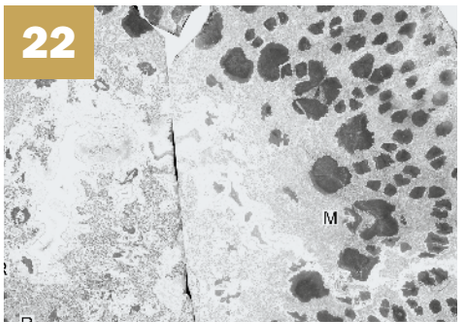
CARDIFF UNIVERSITY
PRIFYSGOL CAERDYDD

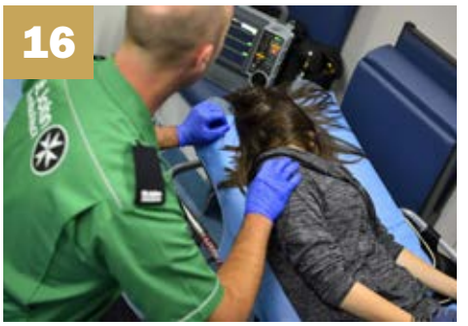
CHALLENGECARDIFF

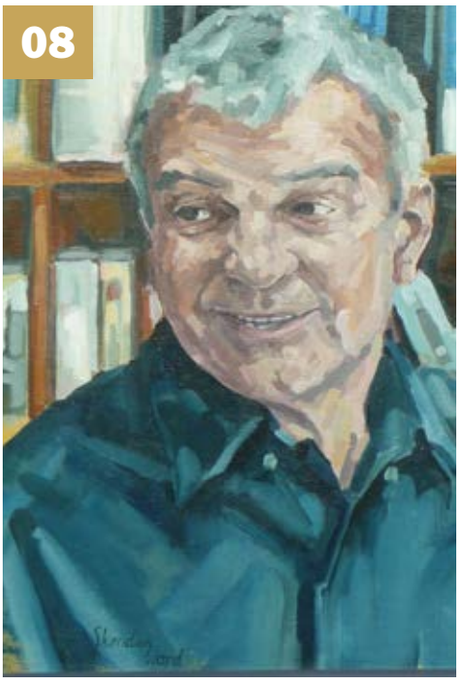
THE RESEARCH MAGAZINE FOR CARDIFF UNIVERSITY
SUMMER 2018

Welcome to the jungle

Assistant Director of Sabah Wildlife Department Dr Senthilvel Nathan discusses conservation with Dr Benoit Goosens







IN THIS ISSUE

Challenge Cardiff Summer 18

Managing Editor – Claire Sanders

Editor – Alison Tobin

Contributors – Katie Bodinger, Jessica Kelly, Julia Short, Victoria Dando and Amy Stackhouse

Photography – Matthew Horwod, Michael Hall, Getty Images, The Royal College of Emergency Medicine, and staff at the Danau Girang Field Centre

Design – ElevatorDesign.co.uk

Proofing – WeltchMedia.com

Print – Harlequin Printing and Packaging

Challenge Cardiff is produced by the Communications and Marketing department, Cardiff University, Friary House, Greyfriars Road, Cardiff, CF10 3AE.

Challenge Cardiff is published in English and Welsh. To ensure we deliver the right medium to you please email challengecardiff@cardiff.ac.uk to let us know which language you would prefer to receive your edition in.

Welcome to Challenge Cardiff

We are proud to be part of a dynamic and ambitious international community, which is reflected in this issue of Challenge Cardiff.

IN SEPTEMBER 2018 our Danau Girang Field Centre in Borneo celebrates its tenth anniversary. This research and training facility is a collaboration between the University and the Sabah Wildlife Department. Led by Dr Benoit Goossens, it undertakes conservation and biosciences research, trains the next generation of local conservationists and also provides opportunities for students from across the world to engage directly with the issues of conservation and biodiversity. Dr Goossens spoke to Dr Senthilvel Nathan of the Sabah Wildlife Department about the centre's research and the important impact it is having in conserving the area's natural heritage.

Closer to home, there has been a rapid decline in the study of modern languages at A-Level in Wales since 2001. Helping to address this issue, Professor Claire Gorrara and her team in the School of Modern Languages have developed a Turbo Tutoring scheme to help pupils bridge the gap from GCSE to A-Level French. Working with schools and colleges across the region, the research conducted as part of the pilot study had excellent results, and the scheme has secured another's year's funding. Nicola Emery, an A-Level student who took part in the scheme last year talks to Professor Gorrara about the purpose of the scheme and how it has helped with her studies.

We have access to more data than ever before. Mining these data will have huge potential for our research. Data processing and management requires expertise and collaboration from across disciplines, which is why we set up our Data Innovation Research Institute. We are creating a Big Data culture at the University, training the next generation of data scientists and developing a network of research software engineers. The Research Institute's projects range from a citizen science project in Brazil to the optimisation of healthcare systems.

To find out more about the work featured in this issue, please go to our website **www.cardiff.ac.uk**

Please contact **challengecardiff@cardiff.ac.uk** if you would like to challenge our academics on an issue that matters to you.

PROFESSOR COLIN RIORDAN
VICE-CHANCELLOR

Green light for exoplanet mission

University scientists will be part of an international space mission, to investigate fundamental questions about how mysterious exoplanets form and evolve.

The Atmospheric Remote-sensing Exoplanet Large-survey (ARIEL) mission, which has been given the green light by the European Space Agency (ESA) and will launch in 2028, will produce the first ever large-scale survey of the atmospheric chemistry of planets outside our solar system.

The four-year mission will extract the chemical fingerprints of the gases in the atmospheres of over 1,000 exoplanets, as well as capturing information about the temperatures and pressures in their atmospheres and the presence of clouds.

