Subtext 7

Autumn 2008

The bone collector
Bristol Dinosaur: some assembly required

The volcano lover
Toxic tales from Hawaii

Relative merits
Two siblings. No rivalry. But plenty of arguing

Science and sussability
No Einstein wigs please, we're physicists

University of BRISTOL

Subtext 7

THE ART OF MATHS

Dr Hinke Osinga, Reader in Mathematics, has had a long association with the Lorenz manifold, one of the most famous objects in chaos theory. She talks to Hilary Brown about how she started with a mathematical equation and ended up with a work of art – via a crocheted prototype.

A winding ribbon of stainless steel stands in a north Bristol living room. It rotates upwards into a helix and scrolls outwards, clockwise and anti-clockwise, to form curving folds that never intersect; it almost seems to move. Shafts of light bounce off the polished surface; the converse, burnished face casts shadows on the wall. It's both chaotic and orderly; complicated in its conception, deceptively simple in its execution.

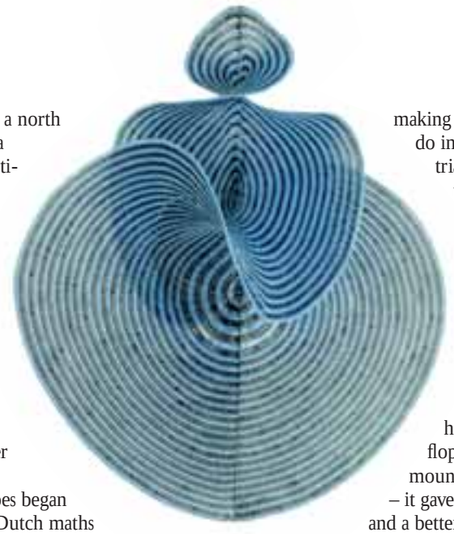
To Hinke Osinga, it's not only a work of art, but also the product of a ten-year research collaboration to visualise the complicated surface that emerges from the Lorenz equations describing chaotic weather patterns (see panel, p6).

Osinga's fascination with geometric shapes began when she was at secondary school and the Dutch maths curriculum changed. 'It was all algebra until someone decided that us kids didn't know how to draw graphs any more,' she says. New geometry texts appeared, but without the answer booklets, and Osinga found herself helping her father – who was the maths teacher – to work out the answers at home. 'You had to solve problems in a graphical way, by drawing objects in 3D rather than writing up equations. I loved that stuff.'

Her PhD at the University of Groningen in the Netherlands focused on the development of computational methods and visualisation of mathematical objects using computer graphics. A job at the former Geometry Center in Minneapolis followed, where she worked on extending these techniques to such complicated surfaces as the Lorenz manifold. 'The Lorenz manifold is an important surface in dynamical systems theory,' explains Osinga, 'but most people think of it as an abstract object. They know it has certain properties, but they don't know what it looks like.'

The work continued when she came to Bristol in collaboration with her partner Professor Bernd Krauskopf, also in the Department of Engineering Mathematics. 'Computing the Lorenz manifold became a sort of holy grail in the field. Bernd and I had our own ideas about how the surface could grow outwards from a central point.' By the time they had developed their version and published both a theoretical and a numerical analysis of their findings, it seemed that they had exhausted the subject. Until the crochet, that is.

It all started with some innocent hexagonal lace motifs. 'I had a book on the history of Irish lace, and wanted to have a go at crocheting these beautiful shapes,' says Osinga. 'Bernd thought I was wasting my time. "It's one thing making your own socks," he said – which I used to do in the days when my handicraft teacher mother trialled her lessons on me and my sisters – "but this? Why don't you make something useful?"'



'It's one thing making your own socks, but what about something more useful?'

It was a Eureka moment, if ever there was one: 'As soon as he said it, we just looked at each other. We were thinking the same thing – why not crochet the Lorenz manifold?'

The pair realised that their computations had naturally generated crochet instructions. Eighty-five hours and 25,511 stitches later, Osinga had crocheted her own model of chaos. 'It was like a big floppy tablecloth until we got it into shape by mounting it with steel wire,' she says. 'It was amazing – it gave us a sense of the shape of the Lorenz manifold and a better understanding of the Lorenz equations themselves.' They published another paper and presented it at a dynamical systems conference. Then all hell broke loose.

'I wasn't prepared for the huge media interest it generated,' says Osinga. 'It wasn't just the science that people were interested in; it was as if I had suddenly made myself more of a "normal" human being. I'd spent my life wanting to be treated as a mathematician, and here I was, the woman who crocheted – it was such a cliché.' All the more ironic for someone who, as one of only 14 women to 100 men in the first year of her undergraduate degree in maths, had hidden her handicraft talents from her fellow undergraduates for this very reason.

Dealing with the media had its challenges. The worst moment was seeing the edited version of an interview she and Krauskopf gave for regional TV news. 'It showed the learned professor, Bernd, talking about the maths behind the manifold, but whenever a particular crochet stitch was mentioned, the camera cut to me,' she said. But they learnt quickly, and it was all good experience for the many interviews that followed, including a live broadcast on *Channel 4 News*. Determined to be the one to explain the maths, Osinga started talking, and even the presenter – the famously voluble Jon Snow – couldn't stop her. 'He eventually directed a question solely at Bernd so that at least he would get to say something before the interview ended,' remembers Osinga. But it worked. The following day colleagues were commenting not on her crochet skills but on how well she'd come across.

There is no denying the benefits of the publicity generated by the crocheted manifold, including contact with the public (see panel, p6) – a new departure for a hardened researcher like Osinga – and outreach activities,

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such as the Popular Lectures organised by the London Mathematical Society. 'It also opened my eyes to a completely different side of applied mathematics – mathematics and the arts,' says Osinga.

The partnership between maths and craft isn't new: repetitive patterns seen in ancient baskets and weaving first hinted at a mathematical subtext to the world, and university maths departments the world over harbour gypsum models dating back a century or more that were used in geometry classes. Even the mathematician Alan Turing, famous for his code-breaking work during the Second World War, was often seen knitting Möbius strips and other geometric shapes.

The annual Bridges Conference is a showcase for the mathematical connections in art, music and science, a combination that is revealing relationships between mathematical subjects and their artistic/aesthetic presentations. 'This is hard-core maths, which combines structural and theoretical knowledge,' says Osinga. 'I have a new respect for colleagues who work in this field.'

It was at Bridges 2006 that artist Benjamin Storch was first inspired to create the steel manifold eventually commissioned by Osinga and Krauskopf. Storch's work originates from a desire to create dynamic surfaces in metal, and the couple had already been captivated by another of his sculptures, a copper Möbius strip, which also adorns their living room. The complex metal-smithing technique Storch employs, in which central surface areas are compressed and peripheral areas stretched, was perfectly suited for creating the sculpture *Manifold*.

'The band of steel corresponds to a part of the Lorenz manifold that is the equivalent of about ten rounds of crochet further outward from the crocheted version – several colleagues have mistaken the photograph on my office door for a computer-generated image,' says Osinga. 'It's real proof of how a tangible, 3D object can add to the mathematical understanding of a geometric shape.'

It's also a beautiful piece of art. Long may it inspire future generations of artists and mathematicians alike.

