much to learn from the ancient people who took it all in their stride. ■

Catherine Brahic is *New Scientist's* environment reporter



Sturdy wooden stilts kept Taino houses above rising water

# The obese brain

The food industry is exploiting our habit-forming brains, but one man is fighting back

*The End of Overeating* by David Kessler, Rodale Press, \$25.95

Reviewed by Bob Holmes



DOES the world really need yet another book about how to lose weight? It does, if that book happens to be written by a former

commissioner of the US Food and Drug Administration.

As FDA commissioner under the first George Bush and Bill Clinton, David Kessler crusaded against the tobacco companies and their conspiracy to keep smokers hooked. Now back in academe at the University of California, San Francisco, Kessler is battling another major public health problem: the rising tide of obesity. *The End of Overeating* is both his diagnosis of the problem and a prescription for its treatment.

In a sequence of short, readable chapters, Kessler lays out the science behind the obesity epidemic. Modern foods have become too palatable, he says. Rich in fat and sugar, they overstimulate the brain's reward pathways, conditioning us to seek more and more. Manufacturers of processed foods and major restaurant chains all exploit this neurological vulnerability by layering fat and sugar into foods to create "craveability". "Where traditional cuisine is made to satisfy, North American industrial food is made to stimulate," Kessler writes.

And it gets worse. When we eat these hyperstimulating foods and experience the neural rewards they offer, the foods become even

more stimulating the next time around. Eventually, the cues that accompany the foods – location, time of day, emotional state – become triggers that drive food-seeking behaviour. That habitual craving, Kessler says, is why he can't resist the plate of chocolate-chip cookies on the table during meetings.

Of course, there's nothing really surprising in any of this. Many of us already know that our palaeolithic bodies and brains are designed to crave the fats and sugars that were once scarce but are now abundant, and that over

**"Hyperstimulating foods offer neural rewards, making them even more stimulating the next time"**



JON FENIGERSH/ZEPH/CORBIS

time we can learn to eat from habit rather than from hunger. Still, for readers of a scientific bent, it is refreshing to see the underlying biology laid out in detail by a writer of impeccable credentials.

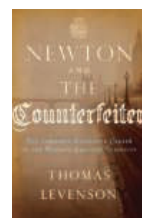
The real strength of Kessler's book comes in the final chapters, where he draws on the neurobiology and psychology of habit reversal to lay out a programme for breaking the tyranny of food-related stimuli and the runaway feedback loop within the brain's reward pathways. He stresses the importance of making rules that govern what one can eat and when. Such rules, especially when they allow little scope for choice, make certain foods "unavailable" – and this, research shows, can muffle the brain's cravings.

Kessler hints that this regimen has worked for him, though he gives few details – an odd omission in a book of this sort, but perhaps further evidence that this is no ordinary diet book.

## Newton the economist

*Newton and the Counterfeiter* by Thomas Levenson, Houghton Mifflin, \$25 (published in the UK in August by Faber, £15.99)

Reviewed by Richard Webb



LONDON, 1696. England is engaged in a ruinous war with France. Its currency, debased by counterfeiters and the "clippers" who shave silver

from its poorly minted coins, is increasingly worthless. The radical solution: recalling all money in circulation to be melted down by the Royal Mint and reminted. Under the mint's indolent master, Thomas Neale, the plan rapidly descends into farce. Soon there is no money left to pay taxes and rents or to buy the daily bread. It's economic meltdown.

Not the ideal circumstances for an unworldly Cambridge academic to take up the post of Warden of the Mint. But this was not any old academic; it was Isaac Newton, the greatest natural philosopher of his age. Within months of assuming office, he had subjected the sclerotic processes of the mint to the same rapier intellect that had dissected the workings of the natural world. The coinage crisis was soon overcome.