Scientists from the School of Physics and Astronomy will provide detailed computer simulations of the ARIEL satellite and its instruments, ensuring that the scientific observations can be carefully planned and the resulting data can be analysed correctly. The team will also be involved in interpreting the data from the observations to characterise the atmospheres of the exoplanets.

Professor Matt Griffin, head of the School of Physics and Astronomy and a member of the School's Astronomy Instrumentation Group, said: "The decision to select the ARIEL mission demonstrates the scientific vision and ambition of ESA, and it's the start of a great adventure for everyone involved. This is a mission that will hugely advance our understanding of the nature of planets and of our place in the Universe, and at Cardiff we are very much looking forward to our participation in the project."

ARIEL will study a diverse population of exoplanets ranging from Jupiter- and Neptune-size planets down to super-Earths. While some of the planets may be in the habitable zones of their stars, the main focus of the mission will be on warm and hot planets in orbits close to their stars.

It is in the scorching temperatures close to stars that the molecules from the surface of an exoplanet make their way into the atmosphere, providing detailed information about the planet's internal composition.

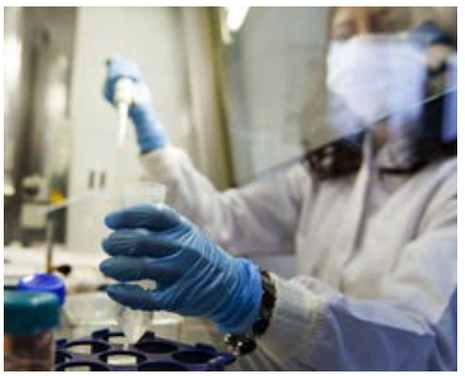
The satellite will be equipped with a mirror to collect visible and infrared light from distant star systems, a spectrometer to detect the chemical fingerprints from the light, and a photometer and guidance system to capture information on the presence of clouds in the atmospheres of the exoplanets and to allow the spacecraft to point to the target star with very high stability.

ARIEL will be launched from Kourou in French Guiana and will be placed around 1.5 million kilometres beyond the Earth's orbit around the Sun. The satellite will be shielded from the Sun and will have a clear view of the whole sky to target the exoplanets more easily.

The ARIEL mission has been developed by a consortium of more than 60 institutes from 15 ESA member state countries. The mission will cost €450m, with additional national funding for the scientific instruments.

£5.5m boost for cancer research

Cancer Research UK plans to invest more than £5.5m over the next five years in ground-breaking work at the University's Centre for Trials Research.



The grant will allow doctors and scientists to continue researching and testing better and gentler treatments for patients.

The Centre for Trials Research combines world-class research and medical expertise to provide the best possible results for cancer patients. Home to leading academics including researchers, trial managers, data managers and statisticians, it is a vital part of Cancer Research UK's research network, helping shape the clinical research landscape in the UK and internationally.

Professor Richard Adams, Cardiff's Director of Cancer Trials, said: "We are very proud that Cardiff has been given this grant. Our clinical research enables us to translate discoveries from the lab and improve cancer treatments, giving more patients the best chance of beating their disease."

He continued: "Clinical trials are vital to test new treatments. For example, we are running trials in oesophageal cancer, head and neck cancers and blood cancer."

The research includes the AML19 (www.cardiff.ac.uk/centre-for-trials-research/research/studies-and-trials/view/aml19) trial for young adults with acute myeloid leukaemia (AML) – an aggressive type of blood cancer.

The latest funding announcement follows a major review by the charity of all its Cancer Research UK Cancer Trials Units. This has resulted in £45m being invested into eight units across the UK, one of the charity's largest investments in clinical research to date.

Harnessing data to improve mental health

A team led by Professor Jeremy Hall has been awarded a £1m grant to harness the power of data science to improve early interventions and treatment in mental health.

Major progress has been made in understanding the genetic basis of many psychiatric disorders, and a substantial part of this has been due to large-scale data sharing.

Professor Hall, Director of the Neuroscience and Mental Health Research Institute, said: "In order to capitalise on this progress there is now a need to extend this large-scale data driven approach forward by integrating genetic information with clinical, environmental, developmental and biological data at scale in mental health to transform the management of psychiatric disorders.

"Our mission is to build a platform that will enable the extension of collaborative efforts required for fundamental progress in psychiatric disorders."

The new project aims to take several approaches, firstly linking more than 15,000 biological samples donated to the University's Medical Research Council (MRC) Centre for Neuropsychiatric Genetics and Genomics and the National Centre for Mental Health, and linking them to electronic health records.

In addition to the patient cohorts, the project will develop a school based adolescent cohort for identifying the antecedents of early-onset psychiatric disorders. Many disorders have their origin in childhood, with early adolescence being a period of increased vulnerability.

This research platform will enable us to track the mental health of young people as they grow up and to identify risk and protective factors.

at an early stage. This will have a significant impact on mental health promotion in schools, and enable development, implementation and evaluation of early, universal preventative mental health interventions."

The project is funded by the Medical Research Council as part of the UK government's National Productivity Investment Fund (NPIF).

Data Justice

The fairness of tools assessing the digital footprints of refugees, ethnic minorities and low-paid workers is the focus of a major study by University researchers.

Led by Dr Lina Dencik, of the School of Journalism, Media and Culture, Data Justice: Understanding datafication in relation to social justice will explore whether systems for gathering and assessing data about individuals are having a disparate impact on specific communities.

Funded by a prestigious €1.4m Starting Grant from the European Research Council, the team will research the effects of 'datafication' - the process by which data is collected and used to create digital profiles of individuals. It is now entrenched in every area of modern living – when shopping or dealing with finances, in the workplace or at home, through friendships and relationships, as well as interactions with governments and corporations. We all leave behind a digital footprint that organisations can use to draw conclusions.