THE SCIENCE BEHIND THE LORENZ MANIFOLD

The Lorenz equations are the classic example used to illustrate the unpredictability of systems such as the weather. In the 1960s, American meteorologist Edward Lorenz showed with these equations that small changes in initial conditions can have a big effect on the long-term behaviour of the system. This is now called the butterfly effect, which refers to the famous conclusion that the flutter of a butterfly's wings in Brazil can cause a tornado in Texas.

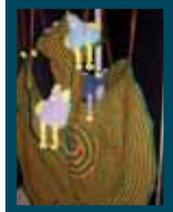
In order to visualise the butterfly effect in the Lorenz equations, Osinga makes the analogy with leaves dropped upstream of a rock in a turbulent river. It's difficult to predict where the leaves will flow in relation to the rock. You would need to drop a lot of leaves and document which one goes where. A more elegant way is to try to document the leaves that end up clinging to the rock rather than passing to the left or right of it – leaves on either side of these special ones predictably go to one side of the rock or the other.

The development of techniques for selecting precisely those special solutions from the equations is the basis of Osinga's research. For the Lorenz equations all initial conditions (the leaves) that take a path to the origin (the rock) form a smooth surface, called the Lorenz manifold. The butterfly effect implies that this surface must have very complex geometry.

THE CROCHET COMPETITION

Osinga and Krauskopf published the crochet instructions along with their paper on the Lorenz manifold, and offered a bottle of champagne for the first person to complete their own version. The response was such that they ended up with three joint winners … and a few surprises.

The winners



Craig Lazarski: maths teacher from North Carolina with a sideline in crocheted stuffed chickens (www.stuffedchickens.com). He deemed it a travesty to mount his Lorenz manifold using steel wire, and instead draped it over a wooden frame decorated with some of his best fowl.

Leslie Carver: housewife from Texas. 'Leslie was one of the many non-mathematicians to read the paper along with the crochet instructions and to come up with some quite complicated questions about the maths behind it,' says Osinga. 'We really didn't expect to have those kinds of conversations with members of the public. We even had one 82-year-old Dutch grandmother grappling with her own version of what the Lorenz manifold was all about on her local TV station – in my home province in the Netherlands.'

Carolyn Yackel: mathematician at Mercer University in Georgia and co-organiser of the American Mathematical Society Special Session on Mathematics and Mathematics Education in Fiber Arts. As well as knitting, Yackel uses Japanese string balls called temari as the basis for creating physical representations of complex geometry. Temari balls are decorative items made from coloured string wrapped around a small wooden or plastic sphere.

Special mention goes to Scott Senate from Syracuse, New York, whose bag containing his half-completed crocheted manifold, yarn, hooks and instructions 'may have been picked up by someone by mistake'. He hopes it will somehow make its way back to him.

For more information on the crocheted manifolds, see www.enm.bris.ac.uk/staff/hinke/crochet

ANIMAL PRAGMATISM

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In a small, rural community of animals and humans at the foot of the Mendips, a quiet revolution is under way. No, this isn't a sinister Orwellian fable. It's a tale of the marketplace and the changing complexion of veterinary practice – and of a woman in a hurry. Nick Riddle catches up with Lynne Hill, CEO of a new University venture.

'Do people at Bristol think much about Langford – or even know where it is?,' Lynne Hill muses. 'It'd be great to do a survey of University staff and find out.'

The Langford House estate, 15 miles southwest of Bristol, is the home of the Department of Clinical Veterinary Science. For over 50 years, Langford has been the base for the clinical side of vet students' training, and for a full programme of research into animal welfare and other topics.

From its beginnings as a field station in 1951, Langford has developed into a community of some 90 academics, 100 administrative staff and over 30 honorary staff and visitors. And its growth is continuing – a fact not unconnected with Hill's arrival early in 2008. She's a qualified vet with years of clinical practice, but it was her business experience that got her the new post.

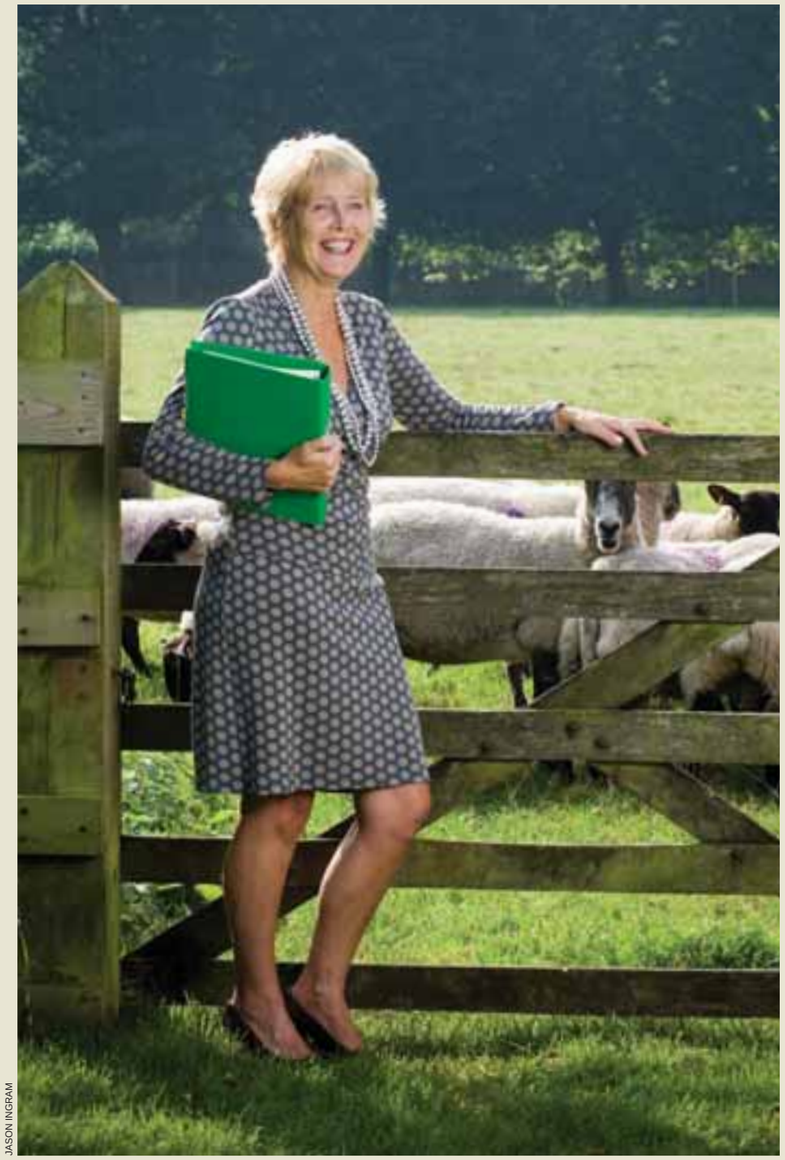
For a while now, there have been plans to turn the clinical services offered at Langford into a proper commercial enterprise. The current range of facilities is impressive: there's a small animal hospital and practice, the Equine Centre (another hospital and practice), a farm animal practice, and several diagnostic and clinical laboratories. Clients come in a steady stream, either as referrals or for a first opinion.

