

I, S, C, I, E, N, C, E



THE SCIENCE MAGAZINE OF IMPERIAL COLLEGE



UNEXPLORED

WORLDS

SKYWHALES

EXPLORING THE DEEP

UNCONTACTED TRIBES?

X-RAY ARTIST HUGH TURVEY

I, SCIENCE

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I, SCIENCE

Important matters first: we hope you've all had a lovely Christmas and seen in the New Year with style! As this is our very first stab at printing *I, Science* we thought we'd use this as an opportunity to introduce the lovely new editorial team for 2011/12, our brand-spanking new website, and all our helpful contributors, bloggers and sub-editors. Not forgetting to give a great big thank you to last year's team for all their help in getting us started. For a more personal introduction to our new team of regular bloggers, take a look at page 9.

And here begins our journey into Unexplored Worlds. The footsteps on the cover of this issue represent a fundamental quality of science; tracing what has gone before but confronting the unknown – something this year's editorial team experienced in getting this issue to press! It was footprints fossilised in mud that showed certain human ancestors walked upright, footprints that can reveal a thing's origin, and it's in the footprints of great scientists and philosophers that we find new realms to explore ourselves.

Exploration seems a particularly relevant topic this year; probes have been launched to Mars, Virgin are pioneering space travel and diving to the deepest trenches of the oceans, whilst it is also the centenary of Scott's doomed polar expedition to the South Pole – an exploration which found fossils to prove geographical theories about the continents being one original land mass and penguin eggs which were used to evaluate existing theories of evolution

Edwin Hubble once remarked "Equipped with his five senses, man explores the universe around him and calls the adventure Science." The Universe can be as far-flung as foreign galaxies, or as close as the thoughts inside your head. However science is more than sensory observations, just as literature is more than a collection of words. New worlds are waiting for us, be they planets on the brink of our solar system, realms so deeply below water they are forever dark, new understandings of the human mind or future worlds where technology transforms our lives in ways we have scarcely begun to imagine.

Just as it is the Universe's intrinsic nature to continually expand, it is the scientist's nature to continually explore it.

Dawkins gives as good a reason as any for doing so: "After sleeping through a hundred million centuries we have finally opened our eyes on a sumptuous planet, sparkling with colour, bountiful with life. Within decades we must close our eyes again. Isn't it a noble, an enlightened way of spending our brief time in the sun, to work at understanding the universe and how we have come to wake up in it? This is how I answer when I am asked, as I am surprisingly often, why I bother to get up in the mornings."

Science is simply an intelligent foray into the unknown and returning with a souvenir. Here is *I, Science's* Winter Issue – enjoy your travels...

NICOLA & JO

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UNEXPLORED WORLDS

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THE FUTURE'S BRIGHT...THE FUTURE'S GREEN

SIOBHAN CHAN



Atle Brunvoll

TAKING BIOMASS OFF THE BACKBURNER...



According to a report written by researchers at Imperial College London and the UK Energy Research Centre (UKERC), biomass could, in the future, sustainably cater for one fifth of the world's energy needs.

The use of biomass, such as agricultural residues, waste materials and energy crops like maize and sugar cane, has sparked controversy in the 'food vs. fuel' debate. Bioenergy crops take up land and water resources that could be used for food production. The ongoing hunt for fossil fuel alternatives has led scientists to consider the role of biomass. Some claim that bioenergy has the potential to single-handedly fuel the planet; others argue that producing more than the 10% of energy that biomass currently provides would bring both environmental and social risks. In an attempt to work out why there is such a wide range of estimates, researchers at Imperial's Centre for Energy Policy and

Technology (ICEPT) and UKERC have conducted the first systematic review of the current literature.

Having reviewed over 90 studies, the report highlights that previous scientists' predictions were based on differing assumptions of population, diet, land use and productivity. The report also explains how biomass prediction studies explore which options are not only physically possible but socially acceptable and environmentally responsible. It was concluded that, without affecting food production, biomass could sustainably provide 100 exajoules of energy, roughly equivalent to one fifth of the global energy demand.

It is clear that a balance must be struck between food and fuel production. Dr Ausilio Bauen, Head of BioEnergy at ICEPT, claims that with productive use of land and plant material "we should be perfectly capable of producing bioenergy, feeding a growing population, and conserving the environment all at the same time."

PENICILLIN: MISTAKEN IDENTITY?

SARAH BYRNE



Few medicines capture the imagination like penicillin. Since its discovery by Alexander Fleming in 1928 this miracle drug of the 20th century

dramatically cut mortality rates resulting from surgery, saved many lives during World War II, and successfully treated diseases once feared as death sentences such as tuberculosis, diphtheria and pneumonia.

Even the story of penicillin's discovery is dramatic. A petri dish containing a bacterial culture was accidentally allowed to become contaminated with mould, a source of annoyance to Fleming – until he realised that the mould appeared to be secreting a substance that killed the bacteria around it. By chance he had found exactly what he was looking for: a powerful anti-bacterial agent which could be developed into a drug safe for human use. The mould was identified as *Penicillium chrysogenum*, and that was the culture used for industrial-scale production of penicillin for medical use, still widely used today.

Recently, Imperial researchers discovered that what we think of as *P. chrysogenum* in fact covers at least four distinct species. By applying modern genetic analysis techniques to historical samples from Fleming's preserved laboratory, they found that his original culture was not quite the same species normally used in current penicillin production but a separate one; one they propose to name *P. flemingii*.

Why does this matter? Well, antibiotic resistance is a serious and growing problem – many bacterial infections are now resistant to the original penicillin and its derivatives, and there is an urgent need to find new anti-bacterial drugs to replace the older ones. A means of reliably distinguishing between species allows researchers to determine quickly whether a sample contains something new and interesting that can be further investigated in the hope of finding what we really need: new antibiotics.





STUDY OF WOLVES HELPS SCIENTISTS PREDICT CLIMATE EFFECTS ON ENDANGERED ANIMALS

HARRIET JARLETT



When we talk about climate change the emphasis is normally on how it will affect us, our children, and our great grand-children. However, a research study published in *Science* has looked into the effects that climate change will have on our furry friends in the animal kingdom.

A study conducted between Imperial College, the Department of the Interior in the US and several other universities has created a mathematical model based on the known links between population size and changing physical traits. These traits, from body size to coat colour, already vary from season to season and so any fluctuations in the surroundings can have a huge impact. Up until now it was unknown if these links were based on particular environmental changes or if they could result in evolutionary transformations.

Grey wolves have been integral to the study, since their large numbers in Yellowstone National Park mean they, and their environment, can be studied in detail and over long periods of time. The information was collected from both data chip collars worn by the wolves and through fieldwork. This required the scientists to fly across

the park in helicopters, tranquilising the wolves in order to weigh and measure them. During 'good years' when the population thrived, and 'bad years' when it dwindled, it was found that the population was responding to long term changes in their environment, instead of the year-to-year fluctuations predicted.

"WE URGENTLY NEED MORE DATA IF WE ARE TO UNDERSTAND HOW THE NATURAL WORLD WILL BE AFFECTED BY CONTINUING CLIMATE CHANGE"

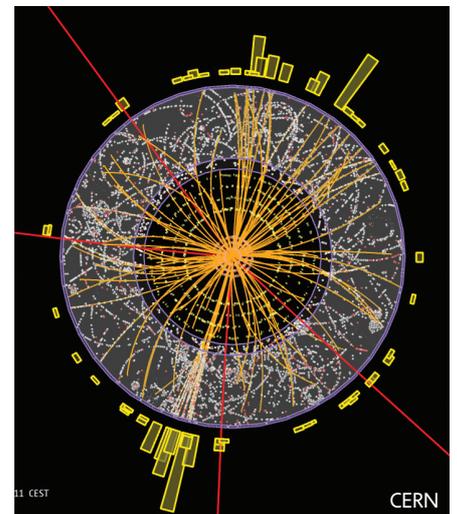
The study was conducted on 15 years worth of data, and this large amount of information just does not exist for most other animal populations. If this data could be collected we could even predict which animals may be in danger of extinction in the future. Professor Tim Coulson, who led the study, said that "we now have a way to predict with unprecedented detail how populations of many different animals will respond to environmental change, including those animals threatened with extinction. However we urgently need more data if we are to understand how the natural world will be affected by continuing climate change."

IN NEWS FROM BEYOND IMPERIAL...

THE HUNT FOR THE HIGGS BOSON

NICOLA GUTTRIDGE

CERN held a press conference on the 13th December 2011 in which they announced the results of their CMS and ATLAS experiments in Geneva. Both searching for the elusive 'God particle' that underpins our current 'standard model' of particle physics, their collected data was analysed to constrain the mass-energy range in which the Higgs might be found (if at all!). The conclusion was that glimpses indicative of the Higgs place the particle at a mass in the range of 124-126 GeV, to a certainty of 3.5 sigma – to be a claim of discovery, this confidence level must reach 5 sigma. Guido Tonelli of CERN said that the Large Hadron Collider will "definitely give an answer" to the Higgs riddle in 2012.



An event with four identified muons from a proton-proton collision in ATLAS. This event is consistent with coming from two Z particles decaying: both Z particles decay to two muons each. Such events are produced by Standard Model processes without Higgs particles. They are also a possible signature for Higgs particle production, but many events must be analysed together in order to tell if there is a Higgs signal. This view is a zoom into the central part of the detector. The four muons are picked out as red tracks.

WORLD NEWS

PICK OF THE BEST



VIRGIN TERRITORIES

SAMUEL CAVENAGH



ancy a trip into space? Well, in less than two years you may be in luck. Richard Branson's Virgin Galactic will soon launch paying members of the public into sub-orbit. However, at \$200,000 a ticket, it won't come cheap.

The spacecraft, named SpaceShipTwo, is based on the award-winning SpaceShipOne, the first private craft to achieve a series of high altitude flights. SpaceShipTwo is twice as large and can take up to six passengers. It will be lifted by its carrier craft WhiteKnightTwo to 50,000 feet, at which point it will hurtle towards space at over three times the speed of sound.

After six minutes of weightlessness, passengers will be returned to Earth. Re-entry is generally considered the most dangerous part of space flight, but SpaceShipTwo's unique feathered system allows it to fall slowly like a badminton shuttlecock, exposing it to temperatures much lower

than previous re-entry mechanisms.

As well as heading up into space, Branson plans to plunge down into the depths of the ocean. But unlike Virgin Galactic's spacecraft, Virgin Oceanic's custom-built submarine carries only its pilot and will not be taking paying passengers.

The submarine will make a mere five dives, one to the deepest point of each of the world's oceans. The first dive is to the Mariana Trench, the deepest part of any of our oceans, and Branson himself will make the second journey to the Puerto Rico Trench.

Each dive will document the changing organisms from the ocean's surface down to its floor in one trajectory, a study that has never been done. The submarine's water sampling system will pump 20,000 litres through an ultra-fine filter, extracting microbes and viruses, hoping to identify new organisms and potentially beneficial genes and enzymes.

WORLD'S LIGHTEST MATERIAL

DHARSHANI WEERASEKERA

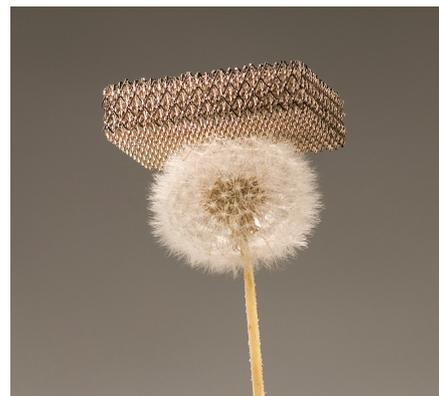


Californian team has developed a metallic substance which could break the record for the world's lightest material. The micro-lattice structure also has remarkable high-energy absorption capabilities, with potential for use in next-generation batteries, thermal insulation, and sound, vibration and shock energy damping. With a density of just 0.9 mg/cm^3 , the material is 100 times lighter than Styrofoam (polystyrene) and is also less dense than a range of other ultra-light metallic foams and aerogels, beating the 1.0 mg/cm^3 record set by a silica aerogel previously recognised as the world's least dense solid.

Announced in *Science* in November 2011, the new material was created by first producing a solid template which was then coated with uniform nickel-phosphorous plating in an electroless process.

“SUBSEQUENT ETCHING LEFT A DELICATE, DIAGONAL LATTICE-WORK...WITH WALLS 1,000 TIMES THINNER THAN HUMAN HAIR”

Unlike other ultra-light materials that typically consist of random cellular structures, micro-lattices are 99.99% air and only 0.01% solid – this ordered design results in their incredible lightness and remarkable strength.



LAURA TEMPLER

PIONEERING FACE TRANSPLANTS

Twenty years ago irreparable facial damage meant lifelong facial deformity. Skin grafts were used, leaving the patient to try and readjust to life, scarred and forever altered. New technology is changing this fate; recent research in Pittsburgh has combined 3D-modelling technology from Hollywood with facial imaging software to perfect face transplants. This new software enables doctors to visualise the donor and recipient tissue in 3D, checking variables like blood supply before surgery.

Facial transplants have improved drastically since premiering in 1994. A young Indian girl, Sandeep Kaur, caught her hair in a threshing machine, pulling off her face and scalp. Surgeons decided that reattachment was the best solution. This surgery introduced the idea that faces can be reattached, culminating in America's first full face transplant in March 2011. Dallas Wiens lost his face and vision in a cherry-picker accident. Though his sight couldn't be restored, the surgery has allowed him to once again enjoy the smell of lasagne and feel the wind on his skin.