Despite the fact that Big Data is now present in nearly all walks of modern life, current research in this field is limited and has centred mainly on developments in the USA. Dr Dencik's work will provide a new understanding of how these vast streams of information are being interpreted in the UK and Europe, offering insight and guidance for how they should or should not be used in the future.

The project will assess how data is collected, what tools are being employed to assess the information and the outcome of any resulting decisions. The project will look particularly at contexts impacting on historically marginalised groups, such as refugees and migrants, ethnic minorities and low-wage workers.

Dr Dencik said: "Our lives are now intrinsically linked to big data systems. These invisible and powerful processes are increasingly being used to make judgments on complex social and economic issues. For example, when a refugee enters a country, the data a government has about them will influence what sort of services they will receive.

"In law enforcement, police could use various information sources, such as social media, to predict whether or not someone will commit a crime.

"For employees, data frequently helps to assess someone's performance at work, which means people are scheduled or fired based on these statistics.

"Despite the impact Big Data is having across all sections of society, we are only beginning to understand how these algorithms might introduce or entrench social and economic inequalities in the UK and Europe. Our work will shine a light on this hugely important issue."

The ground-breaking project will be hosted by the School's recently established Data Justice Lab, which Dr Dencik directs together with Dr Arne Hintz and Dr Joanna Redden.

In addition to academic research publications, the team will produce reports on methodological innovations in studying datafication. They will collaborate with civil society organisations and impacted communities to communicate concerns, improve on software and create alternatives.

The findings of the project will be made available to all via a website https://datajusticeproject.net/

Western Powerhouse success will rely on research, innovation and training

The 'Severn Growth Summit', convened by the UK Government's Secretary of State for Wales, Alun Cairns MP, sought to drum up support for cross-border collaboration. Catalysed by the abolition of the Severn Bridge tolls, Alun Cairns called upon gathered local leaders, businesses and universities to build a 'Western Powerhouse' between South West England and South East Wales.

▲ Dr Sarah Perkins, GW4 Director

The idea isn't new – indeed a 'Severnside region' has been mooted since the 1960s – and this latest summit builds on recent initiatives such as Great Western Cities and the South West England and South East Wales Science and Innovation Audit. I have witnessed first-hand the enthusiasm for cross-border collaboration and likewise the frustrations inherent to this ambition. However the support of a political champion in Westminster such as Alun Cairns could prove transformative.

A lot of detail is still yet to be pinned down (for example, its geographic parameters), but we can be confident that whatever a 'Western powerhouse' looks like, universities will be vital in driving its success.

The recent Industrial Strategy White Paper noted the importance of the regional economic impact of universities and emphasised that the consortia brought together by Science and Innovation Audits – academia, businesses and local government – need to continue to work together to contribute to regional development. Collaboration emerges as the watchword of the Industrial Strategy, and universities acting as stable anchor institutions within their communities have a clear role to play as connectors in this regard.

The GW4 Alliance, established in 2013 and bringing together the research-intensive universities of Bath, Bristol, Cardiff and Exeter, can provide vital expertise in collaborating across universities, industries, governments, health and education systems.

GW4's mission is focused on delivering globally competitive research, innovation and training at a scale that would be impossible for a single institution. To this end it has invested £2.37m in 74 collaborative research communities, which in turn has generated £27m in external research income. GW4's communities work with over 140 external partners as diverse as the Ministry of Justice, Airbus, Sky News and the European Space Agency, and have contributed to real-world impact in terms of addressing policy, economic, societal, health and environment challenges.

GW4 is building a highly skilled workforce for the region, leading 31 externally-funded doctoral training programmes in collaboration with over 350 industry partners (such as Google, the BBC and Boeing). The Alliance also invests in innovation that builds on our regional strengths, such as GW4 Isambard, an ARM-based supercomputer (developed in partnership with the Met Office and Cray Inc.) which was shortlisted for a Times Higher Award.

GW4 also connects with universities across the region where there is clear complementary expertise, such as on creative industries project REACT which brought together the universities of Bath, Bristol, Cardiff, Exeter and UWE Bristol and the Watershed arts centre. Many of GW4's doctoral training programmes include partners outside of the Alliance. The South West England and South East Wales Science and Innovation Audit is the fruit of GW4's partnership with UWE Bristol and Plymouth University, as well as LEPs, Welsh Government and major businesses.

At the Severn Growth Summit, Alun Cairns outlined some of the major areas of research and industry strength for the 'Western Powerhouse', including: creative industries, advanced manufacturing, digital sector, cyber security and financial and professional services. If we included the deeper South West in this region, we could also add new energy systems and resilience, environment and sustainability to the list.

All of these areas rely on university-industry collaboration to ensure that the region remains a UK leader. For example in digital innovation, Cardiff University's partnership with microelectronics manufacturer IQE, which will form the basis of the world's first compound semiconductor cluster, was referenced through the summit as an exemplar. The University of Bristol's £43m Quantum Technologies Innovation Centre (QTIC), which will play a major role in establishing new quantum businesses, includes Airbus as one of its lead partners.

There is also ample evidence to suggest that many of our region's research and industry strengths are cross-cutting in nature. For example, Oracle, a global cloud computing company with its UK HQ in Bristol, has uncovered a rich seam of collaboration with the city's thriving creative community, testing its software to render animated films.

The will, evidence base and partners are all there to create a 'Western Powerhouse' which can lead the UK and compete with the world in future-facing innovation.

All that remains is for us to secure the UK Government recognition and investment needed to get on and do it. Universities – which contribute so much to the region's economy and productivity – will be the key ingredient to ensuring this powerhouse's success.

‘A fascinating life’ (and a little bit of luck)

Professor Harry Collins, of the School of Social Sciences, is one of the pioneers of the sociology of scientific knowledge. Here, he talks about his field of work, the project which kept him hooked for some 45 years, and how luck has played a part in his career.