'The Department has been delivering excellent teaching and clinical experience for the students in farm animal, equine and small animal practice,' says Hill. 'But the veterinary profession has changed a lot. The marketplace is more aggressive; larger corporations are buying smaller practices and investing in better facilities. And Langford isn't in the best position to compete with that, because its priority as a university department has always been to teach students rather than try to get more business.'

'One of the aspects of change management is convincing people that change is needed.'

Langford's competitors aren't other vet schools; they're the local practices, which are competing for staff as well as for clients. 'There's more demand for qualified vets in private practice than there was 15 years ago,' says Hill. 'Private practices are now better equipped, and they can offer higher salaries because their clinical staff spend all their time on money-earning cases, with no teaching component.' Not that it's *all* about money, but staff often have young families, mortgages and student loans. The objectives for Langford's clinical services, says Hill, are now clear: 'Get competitive.'

The process began some years ago, when Pro Vice-Chancellor Professor Avril Waterman-Pearson and members of Research and Enterprise Development looked at how Bristol should respond to the changes in the profession. Should the University get into bed with venture capitalists, for instance? 'They decided that Bristol's philosophy would be best suited by starting up a subsidiary of the University,' says Hill. Hence the imminent launch of Langford Veterinary Services (LVS).



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Her own experience has seen her cross between veterinary practice and business. 'As a vet I did voluntary work for the British Small Animal Veterinary Association, then I became its first woman president. I looked at its business side and made it into a registered charity. And I thought, "I really enjoy this". I'd been doing the general veterinary stuff for a long time, and it had become pretty routine.' So when Hills Pet Nutrition offered her a management job in its marketing department, she went for it.

She followed that with a stint as director/manager of the hospitals and laboratories at the Royal Veterinary College. She hasn't worked as a vet since 1995. 'I don't miss it at all now, although I used to miss lambings in the spring,' she says. 'Our practice served a lot of farmers with pedigree flocks. But I've stayed in the veterinary world – I can still get a bit of it by walking into the wards here without actually doing the hands-on work.'

So when she rolls up her sleeves as CEO of LVS, what does she get her hands dirty with? 'Figures, legal language, contracts,' she says. 'We have to move a lot of staff across from the University into this new subsidiary – nurses, reception staff, administrators. We need to separate out the budgets, establish guidelines on the terms and conditions of every post, iron things out with the unions…' It sounds fiddly. 'Yes it is. And people have a lot of questions. So we're trying to make sure that we let them know what's happening.'

With change on this scale, that last detail is a crucial one; the animals coming in for treatment may be oblivious to such things, but the humans who staff the place are another matter. 'One of the aspects of change management is convincing people that change is needed,' says Hill. 'But I think people have reached the point where they just want the change to happen.'

The quality of clinical training that students get at Langford isn't in question. 'They get a lot of contact time,' says Hill, 'and they graduate with a real loyalty to the place. Academic staff will stay within the University so that we can safeguard the quality of their teaching and research. But the profession is changing, so we have to change what we offer our students.' Such as fresh perspectives? 'Absolutely. It may be great the way we do it here, but there may be other ways of doing some things.'

Hill's notion of 'other ways' was broadened when she did her MBA in 2000 at London Business School. 'We had 37 different nationalities on the course: one guy was in the middle of negotiating a pipeline through Iran, another bought metals for the Chinese Government. There were venture capitalists, a photographer, a theatre manager. It was really helpful to look at different business models.'

Some of those different models have already found their way into higher education and have made their presence felt. 'Academics have to be more accountable now,' says Hill. 'They've got to be able to bring in grants and to show that they're worth having.'

Such talk can still ruffle feathers in academia, and it often falls to the managers to negotiate a path through controversial new territory. 'Administrators in universities are definitely undervalued,' Hill agrees. 'The same goes for support staff in general. Clinicians may bring in a lot of the income at Langford, but they can't do their job without the nurses. If nobody answers the phone, people won't come to us.'

Fortunately, people *do* come to Langford. Hill's job is to maintain this popularity, while reinventing LVS as 'a viable business that can reinvest in itself in order to develop and expand'. A new hospital, surgery and diagnostic imaging centre are currently being built, with facilities including an MRI scanner and a CT scanner. 'That's going to change the face of Langford,' she says. 'I think that LVS will become *the* referral centre for the South West.'

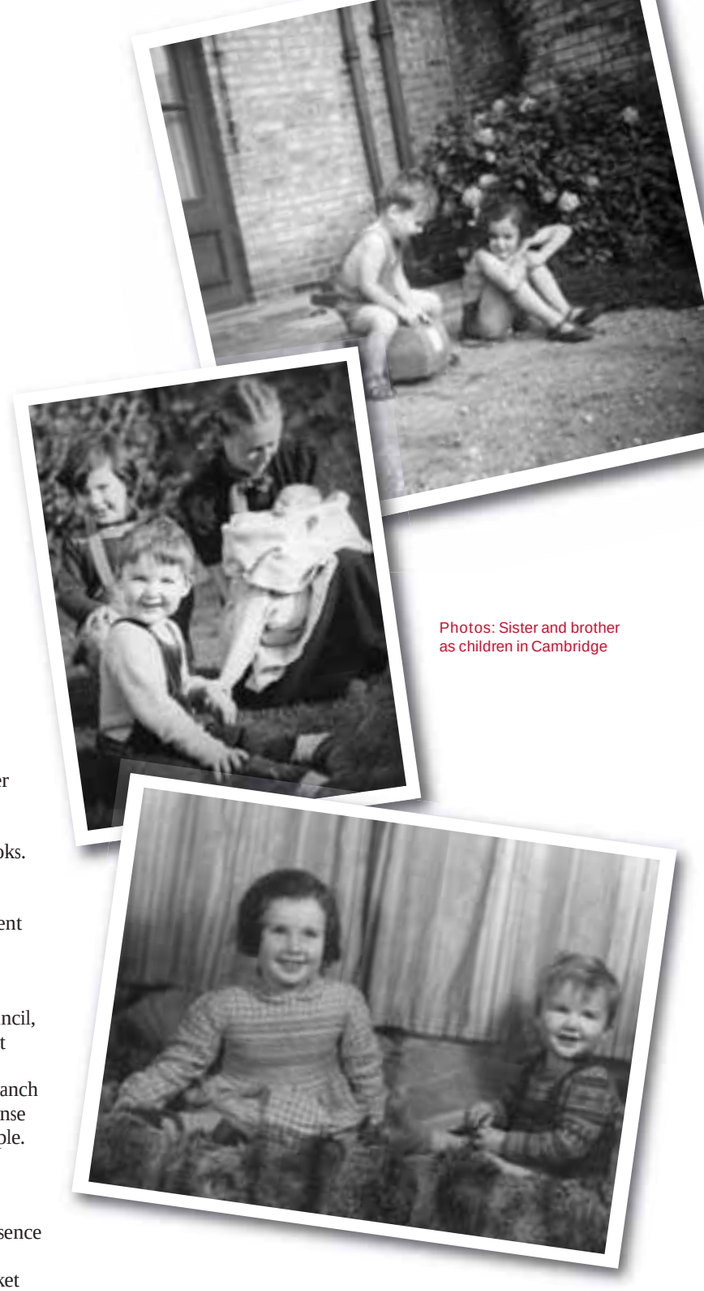
LVS is due to launch this winter. Customers will notice some rebranding, 'because we have to be visibly, legally at arm's length from the University'. And a lot of other institutions will be taking a keen interest.