Such transplants remain an ethically grey area; critics maintain this is not life-saving surgery and therefore not morally acceptable. Other future dilemmas are possible; will we be able to swap our faces for a better one?

Twenty years ago face transplants were a dream, today new faces are rebuilt before sunset. In the suitably festive words of Noddy Holder: "look to the future now, it's only just begun".

"WILL WE BE ABLE TO SWAP OUR FACES FOR A BETTER ONE?"

KELLY OAKES

TIMELINE: NEUTRINO



On 22nd September last year, particle physicists working on the OPERA experiment announced that they had seen neutrinos, a type of fundamental particle, travelling faster than the speed of light.

The experiment saw neutrinos created at particle physics laboratory CERN in Geneva, Switzerland, travel through the Earth and arrive 720km away at the Gran Sasso Laboratory in Italy, 60 nanoseconds earlier than they would have had they been travelling at the speed of light. As soon as the OPERA collaboration uploaded the paper detailing their work to the pre-print repository arXiv.org, scientists across the globe began poring over every detail of their experiment, analysis and conclusions. Some were dismissive — Professor Jim Al-Khalili said that if the result were true he would "eat his boxer shorts live on TV" — others were intrigued, and several theoretical physicists took it as an opportunity to expound on their own theories that might be able to explain the surprising result.

"IF TRUE...HE WOULD EAT HIS BOXER SHORTS LIVE ON TV"

If it were true, the result would have implications more far-reaching than Jim Al-Khalili and his boxer shorts. According to Einstein's theory of relativity, if a particle can travel faster than light in our frame of reference, it must be able to travel backwards in time in a different frame — that is, from the perspective of someone else moving with respect to us. From that person's vantage point, causality — the notion that cause must come after effect — would be broken, blurring the line between past and present.

After the commotion surrounding the initial result, it all went rather quiet until

18th November when the OPERA experiment released a second version of their paper after running a more finely tuned version of their experiment. In the new experiment, the pulses of neutrinos sent from CERN were made thousands of times shorter. Many scientists criticised the original long pulses because of the large errors they could introduce when measuring the exact arrival time of the particles. Shorter pulses allowed the physicists to measure 20 individual neutrinos at Gran Sasso, each one associated with a specific pulse leaving CERN. The new experiment gave the same results as the first; neutrinos still appeared to be travelling faster than light.

Another experiment, Icarus, also based at Gran Sasso Laboratory, thought it might have found a flaw in OPERA's claims, however. Icarus' work was based on a paper by Andrew Cohen and Nobel laureate Sheldon Glashow, both physicists at Boston University. Cohen and Glashow said that if the neutrinos had travelled faster than light, they should have lost energy through releasing pairs of electrons and positrons. Icarus looked for this predicted energy loss but did not find it, concluding that the neutrinos did not travel faster than light after all.

There are, however, ways around this problem. But there are also other problems with OPERA's experiment, such as the synchronisation of the clocks used to measure the neutrinos' time of flight. To be able to decide one way or the other, the experiment will need to be re-run at an independent particle physics laboratory. Plans are underway for this to be done in Japan and the US. Until then, we'll just have to sit tight and wait.



BEHIND THE HEADLINES

The I, Science team, with a little inspiration from Mythbusters, chose a handful of unexpected, weird or just plain interesting news stories over the past few months and investigated the science behind the headlines...

CHRISTMAS SNOWFLAKES AND MOONS ARE 'SNOW JOKE!'



Admittedly, this headline is included purely for its festivity. Peter Barthel, an astrophysicist from the Netherlands, has criticised the artistic depictions of moon phases on Christmas cards, saying that they diminish public understanding of lunar characteristics. It is intriguing that he has also felt it important enough to study this issue in the context of Halloween images, and also comments on cards depicting polar bears and penguins together – something that the vast majority of us, scientists or not, would overlook. The paper is reminiscent of one from 2009, in which a German scientist was incensed by Christmas cards depicting impossible snowflakes. Both of these arguments, while correct, cross the border from perfectionism into pedantry and aren't very in-keeping with the Christmas spirit – or engaging for the public.

doi:10.1038/462985a

DO DEPRESSED MOTHERS HAVE HAPPIER BABIES?

At first glance, a recent study appeared to claim that a newborn baby would physically and mentally thrive if a mother remained in a state of post-natal depression for longer after birth. However, the comparison should not be depressed versus non-depressed, but instead fluctuating versus stable – a constant depressed state is better than a fluctuating one, but by no means more desirable for the baby than a mentally healthy mother. Babies that prepare in the womb for insufficient care from their depressed mother post-birth via biological signals develop a 'survival instinct' and thus cope better than babies whose mother has a fluctuating mental state.

Psychol Sci. 2011 Dec 14.

AUTISM LINKED TO CLEVER PARENTS...



This Cambridge study is incomplete and is actually investigating autism rates of children from parents working in STEM (Science, Technology, Engineering and Maths) subjects, comparing rates to levels of 'systemising behaviour' in the parents. This isn't linked to intelligence and in fact most autistic disorders are associated with mental retardation. Systemising behaviour is also not a core trait of autism. Previous research has found that the offspring of engineers were more likely to be autistic; however it may be simply that educated parents are more likely to seek out an official diagnosis. Strikingly, autism rates in highly-systemising populations like those of Oxford or Cambridge are no higher than usual.

Telegraph, Nov 2011

I DON'T LIKE SPROUTS – IT'S GENETIC!

It's said there's no accounting for taste, but that's not strictly true. Genes code for specific taste receptors on the tongue e.g. a receptor for PTC, a bitter chemical in sprouts. People with this gene will find sprouts, and some other vegetables, completely unpalatable. A genetic disposition to PTC was discovered when the chemist Arthur Fox found his colleagues were unable to tolerate the PTC he was producing. Intrigued why it bothered some and not others, Fox conducted an experiment to find that the reaction to PTC could be predicted based on the response of family members; it was genetic. For a while this was even used as a paternity test! Meanwhile in 2003 the gene TAS2R38 was found – a reason for some of us never to eat sprouts again...

Current Biology 2006 Sep 19.

SUICIDE GENE DISCOVERED

Gene variants of *RGS2* were more commonly found in patients who had committed suicide. It's hard to distinguish 'suicide genes' from genes for depression; furthermore it is exceptionally unlikely there is a gene for suicide; it goes against every rule of evolution. Studies have found that 'depression genes' only come into play when a stressful event takes place; conferring relative but not absolute risk. The suicide risk variant may be a red-herring, actually causing poor parenting or resistance to anti-depressants. Over half of suicides don't possess this risk variant at all; screening for it still won't prevent early death. Questionnaires and relatives are still better assessors of suicide risk than genotype, however the finding may offer up new pathways for drug treatment of major depression.

doi: 10.1016/S0893-133X(00)00228-1

MACHO VOLES DON'T ALWAYS COME OUT ON TOP

A study based on vole behaviour claims that it is not always 'survival of the fittest'; there is a place in the rodent world for both macho and meek creatures. This particular study relies on the vole gender divide – macho and dominating behaviour is desirable for males, but in females produces smaller litters. They aimed to tackle this by introducing the non-gender-specific evolutionary tool of negative frequency-dependent selection, a mechanism that favours a particular trait only when it's rare. This showed that it is not the meek behaviour itself that is favoured, but a non-competitive environment – macho males surrounded by other macho male voles were seen to produce small litters. Maybe they were spending too much time fighting and competing the study's author suggests, but further work is needed to cement the idea of evolution favouring meek behaviour.

doi: 10.1126/science.1208708

WOMEN FAKE ORGASM TO PREVENT THEIR PARTNERS CHEATING

An American study found women who faked orgasms were more likely to have concerns about their partner's fidelity. Some theories suggest female orgasm improves fertility thus faking orgasm would be beneficial in convincing the male his genes had the best chance of being continued, as well as plumping his male ego. However this works in reverse as anxiety affects the female ability to orgasm; concerns about fidelity would lead to faking orgasm. Or perhaps men who play the field are selfish lovers...it's an interesting concept with evolutionary logic, but unlikely to be a conscious train of thought.

doi:10.1007/s10508-011-9874-6

Reskinned and restructured, the new I, Science website went live in December. If you haven't visited yet – or you've not been back in a while – check it out and tell us what you think! As well as the usual mix of science articles, videos, podcasts, and photos, you'll now find posts from our regular bloggers, who introduce themselves below. So, friend us, follow us, leave a comment and join the online discussion! And if you'd like to write for us or just have a great idea for a post, let us know!



5PM GIRL HELEN WILKES

I'm a Somerset-born Biomedical Science graduate of Newcastle University living in London. When I'm not studying for an MSc in Science Communication at Imperial I enjoy traipsing city streets and open spaces with my camera, both at home and abroad. I strongly dislike ironic use of the word geek and people who walk slowly.



CURIOUS & CURIUSER JO POOLE

I'm a medical student who graduated from Oxford before coming to Imperial, focussing on Neuroscience in the last year of my degree. I'm keen on writing and philosophy, particularly evolutionary biology, the mind, the brain and pseudoscience, as well as photography. In my spare time I can be found watching Grey's Anatomy, running and horse-riding.



DON'T MENTION THE TINY ROBOTS PETER LARKIN

I'm a Human Sciences graduate from UCL now studying for a masters in Science Media Production here at Imperial. Mention anything involving design, photography, film, science and technology and you've got my attention. Find a way to combine all five and I'll be your friend forever.



SPACE FOR THOUGHT NICOLA GUTTRIDGE

I recently graduated from studying Astrophysics at UCL and am now on the MSc Science Communication course at Imperial, inspired by a stint of work experience at Physics World last summer and continuing freelancing for Astronomy Now. I love anything to do with astronomy, photography, British music, cooking, old books, cute animals, physics, and stand-up comedy.



DOG & PONY SHOW DOUGLAS HEAVEN

I started life as an Arts graduate but grew up to be a Computer Scientist with a PhD in Software Engineering and 4 years' post-doctoral research experience. For a time I worked with robots. I'm currently doing the Science Communication MSc course at Imperial. Once upon a time I also played bass in a couple of DIY punk bands. I keep vegetables and grow cats.



PERIODIC STORIES ANTONIO TORRISI

After studying Materials Science in Turin, I started life as an "Italian in London" at UCL, where I did a PhD in Chemistry, until my love and nostalgia for humanities pushed me into the MSc of Science Communication at Imperial. I love music, playing instruments, taking photos, playing football, breakdance and reading Hornby. All this dressed up with a good dose of madness.



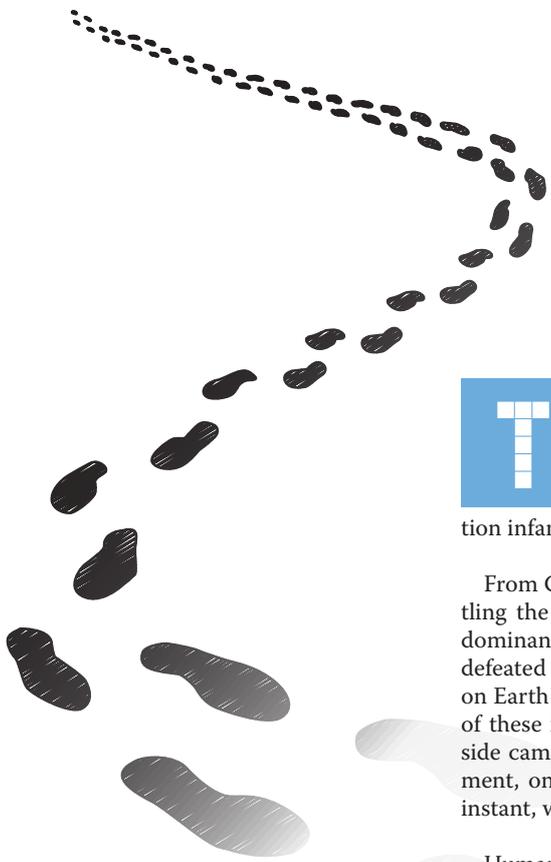
SCIENCE VS POLITICS JOEL WINSTON

From Biochemistry graduate to wildlife licensor, Airbus Project Controller to worldwide adventurer, and struggling DJ/music producer to obedient civil servant...I've been a jack of all trades and master of none! Now a Science Communication MSc student, I'm committed to putting the world to rights, re-uniting with my true science geekhood, and allowing a bit of spare time to bob along to some Detroit Techno.

UNEXPLORED WORLDS

"We must go beyond textbooks, go out into the bypaths and untrodden depths of the wilderness and travel and explore and tell the world the glories of our journey."

– John Franklin



There is nothing more quintessentially human than the yearning to discover more about the world around us. There's a reason the first question infants learn is "why?"

From Columbus to Scott to Einstein, battling the unknown has made us the most dominant species on the planet. We have defeated disease, colonised every continent on Earth and even learned how to fly. Tales of these feats have been handed down beside campfires, in hieroglyphics, on parchment, on cinema screens and now via the instant, world-wide internet.

Humans love discovery; so much so that we name it after ourselves, be it an island, a particle or a research paper. Our ancestors left darkest Africa to fan out across Asia, Europe, the Poles, America and Australa-

sia...and eventually reached the moon. We have delved so deep into the human body we know how to regenerate organs and why we look like our parents. We have traced human history back to the very start of life itself and know why the sky, that countless billions have lived beneath, is blue. We know that the speed of light is constant in a vacuum and that the sun is a ball of gas.

But most importantly, we understand that *we don't know everything* – and this issue of *I, Science* celebrates where curiosity has recently taken us, and where we may travel next.

From the skywhales of exoplanets to the depths of Earth's oceans, the enigma of the human mind to entire tribes who choose to isolate themselves from the world, this issue pays tribute to findings you could scarcely have imagined...