“Luck is very important in academic life. Absolutely vital,” says Professor Harry Collins, as he reflects on his career which has spanned more than 50 years.

One of the founders of the field of the sociology of scientific knowledge, Professor Collins has spent the last five decades asking searching questions about what we know and why we know it. He’s interviewed scientists and observed them in the field with the aim of finding out how one idea prevails over another. “When you think about it, you realise most of what you think you know for very good rational reasons you actually know because of where you have been born and brought up,” he said. “The subject of the sociology of knowledge deals with how people come to know what they know and what they think they know. Science is a very interesting topic to look at - would we think different things were true and count something entirely different as true scientific knowledge, if we had been born and brought up differently?”

Starting from these questions, Professor Collins has tackled subjects as diverse as artificial intelligence, technology in sport, democracy, politics and populism. “That’s one of the unusual things about my field,” he said. “You can explore in many directions so although you’re dealing with the same topic all the time – knowledge – it’s other people’s knowledge. You get to know lots of different bits of stuff. That’s one of the things that makes it such a fascinating life.”

This fascinating life has, by Professor Collins’ own admittance, been punctuated with some “pretty lucky” breaks. He describes his first journal paper which explored how people learned to build a new type of laser called a TEA-laser as “quite successful”, adding “around that time a new field called the sociology of scientific knowledge was developing and I turned out to be one of the pioneers. It was a stroke of luck.”

But there was one topic that kept him hooked for 45 years and which consolidated his research career - the search for gravitational waves. And, luck played a part in this too.

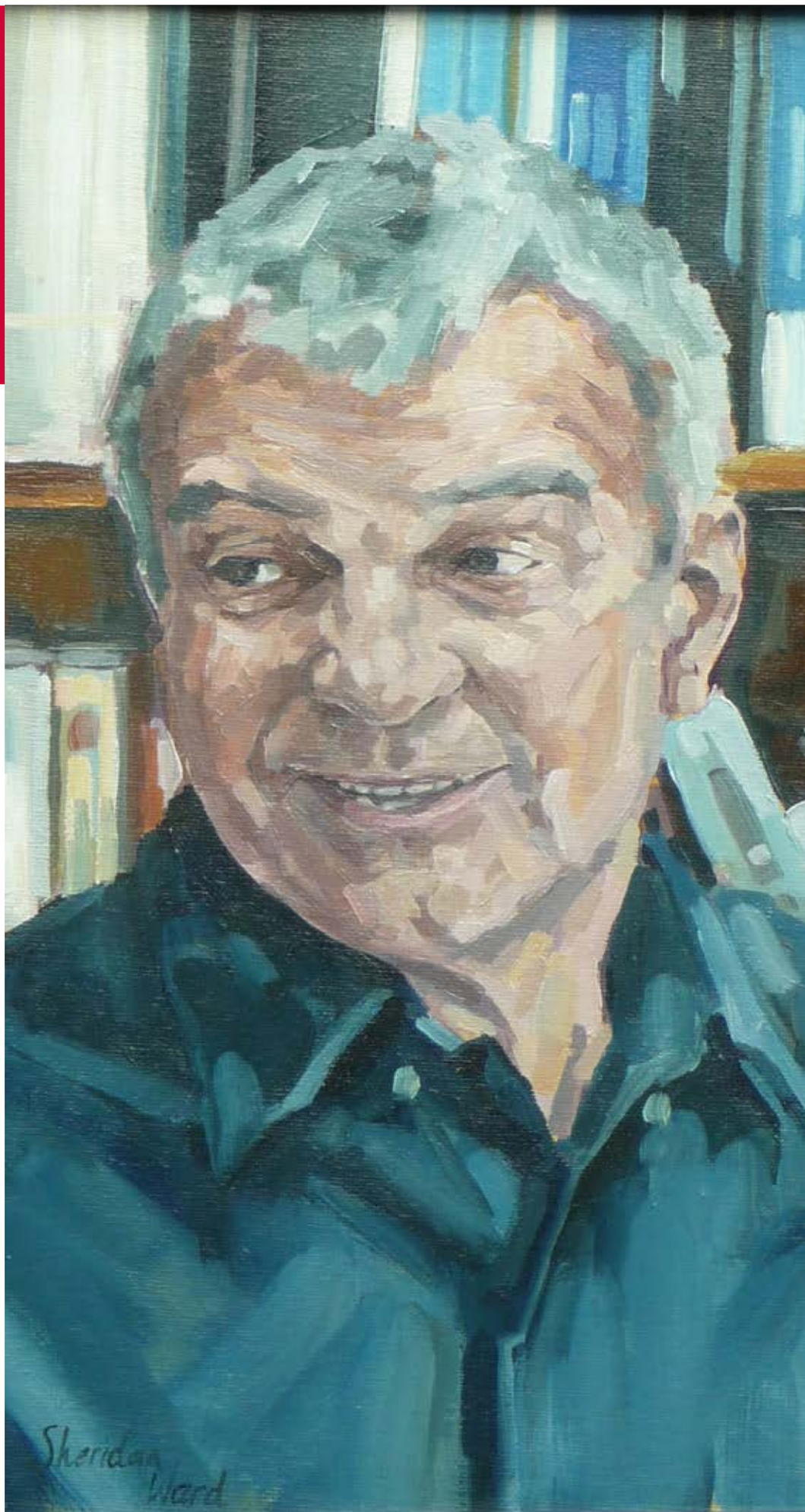
First predicted by Einstein in 1916, gravitational waves are tiny ripples in space-time that are emitted as a result of violent cosmic events, such as exploding stars and merging black holes. They carry information about their dramatic origins and about the nature of gravity that cannot otherwise be obtained.