'No other UK university has put all of its facilities into a subsidiary company like this. There are all sorts of nuances: how is the interface between the academics and this new company going to work? What sort of payment scales will we use? What about profit sharing and bonus schemes?'

It's clear that LVS will hit the ground at a gallop, and equally clear that that's how Hill likes it. 'I like to get things moving,' she says. 'I'm always in a hurry. Which is why I have broken toes at the moment; I fell down the stairs running to answer a phone…'

RELATIVE MERITS

Professor Harriet Bradley is a sociologist and former Dean of the Faculty of Social Sciences. Professor Charles Martindale is a classicist and will become Dean of the Faculty of Arts in August 2009. Professors Bradley and Martindale are also sister and brother. They talk to Nick Riddle about family, the sixties and arguing.



Photos: Sister and brother as children in Cambridge

Ab initio

HB: We grew up in Cambridge; our grandfather was a don at Cambridge University.
CM: He taught history until he was in his eighties. He was rather a Victorian figure.
HB: He wore wing collars…
CM: …till the end of his life. He had something like 30,000 books.
HB: Our parents were Cambridge graduates, but not academics. It skipped a generation – we must have inherited some terrible gene, because our sister Joanna is married to a professor of Ancient History at Oxford.
CM: Our father got a first-class Law degree and was going to become a lawyer, but he couldn't afford the training.
HB: He worked for an organisation called the Community Council, which was a charitable organisation, run by Rowntree, that dealt with rural life, village halls, that sort of thing. Later on it was integrated into the Civil Service. He ran the Cambridgeshire branch and he was a big local figure. We both inherited a very strong sense of public service and trying to make things work better for people.
CM: Critics might call it 'telling other people what to do'…

Childhood

CM: We were a close family. Our mother was the dominant presence in the household. Harriet was the most rebellious.
HB: I was a very bookish child. I would read the cornflakes packet if there was nothing else. Books, music and art were part of our household – they were what life was about.
CM: I wasn't a particular reader when I was a child, but our mother read all the time and we went to the theatre, films, concerts and the opera.
HB: Charles and I used to run around the streets and have a kind of fantasy life. Charles played with soldiers and I was into romantic storytelling and things. When I went to secondary school I got more involved in teenage culture than Charles did.

School and university

HB: I was a bit of a swot, always top of the class at school. But I didn't get on with the teachers. They thought I didn't do any work. I worked like hell, but I did it at home, and I tended to fool around at school. They got the wrong impression of me.
CM: I wasn't a very good pupil to begin with. But I discovered I could do certain things, like Latin, so I focused on them. It wasn't some sort of grand revelation, I was just good at it and other people weren't. I liked the nuts and bolts of the language. I kept trying to get out of classics, actually. I thought about doing modern languages and art history and various other things, but I couldn't escape! That's probably why my own approach to classics is so broad, and so concerned with the influence of classics in other areas.
HB: I decided that since reading novels was my greatest pleasure in life I'd do a degree in English. I came to Bristol and loved it, but I didn't get a good enough result to go into research. So I became a schoolteacher instead, teaching English and drama. I did enjoy it – I tried to make it more interesting than the 'traditional' education I'd been subjected to.
CM: I got my first job at Sussex University, although I was told that if I went there my career would be finished. It didn't have a Classics department; we taught broad courses, called 'contextuals'. There was one called 'The Western Tradition', which covered Homer, Virgil, Dante and the Bible. Sussex was a really exciting intellectual environment – everybody talked to everybody else. I learnt a lot and changed radically. But it didn't advance my career as a classicist. When I moved to Bristol, I suddenly became controversial because of the trendy, modern ways I'd picked up at Sussex. Now I'm a grand old man and totally respectable, but back then, several academics said that I was 'destroying classics'.

O tempora, o mores

CM: Our mother told us that in her day at Newnham College, if she had a male guest in her room, she had to push the bed out into the corridor. When I first went to Oxford, colleges were still locked at ten o'clock and women weren't allowed in after nine.
HB: Everything was very formalised at Bristol, too. At Clifton Hill House we weren't allowed male visitors except on Wednesdays and Saturdays when they could come for tea in the common room.
CM: But that sort of thing was swept away very quickly, even in bastions of conservatism like Oxford and Cambridge. My college, Wadham, was one of the first to start liberalising and removing gate rules, and stop people having to wear gowns on all occasions.

The sixties

HB: I loved the sixties. I was a protesting hippie student. It was very liberating for me; in those days you did what your teachers and parents told you to do. I became a bit of a radical outlier in the family during the sixties.
CM: I wasn't particularly political, but I thought of myself as Labour. Radicalism wasn't very strong at Oxford – there was one famous episode of 'the storming of the Indian Institute', where about 25 people turned up.
HB: I was at the big anti-war US Embassy demonstration in Grosvenor Square in 1968. And I was part of a student protest movement here, called the Free University, where we tried to get rid of teachers and it was all quite exciting and fun.

Coming to Bristol

HB: I was ill for a couple of years – it was probably ME although they didn't use the term then – and I wasn't sure about going back to schoolteaching, so I decided to do another degree. I'd already developed an interest in sociology at Bristol, when I was taught by a great, inspiring educational sociologist called Roger Taylor. I always had a passionate interest in the individual's relationship with society, going back to my love of 19th-century novels like *Middlemarch* and *Bleak House*. I did a BSc in Sociology at Leicester University and discovered feminism for the first time, then did my PhD at Nuffield University and started my research on women and work. That became the core of my research. But I graduated at a bad moment for getting jobs. Margaret Thatcher was trying to get rid of sociology because it was too radical a subject.
CM: Well, it wasn't a subject, since there was 'no such thing as society'…
HB: Also, in the early 1990s, universities had something called 'new blood' posts because they were worried about the age structure. So I kept being interviewed as a 40-year-old up against all these youngsters, and it wasn't looking very promising. I was fortunate enough to get a job here.

Classics

CM: Classics as a subject has really opened up, and we played a big role in that at Bristol. The subject used to end in the second century AD; there was no Later Antiquity, you didn't think about the influence the classics had on subsequent ages, or about issues like feminism. You translated, and did some political history. But the subject is fundamental to every aspect of Western civilisation.
HB: At school it was taught more as a language, but I think it's now seen more as a cultural area. We did read some beautiful poetry – I still remember reading Horace and Catullus at school. But you started by reading Caesar and Livy and Cicero, which wasn't so much fun.
CM: That's very different at schools today. Nobody reads Caesar now, but it was the first thing we read because it was considered 'proper', correct, golden Latin prose.
HB: But it was all about armies and spears, so you learnt a vocabulary which was extremely boring for women. It's only when we got to the love bit that I got really excited, but I did like the muscularity of the language. I rather envy Charles in some ways, dealing with Latin. I think it's a splendid language, and of course it's the root of so many other languages as well.