Thomas Levenson's *Newton and the Counterfeiter* views Newton's second, often overlooked, public career through the prism of his extraordinary hounding of William Chaloner, a charismatic forger who for years lent the counterfeiting business a raffish appeal. Newton was dogged in his pursuit, if not immediately successful, but Chaloner was eventually tried for high treason and hanged in March 1699.

Chaloner had inhabited the sewage-infested underbelly of a London then approaching the unprecedented mark of a million inhabitants – most of them hideously poor and desperate for





any crust they could earn. Levenson's account of this world of criminality, collusion and denunciation is meticulously researched and highly readable, yet it never quite manages to dispel the impression that Chaloner's downfall owed as much to the city's machinations as it did to Newton's detective nous.

The result is a book that somewhere loses its internal logic. The first half is a potted history of Newton's well-documented scientific career, the second a detective story that does not quite live up to its billing. Attempts to thread the two together – such as suggesting that Newton was so tenacious in pursuing Chaloner because he saw his counterfeiting as perverting alchemy, a quasi-sacred pursuit to Newton – have a smack of desperation.

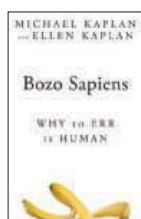
Still, the tale of Newton the economist is one worth telling. His influence has been enduring: his musings on the value of currency led, almost incidentally, to Britain adopting the gold standard in 1717, a policy that remained more on than off until 1931.

Newton's success was not unqualified. When the South Sea bubble burst in 1720, it took a substantial proportion of his invested savings with it. Then as now, the dismal science seemed able to get the better of even the best brains.

## Dumb but creative

*Bozo Sapiens: Why to err is human*  
by Michael Kaplan and Ellen Kaplan,  
Bloomsbury, \$26

Reviewed by Michael Marshall



HUMANS are idiots – and pointing this out is all the rage. In popular science, humanity's irrational side is the topic du jour.

It all started with Antonio Damasio's *Descartes' Error*, which demolished the old idea that cold, emotionless rationality is the best way to make decisions. Using numerous neurological case studies, Damasio showed that without gut feelings we are left hopelessly adrift.

The idea that humans sometimes benefit from thinking emotionally rather than rationally has since been seized upon by writers like Malcolm Gladwell in *Blink* and Jonah Lehrer in *The Decisive Moment*.

*Bozo Sapiens* is rooted firmly in this tradition. Written by mother-and-son team Ellen and Michael Kaplan, its thesis is that humans make mistakes – a lot of them. We are seduced by dumb ideas, follow idiotic leaders and delude ourselves about everything from the economy to romantic love.

Armed with sheaves of anecdotes and research, the Kaplans show just how daft even the most intelligent people can be. The writing is delightful: graceful and packed with allusions, switching easily between hilarity and tragedy.

Our frequent mistakes, they argue, are a necessary side effect of our adaptability and inventiveness. Coming up with new ideas is a scattergun process – most will be wrong and we are bad at picking out those that are right. Unless we want to be mindless automata, we are stuck with our stupidity.

This is a familiar idea in science fiction and a rich vein of psychological research. *Bozo Sapiens*, however, never develops this central idea, and says little about creativity.

While the Kaplans do an excellent job of detailing human stupidity, they do not make any sense of it. The stories, while gripping, are never integrated into an overall picture of how and why we make mistakes. In the end, *Bozo Sapiens* is hugely entertaining, but unsatisfying.

## Shaping science

*Science: A four thousand year history*  
by Patricia Fara, Oxford University  
Press, £20/\$34.95

Reviewed by Jo Marchant



PATRICIA FARA's epic history of science ranges from the astronomers of ancient Babylon to today's geneticists and particle physicists. But it is no ordinary account of how scientific knowledge has accumulated. Instead, Fara focuses on how science has been guided and controlled by social and political factors. Her aim is to debunk the notion of science as an objective search for truth.