“It was 1972, the field of gravitational waves had come about a few years earlier and I decided to focus on it for my PhD,” said Professor Collins. “I bought a Ford Galaxy for $250 and drove across America on Route 66 interviewing the scientists involved in the project. I was learning to do something new, enjoying driving this big American car, drinking Budweiser in the evenings and watching baseball on the TV. It was quite an adventure. What the scientists were trying to do was completely insane. I like people wanting to do an impossible thing and I liked the science.

“I realised that if I was extremely lucky, my entire sociological career would coincide with the terrestrial detection of gravitational waves. I stuck with gravitational waves for 45 years because I thought there was a chance they would be discovered in my lifetime, and it seemed a good gamble. What kept me hooked was the near impossibility of achieving it.”

Professor Collins’ biggest breakthrough came early on in 1972 with the serendipity that has peppered his career. “I was driving through some horrible scrubby desert in Nevada and suddenly I realised my project on gravitational waves had gone completely and utterly wrong. The hairs on the back of my neck stood up for about 20 minutes, until I realised that I had discovered something far more interesting than I set out to discover. I thought I was learning how people learned from each other, how to build a certain kind of apparatus, but what I suddenly realised was no-one knew if they had a working gravitational waves detector or not and the far more interesting piece of sociology is how they decided whether they had an apparatus that worked or not. That turned into an idea called the ‘experimenter’s regress’ which established my position as a sociologist of science.”

As time went on and the science of gravitational wave detection changed from a small laboratory-based science to ‘big science’ costing hundreds of millions of dollars with apparatus built in remote sites, Professor Collins observed and watched things change. He saw apparatus being built, witnessed the craftsmanship of the engineers and observed how this convinced scientists that gravitational waves would one day be detected. “You create reality on the ground – I saw that as a sociologist – it was very distinctive,” he said.



In 2015, scientists discovered gravitational waves, making headline news around the world. “I was sitting there at home with my laptop seeing that first email saying we found an interesting signal which, astonishingly, turned out to be the real thing,” said Professor Collins.

> I stuck with gravitational waves for 45 years because I thought there was a chance they would be discovered in my lifetime, and it seemed a good gamble. What kept me hooked was the near impossibility of achieving it.

His 45-year research journey and the eventual discovery of gravitational waves is documented in his book *Gravity’s Kiss* – a real-time account that reveals the intricacies of the discovery, the characters involved in the project and the reception of the news.

“The stories, the things that happened, it was more dramatic than opera. But they did it and it was a great surprise when it happened,” said Professor Collins, adding: “I am absolutely privileged and lucky to have been a part of the gravitational waves project - it’s the spine of my career, really.”

There aren't many campus buildings where a lunchtime stroll around the 'block' could result in a sighting of an endangered great ape or a herd of elephants. But at the Danau Girang Field Centre, in the heart of the Borneo jungle, these are common sights that, thanks to the conservation efforts of the team that live and work at this jungle outpost, have a chance of being around for future generations to enjoy.

WELCOME TO THE JUNGLE

An unassuming one-storey building, surrounded by tropical vegetation, the Danau Girang Field Centre certainly isn't your average university site. A collaborative research and training facility, managed by Sabah Wildlife Department and Cardiff University, it is dedicated to the conservation of tropical ecosystems and the management of wildlife in the increasingly fragmented Bornean landscape.

And once a year it also becomes home to a group of eager bioscience students from the University who spend two weeks learning about rainforest biodiversity in this unique ecosystem.

As **Assistant Director of Sabah Wildlife Department, Dr Senthilvel Nathan** is committed to the conservation of Sabah's natural resources and wildlife. He talked to the University's **Dr Benoit Goossens, Director of the Danau Girang Field Centre,** about what the Centre brings to the area and the students who visit.

"Many of us in Sabah are aware that the Field Centre has its tenth anniversary this year," said Dr Nathan. "Having worked for both Sabah Wildlife Department and the Field Centre, I'm aware of many of its achievements over the years, but I'm also curious to know more about its origins."

A founding member of the Field Centre, Dr Benoit Goossens first came across the building in 1999 while doing orangutan research in the area. "The Centre was originally set up by Sabah Wildlife Department as an education facility in the late 1990s, but unfortunately it stopped operating because of lack of funding," he said. "When I came back in 2005, for a research project focused on elephants, I saw the Centre again and it was falling apart. It was then that I came up with the idea of setting up a research and training centre for Cardiff University and Sabah Wildlife Department. Both the Department and the University were very supportive and we opened the doors in July 2008."

Sabah has become a global hotspot of forest loss and degradation, due to timber and oil palm industries. For Dr Nathan, in his role of Assistant Director at the Sabah Wildlife Department, this has led to many projects to rescue and translocate numerous wildlife species over the years. "The Field Centre has played an important role in our rescue and conservation efforts by studying how the wildlife in the area is responding to fragmentation and degradation," he said. "Also, Dr Goossens and his team are providing a very important service in terms of capacity building for locals, by training young Malaysian conservationists to protect our natural heritage."

Dr Goossens agreed that the Centre plays several important roles. "In addition to gaining new information about the wildlife in the area, the Centre has also supported efforts needed to conserve it, which includes contributing to state action plans," he commented. "A great example of this is when we worked with Sabah Wildlife Department to stop government plans to build a bridge across the Kinabatangan river. This bridge would have endangered Bornean elephants, orangutans and many other jungle species."

> "We're very proud of what we've built and achieved here over the last ten years. From discovering a new orangutan species within Indonesia, to training the next generation of conservationists, our team has put Cardiff University on the map for world-class bioscience research and applied conservation."