BENEATH THE ANTARCTIC ICE CAP:

Sub-surface life?

Antonio Torrisi
uncovers the secrets
held by the mysterious
Lake Vostok, Antarctica's
as-yet unexplored sub-
surface lake.



The Antarctic is one of the most extreme places on Earth and as a result, one of the least explored. However, remote areas spark scientific and public curiosity, and in 1957 a group of scientists established a research facility, Vostok, in the coldest place on Earth: the East Antarctic Ice Sheet.

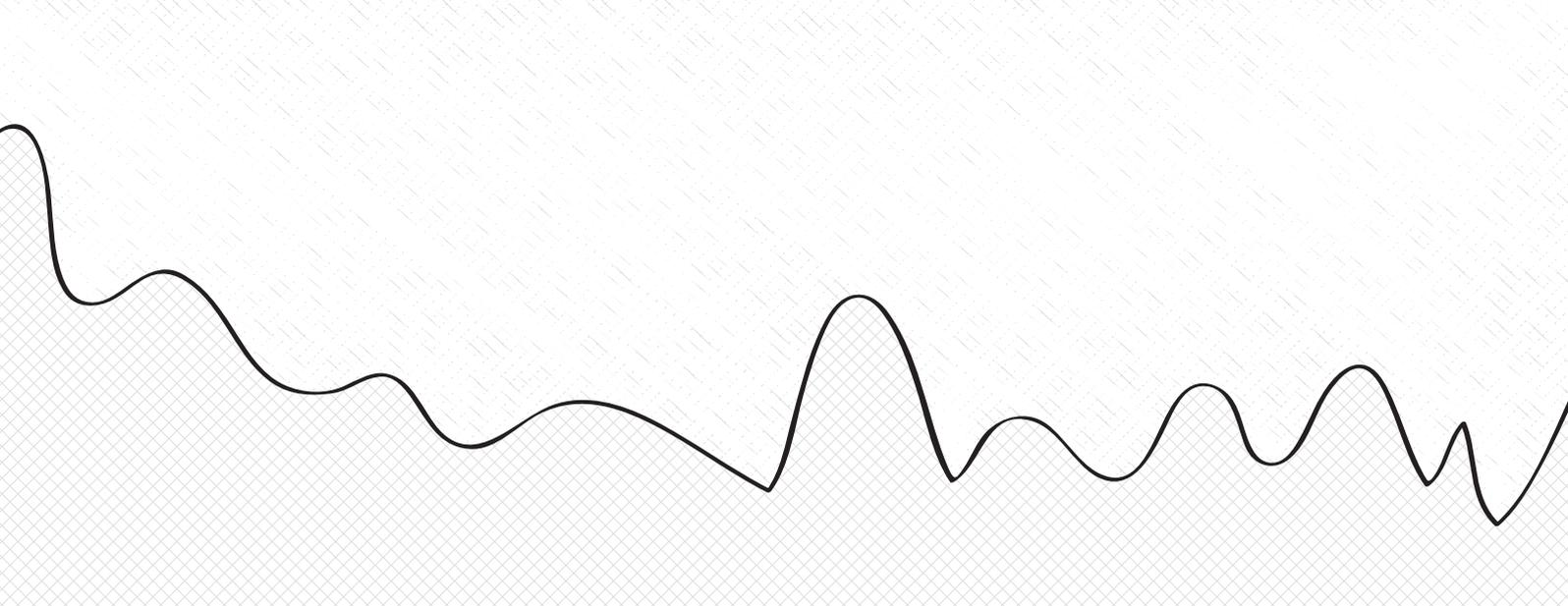
Forty years on, scientists confirmed the presence of a long-suspected prehistoric lake 3 miles below the surface. Vostok soon became one of the most-talked-about research facilities in the world, and an international effort was sparked to fund an expedition to the lake. Named Lake Vostok, it is one of the largest lakes on Earth at

15,690 km²; slightly larger than Wales. It remains unique, not only for its great size but also for its huge sub-surface depth. The extreme temperatures, lack of light, and isolation from anything – let alone anything living – present analogies to outer space, and discussions over whether the lake can sustain life.

BELOW THE SURFACE

Robin Bell and Michael Studinger, of the Lamont Docherty Observatory at Columbia University, understand how vital it is to identify the lake's unique geologic structures in order to address the important biological questions that inevitably follow.





In 2001, they had a breakthrough in understanding how the lake may have formed, despite its unusual and inaccessible location. They claim Lake Vostok could be a rift lake, generated by two blocks of Antarctic crust moving apart from one another. Consequently, the high temperatures created by the friction of the moving blocks caused hot springs to form, which then melted the covering ice. The extreme high pressure exerted by the ice sheet keeps the water in a liquid state even though, at -3°C , it should, technically, be frozen.

“ANY ORGANISMS PRESENT HERE WOULD HAVE EVOLVED IN A VERY DIFFERENT WAY TO US”

If life has formed from the energy of the hot springs then, since the lake is in complete darkness, it would have been unable to respire through photosynthesis. Scientists think the lake might be up to one million years old and could be supersaturated with nitrogen and oxygen, which are more easily absorbed by water at the extremely high pressures exerted by the 3 miles of overlying ice. Any organisms present here would have evolved in a very different way to us, and only bacteria and micro-organisms are likely to exist.

Russian scientists have been drilling the ice sheet around Vostok station, but have yet to penetrate the lake itself. From analysis of extracted ice-cores they have found three bacteria undoubtedly belonging to the lake surface ice, two of which confirm

the theories of Bell and Studinger since they have previously been found in other hot springs in Japan, the US and on the Galapagos islands. Only one type was unclassifiable. In order for further examples of life to be found, researchers need a sample from the lake itself; however, this creates a huge technical and scientific issue.

Since the lake has so far remained untouched by humans, any exposure to the atmosphere could contaminate it. Similarly, the kerosene fluid used in the drilling operation to prevent the borehole re-freezing could irreparably pollute the lake, destroying natural habitats and preventing a true scientific investigation. Another risk factor is the possible de-gasification of methane and carbon dioxide, which have accumulated in the lake and can only be maintained at very high pressures; their release could generate a geyser-like explosion, destroying any life below.

OVERCOMING THE DANGERS

American and British scientists believe they have found an answer to the dangers of probing. A team of scientists led by Professor Siegert of the University of Edinburgh will use a new technique to explore another sub-glacial lake. Hot water would be used to excavate down to the lake surface, before carefully inserting a sterilized thermoprobe into the lake and then introducing a submersible hydrobot. This small robot could be guided from the surface to search for bacteria and extract samples of sediment. It would not return to the surface, but instead carry all the instrumentation needed



to analyse collected sediments and bacterial life. A masterpiece of engineering and technology, its titanium structure would not degrade and risk contamination of future experiments.

“LAKE VOSTOK IS THE HOLY GRAIL” – AND THE LAST CRUSADE HAS ALREADY STARTED.

Whilst the exploration of sub-glacial lakes could throw light on the origin of life on Earth, it could also indicate whether or not life could exist on solar system moons such as Europa, which is known to have sub-glacial lakes similar to Vostok. It can also give us an important insight into the workings of our own planet through the decoding of the glacial history of the Antarctic, which, in our current climate crisis, could help the study of the instability, and possible future collapse, of the Western Antarctic Ice Sheet.

As stated by the University of California's Professor Priscu, “Lake Vostok is the holy grail” – and the last crusade has already started.

EXPLORING THE DEEP

Juan Casasbuenas explores the mysterious world of the deep sea and the extraordinary technology being used to find out exactly what's lurking beneath the surface...



The mission has been going for hours. The atmosphere is tense. In the dark room, multiple screens feed the pilot information about the mysterious world being explored remotely. The instruments indicate an extreme pressure and a temperature of about 3°C. Salinity levels are through the roof and oxygen levels minimal. The camera feeds display nothing noteworthy.

The pilot extends the remote manipulator arm of the vehicle by operating the controls; the arm is equipped with an array of sensors and has a strong light that reveals tiny particles gliding across the screen, reminiscent of a light snow flurry. As the pilot ponders the hostility of this eternally dark world, a hint of movement captures his eye on one of the other screens. He carefully adjusts the camera to capture it and focuses the image, revealing a surreal figure...

This scene may evoke ideas of space exploration or even science fiction, but it is in fact a mission into the deep sea. The deep sea is a hostile world: beginning at a depth of 1800m and culminating at about 11000m, it is deep enough to comfortably submerge Mount Everest.

“Two thirds of the surface of our planet is deep-ocean floor – it is the dominant habitat, we are the aliens,” explains Deep sea

biologist Dr Brian Bett, from the National Oceanography Centre in Southampton. “The exploration aspect can certainly be exciting and intriguing – many of the places I visit, the landscapes I map, and the animals I encounter are previously unknown.”

Humans have reached the bottom of the ocean using submersibles but never set foot on it – the extreme pressure would crush us instantly. Dr Bett adds: “a dozen men have walked on the moon; no one has or is likely to walk on the deep-ocean floor. A visit is possible by submersible, but with only three suitable vehicles in the world, your chances are pretty slim.”

TECHNOLOGY

Much of what we learn about the deep sea therefore relies on the use of highly sophisticated unmanned vehicles. Remote Operating Vehicles (ROVs) like Ventana from the Monterey Bay Aquarium Research Institute (MBARI) are piloted from a mission control room on board a ship at the sea's surface, like the scene shown to the left. The vehicles are equipped with numerous gadgets, including high definition cameras, hydraulic thrusters, fibre optic telemetry, variable buoyancy systems and even mass spectrometers, all helping to unravel the puzzles of the deep. Another, newer generation of vehicles are autonomous underwater vehi-



The flight room – mission control – aboard one of MBARI's research vessels, where missions can last up to 12 hours. Image: Todd Walsh © 2006 MBARI



The barreleye fish *Macropinna microstoma*. Its eyes are at the top of its head – the dark patches on the front of its head are olfactory organs. © 2004 MBARI

cles known as AUVs, such as NASA's Jaguar. Jaguar is currently being used to map the ocean floor, and further evolved versions of it may one day visit the deep ice covered oceans of Jupiter's Europa.

In Dr Bett's view, AUVs have the capability to "revolutionise the detailed mapping of the deep-sea floor. They are unmanned and untethered systems that carry out pre-programmed diving missions, but have sufficient intelligence to avoid and navigate around obstructions."

LIFE AND BIODIVERSITY

The strange figure is a fish; now in focus it flaps its large fins but remains unperturbed by the encounter. The light from the ROV reveals something curious about it...a transparent head. Before the pilot can have a closer look, the fish disappears into the darkness, never to be seen again.

Footage of this oddity – the barreleye fish *Macropinna microstoma* (shown above) –

was first recorded during one of these fleeting encounters by researchers at MBARI. Its strange adaptations include tubular eyes and a transparent head. Its eyes are found at the top of its head, enclosed in transparent shields like the canopy of a jetfighter. They can rotate within the shield in order to peer up towards falling pieces of organic litter – marine snow – or faint silhouettes of prey. Other oddities include angler fish (*Melanocetus johnsonii*) that use a bioluminescent growth on their head in order to lure and capture prey, sea worms that release glowing bombs to thwart attacking predators and predatory sea squirts that lay 'leaves' on the ocean floor which trap unsuspecting shrimp or worms that move across them.

Although every descent into the deep sea brings with it intriguing new findings, describing all these new species remains a huge challenge due to the shortage of taxonomists across all fields of biology.

Dr Bett explains it best: "The diversity of the deep sea is comparable to any ecosystem on earth, but despite being the foundation stone of all biology, and critical to ecology and biodiversity – taxonomy remains extremely difficult to fund. So for now, and for a long, long time into the future, the deep sea will contain more unknown than known species."

The pilot operates the controls and the long treacherous ascent to the surface begins; another journey into the abyss comes to an end.

"A DOZEN MEN HAVE WALKED ON THE MOON; NO ONE HAS OR IS LIKELY TO WALK ON THE DEEP-OCEAN FLOOR."

Uncontacted Tribes?

Douglas Heaven asks Dr. Michael Stewart if there really are any uncontacted tribes left out there.

In January 2006, two Indian fishermen were killed by indigenous tribesmen when their boat drifted too close to North Sentinel Island, a tiny outcrop in the Andaman archipelago between India and Burma. When an Indian coastguard helicopter later approached the island to investigate, Sentinelese warriors repelled it with spears and arrows – but not before the helicopter’s down-draft had revealed the fishermen’s bodies lying in shallow graves on the beach. This at least put paid to local rumours that this uncontactable tribe, a people reportedly without the ability to work metal or use fire, had eaten the unfortunate men.

Keen to know more about these isolated Andaman Islanders, I contacted Dr. Michael Stewart, an anthropologist at University College London. “It’s all fantasy, the idea of an uncontacted tribe!” he interrupts, when I broach the subject. “It’s a total fantasy. And the Andaman Islanders are a wonderful example of that. The Andaman Islands are one of the major tourist destinations for South Asian tourists. Tens of thousands, if not hundreds of thousands go there every year”.

It is the Sentinelese who are at threat from an encroaching outside world. Their Andaman neighbours, the Jarawa, have suffered disruption, measles outbreaks,



CHRISTIAN CARON



and unwanted tourist attention since the 300km-long Great Andaman Trunk Road was built through their forest homeland. Private companies operate illegal sightseeing tours for curious outsiders to take photographs, while dislocated Jarawa beg at the roadside. Legislation has been put in place to offer some protection but the fate of these people may still end up being similar to that of the Native Americans. “When the Andaman Islanders throw things at people it’s because they know them and they’ve had a bad experience with them”, Stewart wryly suggests. “It’s precisely the opposite of an uncontacted people”.