Fara writes, for example, that

the ancient Greeks' attempts to understand the cosmos were inextricably entwined with their view of it as a divine, therefore mathematically perfect, creation. Linnaeus's plant classification system reflected 18th-century social prejudices by prioritising male reproductive organs. Today's "big science" is bound to the "five 'M's": money, manpower, the military, machines and the media.

*Science* is an impressive antidote to the idea of scientific endeavour as a straight line of progress. Yet Fara takes it too far by ignoring how the knowledge produced relates to the external world: she treats all theories as equal, regardless of the evidence. For instance, when arguing that doctors rejected the "animal magnetism" therapies of Franz Mesmer in the 19th century because they feared he was stealing their patients, she discounts the lack of a rational explanation for his theories and does not mention that they failed the first ever controlled clinical trial.

A more worrying case is Fara's interpretation of global warming. She argues that the theory arose because selling doomsday scenarios helps researchers to win funding. And putting the blame on humanity also enables scientists to "fulfil the same psychological needs as religious prophets who preached that the end of the world represents God's punishment of the sinful". She does not appear to acknowledge that scientists might be convinced by global warming because it is actually happening.

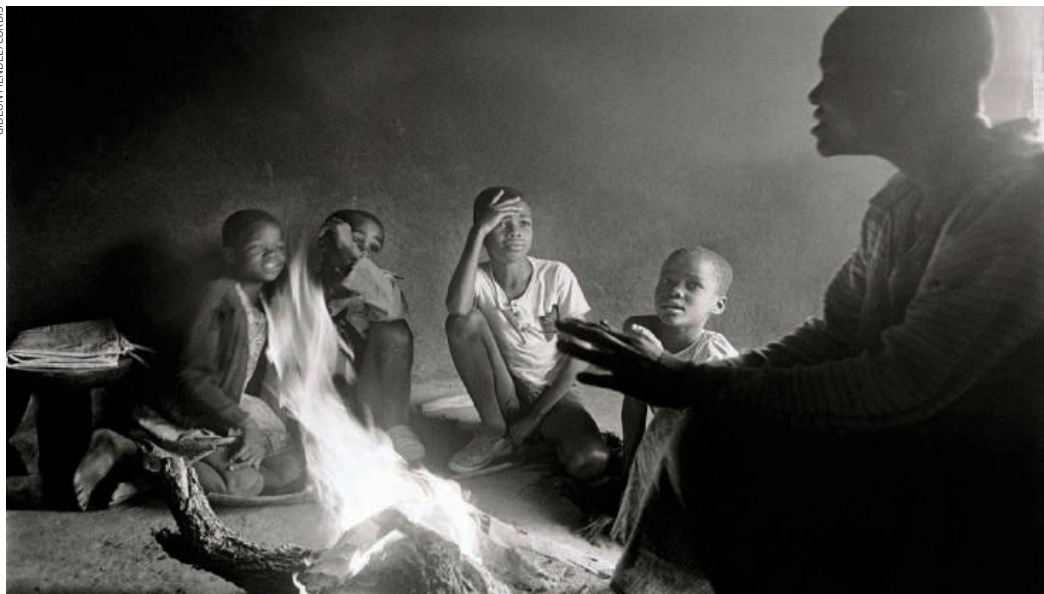
The book is a valuable reminder that science is inevitably a product of the people who carry it out, and that the way we explain the world cannot be separated from social prejudices and political priorities. This alone, though, does not explain science's success. Science has become so dominant because it works. Medicines do save lives, aeroplanes do fly, nuclear bombs do explode. Ignoring this is misguided, and in some cases downright dangerous.



# How storytelling changed us

A new book looks at how evolution influenced fiction, and how fiction influences the mind

GIDEON MENDEL/CORBIS



*On the Origin of Stories: Evolution, cognition and fiction* by Brian Boyd, Belknap Press, \$35/£25.95

Reviewed by Kate Douglas



LIKE all the best stories, this one has a pleasing symmetry. It is a book in two parts, each illuminating the other. On one side stands

evolutionary theory and its attempts to explain human nature. On the other is story itself, represented by two great works of fiction: Homer's *Odyssey* and Dr Seuss's *Horton Hears a Who!*

Brian Boyd's thesis is that current literary criticism – or “Theory” as it is hubristically known – has failed because it regards fiction purely as a cultural construct, ignoring the minds that create and consume it. Viewed in the light of evolution,

however, stories acquire a new depth. Better yet, literature provides an untapped source of material to study the mind.