With most of Sabah being a protected area surrounded by oil palm plantations, much of the Centre's research is focused on the interface between these plantations and tropical forest. "We are looking at how wildlife is responding as it's increasingly hemmed in by the spreading plantations," said Dr Goossens. "So most of our research is focused on following the movements of species in the local landscape, looking at whether they are using the oil palm plantation and how they are adapting to it. This research includes most of the species in the area, including the Bornean elephant, the clouded leopard, the sun bear, the Sunda pangolin and the proboscis monkey.

Some of the Centre's latest projects highlight the very urgent need to step up conservation efforts in Sabah. Dr Goossens and his team recently discovered that 100,000 orangutans have disappeared in Borneo in the last 16 years. "This worrying high number is due to hunting and the destruction of habitat," he said. "It's not all bad news, though; we are working with Sabah Wildlife Department who are committed to protecting 30% of the forest so that orangutans have enough land to establish territories. This will be a game-changer for the largest populations."

Dr Goossens and his team also recently discovered that degraded areas of forest, previously cleared for logging or agriculture, are ideal habitats for elephants in Sabah. "We

made this discovery by tracking the movements of elephants through GPS collars and using airborne laser-based imaging to analyse the forests, giving us a three-dimensional map of the rainforest canopy height and structure," he said. "While this finding is good news, the danger now is that a large proportion of these lower-stature forest habitats could be prime candidates for conversion to large-scale agriculture before their importance is fully realised.

"The hope is that this study will reinforce the importance of protecting habitats perceived as low-quality, rather than solely old growth, high carbon, forests."

When it comes to the educational work of Danau Girang, Dr Nathan has first-hand experience of the unique biodiversity and conservation training that the Centre provides. "The Field Centre has given me the opportunity to pursue a PhD in Conservation Genetics and Management of the Proboscis Monkey," he commented. "It's the ideal location to study wildlife and the effects of habitat alteration on biodiversity, while also contributing to long-term data that could make a real difference to the future of this beautiful landscape and its inhabitants. It's also a great opportunity to work alongside students and researchers from all over the world who are passionate about wildlife conservation."

For Dr Goossens, one of the most important functions of the Field Centre is the training it provides for local students. "As well as hosting postgrad field courses from all over the world, we are open to local undergraduate and postgraduate students," he said. "Our first Malaysian graduate got her PhD this year and we currently have four PhD and five master's degree students from Malaysia. It's great that we can train local people who want to use this training to look after the unique species in this beautiful part of the world.

"One of my current PhD students is from right here in Sabah. She is currently working on the Sunda pangolin and becoming a prominent conservation figure in the area.

▲ Dr Senthlivel Nathan and Dr Benoit Goossens

Looking back on the last decade, Dr Goossens concluded: "We're very proud of what we've built and achieved here over the last ten years. From discovering a new orangutan species within Indonesia, to training the next generation of conservationists, our team has put Cardiff University on the map for world-class bioscience research and applied conservation."

Professor Claire Gorrara

A-Level student **Nicola Emery** quizzes **Professor Claire Gorrara** of the School of Modern Languages on the success of the Welsh Government-funded Turbo Tutoring initiative, which she was a part of last year.

TURBO TUTORING

A student of French, German and maths at Caerleon Comprehensive School in Newport, Nicola Emery is taking a year out after her exams to travel. First stop, Canada, where she will be using her French skills at a summer camp, before travelling Europe to spend time in France and Germany.

"It's about being able to engage with other cultures," said Nicola. "Learning other languages has also improved my confidence and problem-solving skills. I think it makes you a more interesting candidate in the workplace too."

But it seems, despite the many and varied benefits of speaking another language, not enough students are tempted into choosing them as subjects.

Uptake for modern foreign languages (MFL) at A-Level has been decreasing at worrying levels in Wales – down 44% since 2001. Entries for French are well below half the level they were at in 2001 (40%). And the 2015/16 Language Trends survey of MFL teaching in Wales showed that, in schools which offer post-16 courses, numbers for AS and A2 courses were low and decreasing.

In September 2016, new A-Level specifications for languages were introduced, raising fears that unfamiliarity with the new exams would cause attainment levels to fall and drop-out levels to increase further.

So, Professor Claire Gorrara and the team at the School of Modern Languages sprang into action with the launch of Turbo Tutoring. Now in its second year, its aim is to support students as they make the transition from GCSE to AS-Level.

Professor Gorrara said: "There are many myths surrounding modern foreign languages, one of them being that it is harder to get a high grade in those subjects than say for example, maths. But the results don't indicate this at all.

"Another is that most people in the world speak English so there is no need to be bilingual. This is just not the case and in fact, three quarters of the world's population does not speak English.

"Perhaps one of the most worrying myths is that studying a language is not as valuable as other subjects, such as the sciences. The truth is it can be a wonderful preparation for students who want an international career."

Nicola said she had come up against these opinions. "People do seem to worry that it's difficult to obtain a high grade. But it's like any A-Level subject – if you work hard and put in the time, you'll get a good mark.

▲ Nicola Emery

"Quite a few people have also said they don't quite understand what I could do after school with these qualifications and there's a view that they are quite limiting subjects.

"But once I finish my A-Levels in the summer, I'm leaving the classroom and using my languages straight away. I'll see immediate advantages even before I take into account the wider benefits – I'm not sure you can say this about every subject."

> Our research has shown that the biggest advantage students took away was improved exam technique, followed by increased confidence.

Professor Gorrara agreed: "Even if they choose to stay and work in the UK, individuals who can speak another language have better communication skills and a deeper understanding of other cultures. The latest research *(Languages After Brexit: How the UK Speaks to the World)* around language policy suggests these students work more effectively in teams and are far more confident in their outlook. It's a skill that you can take with you after your education and improve on every day, throughout your life."