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Writing and style

HB: I like to write in a way that can be read by people in other disciplines; I think that's something Charles and I have in common. Our audience is a broader one than just the tight disciplinary community.
CM: I write in different ways for different audiences, but I'm always interested in style and how you communicate with different audiences. Harriet has written some wonderful pieces. This isn't the kind of thing that you can generally do in sociology, but Harriet has a real gift for it.
HB: I'm hoping to write much more in that style. In a way I've revisited my teenage ambition to become a novelist, writing creatively and imaginatively within my own discipline.
CM: I'm concerned to communicate but not to dumb down. You want it to be intellectually demanding but at the same time exciting, interesting, well written.
HB: Charles' interest in style and writing in different ways definitely influenced me to try doing more interesting and ambitious things.
CM: I always thought Harriet was intellectually more conservative than me. I was rather a postmodernist. Harriet was more from the solid, positivist, facts-are-facts school.
HB: Perhaps I'm a bit bland now – I like to feel that all positions have something to offer.

Administrating and arguing

CM: We both usually sit on University Senate, so we sometimes express disagreement with the top table.
HB: We're not the kind of people who accept the orthodoxies of the time. We're modernisers, but if we think the modernising is going in the wrong direction we can be very critical of it.
CM: Improvements come through discussion, and dialogue and argument, and the results are better than would be the case if you didn't have that process.
HB: I think that comes from our family as well. Everyone was rather opinionated, and the opinions clashed a lot, and that has had a profound impact on both of us. We'll never be company men or women in that sense. Although in another sense we are both very committed to the University and we give a lot of our free time to serving it.
CM: I think part of Bristol becoming a top place is having the courage to disagree and debate and not just have a cosy consensus.
HB: That's why we sometimes take a position that we don't completely agree with, just to open up a debate. I hope we've done a service to the University by sometimes being controversial, though it doesn't please everybody.
CM: That said, we often have different opinions. We don't sit next to each other in Senate.
HB: We're very careful about that.
CM: But it may be that other people see us as 'those dratted Martindales'.

Looking back

HB: I'm getting close to retirement, and I think more and more about my childhood and youth and how my past has influenced my present. I think Charles probably lives a bit more in the present.
CM: Probably, yes. But it is remarkable that we've both ended up as professors at Bristol and deans of faculties.
HB: We certainly talk about how odd it is.
CM: I can't decide whether it's just because I'm old, but when I first came here we had very close relationships with students, a lot closer than now, and I think that's all part of the culture change, too. I used to go out drinking with them and socialising, and I think now people would be a bit wary about doing that. Maybe my younger colleagues find that communication a bit easier. Or maybe the students are afraid of me.
HB: Terrifying man that you are…

SOMETHING IN THE AIR

What's that infernal smell? That'd be sulphur dioxide. It's a whiff that Adam Durant is familiar with. A research assistant in the School of Geographical Sciences, some of his recent work focuses on gases from erupting volcanoes. He talks to Hilary Brown.

You don't really want to be downwind of an erupting volcano, and not just because of the smell. Admittedly, we Brits don't have to spend much time worrying about being stranded in the path of a lava flow – for most of us, that's the stuff of Hollywood disaster films. But active volcanoes also emit gases, such as sulphur dioxide and carbon dioxide, which can be hazardous to human and animal health and degrade ecosystems.

Then there's the way these gases evolve once they're in the atmosphere: sulphur dioxide, for example, converts to sulphate aerosol, forming a haze that may lower the Earth's temperature by reflecting away the sun's rays. This in turn has wider implications for climate change, which is something we all need be concerned about.

Adam Durant (pictured right) is certainly taking it seriously. A postdoc in the Department of Geographical Sciences and an adjunct geological sciences faculty member at Michigan Technological University, Durant has recently returned from US National Science Foundation-funded fieldwork in Hawaii where he's been measuring the concentration of volcanic gases in the atmosphere. And he's been doing it in a rather unusual way – by flying balloons in the plume of Kilauea volcano, which began a new eruption at the summit caldera in March.

Durant and his colleagues – Dr Matt Watson, a lecturer in geophysical natural hazards in the Department of Earth Sciences, and Paul Voss of Smith College, Massachusetts – successfully took the first-ever direct (*in situ*) balloon-based measurements of volcanic gases as they actually spew from the mouth of the crater. Even more impressively, they did so using a couple of sorry-looking, slightly saggy inflatables.

These are no ordinary balloons, however – they're altitude-controlled meteorological balloons, with sensors hanging below them for measuring air temperature, humidity and pressure, as well as concentrations of sulphur dioxide and carbon dioxide. 'The balloons are piloted remotely by satellite link,' explains Durant. 'The great thing about them is that they enable us to take measurements in real time, and to see how the composition of the atmosphere changes over time as the balloons drift in the wind.'

The first balloon was released into strong trade winds and flew for a couple of hours, ascending to 2,500 metres before crashing into the side of Mauna Loa, another of Hawaii's five volcanoes: 'We hadn't bargained for the anabatic winds that were blowing up the mountain side in the opposite direction,' says Durant.

'You don't go wandering into a crater if it's about to erupt.'

He and Watson recovered the balloon intact, but not without a three-hour slog through the jungle.

Flight number two was more successful. This time, Durant and Watson coordinated the flight plan with Voss in 'real time' from the comfort of their field cabin balcony using Google Earth to help visualise the flight path. If anything, the balloon stayed airborne too long, and after five hours they had to terminate the flight to avoid exceeding the US Federal Aviation Administration's approved time window. The balloon landed in a plantation, and Google Earth came into its own, allowing Durant and Watson to locate it to the nearest Macadamia nut tree.

The ability to measure volcanic gas emissions several hours after eruptions could have immediate consequences for people living in the vicinity of the volcano. Sulphur dioxide is toxic to humans and levels of the gas detected in the atmosphere over a large residential development downwind of Kilauea were high enough to warrant further monitoring. Although Durant's findings indicate that there is a rapid loss of sulphur dioxide the further the plume gets from the crater, this is most likely because it is being converted to sulphate aerosol, and forms what is locally known as 'vog'. This is a volcanic smog that occurs when sulphur dioxide and other gases mix with oxygen and atmospheric moisture in sunlight. Kilauea volcano emits an estimated 2,000 tons of sulphur dioxide every day. Many residents of Hawaii report physical complaints associated with vog exposure, such as headaches, breathing difficulties and flu-like symptoms.

Does Durant worry about inhaling too many poisonous fumes during the course of his work? 'Not really,' he says. 'You take sensible precautions when you visit volcanoes close up – you wear hard hats, protective clothing and respirators. Of course, there's always an element of risk involved in being on an active volcano – there are plenty of stories about volcanologists who have perished. But you don't go wandering into a crater if it's about to erupt, and these days scientists are much better informed. We know what the warning signs are, and we have more sophisticated ways of predicting volcanic activity.'

Durant has done his fair share of high-octane fieldwork, although most of the dangers he's encountered have been on the way up to, or down from, the volcano. 'In the Cascade volcanic range in the western US, you can often be working at very high altitudes and there's always a chance of storms or blizzards coming in unexpectedly. It's easy to lose your way on mountains in bad weather. There were some dicey moments coming down Mount Rainier on one trip, because we'd stayed a little long working at the summit on a day in the mid-summer and snow bridges over the crevasses were starting to become soft from the warm air.'