The fantasy of unknown peoples is a compelling part of popular culture and promoted by TV programmes like BBC2’s Tribal Wives. “It’s more a kind of romantic fantasy that it would be possible to really get away and hide – it’s a humanized version of the yeti story”, Stewart says. He mentions an episode of Tribal Wives featuring the Huaorani – a remote Ecuadorian tribe – which doesn’t quite manage to keep the airstrip the Houarani have built to receive tourists out of shot. Similarly, in The Tribe That Hides From Man, a famous 1970 documentary film about ‘first contact’ with a Brazilian tribe: “If you watch it with a critical eye, it becomes quite clear that these people have steel axes – steel axes don’t grow in the Amazon jungle, they’ve got them through barter with other people”.

That’s not to say there aren’t pockets of truly isolated people, but it’s more accurate to think of them as reclusive than uncontacted. “There are Huaorani who are living in the Amazon who travel around in

very small groups – just a family – a man, a woman, and some children – who really do avoid, as far as is possible, contact with other people”. The Mbuti – an indigenous pygmy people from the Congo region of Africa – are another group who are “ambivalent about contact with outsiders”, as Stewart puts it. For the Mbuti a history of indebtedness and exploitation at the hands of neighbouring tribes led them to shun interaction.

If such people have deliberately sought isolation, there are obviously ethical questions about studying them. “It’s a constant source of self-questioning”, agrees Stewart. Generally, he believes social research is for the public good, noting parallels between much ethnographic research and journalism. As in the Leveson Inquiry, the issue is where to draw the lines. “Somebody who in some way betrays the secrets of a population they do research with – if that includes where they hide out, as it were – that would be universally condemned”.

But are there truly no unexplored peoples left in the world? “There are people who systematically avoid contact. If people don’t want to be studied then they don’t get studied”, he says. “Famously, anthropologists don’t study the super rich of the Western world, who don’t want to have their lives exposed – there’s no ethnography of the Saudi royal family – these people stop you. Anthropologists have tried to do ethnography of the super rich and the super powerful but they don’t want to let anthropologists in”. And the super rich are a lot better than indigenous tribes at keeping outsiders away.

HUAORANI

Location: Ecuadorian Amazon
Population: 2500-4000

MBUTI

Location: Democratic Republic of the Congo
Population: 30000-50000

SENTINELESE

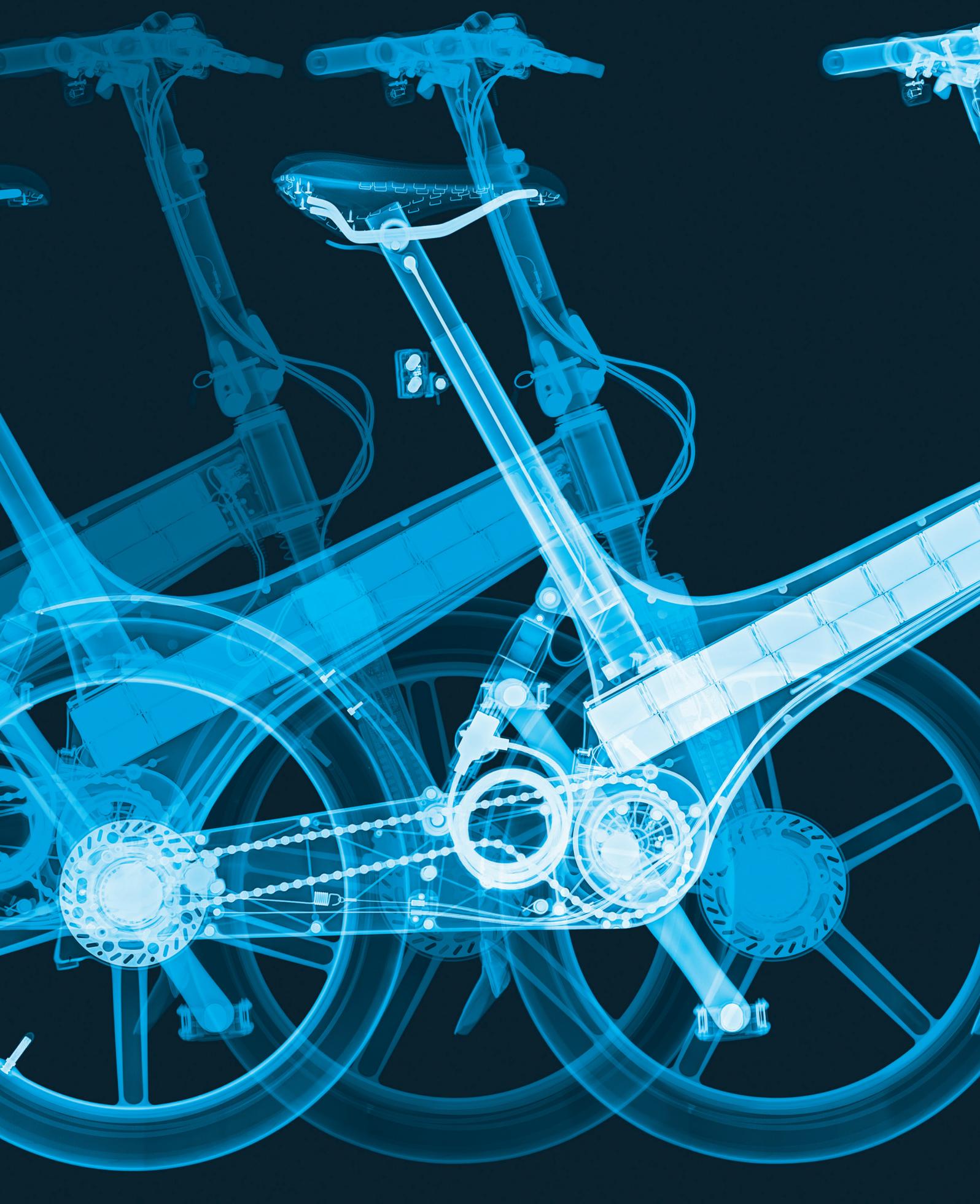
Location: North Sentinel Island
Population: ~250 (incomplete but official census: 39)

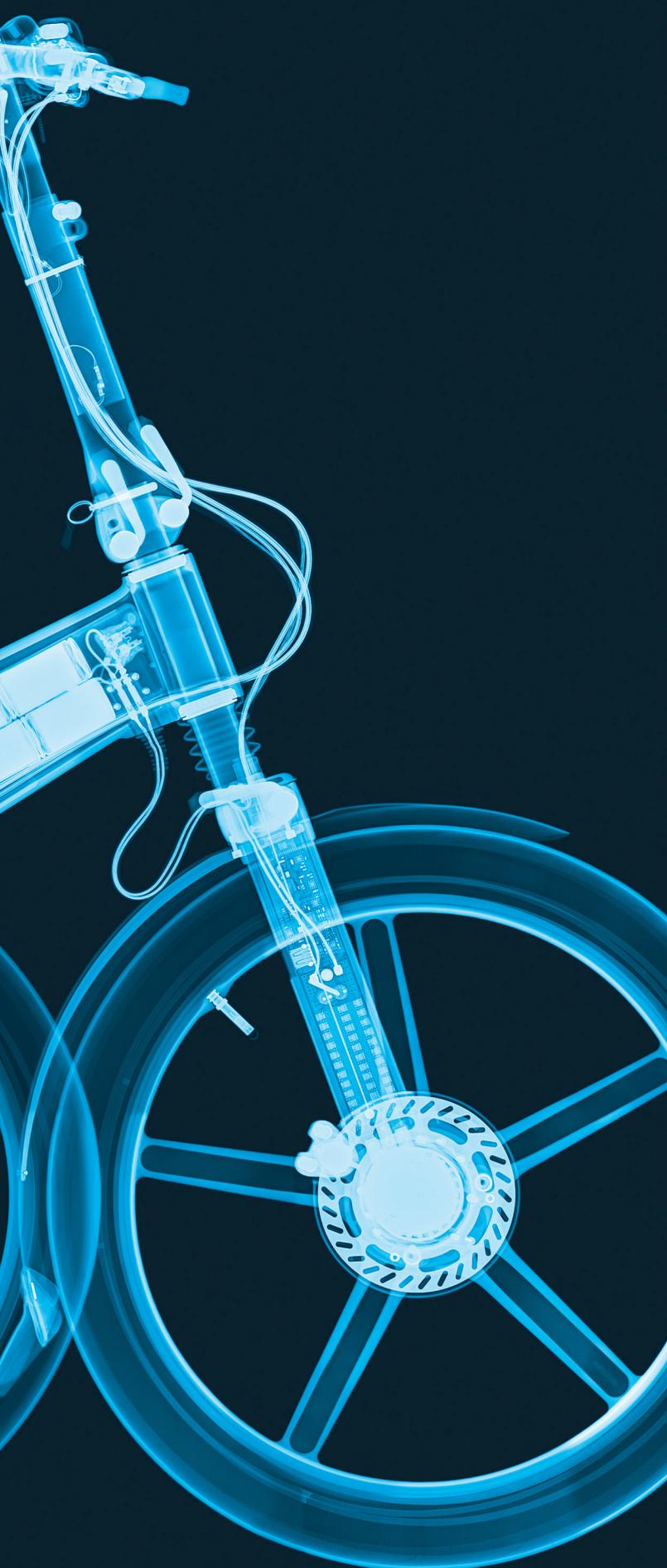
JARAWA

Location: Western side of South Andaman and Middle Andaman Islands
Population: 250-300

SPINIFEX

Location: Great Victoria Desert, Western Australia.
Population: ~150 in the 1950s. So low that their lands were considered unhabited and used as an atomic-bomb testing site.





SCIENCE BEHIND THE PHOTO

X-RAY ARTIST HUGH TURVEY

www.x-rayartist.com

Radiography has been around for over 100 years now but it's not often used to reveal to us the inner workings of everyday items. The concept behind radiography is relatively simple; x-rays from an x-ray generator get fired through an object and those that make it through get picked up by a detector. The denser the object, the fewer x-rays it will let through – explaining why bones come up as mostly white.

In 1996, photographer Hugh Turvey started exploring x-rays as an artistic medium and has been experimenting with them ever since. Hugh is now the permanent artist in residence for the British Institute of Radiology and has created an impressive collection of x-ray art. The electric bike to the left is 'beautifully designed to hide its technology', says Hugh; reason enough to get inside and see what it's hiding.

Hugh was also asked to become artist in residence at Yeovil District Hospital, leading the *inr-i* ('inner eye') project there. This project evolved rapidly into an engagement project consisting of 'x-ray art' workshops. Staff and the public were asked to bring objects to be x-rayed, with the aim of creating a large collection of images that would eventually hang in the x-ray department. These workshops provided the public with a chance to learn about the process behind x-rays, giving them a new perspective on diagnostic imaging and strengthening the identity of the x-ray department at the hospital.

Hugh has recently teamed up with publisher Touch Press to create an immersive ebook for children called *X is for X-ray*. The ebook comes as an app, available for iPhone and iPad, and lets users explore a completely new dimension of 26 everyday objects. It is hoped it will challenge and excite children's understanding of the world around them. *X is for X-ray* is available now in the App Store.

To see the full interview with Hugh, visit the *I, Science* website at www.isciencemag.co.uk

WORDS BY PETER LARKIN

Exploring Our Planetary Neighbourhood

Nicola Guttridge explores the hunt for planets around other stars, and how this is helping to answer questions about the possible existence of alien life in our universe.

There is no place more inhospitable and mysterious than space, although having now read *Exploring The Deep* and *Sub-surface Life?*, you might now disagree! This is one of the reasons that it inspires such passion and dedication amongst astronomers, as in spite of our many years of stargazing and spaceflight, we still know very little about the universe in which we live.

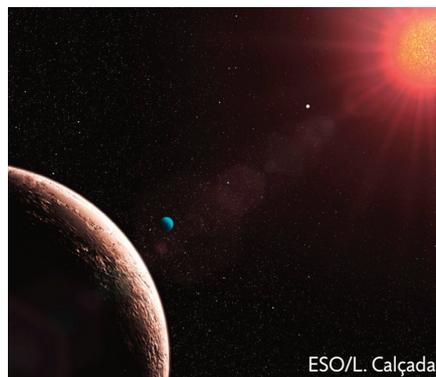
Great progress has been made in the hunt for planets that lie outside of our solar system. Known as extrasolar planets or exoplanets, analysis of their atmospheres and possible surface conditions allows scientists to postulate on one of the most poignant and scientifically frustrating questions known: Are we alone?

This question has occupied the scientific community since the early nineties, when researchers Wolszczan and Frail stumbled across the existence of the imaginatively-named planetary system PSR B1257+12. Since this discovery, there have been many other forays in search of new planets.

The launch of MOST, the Microvariability and Oscillations of Stars project, in 2003 was followed by three subsequent missions in 2005, 2006 and 2009, all supported by the invaluable Hubble Space Telescope. Planet-searching equipment known as HARPS has played a key role from the ground. This blur of acronyms has led to an impressively high success rate; currently, the tally stands at over 680 planets discovered, orbiting over 470 stars – a remarkable achievement in just under 20 years.

The discovery of new exoplanets inevitably leads to questions concerning how many of these worlds could be home to life – intelligent or otherwise. One recent study tackled exactly this, directly comparing both exoplanets and planets within our own solar system to planet Earth.