“Evocriticism”, as Boyd calls it, is not new – literary Darwinists have been preaching this creed for more than a decade (*New Scientist*, 3 March 2007, p 38) – but the professor of English from the University of Auckland has some novel and thought-provoking ideas, and his book covers an impressively wide terrain.

Boyd argues that art, including fiction, is a unique human adaptation whose chief function is “for improving human cognition, cooperation and creativity”. His excellent accounts of these three areas of human activity show both an impressive mastery of the science and an admirable inclination to question orthodoxy. The “mating mind theory” – art as a product of sexual selection – is subjected to

Storytelling provides a portal into other worlds and other minds

forensic analysis, the notion of “personal narrative” is pooh-poohed, and even Aristotle is not beyond cross-examination.

Art, Boyd says, is a form of play. It is an interesting idea. In recent years, biologists who study play have come to see it as an adaptation allowing intelligent

**“In the light of evolution, stories acquire new depth, and become untapped material to study the mind”**

animals to hone mental and physical skills in non-threatening environments. This fits perfectly with Boyd's assertion that fiction fosters cognition, cooperation and creativity. Where the idea falls short is in its failure to recognise that play is primarily interactive, whereas storytelling

is more of a spectator sport.

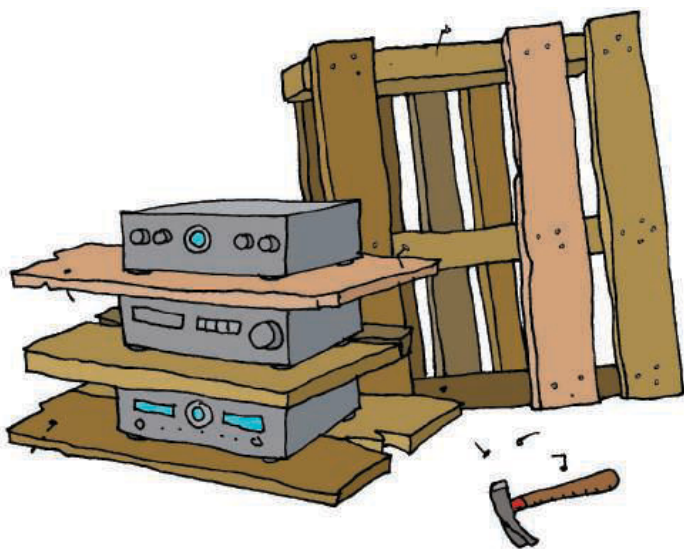
Elsewhere, though, Boyd does acknowledge that stories need both creators and audiences, and he analyses their different evolutionary roles. Taking a cost/benefit approach, he argues that the process of creating a story may be expensive in terms of time and energy but is intrinsically rewarding because it appeals to our brain's love affair with pattern. It also reshapes the mind, promotes a creative approach to problem solving and increases the storyteller's social status. The audience, meanwhile, pay a price in their time, but in return acquire a deeper insight into society and the minds of other individuals.

This cognitive exchange, however, requires attention. “Art alters our minds because it engages and reengages our attention,” Boyd writes. This may sound obvious, but for Boyd it has sweeping implications for the content of stories. For one, it means that surprise is crucial – fiction must appeal to our evolved preference to pay attention to the unexpected. So too are elements of the fantastical, the ability to take readers beyond the here and now, and the capacity to engage their emotions and appeal to their innate attraction to pattern.