Remotely controlled balloon experiments may keep Durant out of trouble for the time being, but the lure of the active volcano is always there. 'There's something very elemental about volcanoes,' he says. 'Seeing gases being emitted into the atmosphere and watching new rock forming as lava is erupted is highly appealing. It's geology in action.' ↙

Top: The plume at Halema'uma'u Crater, Kilauea, early on the morning of 15 July 2008. The plume contains a mixture of gases (mainly water, carbon dioxide and sulphur dioxide), small aerosol particles and volcanic ash. On most days the plume is carried south-west by trade winds

ALL PHOTOGRAPHS: ADAM DURANT

JASON INGRAM

SCIENCE & SUSSABILITY

Food and penguins: Peter Barham, Professorial Teaching Fellow in the Department of Physics, is the media's 'go-to' person for both topics. How come? And will he ever wear an Einstein wig on live TV? He talks to Nick Riddle.

Peter Barham is recalling, with a shiver, his early brush with the media. '"The physics of black forest gateau". That was one of my first public lectures, back in the early 1980s. Afterwards, the *Bristol Evening Post* printed a letter from a woman asking why these scientists couldn't do something useful like curing cancer instead of wasting time and money on making cakes.'

Another public lecture involved Barham cooking potatoes, to illustrate the principle of heat transfer. 'As part of that, I wrote an equation down,' says Barham. 'And it ended up in the *Sun*, under a headline saying "Batty boffin" or something. After that, I decided I needed to be more aware of how the media works.'

Barham's more considered approach has paid off: his advocacy of 'molecular gastronomy' and his collaborations with chef Heston Blumenthal caught the public's imagination, and as for the whole penguin thing… but let's not get ahead of ourselves.

Back in the late 1980s, media training wasn't really on the academic map. 'The Institute of Physics organised a media training day,' Barham recalls. 'Kathy Sykes was my PhD student in those days, and she was just getting into media work, so we both went along. The organisers greeted us with "Actually, we hoped *you'd* be doing some of the teaching on this…"'

Nevertheless, the meeting – which included journalists from the *Daily Telegraph*, *The Guardian* and *New Scientist* – was productive. 'We figured a few things out, not necessarily about how to answer a question, but how to convey what the question *should* have been.'

If journalist and academic meet each other halfway, then the relationship is much happier. 'You say "Here's the answer to your question, but this is what you *should* have asked me",' says Barham. 'As long as you give them something sensible, they don't complain that you haven't answered their question because they realise very quickly that the question isn't relevant.'

Barham's key piece of advice concerning live interviews is something echoed by many academics we've talked to for 'The scholar and the soundbite': Preparation is everything. Listen to the show first, for example. 'I once got a call from a radio show asking whether I'd do a slot for them on food. For a serious programme, they assured me. I said yes. It turned out to be a lightweight show with jokes and loads of music, and people calling in with questions. I didn't know any better because I didn't do my homework.'

So now he does. Before a radio interview, he talks to the producer to find out what's expected of him and where he fits in, and to clear up any misconceptions about the science involved. He also recommends mastering the art of circular breathing: 'If you can keep on speaking without drawing breath, they can't interrupt you without seeming rude.'

Engagement and embarrassment

Media training is becoming a staple of the postgraduate experience. The reason is simple: presentation skills are now a crucial part of an academic's armoury. 'You won't get on in science if you can't go to a conference and present your work in a coherent, accessible way,' says Barham. 'Mumble through it or look like a twit and nobody will pay any attention, unless you're some kind of genius.'

Barham has been telling this to his postgraduate students for years, and he gives them the chance to go out to public engagement events to get plenty of practice. He also sets up mock video seminars so that they can watch their own performance, a process they find 'incredibly helpful but horrendously embarrassing'.

Talking to the public in small groups, says Barham, helps you to judge what's getting across and what isn't. 'You can stand up and give a public talk and get a nice round of applause, but it's only when people come up afterwards to ask you questions that you realise that maybe two people have understood what you were talking about. You haven't really engaged anybody.'

One sure sign that you're engaging people is when the media add you to their 'go-to' lists. 'In an average week, I get two or three press enquiries about food, and maybe half that on penguins. If there's a penguin story in the media, I'm probably the person they call. I'm far from being the only person in the UK working on penguins, but I'm the person they know.'

Creating a flap

Ah, yes, the penguin thing. It all started because Barham, for his physics lectures, needed place-holder slides between the important pictures. His wife was obsessed with penguins, so he plumped for them. 'People got used to seeing penguins somewhere in my lectures – they'd start looking out for them. At some point I became Penguin Man.' Barham and his wife started travelling to see them and went to a penguin conference in South Africa for biologists. 'It turned out that there were problems with penguin identification bands, problems that materials science could help with, so with my physicist hat on I said I'd look at it.'

That led to collaborations with colleagues in the School of Biological Sciences and elsewhere. 'I'm actually the chair of the next penguin conference – and I've got an honorary position in Zoology at the University of Cape Town.'

It was Barham's work on penguins that recently led him to take a more proactive approach to the media. 'We were running a project on penguin identification, which is hard to get funded because it doesn't fall naturally within the remit of any one funding council. We created a striking demonstration and an exhibition at the Royal Society to get publicity and impress the funders.' And it worked: Barham and his colleagues made important contacts and increased their chances of securing funding for the project.

FRANCES TOUT

FRANCES TOUT

Above: One of Barham's early sorties into public engagement: a 'Scientific Dinner Party' at Filton Technical College Catering School in the late 1980s

Others have turned this strategy into a fine art. 'Every couple of weeks on the *Today* programme, there's a story about new developments in some area of medical research,' says Barham. 'If you then check the Medical Research Council website, you'll almost always find a grant application on that very subject.' Get it in the media and the people on the grant committees – who, after all, read the newspapers like the rest of us – will prick up their ears. 'And they'll know a little more about the subject than whatever your rather dry research proposal says,' Barham points out.

It's nice, he admits, to see your name in print. 'But if you make a balls-up of it and that ends up in print, that's not so nice,' he says. And the history of academics in the media does include some cautionary tales. Remember the cold fusion story? 'Some guys thought they'd discovered something brand-new in cold fusion, which would solve the world's energy problems,' says Barham. 'Brilliant – had it been true. Somehow it became a big media story before their work had been peer-reviewed. When it *was* peer-reviewed, it got slammed. And that wrecked several careers.'

It isn't being wrong that gets you into trouble, says Barham: 'In science, you *have* to be wrong most of the time in order to get anywhere. But you find out you're wrong when someone tries to repeat your work and fails, or when a peer-reviewer says, "Whoops, look what you did". By the time you engage with the media, it has to be right. Otherwise you're in deep do-do.'

But there are some things over which the scientist has no control. Take public perception of scientists. Barham, with another shudder, relates an instance of The Cliché That Wouldn't Die: 'Some years ago, Breakfast TV wanted me to come on for a piece wearing a white coat and an Einstein wig. I said "No way" – and they were completely flabbergasted.'