By attributing values from 0 to 1 to the planets based on various characteristics (1 being the Earth itself), the 'Habitability' in-



Artist's impression of the newly discovered planetary system Gliese 581

dex considered factors such as atmosphere, magnetic field, available sunlight, surface organic compounds and tides. Another index, 'Earth Similarity', dealt with density, distance from parent star and size.

Three exoplanets from the Gliese 581 system topped the 'Similarity' list, with Mars, Mercury and the Moon also scoring above 0.5. However, although the Moon may be physically similar to us, we know that this

does not mean it is able to support life. To remedy this, the 'Habitability' index was applied to the same planets with vastly different results. Saturn's moon Titan, Mars, Jupiter's moon Europa and again the Gliese system were the top scorers, with Jupiter, Saturn, Venus and Enceladus also appearing.

There are a vast range of bodies considered to be habitable, and this raises new questions. For example, who says life should be carbon-based? Is oxygen necessary? Does the planet need a Moon for life to evolve? Does the planet need a solid core? These culminate in a single question: does a planet need to be similar to Earth to sustain life?

This question remains unanswered, but as shown by the study above, the answer may lie within our own solar system. Most people have heard of the past history of water on Mars, and recent NASA research has uncovered evidence for liquid water on Jupiter's icy moon Europa. Titan, as previously mentioned, is very Earth-like in many respects, and has not yet been fully explored. Another rocky body that has piqued interest is Saturn's moon Enceladus, a moon postulated to house an underground ocean of liquid water.

The progress achieved by missions such as NASA's PlanetQuest is promising. However, as the search progresses, it becomes apparent just how much there is left to explore in our solar system, galaxy and universe – and just how alien our stellar neighbourhood is to us.

Joel Winston deconstructs the creative mechanism planned to help land NASA's Mars Curiosity rover next year, and what this might mean for the evolution of space exploration.

Image courtesy of NASA/JPL-Caltech

The Descent to Mars



As Mars continues to intrigue us and yield ever more ambitious missions, even greater technological advances are required to land there. As NASA's Mars Science Laboratory hurtles towards the red planet with its precious cargo, the Curiosity rover, scientists wait in the hope of a successful landing in August 2012. However, with over half of all Mars missions having failed, it is clear that the stakes are high and the technological challenges immense.

After years of development followed by months of space travel, the biggest gamble for the Curiosity rover comes in the last few crucial minutes, when, after travelling 25 times faster than a speeding bullet, it needs to touchdown safely.

The 'Entry, Descent and Landing' phase begins 80 miles above the surface of the planet when the spacecraft hits the Martian atmosphere at an astonishing 12,000mph. This speed has to decrease to zero in just six minutes, requiring a carefully orchestrated sequence of events – all performed by a spacecraft running on autopilot.

Navigating the Martian atmosphere is particularly problematic. While it is thick enough to create dangerous amounts of friction and heat, it is too thin to help slow the spacecraft's descent. The exterior temperature caused by friction during entry is nearly 6000°C, as hot as the surface of the Sun. The heat shield of the craft needs to resist this for 30 seconds and prevent the equipment inside from even reaching

room temperature.

Small rockets guide the spacecraft's entry into the lower atmosphere. Once it slows down to 1000 mph a parachute opens, triggering a powerful drop in speed to 250 mph and the beginning of a tricky landing sequence.

Previous missions have used airbag-assisted landings; however, the Curiosity rover weighs in at nearly five times heavier than previous rovers at 900 kilos, making this impossible.

This is where the new 'sky crane' landing system comes in. A first for space exploration, it involves lowering the rover onto the Martian surface via a hovering rocket-powered sky crane, requiring some hair-raising robotic flight manoeuvres.

At around a mile above the surface, and still travelling at over 200 mph, the rover remains attached beneath the descent stage. This then detaches from the parachute, and four rocket thrusters fire-up to control their descent. Once slowed to just 2 mph Curiosity is lowered from the descent stage using bridles. The sky crane then gently lowers the rover to a soft-landing on its wheels, ready for it to begin its mission.

While it is uncertain whether such an ambitious procedure will work, creative landing solutions like these are becoming increasingly vital as Mars missions with even heavier payloads are developed. The result of August's descent will therefore have huge implications for the possibility of future human exploration.

The Neural Code

Jo Poole talks brain cells, 'roborats', and how cutting-edge neurology may help us overcome Parkinson's



Sherrington described the brain as 'Biology's final frontier'. The greatest differences between us and our closest relatives lie in the convoluted

folds of a jelly-like organ that constitutes 2% of our body weight and requires 20% of our nutrition. Neuroscience has experienced a renaissance in the last few decades, bringing neurology to the forefront of science.

LANGUAGE OF THE BRAIN

Chapin ranks the neural code as one of science's greatest mysteries, alongside the origin of the universe and life itself.

We have nearly 100 billion brain cells, each connected to as many as 100,000 others; equivalent to the number of stars in the Milky Way. These cellular networks are continuously remodelling, even in adulthood. Thus any code is unique to a particular brain. There is, however, enough consistency to produce theories about higher thinking.

MIND CONTROL

Last year the Economist said science was on the verge of 'overturning the essential essence of humanity', envisaging a cyberpunk dystopia where governments control our movements, thoughts, fears and emotions. Several years ago, there was a media storm about 'roborats'; researchers could steer rats through a maze using remote controlled electrode implants. In the 1960s Delgado, a Yale neuroscientist, astonished and appalled onlookers as a finger on the button of a remote electrode caused a charging bull to stop and wander away.

Fortunately, these crude stimulations merely tap into primate neural circuits; those for physical and instinctive habits like eating, drinking and feeling scared. When it comes to mimicking

or manipulating higher thought we are still complete novices. But films like *Inception* have set us wondering if this science fiction will be realised in our lifetime.

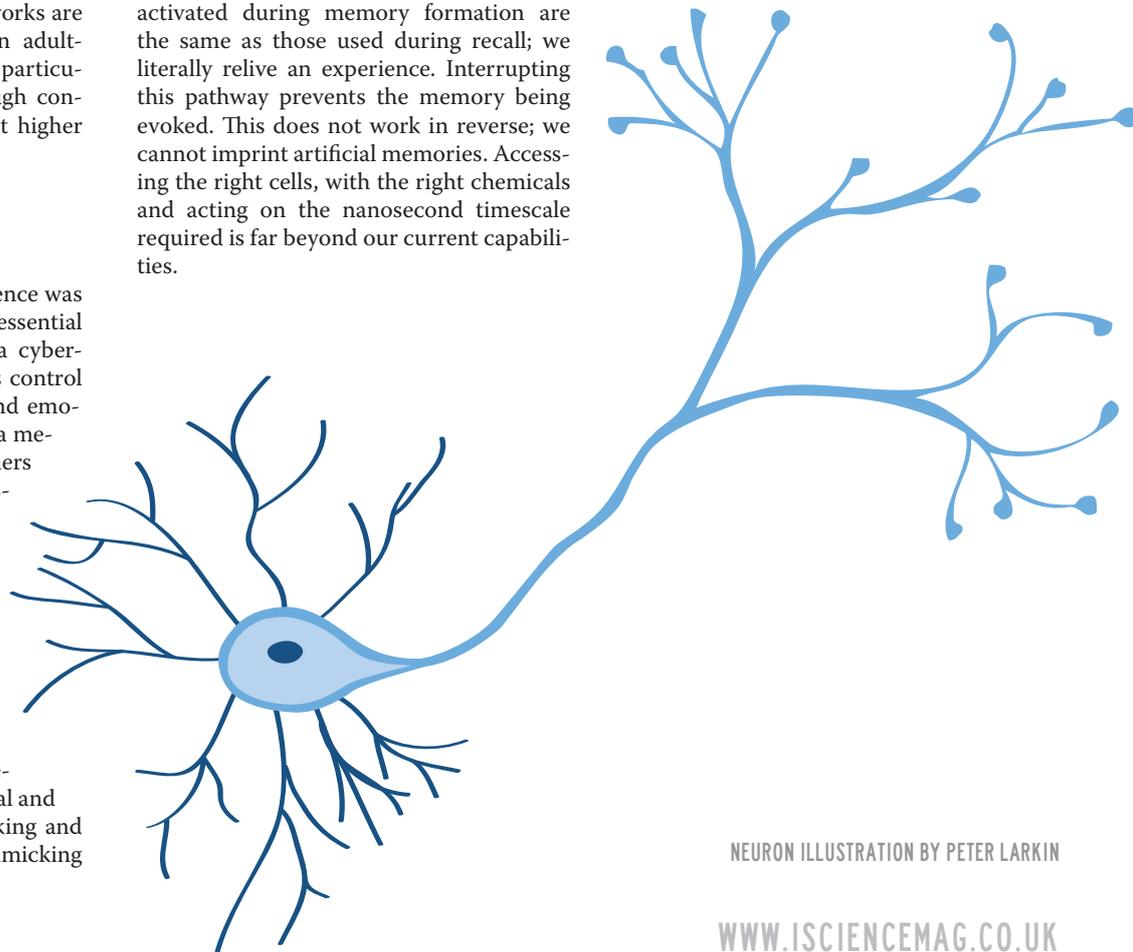
MEMORY

The way memory works is one of our greatest fascinations. Its toolbox includes a small, coiled structure lying behind our temporal lobes; the hippocampus. Genetic ablation, or gene silencing, of this area, leads to devastating short-term memory loss and the inability to form new memories. Yet its destruction cannot displace long-term memories, fear memories generated in the amygdala or muscle memory in the motor cortices and cerebellum.

Recent studies show that the brain cells activated during memory formation are the same as those used during recall; we literally relive an experience. Interrupting this pathway prevents the memory being evoked. This does not work in reverse; we cannot imprint artificial memories. Accessing the right cells, with the right chemicals and acting on the nanosecond timescale required is far beyond our current capabilities.

However neuroscience has brought us considerable medical advancement. Already telepathic prosthetic devices are available for amputees. We will be able to slow, if not reverse, diseases of brain degeneration. Small-scale brain tissue transplants are underway, using foetal tissue, post-stroke or for Parkinson's disease. We know the genes responsible for diseases like fragile X syndrome, an X-linked disorder affecting the production of neurotransmitters, which causes severe mental retardation; treatments are now available as a direct result of research.

The brain may well be biology's final frontier, but the last two decades shows rapid progress and as 'the Art of War' declares: all obstacles can be overcome with strategy.



NEURON ILLUSTRATION BY PETER LARKIN

SIX GREAT EXPEDITIONS

GUNUNG MULU WHOSE EDEN?

1

The words Mulu, Sarawak and Borneo quicken the pulse of any budding explorer: cloud-shrouded mountain ridges, deep rainforest-clad valleys and twisting rivers, unimaginably beautiful ecosystems teeming with exotic plants and animals – gibbons, hornbills, flying lizards, spectral tarsiers, pitcher plants, mosses and bird-wing butterflies. The Mount Mulu expedition of 1976 was assembled to record these wonders for a new National Park, as the bulldozers and chain-saws closed in around an island of primal beauty in the name of economic development. While this project made invaluable recommendations for the conservation and development of this natural reserve, there were casualties – the hunter-gatherer Penan people, who were expelled from this Eden.

2

WALLACE AND DARWIN HALLUCINATIONS, A LETTER AND A SCIENTIFIC REVOLUTION

In February 1858, Alfred Wallace, a British naturalist and explorer, was on a remote island of Indonesia suffering a bout of heavy fever, when in the midst of hallucinations he had a moment of inspiration: a theory of evolution analogous to that of Darwin. The sudden moment of inspiration prompted him to write to Darwin, who had been keeping his own theory secret for 20 years, worried about its potential reception. This correspondence hastened Darwin into making his theory public, publishing 'On the Origin of the Species'. Far from the scientific buzz of London, Wallace initiated arguably the most important discovery in scientific history.

LEWIS AND CLARK CORPS OF DISCOVERY

3

In May 1804, the "Corps of Discovery", fifty men led by explorers Lewis and Clark, left St. Louis, Missouri, heading towards the North-West territories of the USA. Appointed by President Thomas Jefferson, they aimed to find a direct water communication to the Pacific coast for commercial purposes. Following Missouri and Columbia's big rivers across the Great Plains, crossing the Great Falls and Rocky Mountains, the mission reached the Pacific in Oregon by November 1805 and took two and a half years in total. They studied minerals, plants, wildlife and ethnography of Native American tribes who were hospitable and cooperative.

4

ROBERT FALCON SCOTT DEATH AND DISCOVERY

Captain Robert Falcon Scott undertook two voyages of discovery to the Antarctic region. At the beginning of the twentieth century, this was a dangerous and difficult task, and Captain Scott became an icon of this era of British exploration. Scott's travels met with a tragic ending; during his second excursion, the Terra Nova Expedition, Scott and his team perished in Antarctica. They managed to reach the South Pole, only to find they had been beaten there by an expedition led by Roald Amundsen. An exhibition dedicated to Scott's Terra Nova Expedition will begin at the Natural History Museum on 20th January 2012.

CABOT AND AMUNDSEN NORTHWEST PASSAGE

5

Thought to have been known to Viking traders before the Little Ice Age (1550-1950), the Northwest Passage – a sea route linking the Atlantic with the Pacific via the Arctic waters of northern Canada – became easily navigable again only in 2007 with the retreating pack ice. Nevertheless, for centuries explorers searched for a shorter trade route to China through the maze of waterways and floes, many disappearing during ice-locked winters. The first recorded expedition was led by John Cabot and backed by Henry VII in 1497 and the route wasn't successfully traversed until Roald Amundsen's voyage of 1903.