Professor Gorrara said there was a huge task ahead in encouraging more people to choose languages. "The drop-out rate between AS and A-Level indicates a lack of confidence, and anxiety from students. Turbo Tutoring is a direct response to this and was set up with the intention of helping students feel fully prepared for exams as well as inspiring them about the possibilities their new-found knowledge could bring."

Nicola admitted even with her huge enthusiasm for languages, the jump from GCSE to AS-Level had been a daunting one.

"There was an awful lot of course material to get through. Given the oral exam was in April, it left only a few months to get up to speed. The new curriculum meant there were very few specimen papers to look at."

She added: "It doesn't matter how much you know, you have to understand the exam technique to be able to apply your French knowledge in the right way."

Professor Gorrara agreed Nicola's concerns were common themes among learners. The team of turbo tutors set out to alleviate these worries during the intensive 10-week programme.

"Our approach is to show students how to 'attack' the exam paper," said Professor Gorrara. "It's by no means a copy of the

curriculum. Turbo tutors show them where their strengths and weaknesses lie giving them a focus on how they can work to improve their grades at the end of their studies.

"Turbo tutors were given insight into assessment and examination expectations from the chief examiner of French for the WJEC (examination board) before the course commenced so they had a firm understanding of what was expected and how to maximise student performance.

"They then met with students and created individual learning programmes."

Nicola explained how it worked at her school: "We met with the turbo tutor in groups of two or three. We were asked what we wanted to concentrate on during our time together, so the tutoring was very much tailored to our needs.

"In my case, I felt most nervous about my listening exam, so we focused on exam technique around that. We looked at the types of questions we might be asked and practised from there.

"It was great to be able to have time away from the classroom where we were simply getting through the curriculum, to think about how we applied what we were learning to the exam.

"It really helped me to stay on track as I revised."

Nicola went on to achieve an A in French AS-Level, with the results from the pilot study showing an overall improvement across the group. Teachers had expected only 8% of learners to achieve an A but in fact 20% did so.

The impact on oral grades was an average of more than one grade per learner, compared to teachers' predictions.

The improvement also converted into more learners deciding to continue with their studies into A- Level than the national average.

Nicola said: "I was really pleased with my grade at the end of it. I felt so motivated going into my A- Level course."

Professor Gorrara said Nicola's feedback echoed overall opinions from other students and teachers. Its success resulted in the Welsh Government giving the go-ahead for another year's funding.

"Our research has shown that the biggest advantage students took away was improved exam technique, followed by increased confidence," she said.

"We have also sought to improve this year's offering by providing training to teachers too, so they feel fully briefed on the syllabus. In many ways, the turbo tutor acts as a mentor for teachers as well as being a great support for students."

This year, Nicola has been working towards her A-Levels without the help of Turbo Tutoring, which focused solely on AS-Level students.

"It has felt more nerve-wracking this year," she admitted. "The course really helped me think about what I might expect from my exams and kept me calm and focused. This year, it feels like I am going into the unknown somewhat.

"I definitely feel that extra support would have been of huge benefit as I approach my final exams."

This is a real challenge for the future and much work needs to be done to ensure the UK does not fall behind the rest of the world in terms of multilingualism.

Professor Gorrara agreed that she would like to see the scheme expanded. There are currently only 12 schools and four further education colleges taking part in the project.

"I would be thrilled if we could integrate this into the curriculum across Wales," she said. "The model could easily be adapted for A-Level students too. We chose to focus on AS-Level students as a priority as we wanted to try and support people and reduce drop-out before they began their final year.

"There is still much work to be done in the studying of modern foreign languages. Only 18% of students choose this subject at GCSE, which is a hugely concerning figure and means many pupils are excluded from considering AS-Level before they're even 16.

"We're doing a lot of work with pupils from years 8 and 9 to demonstrate the value of learning a language. It's about showing young people that languages open doors that would otherwise be closed if they weren't able to understand other cultures."

Nicola, who is also revising for her German exams, also wondered why French was the sole focus for this scheme.

Professor Gorrara responded: "It would be great to be able to work with other languages too. We chose French because it is the largest A-Level subject in modern foreign languages. But the uptake of German is another key concern.

"It's often a vicious cycle – if you don't give targeted support, the overall grades go down and it becomes less attractive to prospective students.

"This is a real challenge for the future and much work needs to be done to ensure the UK does not fall behind the rest of the world in terms of multilingualism. With the advantage of being a bilingual nation, here in Wales we need to build on the rich linguistic resources of the Welsh language and support further our multilingual aspirations. Brexit means that we will need multilingual speakers and communicators even more than before."

Nicola, who leaves the day after her exams for a summer teaching horse riding to children in Canada, said: "It would be really disheartening to think that the number of people taking up a language will drop further. The wide-ranging benefits of taking these subjects need to be promoted heavily to students.

"I've already got so much out of learning French and German. I can't wait to see where my studies will take me next."

Time for an intervention?

Professor Simon Moore (PhD 2001)

Could drunk tanks and minimum pricing be the answer to Britain's drink problem?

As the UK's alcohol industry continues to make healthy profits, the nation is left counting the increasing cost of our unhealthy relationship with booze

From overstretched accident and emergency departments to a steady incidence of alcohol-related disease, the cost is massive, with recent figures revealing that alcohol-related harms cost the NHS around £3.5 billion annually.

And the problem doesn't end there. Walk down any UK high street on a Saturday night and you'll almost certainly have to dodge several obstacles, from aggressive drinkers to broken glass. Unfortunately, the atmosphere and safety of our town centres can rapidly deteriorate as alcohol consumption increases.

With an estimated 1.1 million hospital admissions related to alcohol consumption in 2015/16, we clearly need some kind of intervention. However, as many of us enjoy a tipple, and only experience the edge of the problem, we may not be inclined to back a hard-line when it comes to alcohol restriction. But for those on the front line it's a different story.