DAVE PRATT

THE BONE COLLECTOR

How is the knee bone connected to the thigh bone of a Thecodontosaurus*? Hilary Brown meets Remmert Schouten, a fossil preparator in the Department of Earth Sciences, to try to find out.*

Everyone loves a dinosaur, not least Remmert Schouten, who has the kind of job for which the country's entire primary school population would willingly trade their collection of plastic sauropods. Schouten is a fossil preparator and conservator, specialising in vertebrate animals. Simply put, he takes fossilised bones out of the rocks they are embedded in and cleans them up.

Everyone loves a mystery, too, and Schouten is also involved in solving the puzzle of how a miscellaneous collection of claws and vertebrae, which he has spent the past eight years extracting, connect to form the skeleton of *Thecodontosaurus*, the Bristol Dinosaur.

But first back to an earlier age when the six-year-old Schouten roamed the shores of his native Netherlands on the look-out for fossils. A bit of a geeky kid, then? 'I may have been a bit obsessive,' admits Schouten. 'I was digging stuff up before learning how to read or write, and certainly before I realised what it was that I'd found. It started off as a hobby, though; I never thought it would be a career one day.'

A nearby quarry provided rich pickings and it was there that the fledgling fossil hunter discovered his first vertebrate fossils – the 240-million-year-old remnants of nothosaurs, reptiles that caught food in water but came ashore on rocks and beaches. 'They're close to the ancestors of plesiosaurs, which were true marine reptiles – generally speaking, a family that looked like the Loch Ness monster, with a long neck and flippers,' says Schouten.

He topped up his collection on trips to a famous fossil site in Maastricht, where two centuries ago scientists found the skull of a giant reptile, with wicked rows of teeth set in jaws more than three feet long. The monster was named *Mosasaurus* after the Maas River, which runs through the Dutch city. The real fossil, so the story goes, was seized by Napoleon's occupation army in 1794 and shipped to France, where it is now on display in the Paris Museum of Natural History. The Dutch have had to content themselves with a plaster surrogate ever since, despite various appeals – sometimes emotional ones – for the return of the unique specimen. The Dutch have had the last laugh, however. A new specimen – even better than the original and now proudly on display in Maastricht – was found in a recent excavation that Schouten was involved in.

Sites around the Netherlands fuelled in Schouten a lasting interest in palaeontology. He began reading widely, visiting museums and poring over geological maps. Soon his fossil-hunting trips were taking him all over Europe.

Schouten honed his preparation skills by volunteering on excavations and in museum laboratories around the world, stabilising and preparing finds, and making moulds and casts for reconstruction work, eventually evolving into that rarest of creatures – lone fossil preparator in the University's Department of Earth Sciences.

Much of Schouten's time here is spent chipping his way through seven tonnes of limestone quarry rock as part of the Bristol Dinosaur Project. The first *Thecodontosaurus* bones were found in Bristol in 1834 on a site that has since been built on. In 1975, several tonnes of rock full of dinosaur bones were found in a South Gloucestershire quarry. The huge boulders, some of them a metre cubed, were stored in farm buildings for 25 years until the University secured funding to begin work on them.

To get the specimens into the lab, Schouten had to 'control break' the boulders into smaller blocks, incurring minimal damage to the precious bones. Then began the laborious process of getting the bones out of the rock. 'One way of doing this is to use acetic acid, which can dissolve limestone and leave the bones intact,' explains Schouten. 'But in the case of the rock containing the remains of the Bristol Dinosaur, the acid would get at the limestone inside the bones and destabilise them. So I had to use largely mechanical methods.'

DAVE PRATT

DAVE PRATT

So out came the hammer and chisel, and an airpen for more delicate work. The airpen is a narrow tube through which air is blasted at very high pressure. 'This type of brecciated rock is difficult to prepare, because the component parts are large and angular,' says Schouten. 'It would have formed during rapidly occuring events, such as floods, where rubble and sometimes animal remains were washed underground into cave systems. The rubble and bones then compacted into new rock, called a cave deposit.'

For every ten bones retrieved, only one or two are in good condition. But with potentially hundreds more bones at his disposal, and a stream of student volunteers keen to learn preparation techniques, Schouten is optimistic about the chances of accumulating enough material to reconstruct *Thecodontosaurus* in its entirety. 'It's tricky, because the bones are from many different individual animals. On the other hand, the fact that the Bristol Dinosaur is small – less than five feet high at the hips and around two metres long including the tail – makes the job easier.'

Progress has been made: Schouten has already reconstructed two arms, which are on display in Bristol City Museum. 'Only about four more tonnes of rock to get through,' says Schouten cheerfully, hoping that some of it will yield the rarer bones, such as those from the pelvic girdle.

It seems that *Thecodontosaurus* has much to teach us. It's an ancestor of the better-known sauropods, the largest animals ever to have lived on land which include among their number such firm favourites as *Brachiosaurus* and *Diplodocus*. 'For a long time, *Thecodontosaurus* wasn't considered a dinosaur because it wasn't big and terrifying enough ["dino" means terrible],' says Schouten. 'It took Darwin's colleague, the biologist Thomas Henry Huxley, to confirm it as a dinosaur in the 1870s. This was part of a big change in our understanding of dinosaur evolution to discover that not all of them were huge.'

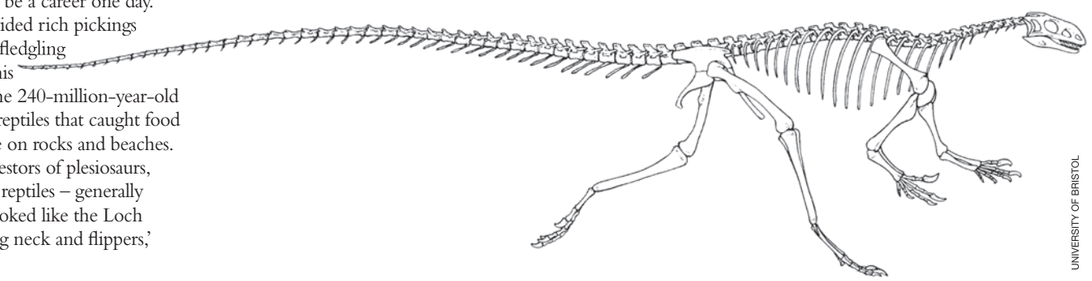
Lest he become an endangered species himself, Schouten occasionally escapes the laboratory to take part in fieldwork. He is currently working with Bristol's Department of Archaeology and Anthropology and the University of Sheffield on an excavation of Creswell Crags, uncovering the remains of Ice Age tools and animals, largely reindeer, aurochs (a type of wild ox), wild cats, rhinos, mammoths and hyenas.

He is also working on a project with the Jurassic Coast World Heritage Team, preparing for research (with display in mind) a complete crocodile skull found recently near Swanage. 'It was embedded in a huge slab of rock and only the top of the head was visible. I had to drill it out so that researchers had access to the palate and base of the skull. We took it to the Royal Veterinary College to be X-rayed in their CT scanner and got some funny looks from the vets while we were waiting for them to finish scanning a kitten with a brain tumour.' As for the future, Schouten is focusing on next year's Society of Palaeontology meeting, attended by palaeontologists and preparators from around the world, which will be held in Bristol.

When it comes to outreach work in schools, however, dinosaurs definitely rule. 'They appeal to kids for obvious reasons – they're spectacular, and there's a lot of mystery surrounding them,' says Schouten. 'But the Bristol Dinosaur is a really versatile tool for explaining basic geology and palaeontology as well, because you have the bones there in the rock and you can show how they became fossilised in the first place.'