6

ESA MARS500

Russia's 'Mars500' experiment began on 3 June last year, and had a very unique twist – this project was based in just one location for its entirety: a mock spacecraft in Moscow. The aim was to simulate the conditions on board a mission to Mars. The six astronauts were locked in the fake craft for a total of 520 days to simulate "how a crew would cope with the difficulties and inevitable tedium of long-duration space flight," explained Swedish ESA astronaut Dr Christer Fuglesang. The men were released in November 2011, and research gathered over the nearly 12,500 hours of confinement will be invaluable in planning future missions to the red planet.

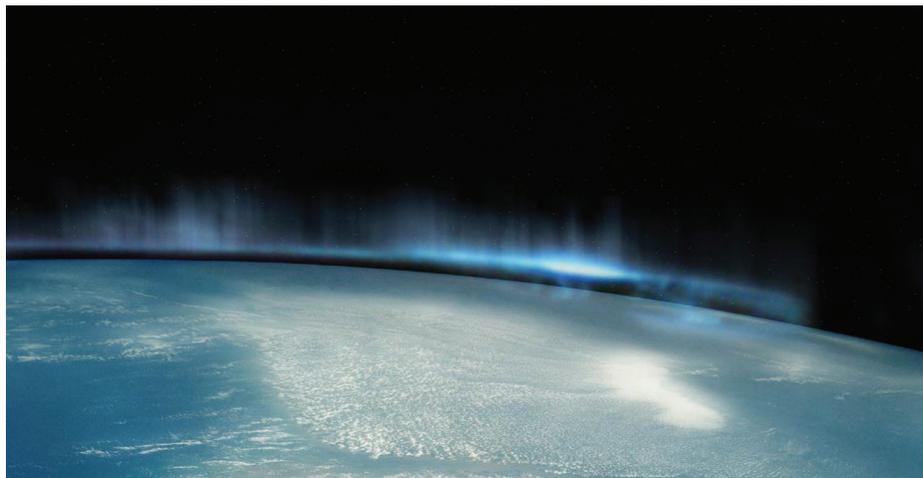
AUTHORS: 1 - KAZ JANOWSKI, 2 - SACHA THORPE, 3 - ANTONIO TORRISI, 4 - PENELOPE HILL, 5 - DOUGLAS HEAVEN, 6 - NICOLA GUTTRIDGE

AURORA:

delights and delusions

RICHARD MILLAR

explains why the
Aurora Borealis isn't just
about show...



Throughout human history the Aurora Borealis has been an ever-mystical backdrop and inspiration to the life beneath. Whether you see the aurora as lights carried by Norse Valkyries as they ride across the sky, or spy the swirling shapes of cities and other worlds as in Pullman's *His Dark Materials*, the Northern Lights never fail to cause us wonder. In today's age of earth-orbit exploration we have unprecedented vantage points into our earthly aurora, as the awe-inspiring International Space Station time-lapse videos show. So, what is the cause of these 'leaping heavens' in the sky? What are the Northern Lights?

**"..OPERATORS 2,500
MILES AWAY COULD
COMMUNICATE FROM
THE POWER OF THE
AURORA ALONE.."**

Despite the huge vacuum of space between the Earth and Sun, these two bodies are far more connected than people think. Solar particles from the Sun known as the

solar wind continually bombard Earth's atmosphere at very high speeds. Upon arrival these particles crash into the ionosphere, emitting characteristic wavelengths of light which then reaches us at the Earth's surface. For example the characteristic green colour of the aurora comes from solar particles exciting the atomic oxygen.

MERE PYROTECHNICS?

So what can these celestial lightshows do for us? Will they forever remain mere natural pyrotechnics in the sky, or can they have a more direct impact on our lives? The intense electric and magnetic fields associated with auroral activity can damage electronics orbiting Earth, particularly hazardous for satellites. The next time a large sunspot is formed it could cause your TV to black out or allow your sat-nav to lead you off course! Perhaps the most significant problem posed by the aurora is the danger to manned spaceflight. In 1989, during a particularly significant auroral storm, the cosmonauts aboard the Mir space station were exposed to more than their safe dose of radiation for the entire year. In order to effectively safeguard an ever more technologically dependent Earth, and a civilisation reaching out from our home planet for the first time, auroral weather forecasting will

have to become as accurate and commonplace as today's large-scale weather forecasts.

However, the aurora offers us advantages too. Occasionally, strong auroral currents and fields can be experienced on the Earth's surface, affecting communication systems such as telephone networks. Sometimes the telephone lines can be arranged so as to produce geomagnetically induced current from the aurora. For instance, during one of the most violent auroral storms in recorded history in 1859, two telegraph operators 2.5 thousand miles apart were able to switch off their power supplies and communicate for over two hours due to the current induced by the aurora alone!

Nature has the power to awe and enthrall; never truer than with the Northern Lights. In order to continue expanding our domain in the universe and satisfy our unquenched thirst to further explore, the aurora must go from being something we merely marvel at to being something that we can understand and predict in great detail. In many ways, understanding the aurora really is humanity's gateway to other worlds.

For the astonishing videos of the Aurora from the ISS, go to <http://vimeo.com/32001208>

PLACEBO:

brainpower, or ritual healing?

Since the case of Mr. Wright in 1957, whose cancer shrunk dramatically thanks only to his deep trust in a drug that was in reality ineffective, the world of medicine has become more and more aware of the placebo effect. The word placebo comes from the latin verb 'placere' which means 'to please'. In clinical studies it embraces a complex unexplained phenomenon in which trust in a medicine seems to cause the medicine to have beneficial physiological effects, whether or not it is pharmacologically active.

Doctors and scientists have been investigating this effect in illnesses such as Parkinson's disease and irritable bowel syndrome by using randomised controlled trials and 'double blinding', in which they separately treat two large groups of patients – one is given the standard pharmacological treatment (the control group) and the other is given inactive pills (the placebo group). Neither the patients nor the doctors in charge of the treatment know which group gets which pills.

“IT IS PRESENT AND COMPLEX, DEPENDING ON PSYCHOLOGICAL AND CULTURAL FACTORS”

Controversy and scepticism about the statistical significance of the effect are still present among scientists. Nevertheless, many experiments have shown that it is present and complex, depending on different psychological and cultural factors.

By using modern brain scanning techniques such as positron electron tomography, neuroscientists have observed important brain activity in patients experiencing the placebo effect, with release of endogenous opioids in the case of pain treatment or dopamine in the case of diseases affecting mobility such as Parkinson's disease. Recently, scientists from Germany and Switzerland have also observed a partial activation of physiological mechanisms that promote the immune function in immunological diseases.

“RITUALS HAVE A CATHARTIC ROLE IN MEDICINE AS WELL AS IN LIFE”

The placebo effect does not occur only within biomedical treatment, but also in surgical treatments and acupuncture.

A patient's expectancy and trust in the medical treatment play an important role, but other factors seem to be important too, such as the patient's psychology, interaction with the doctor, environmental conditions, as well as the care and assistance the patient receives. A study from Harvard Medical School compares Navajo healing rituals with ritual aspects in traditional acupuncture and biomedical treatment in the western world. Though there are many differences between all of these treatment methods, the common ritual component seems to be a very important factor in inducing a beneficial response in a patient. Like in Michael Cimino's movie 'Sunchaser', believing in rituals can have a beneficial cathartic role in medicine as well as in life.

ANTONIO TORRISI

finds out why
'never trusting a doctor'
could be a
fatal mistake...

A 10-cent pill doesn't kill pain as well as a \$2.50 pill, even when they are identical placebos, according to a provocative study by Dan Ariely, a behavioral economist at Duke University.

In the full-price group, 85% of participants experienced a reduction in pain after taking the placebo. In the low-price group, 61% said the pain was less.

MONEY MATTERS



Bone Wars

The story of 19th century palaeontology is one of personalities and conflicts as well as fossils.

SOPHIE BUIJSEN

investigates the rivalry that fuelled an unprecedented rush of discoveries.

In the ground below us lies a world that, in recent centuries, has slowly started to be uncovered. This is a world that seems almost alien to us with plants and animals that no longer exist, including the most famous of all: the dinosaurs. It was in the late 19th century that two palaeontologists started the very first 'dinomania', in what would later become known as the 'Bone Wars'.

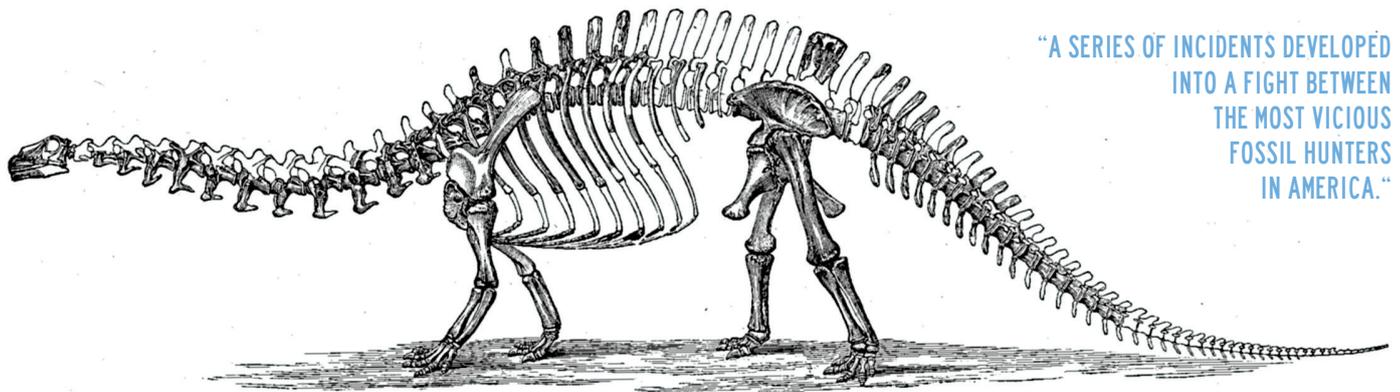
Edward Cope (1840-1897) and Othniel Marsh (1831-1899) were both wealthy and respected palaeontologists with a strong desire to find fossils. Initially on friendly terms, they even named fossils after each other. But that changed in the early 1870s, when a series of incidents developed into a fight between the most vicious fossil hunters in America.

According to Marsh, the Bone Wars started in 1870, when Cope reconstructed a dinosaur species he called *Elasmosaurus*. Marsh visited Cope to admire his work. Upon looking at the fossil, he suggested that the vertebrae were laid out backwards. Cope was deeply offended by this accusation and eventually Cope's teacher Joseph Leidy gave the final verdict, proving both men wrong by simply moving the skull from one end of the spine to the other. Marsh claimed Cope never got over the humiliation of this event.

Cope however, maintained that the war started in 1872 when he accidentally hired Marsh's crew for an expedition. Marsh was infuriated by this and bribed his men to inform him of all proceedings.

The pair never resolved their rivalry and spent nearly 15 years bribing workers, academically slating each other and even hiring so-called 'dinosaur rustlers' to steal fossils. Both men were held back considerably by their greed. Marsh would treat his workforce badly and thus many of his people quit to work for Cope. In turn Cope would publish hastily written work in order to be first with a new fossil. Marsh seemed to enjoy publicly pointing out Cope's errors in these papers. But while Cope's mistakes were plentiful, it was Marsh whose sloppiness had the most impact – in 1883, Marsh introduced the popular *Brontosaurus* as a new species. It was only later, in 1903, that the discovery this was in fact an *Apatosaurus* with a mismatched skull came to light.

In 1897 Edward Cope died and the Bone Wars ended. By this point both men had completely bankrupted themselves. However, before the Bone Wars, only seven species of dinosaur were known. By the end, a full 142 species had been recorded. With 80 species to his name, Marsh had won the war.



"A SERIES OF INCIDENTS DEVELOPED INTO A FIGHT BETWEEN THE MOST VICIOUS FOSSIL HUNTERS IN AMERICA."

INTERVIEW: *Lewis Dartnell*

Jennifer Whyntie talks to astrobiologist *Lewis Dartnell* about what got him started, Conan the Bacterium, skywhales, and how he balances science outreach with his 'real work'...

HOW DID YOU GET INTO ASTROBIOLOGY – WHAT ATTRACTED YOU TO IT?

Erm...the fundamental answer is that I was just a big geek. I read lots of sci-fi as a kid and was always thinking about aliens and Starfleet. The science has matured. It's treated as a real science now, as a meaningful area of research. There's been some big breakthroughs that have opened people's eyes to this in terms of finding extreme forms of life on Earth, called extremophiles, and discovering planets orbiting other stars in the galaxy – there's clearly a lot of real estate in the galaxy now. So astrobiology has come in from the cold because we've made big discoveries that tell us about the possibilities of life beyond Earth.

YOU SAID THAT YOU'VE BEEN LOOKING AT THESE CREATURES ON EARTH CALLED 'EXTREMOPHILES' – WHAT'S THE COOLEST ORGANISM YOU'VE EXAMINED SO FAR?

I've directly been researching a bacterium called *Deinococcus radiodurans*, which is the most radiation-resistant organism on the planet. It's sometimes referred to as "Conan the Bacterium" because it can survive a whole lot of different extremes – it's a polyextremophile. It can survive being desiccated, and blasted with ultraviolet radiation, and zapped with ionising radiation like gamma rays. It's an altogether superhero of survival. And it forms these cute little bright pink colonies on agar.

SO ARE YOU CURRENTLY LIMITED BY THE FACT THAT WE HAVEN'T YET MANAGED TO GET MANY PROBES TO OTHER PLANETS?