In the second half of the book, Boyd reveals how two master storytellers achieve all of this. His guided tour of the *Odyssey* is fascinating, as is his insight into the genius of Dr Seuss – even if the earnest analysis of *Horton* seems rather incongruous.

Unfortunately, Boyd doesn't always take his own lessons to heart, and if his storytelling has one fault it is a lack of narrative drive. Perhaps a little meandering is inevitable given the sheer scope of Boyd's intellectual journey. What really matters, Boyd makes clear, is whether a story is worthy of our attention. *On the Origin of Stories* surely is. ■

Kate Douglas is a features editor at *New Scientist*



READER William Bowden points us to adverts which offer hi-fi buffs the opportunity to pay \$2400 for some bits of wood to put under their audio equipment. Not just any old wood, of course, but unspecified special wood for a Harmonix "Tuning System Board" that makes things sound better.

Intrigued, we wondered how this could work, and found some words of wisdom on the wood in "Positive Feedback Online – a Creative Forum for the Audio Arts". After putting hi-fi amplifiers on the boards, a reviewer declares: "Yikes! By golly, those ninety heads in the Mahler *Symphony 2* were suddenly accounted for. The space just exploded in front of me; the revelation of depth and 3-D cues was startling... How a board, albeit a very expensive one (\$2400 each), can engender involvement and intimacy is pretty far out – quite beyond all our measuring tools. Those objectivists have no idea what we're talking about."

Well, that puts science in its place. How could those silly old objectivists know anything about anything?

But it seems that not everyone with an amplifier has been impressed by the hype. The company selling the wood, based in Niagara Falls, New York, tells us: "The TU-888 Tuning System Board has been discontinued, but we do have a few of these in stock. If you are genuinely interested, let me know and I can give you a reasonable price."

Thanks, but no thanks.

WHEN Ian Sturrock logged on to the online email group he administers at Yahoo Groups, he was told: "Pending members require your approval. If you take no action, they will automatically expire after 14 days."

Ian says he is not sure he is ready for the responsibility of causing someone's demise solely because he has omitted to tell Yahoo that he approves of them.

YOU can live and work in the UK if you can show that you are a Commonwealth citizen and that you have "a grandparent who was born in the United Kingdom (including the Channel Islands or Isle of Man) or a grandparent who was born in what is now the Republic of Ireland before 31 March 1922". That's according to the UK Border Authority web page which can be viewed via [www.border.notlong.com](http://www.border.notlong.com).

Meet the other conditions, fill out the right forms in the right order and you "will be allowed to stay for five years", the site says. What's more: "After five years, you will be able to apply to live here permanently provided you still meet the requirements for United Kingdom ancestry."

Feedback is as puzzled as Hannah Kaye, who spotted this, as to how an initially successful applicant could suddenly fail to meet those requirements. "At what point during those five years," she wonders, "might one's grandparents cease to have been born in the UK?"

GREAT science writers make the complex seem simple. Others make the simple complex. Take this gem spotted by Mark Crowe in *Australian Life Scientist*: "Around 50.55 per cent of Australia's population has a double X karyotype." This, Mark suggests, seems a very roundabout way of saying that half the Australian population is female.

THE kidneys, according to *Biology* by Kenneth Miller and Joseph Levine, "remove 180 litres of filtrate from the blood per day". For those who find such a figure difficult to comprehend, the book clarifies: "This volume is equivalent to 90 2-litre bottles of soft drink." Sam Joyce-Farley, who told us about this, clarifies further: "It would also be equivalent to 120 1.5-litre bottles or 60 3-litre bottles." Or indeed 30 6-litre bottles...

We could go on, but meanwhile some readers may be wondering if this means people normally expel 180 litres of urine per day. This is definitely not Feedback's experience and readers can rest assured that the kidneys put most of what they take out of the blood straight back in again.

THE redcurrant jelly Ian Wordsworth bought from an Asda store looked tasty enough and he was on the point of adding a spoonful to his lamb casserole when he noticed a prominent announcement on the jar. It said: "NO FLAVOURS - We've done the hard work by removing each and every flavour from this product."