They may have been around for 200 million years, but there's life in the old bones yet.

Left: Schouten with the reconstructed leg of a *Camarasaurus* at Bristol City Museum. The Bristol Dinosaur is at the base of the family tree of large sauropod dinosaurs such as *Camarasaurus* **Above:** At work in the lab **Below:** Skeletal reconstruction of the Bristol Dinosaur by John Sibbick



UNIVERSITY OF BRISTOL

… AN IMMUNOLOGIST

(AND AN ENTREPRENEUR AND MUSICIAN)

A tough but inspirational schoolmistress and an urge to turn laboratory research into treatments for disease both feature strongly in the story of Professor Neil Williams, Head of Cellular and Molecular Medicine. So does the music of Radiohead. He talks to Barry Taylor about influences and motivations.

'My biology teacher had taught my father and she would interrupt lessons with stories about him.'

JASON INGRAM

I was born in 1964 in Letchworth, Hertfordshire – the world's first garden city, as it happens.

'He's bright, but doesn't apply himself' was the sort of thing my school reports used to say. I wasn't a troublemaker, but I tended to look for the easy path through life. I don't think the education system pushed people like it does now, and mediocrity often seemed to be accepted with a shrug. My older sister was naturally very studious; perhaps I reacted against that.

At grammar school my biology teacher was a very strict lady, but she loved teaching. Her enthusiasm got me hooked on science and maths. She had taught my father when he was at the same school, and sometimes she would interrupt lessons with stories about him. I enjoyed that feeling of continuity with the past. The teacher had probably inspired him, too – he became a materials scientist.

My dad was into jazz and was influenced by the music that John Peel played, and that rubbed off on me. In maths we once had to express the class's musical preferences using a bar chart. The Bay City Rollers and Sweet were way out in front; I was on my own with Emerson, Lake and Palmer. I was one of those nerdy teenagers who read the backs of album covers obsessively.

I did a lot of singing when I was young, and got the title role in *Joseph* at school. Now I sing and play guitar in a band called The Excuses. We do cover versions, including songs by my big musical passion: Radiohead. When their latest album came out, you could download it for 50p, but I had to have the £40 box set. I took my sons, Harley and Joel – both drummers – to Glastonbury for the first time this year. The Raconteurs and Seasick Steve were the real highlights for us.

I went to Birmingham in 1982 to study Biological Sciences. I fell for immunology because it was the first subject I'd come across where the experts were standing up and saying, 'We really don't know'. I convinced myself I knew as much as anyone. I was wrong, of course, but it was refreshing to be part of something so dynamic. You felt you were working at the cutting edge of science. I became interested in how you might modulate the immune system. In infectious diseases, like meningitis, the system isn't working hard enough; in some other diseases, like asthma, it's working when it shouldn't be.

I came to Bristol for my PhD in 1985. (I think of it as the year of Live Aid.) I researched the herpes simplex virus, which causes cold sores and eye infections. I met my wife, Sarah, here – when I arrived, she was finishing a PhD in the same lab. I was two years into postdoctoral work when a microbiology lectureship came up. I was only 26, but they took a risk and gave me the job.

After a few years it might have been time to move on, but then the University decided to invest in medical sciences and things really took off. There was no reason to leave. Five years ago, I became head of department.

In the mid-'90s, we made some discoveries in a field that has absorbed me since my undergraduate days – how to modulate the immune response. These led to international patents and the formation of two spinout companies. Through one, we're about to enter clinical trials of what we hope will be an effective treatment for asthma. The other company works with pharmaceutical and biotech companies, advising them and helping them to develop their drugs. It's exciting stuff.

I've always felt it's important to give something back. I've been the meetings secretary and a trustee of the British Society for Immunology for the past five years. Another enthusiasm is the London International Youth Science Forum. This is an annual two-week gathering of delegates from 50 countries. When I was 16, I was chosen by my home-town to attend; for the past seven years, I've been a lecturer at the event. At first I was daunted by the prospect of filling a two-hour slot, but I needn't have worried – the delegates are fantastically motivated and bursting with questions. Now I'm Honorary Vice-President.

Life has had a certain consistency – same school as my dad; same lab as my wife; same university for 23 years; similar musical leanings to my father and sons. That's rather comforting when much of your work is about exploring the unknown.

NICK RIDDLE

GUNS AT THE LYCEUM

These duelling pistols belonged to the great 19th-century actor-manager Sir Henry Irving. They were made by Dempsey, an Irish gunsmith, and used by Irving onstage at the Lyceum Theatre in London, possibly as the character of Dr Primrose in *Olivia* (1885), an adaptation of Oliver Goldsmith's novel *The Vicar of Wakefield*. Each pistol bears the inscription 'Only an actor,' signifying their function as stage props.

The guns form part of the Irving Family archive, which was recently donated to the University's Theatre Collection by John H B Irving, great-grandson of Sir Henry. The archive contains material including diaries, letters and photographs, which will provide further insight into the public and private lives of one of the most celebrated figures of the Victorian era.

Endnotes

1 A scene from *Mile End* by former Bristol student, Dan Rebellato. The play, performed by Analogue theatre company, is part of the autumn season at the Wickham Theatre, situated in the Department of Drama. Inspired by the true story of a commuter pushed in front of a train at Mile End station by a man with a history of mental illness, it was an Edinburgh Fringe First Award winner in 2007. It will be performed on 30 October at 7.30pm. More details of the autumn programme can be found at www.bristol.ac.uk/news/2008/5870.html.

2 Botanist David Bellamy OBE presided at the opening of the 'Evolution Collection' at the University's Botanic Garden in July. The event focused on the education and conservation work that are a feature of the development of the new garden. As well as 'Evolution', the garden's core collections comprise plants from Mediterranean climates; useful plants; and rare and threatened native plants associated with the Bristol area. For details of garden opening times, visit www.bristol.ac.uk/Depts/BotanicGardens.

3 Gaynor Dark (left) with Lucy, winner in the Best Rescue Dog category at the Vet School's Fun Day and Dog Show, and Paula Anstey of the Public Relations Office with competitor Sunny. The event, organised by the Division of Companion Animal Studies and held at Langford, is becoming a favourite fixture in the calendars of local residents.

4 African penguins on Robben Island, the subject of groundbreaking research by scientists in the Departments of Physics and Computer Science and the School of Biological Sciences. The Penguin Recognition Project, devised by Professor Peter Barham (see p14), uses an intelligent visual-surveillance system to enable the automatic identification and monitoring of large numbers of endangered animals without their being captured. African penguins are suited to the research because they carry an individual pattern of black spots on their chests that does not change during their adult life. The new technology was shown to the public for the first time at this year's Royal Society Summer Science exhibition.

5 Jake Cadwaller (left), of New Fosseway School, Hengrove, and Josh Beesley of Ravenswood School, Nailsea, two of the pupils from local special schools that participated in the West of England Festival of Sporting Ability at Coombe Dingle Sports Complex over the summer. This was a sister event to the Festival of School Sport, also hosted at Coombe Dingle. Both events were aimed at inspiring children to stay active by playing sport.

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