Well, our nearest planet, Mars, we have explored in the past with probes. One of the other places in the solar system that we think has got a good shot of hosting life is Europa – one of the icy moons of Jupiter. What we really want to do is get a dedicated mission to Europa. Hopefully, in the not too distant future i.e. in my career we'll go to the next step, which is to land on its surface and try to drill through its ice into the ocean that we think is there – the alien ocean. But that's going to be a very difficult thing to do.

It's going to be expensive, and it's going to take time before we can get there.

"ALIEN OCEAN" IS THE BEST PHRASE I THINK I'VE HEARD YOU USE SO FAR! GOING BEYOND THE SOLAR SYSTEM, I'VE HEARD YOU TALK ABOUT SKYWHALES BEFORE. CAN YOU TELL ME A LITTLE BIT MORE ABOUT THEM?

One of the public outreach talks I do is called 'What would an alien look like?'. It's deliberately provocative in the title, but you can draw an awful lot of quite robust, firm conclusions about what alien life might look like. You can work from basic physical principles and engineering constraints. At the end of the day life is just evolving to solve a problem – it might find the same solution on different planets, as we found here. So the idea is that if you've got a more massive planet with a stronger gravity, paradoxically, it would actually be easier to fly, not more difficult, because although the weight would increase with the gravity, the density of the air around you would increase faster. So on a "super Earth" – an Earth-like rocky planet with more gravity, with more mass and a thicker atmosphere – you might find some very big things soaring in the clouds above your head, such as things the size of elephants, which would be skywhales.

YOU MENTION THAT YOU DISCUSS SKY-WHALES WHEN YOU DO OUTREACH. YOU'VE DONE LOTS OF SCIENCE COMMUNICATION. HOW DO YOU FIND BALANCING DOING YOUR SCI COMM AND YOUR RESEARCH?

Tricky. I mean, it's a problem of time management. I think you've got to be careful because a lot of the sci comm can be more enjoyable on a short-term basis. But you need to keep up your science. If you don't keep up your publication record, you don't get your next post-doc, your next fellowship position. You need to be very good at juggling between them. Often I find myself working on a Saturday or a Sunday to catch up from work in the week when I do a talk in a school, or working in the evenings. But if it's something you enjoy doing then it doesn't feel like a chore.

"ON A MASSIVE PLANET IT WOULD BE EASIER TO FLY BECAUSE THE AIR IS DENSE... YOU MIGHT FIND SOME VERY BIG THINGS SOARING ABOVE YOUR HEAD... THE SIZE OF ELEPHANTS, WHICH WOULD BE SKYWHALES"



Lewis is a research fellow at UCL's Institute of Origins, having done a PhD in astrobiology and the search for life on Mars. He is also a prolific figure in science outreach, writing for the Daily Telegraph, New Scientist, BBC Focus and the Sky At Night. He has just published his first book 'Life in the Universe: A Beginner's Guide'.

LANIER vs. ZUCKERBERG

Douglas Heaven reviews Jaron Lanier's *You Are Not A Gadget* (Penguin, 2010) and the BBC's documentary *Mark Zuckerberg: Inside Facebook* (December 2011).

In *You Are Not A Gadget*, Jaron Lanier – computer scientist, virtual-reality pioneer, and 'scholar-at-large' for Microsoft Research – describes the rapid rise in computing power and the exponential growth of the internet since his early programming days in the 1970s: "It's as if you kneel to plant a seed of a tree and it grows so fast that it swallows your whole village before you can even rise to your feet". Lanier is a technological visionary who witnessed the web explode from being the bespoke tool of a niche community, into the multi-purpose platform on which everybody does everything. But he believes that "the internet has gone sour".

"The early waves of web activity were remarkably energetic and had a personal quality. People created personal 'home-pages', and each of them was different, and often strange. The web had flavour". Part of the reason this has been lost is due to the commercialisation the web has seen: "Commercial interests promoted the widespread adoption of standardised designs like the blog, and these designs encouraged pseudonymity...instead of the proud extroversion that characterised the first wave of web culture".

Despite how that sounds, it is not a matter of nostalgia but of choice. Lanier's point is that there was an arbitrariness to the web's inception – Tim Berners-Lee, its inventor, was just one man working at CERN, looking for an easy way to share research materials. Currently, despite the impression that Web 2.0 is largely controlled and created by us, its users, the vast majority of its content is channelled through homogenisers like WordPress, Facebook, or Google.

Lanier wants us to be aware of lock-in. Superficial design decisions can stick around – most especially in complex and interdependent software systems, where layers are built on top of layers and choices, once made, become fossilised. This is a problem for the software industry in general, but on the web it underpins a new online society. Facebook alone has 800 million users (20 million of them in the UK) and at its peak recorded half a billion online at once – that's more than the population of the US and EU combined. Recently, Lanier appeared on BBC2's *Mark Zuckerberg: Inside Facebook*, where he spoke of the "flattening" effect of social network interfaces, where "everybody's just filling out a form". The choices made by Facebook's designers – 'relationship status', 'philosophy', 'music', 'movies', etc – became the way we express an identity: "If you want to know me, know my forms!"

"IT'S AS IF YOU KNEEL TO PLANT A SEED OF A TREE AND IT GROWS SO FAST THAT IT SWALLOWS YOUR WHOLE VILLAGE BEFORE YOU CAN EVEN RISE TO YOUR FEET"

Lanier's book is a manifesto for engineering, a salutary reminder not to miss out on a technology's full potential because of a

limiting design. “It takes only a tiny group of engineers to create technology that can shape the entire future of human experience with incredible speed”, he writes. “Therefore, crucial arguments about the human relationship with technology should take place between developers and users before such direct manipulations are designed”.

Is it too idealistic to assume this kind of dialogue could take place? At times it looks as if Facebook listens. Outcries over its tinkering with privacy settings, rights to uploaded photos after users had removed them, and innovations like Beacon, which alerted your friends to what you'd been buying online were all met with appeasing U-turns.

Of course, Facebook needs our trust to survive. We cannot forget this is a company with an estimated value of \$100 billion, despite Zuckerberg's way with faux-naive pronouncements: “If you go back, most people had no voice, no podium where they could share things. Now everybody does”, he says in an interview in the documentary.

Facebook's COO, Sheryl Sandberg, is a Google executive brought over to show Facebook how to make the most of its advertising opportunities. She pushes a similarly utopian line: “When you put technology behind the power of who we are as people, the world changes. That is the power of what we do”. Perhaps the most telling moment is when Elliot Schrage, Facebook's VP of Public Policy, pauses for a full 15 seconds – an age in TV time – during a quibble over whether Liking a brand is different to implicitly agreeing to advertise it, as in the Sponsored Story sidebar where the click of a button can make you the new face of Coca-Cola. “You're asking a profound ques-

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tion”, he finally manages. “What's advertising? On the Facebook system when I click a Like button I'm affirmatively communicating that I'm associating myself with whatever I'm Liking”.

Of course, Facebook is paid each time somebody clicks that button. Our online identity and behaviour are what it sells. “It's not that people don't care about privacy”, Zuckerberg says. “But people are seeing every day [sharing is] awesome and that's why the world is moving in that direction. Is 'awesome' enough?



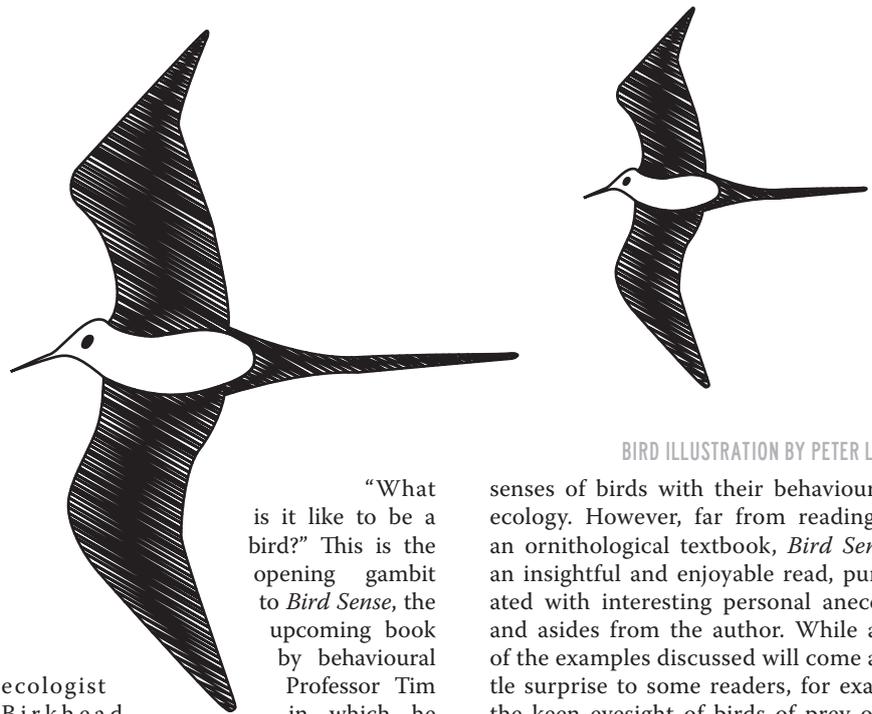
Jaron Lanier is an American computer scientist best known for his work on virtual reality. He lists Atari, Linden Lab (Second Life) and Microsoft among his previous employers. At Microsoft he was part of the team that developed the Kinect. In 2010, Lanier was nominated in the TIME 100 list of the most influential people.



Mark Zuckerberg is now infamous for his role in co-creating the social networking platform Facebook. He started the company with three of his classmates while they will still students at Harvard. Zuckerberg was named TIME magazine's Person of the Year in 2010 and is now estimated to be worth around £11 billion.

Bird-brained or a bird's-eye view?

Vanna Barber reviews *Bird Sense* by Tim Birkhead, a new book on the behavioural ecology of our avian friends



BIRD ILLUSTRATION BY PETER LARKIN

ecologist Birkhead, argues that, far from being bird-brained, our avian friends in fact possess an array of senses far beyond our own. “After decades of watching and studying birds I began to realise that there was much more going on in a bird’s brain than we give them credit for. Birds see better and differently from us; their sense of smell, touch and taste are much better than we have so far imagined,” explains Birkhead.

The inspiration behind *Bird Sense* sprung from a general feeling in behavioural ecology that in order to better understand evolutionary adaptations it is important to know more about how animals work: their physiology, their senses and what is going on in their heads. In *Bird Sense*, Birkhead artfully unites what is known about the

“What is it like to be a bird?” This is the opening gambit to *Bird Sense*, the upcoming book by behavioural

Professor Tim

in which he

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senses of birds with their behaviour and ecology. However, far from reading like an ornithological textbook, *Bird Sense* is an insightful and enjoyable read, punctuated with interesting personal anecdotes and asides from the author. While a few of the examples discussed will come as little surprise to some readers, for example the keen eyesight of birds-of-prey or the magnetic sense of migratory species, Birkhead also includes real revelations about the amazing senses bird species possess which we do not. These include the Oil-bird from Ecuador, which uses echolocation to navigate at night, and the unknown mechanism by which Flamingos in Etosha Pan National Park in Namibia can sense the arrival of rain 500km away.

By the end you are certainly left with a greater appreciation for birds and their senses, and perhaps even glean from it a ‘bird’s-eye view’ of the world around you. Moreover, with research into sensory studies still in their infancy, it leaves you contemplating how much there still remains to be discovered.

Bird Sense is out 2nd February 2012

DOCUMENTARY THROUGH PHOTOGRAPHY

PENELOPE HILL

Five rooms, five photographers. Unique projects connected by one idea: new documentary forms. Each artist uses photographs for a subjective retelling of events or ideas.

Mitch Epstein's photographs look at the relationship between the American population and their landscape. To him, the natural link between these two is power production; in his own words, "energy is the 'lynchpin' to the American way of life". These photographs show the juxtaposition between man and environment, much like Urban Wildlife in Veolia Environnement Wildlife Photographer of the Year. What makes Epstein's images particularly effective is their setting in the Tate Modern, itself a former power station.

Boris Mikhailov chronicles the post-Soviet era in the Ukraine through a collage of photographs spread across a wall. These images capture and display the everyday lives of ordinary people. Mikhailov connects these independent photos using red, connoting Sovietism, thus creating a cohesive canvas. A second set of photographs, entitled "At dusk", use a blue motif to show a slightly darker side of the Ukraine, in direct contrast with the more light hearted photographs infused with red.

Arkham Zaatari features a range of images from the work of photographer Hashem el Madani in Lebanon, to demonstrate the use of both studio and posed photography. Zaatari chose to feature many of the images that were staged by Madani in a studio in order to comment on recent Lebanese history and challenge traditional gender roles.

The other photographers featured are Luc Delahaye and Guy Tillin, who document political events – Delahaye shows us events in Iraq and Afghanistan, and Tillin depicts the recent 2006 democratic elections in the Congo. Much like Mikhailov and Zaatari, the collections are highly selective and subjective, whilst simultaneously giving insight into the lives of those depicted.

Photography: New Documentary Forms runs until 31st March 2012 at the Tate Modern

WILDLIFE PHOTOGRAPHY OF THE YEAR EXHIBITION

JULIA ROBINSON

Photography that not only wins prizes, but hearts too.

In recent years I've heard much about the prestigious Wildlife Photographer of the Year but only this autumn, with the exhibition on its 47th run, did I get to experience it for myself.

As soon as you step into the gallery you are swept away from the hustle and bustle of the main museum; every detail has been thought about, from the soft carpet underfoot, the dimmed lighting, to the large, beautifully-backlit screens projecting the photographs; all of your senses are focused on the images and the effect is stunning.