Ian was left wondering if there was any point in adding any of it to his stew after all.

FINALLY, disclaimers at the bottom of emails sometimes threaten those who make unauthorised use of them with legal action. The email Mike Donoghue received from the University of Washington took a different tack: "If you are not the intended recipient, or if the message has



been addressed to you in error, do not read, disclose, reproduce, distribute or otherwise use this transmission. Otherwise, your shoes will suddenly get too tight."

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

Charles McCutchen notes a *New Scientist* report on a lab at the University of Nevada in Reno that tests how structures cope with earthquakes. The lab is run by I. Buckle (18 April, p 20)





## Bad soap

I found this forgotten bar of soap (see photo, above) after winter at my home in northern Sardinia. It had grown a coat of mould. What is the mould and how did it grow on soap, which is supposed to keep your hands clean?

■ We use soap for cleaning because it is a detergent: a means of emulsifying insoluble, largely fatty, dirt in water. Its nutritional value is usually irrelevant, but pure traditional soap consists of fatty-acid salts. Because of this, it is completely digestible in modest quantities. You may see a dog scoffing a chunk of soap because it smells appetisingly of fatty acids, but only if it doesn't contain too much scent or lye – sodium hydroxide, which is used in the production process. Missionaries who introduced soap to some tribal communities in Africa were startled to find that members of

their congregations would treasure a fatty-tasting bar as a treat, occasionally licking a finger that had been moistened and rubbed on the soap.

Toilet soap commonly contains surprising amounts of starches, oils, glycerol and other materials that make it smoother, less aggressive to the skin or simply cheaper to produce. These are all edible too, and moulds are happy to consume them. As long as the soap doesn't contain too much sodium and the air is moist enough, as it well might be in a bathroom, a bar of soap can certainly grow some very contented fungi.

I suspect your soap sported a selection of Sardinian domestic moulds. *Fusarium*, *Mucor*, even white strains of cheese fungi, such as *Penicillium camemberti*, might be present. They are probably harmless. Try some if you like...  
*Jon Richfield*  
Somerset West, South Africa

*Though we admire Jon Richfield's desire for direct scientific experimentation, we recommend that you do not eat the soap before finding out exactly what is growing on it – Ed*

■ While I can't help your reader identify the strain of mould on the soap, I can explain how mould can grow on something that is used for cleaning your hands.

Soap consists of long-chain organic molecules, with one end that is polar (charged) and the other non-polar (uncharged). The polar end readily dissolves in water, which is also polar, while the non-polar chain readily attaches to grease and oil which are similarly non-polar.

The soap therefore acts as a go-between: one end attaches to the oil and the other end wants to be in the water. This enables the oil on your skin to dissolve and be washed off. Without the soap, the polar water molecules would rather stick together than attach themselves to the oil on your hands.

Mould can grow on all sorts of apparently uninviting materials, including leather or wallpaper. Soap is no different – it's just another organic material. This is not really a paradox. After all, when you use soap you don't actually leave it on your hands in order for them to stay clean; you wash it off.

*Simon Iveson*  
School of Engineering  
University of Newcastle  
New South Wales, Australia

## THIS WEEK'S QUESTIONS

### BEE ALERT

When I was wandering around my garden one evening I noticed a European honeybee hanging strangely from a lillipilli flower. On closer inspection I saw a well-camouflaged spider holding the bee in place and a number of small flies covering its body (see photo, below). I can understand the spider's role in all this, but what are the flies doing?  
*Robert McKinlay*  
Balgownie, New South Wales, Australia



### AERIAL GLUE

I heard that a Formula 1 car travelling at 200 kilometres per hour would generate enough downforce (or suction) to allow it to stick to the ceiling. Is this correct? And if it is, how is the force generated?  
*Robert Webber*  
Melbourne, Australia

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