The winner of the competition this year was Daniel Beltra for his 'Still Life in Oil' which shows eight brown pelicans huddled together following their rescue from the BP oil leak, off the Gulf of Mexico. The image is shockingly sad, showing crude oil caked to the birds' feathers, but it represents such an important environmental message to the

viewer that it is clear why the judges chose it.

Every image in the exhibition has its own story, whether a tale of the wildlife itself, or how the picture came to be taken – one photographer describes his close encounter with a polar bear while capturing a breathtaking underwater image. It is obvious why the exhibition is consistently so popular; the incredible standard of the images can hold you captivated on one photograph for several minutes, each one conjuring up a whole host of emotions.

In the same way that Attenborough continues to fascinate audiences, the photography awards present wildlife at its best, in an unassuming and natural way that suits every audience. As a result I would recommend it to anyone – just make sure you arrive as early as possible because for me, two hours simply wasn't long enough.

Cyril Ruoso/Natural History Museum



The Wildlife Photographer of the Year exhibition runs until 11th March 2012 at the Natural History Museum.

AMAZON: *Somerset House*

EMMA HOUGHTON-BROWN

Nestled in the east wing of Somerset House, this collection of images by Sebastião Salgado and Per-Anders Pettersson is a stunning illustration of the Amazon rainforest and its inhabitants. In aid of Sky Rainforest Rescue, a collaboration of Sky and WWF, the exhibition aims to raise awareness of the region's demise due to deforestation.

On entering the gallery I was hit with a shocking statistic: Every minute, an area of the Amazon rainforest the size of three football pitches is lost. "Wow" I thought, "There can't be much left..."

But the intensely powerful work of Salgado proves that there is; and it's imperative that we save it. Displayed in black and white, his images not only communicate the breathtaking beauty of the region, but also give an insight into the lives of the Alto Xingu and Zo'é indigenous tribes, who clearly live as one with the forest. Hauntingly, through the beauty of the images, cuts the fearful sorrow of the indigenous people, acutely aware of the destruction of their home.

Moving through the exhibition, Per-Anders Pettersson's work lifts the mood with colourful, optimistic images. A documentation of a recent trip to Acre with actress Gemma Arterton, his work focusses on deforestation and the local people who are benefiting from Sky Rainforest Rescue. Because much deforestation is due to slash-and-burn farming, these images stress the importance of working with locals for conservation. Mostly touching personal accounts of the lives of the local people, I found only a few to be slightly over-promotional/commercialised.

The magnificence of the Amazonian region in these pieces is arresting. Simultaneously unnerving and heartening the exhibition makes apparent the incomprehensible speed of deforestation and what this threatens. It's also serving as an educational tool for school children, and indeed, a group were shown around when I visited. Raising awareness is imperative. The Amazon is a region which plays a vital role in our global ecosystem but is one which can seem so far removed from our daily lives. Hopefully, enough awareness can be raised through projects such as this, to prevent these images from becoming merely records of an extinct world.

2011: *A PHOTOGRAPHIC ODYSSEY*

HARRIET JARLETT



A truly star-studded event, the Astronomy Photographer of the Year exhibition is spectacular. Held at the Royal Observatory in Greenwich, the history and grandeur of the venue appear banal in comparison to the sights displayed inside. Once you tear yourself away from playing with the telescopes and enter into the dim gallery, it feels like you've taken a Space Shuttle ride into infinity...and beyond.

Ok, maybe not – the photos are quite small, cramped and there's not enough space for groups to read the captions. However, once you forget about these flaws and focus on the pictures themselves you are truly transported to another world. This year's winner, the first Brit to hold the accolade, is Damian Peach with his amazingly detailed composite image of Jupiter and its moons. He managed to capture Io and Ganymede separately but joined them into the same shot, showcasing just one of the ways this exhibition extols on the power of photography to capture images we could never imagine seeing with the naked eye.

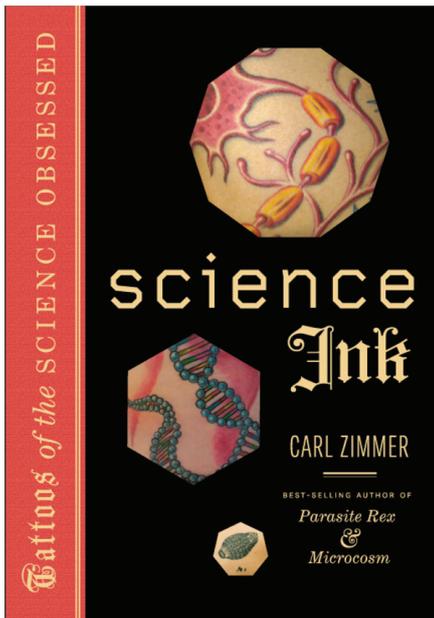
The most staggering concept behind these images was the incredible patience and timing all of the photographers showed, in particular the fleeting second in which Dani Caxete captured the International Space Station crossing in front of the sun, and the wispy debris of a supernovae, which are so clear they could be being seen through glass. This exhibition gives the impression that these photographers have a special knowledge about the universe and is inviting us a glimpse into their out-of-this-world vistas. The exhibition runs until February 2012, and for any other aspiring astronauts is one step closer to seeing these sights for yourself.

Astronomy Photography of the Year runs until 12th February 2012 at the Royal Observatory in Greenwich

If you can think it, you can ink it

Tse Ling reviews *Science Ink: Tattoos of the Science Obsessed* by Carl Zimmer

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Picture a member of NASA's Goddard Space Flight Centre, with an abstract image of the Cigar Galaxy stretching from one dimple of Venus to the other, rendered on her back.

Or a postgraduate chemist with coeliac disease, with a ball-and-stick model of gluten, the pesky peptide that ignites her immune system, permanently etched down her thigh.

If you can think it, you can ink it, and these girls have done both, as have the 228 other contributors who proudly show off their creations in Carl Zimmer's collection of science-related tattoos, solicited through popular blog-site The Loom.

As if the idea of how geeks – I say that fondly – choose to get their ink on isn't enough of a clue, *Science Ink's* cool credentials are cemented with a foreword by the hilarious (and bizarre) Mary Roach, best-selling author of *Bonk: The Curious Coupling of Science and Sex*, *Stiff: The Curious Life of Human Cadavers*, and, most recently, *Packing for Mars: The Curious Science of Life in the Void*.

Her ideal tattoo? Figure 1 from a European urology paper entitled Effects of Different Textiles on Sexual Activity: an image of "the underpants worn by the rat".

The lack of underpant-wearing rodents notwithstanding, *Science Ink* has plenty to offer the curious: molecular structures of buckminsterfullerene and diazepam; Dirac's equation and the Mandelbrot Set; a giant sperm-dwelling homunculus weaving in and out of an arm; electrophoresed DNA fragments suspended and fluorescent in an agar slab; a patent diagram of a Tesla motor; jagged seismo-, electrocardio- and Seposki-graph traces (perhaps the barbed wire equivalent of the science world). All beautiful, accurate and skin-deep.

The motley collection somewhat reflects Zimmer's unintentional role as a random "curator of tattoos" and "scholar of science

ink", which took root around four years ago when a DNA double helix tattoo on a friend's arm revealed itself at a pool party. The friend happened to be a neurobiologist from Harvard, the codons he sported in the DNA strand spelling out his wife's initials in, as Zimmer puts it, a "true expression of geek love".

Intrigued by the idea of science and stories colliding on skin, Zimmer reached out across the web in search of other science ink and soon began receiving images from around the world.

Most came from scientists, some from science-lovers. Schrodinger's Cat, for example, appears on the forearm of an actor as a square containing two line drawings of cats – one supine, the other standing – superimposed over each other. It's amusing, he says, to explain "no, it's not two cats fornicating, it's one superpositioned cat".

While their forms place these tattoos beyond your average pigments of imagination, the stories that accompany them speak of the usual rites of passage, totemism, and tribal identity that accompany the inking ritual (with the exception of one crib-sheet on squid anatomy, tattooed onto a foot for easy reference). For example, a pair of siphonophores, relatives of the poisonous Portuguese Man-o-war, tattooed to commemorate the wedding of two zoologists. Or a tadpole hovering above one hairy (relax, male) nipple as a reminder of genetic versus epigenetic destiny as revealed by metamorphosis. Or the range of endangered flora and fauna immortalised on participants' skin at Extinked, a three-day tattoo marathon held in celebration of (strictly speaking, what would have been) Darwin's 200th birthday.

In short, they speak of the universal *raisons d'être* that motivate all immortalisations in ink, uniquely coded in the semiotic languages of various tribes of scientists, and offering us a glimpse into their worlds through an entirely novel medium.

WHEN THE FAMILIAR VANISHES

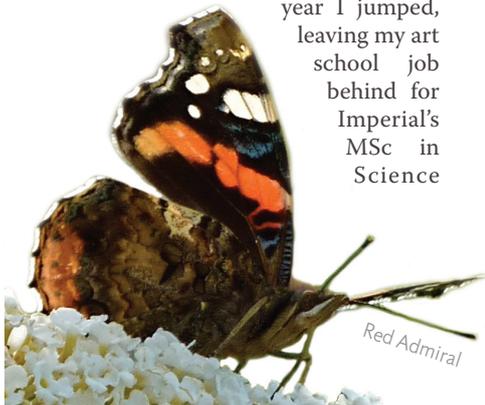
Are we in a post-butterfly era? *Kevin Edge* explores the role amateur contributions could play in saving the British butterfly population.

Mid-winter, many like to recall warm summer days when meadow, wood and cliff walks are alive with countless flowers, bees and butterflies. Yet, is the abundant wildlife inhabiting our daydreams exaggerated; warped by the warmth of childhood, or memories of holidays in hotter latitudes? The reality of UK butterfly numbers presents a different picture; population declines in the UK's 59 butterfly species are now of major concern. It is time to wake up and act before the only butterflies left are those in our mind's eye.

Could a lay butterfly enthusiast like me from a non-science background help? Could I leave the familiarity of a lecturing career to do more than renew charity subscriptions or count Large Whites circling the cabbages? This article is about a personal leap of faith into a world of science and vanishing beauty.

My jump from the arts did entail preliminary steps. I had contemplated the compulsive pleasures of butterflies when walking in Dorset, away from the grind of my PhD. There, in the field, the immediacy of electric blue 'shocks' – diffracted light from the wings of Adonis Blues (*Lysandra bellargus*) – became addictive as these butterflies followed their grassy beats.

I became an eco-tourist too, helping experts confirm the presence of four large blue butterfly species in Hungary's Órség National Park. Last year I jumped, leaving my art school job behind for Imperial's MSc in Science



Red Admiral

Communication. Here, as a student and lay enthusiast in a culture of science, I intend to prepare for a life in communication of ecology.

At a 2008 butterfly survival zones event, Butterfly Conservation President and wildlife broadcaster David Attenborough warned that "scientists fear that in some areas we're entering a post-butterfly era." Extreme perhaps, but when did you last see more than an odd butterfly or two crossing your path? Yes, annual populations fluctuate due to weather and species hotspots exist, but three decades of detailed UK transect records present a bleak reality of long-term population falls. According to the national Big Butterfly Count, last year many UK species numbers were down on 2010 – including a 29% drop for Large Whites, and a drastic 61% for the Common Blue.

Science writer James Hamilton-Paterson observes that "*Homo* is an aesthetic animal" that feels "diminution when the familiar vanishes." He adds that "each generation adapts to an impoverished world, but for the first time people are conscious of having to make do with remains."

Entomology has a distinguished history of amateur contributions. Is this still true today? Can there be co-operation between enthusiastic professional entomologists, habitat managers and enthusiastic amateurs?

Involvement of passionate amateurs in some capacity remains necessary. Lay hands and keen eyes in the field can supplement research in labs, conferences and journals. Precedent for mass amateur participation, or 'citizen science' experimentation, has already been set. Last year, the Big Butterfly Count involved a record 34,000 volunteers who logged 322,000 butterflies and day-flying moths. Implementation of 20 UK landscape-scale butterfly zones will no doubt need a specialist-enthusiast axis to monitor,



Adonis Blue



Large White

restore habitat and encourage ecological literacy across regional communities.

Butterflies are now more than beautiful phenomena. They are also official UK biodiversity indicators for the government, alongside birds. While there is still plenty to enjoy, there is a great deal to do. Work need not be confined to helping charismatic butterflies. Appreciation and study of insects can extend to dragonflies or getting more 'beastly': working with invertebrate conservationists Buglife. June 25 2012 marks the start of National Insect Week, so why not go to nationalinsectweek.co.uk and get involved?

PHOTOGRAPHS BY KEVIN EDGE & KATIE COOMBS

I, SCIENCE ON THE WEB

www.isciencemag.co.uk

TOP POSTS THIS MONTH



EDIBLE CERN

This post contains a nice little stop-motion animation made by a group of Science Communication students at Imperial. With the help of a few sweets the video explains how the Large Hadron Collider works at CERN.



BUG BUGGY

You might have seen this image doing the rounds online. It's the newly discovered giant weta – the largest insect to be found so far, weighing in at around 70g. They seem to have a certain taste for carrots.



V&A MUSEUM: THE POWER OF MAKING

One of our new bloggers, 5pm Girl (A.K.A. Helen Wilkes), popped along to review The Power of Making exhibition at the V&A. Make sure to follow the *I, Science* website to keep up with all the latest science events.

SCIENCE BEHIND THE PHOTO



On the *I, Science* website we regularly feature photographs with a scientific story behind them. We've now set up a Flickr group so you can upload your own contributions. We'll pick out the best of the submissions to feature online and, if we're really impressed, we may even ask to feature your work in the magazine. Just remember to leave a description of the science behind your photo!



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