Dr Adrian Boyle, Consultant Emergency Physician at Addenbrookes Hospital and Alcohol Lead for The Royal College of Emergency Medicine, knows only too well the damage brought about by excessive alcohol consumption. With **Professor Simon Moore (PhD 2001), Director of the Alcohol and Violence Research Group at the University**, he discusses the urgent need for change.

For Dr Boyle, a move to minimum pricing in line with Scotland could make a significant difference to the number of intoxicated people that pass through his A&E department, but he understands there may be barriers to its

implementation and success. He also wonders if Scotland's successful approach of treating violence as a public health problem, rather than a criminal justice problem, could also be translated to the rest of the UK. "Scotland has seen really impressive reductions in violence over the last decade, much greater than the rest of the UK," commented Dr Boyle. "They claim this is because they treat violence as a public health problem, rather than a criminal justice problem, so maybe it's time that other UK nations think about adopting the Scottish approach."

With his extensive research in areas such as alcohol harms, effectiveness of drunk tanks and crime prevention, Professor Moore offers some interesting insights. "There are two main barriers when it comes to minimum pricing across the UK," he said. "First, the alcohol industry has tried to derail initiatives, mostly through legal challenges. But with manufacturers of alcohol bearing none of the costs associated with alcohol misuse, organisations like the NHS are effectively subsidising their business model.

"The second barrier involves a particular type of alcohol user - those who vociferously object to anyone interfering with their hard-earned pint. What is unusual about this second group is that minimum unit pricing is unlikely to affect the price of their usual drink. And when the primary effect of minimum pricing is explained (ostensibly removing the absurdly cheap strong ciders and cut-price spirits - the kind of brands that those with taste buds or without alcohol dependence aren't likely to go near) most people agree that minimum pricing is a good idea."

A recent study by Professor Moore and his team at the Alcohol and Violence Research Group revealed that reform of alcohol taxation could be a viable alternative to minimum pricing. They found that 6,000 fewer violence-related accident and emergency department (A&E) attendances per year would result from a 1% rise above inflation on alcohol sold through drinking establishments and shops. "Our findings suggest that reforming the current alcohol taxation system would be more effective at reducing violence-related injury and other alcohol-related harms than minimum unit pricing," said Professor Moore. "However, any such policy would need to increase the price of alcohol in both drinking establishments and shops. The additional tax revenue of about £1 billion a year could be used to offset the cost of alcohol-related harm to the NHS."

Dr Adrian Boyle, Consultant Emergency Physician, Addenbrookes Hospital and Alcohol Lead for The Royal College of Emergency Medicine

> With an estimated 1.1 million hospital admissions related to alcohol consumption in 2015/16, we clearly need some kind of intervention.

In regards to England and Wales's approach to dealing with violence, Professor Moore admits that he is continually amazed that alcohol and violence remain criminal justice matters. "It is our health services who handle the consequences of alcohol and violence, so much more needs to be done to encourage health to play a more active role," he stressed. "Despite a number of very positive initiatives, health remains on a somewhat reactive footing, rather than proactively reaching out in an attempt to challenge the causes. Given the number of health service staff who experience assault by patients, this is somewhat surprising."

While alcohol-related violence is generally on the decline in England and Wales it still places a substantial burden on health services and our emergency departments. "Latest figures show that we are getting less violent as a society but for those of us working in emergency departments it's still a serious problem that takes staff away from other emergencies," commented Dr Boyle. "There is still a very real need for new strategies when it comes to dealing with alcohol-related community violence."

The research of Professor Moore's team has found a substantial year-on-year decline in serious violence, but doesn't reveal the reasons. "There is widespread speculation, from less lead in the environment to youngsters spending more time playing computer games instead of going out," said Professor Moore. "Undoubtedly, collaboration between services, including the police, evaluators, academics and others is likely playing a role."

He admits that it's not all good news, as their findings suggest that alcohol-related violence remains a significant problem, with violence-related A&E attendance consistently at its highest levels on weekends. He explained further, "I would caution anyone to claim that as a species we are innately less violent. Violence is common across the animal kingdom and we are no exception. More work to better understand who is most at risk, and where and why, is needed so we can continue to arrange interventions that minimise these harms."

So what's the best way to way to deal with alcohol-related community violence? Professor Moore feels there are many reasons for the issues we see in city centres and there is no single solution. Interestingly, and somewhat anecdotally, he believes many people think that their activities on a Friday or Saturday night have limited effect - that drinking to excess and getting into fights are legitimate behaviours. He said, "Emergency services are increasingly stretched, and nurses, paramedics and police officers are routinely abused. But it does not end there; the whole community suffers. Ambulances diverted to town centres to sort out those who have drunk to excess cannot respond to calls in the community, A&E waiting rooms are besieged by drunks who affect other patients. I've heard of elderly patients self-discharging from A&E because they could not stand being there on a Friday night. So what happens in town on Friday night does not stay in town on a Friday night – it has repercussions for all of us."

Drunk tanks are one potential solution that Professor Moore's team is researching. The findings of the study are due later this year and are intended to provide evidence on whether these alcohol intoxication management services should be rolled out across the UK.

"Evidence suggests that A&E sees more intoxicated people than is necessary, possibly due to risk aversion on the part of those referring people to them, and also because there is nowhere else for the intoxicated to go. This would suggest there is a role for alcohol intoxication management services, even in the form of safe havens that don't offer full A&E services," said Professor Moore. "However, there is still limited evidence of the effectiveness of those that are up and running. By comparing data from cities with and without bespoke services, we hope to get a clearer picture of their effectiveness for patients, cost effectiveness and impact on frontline staff."

While Dr Boyle agrees that drunk tanks can relieve pressure on A&Es, he's not yet convinced they are the best solution. "Although the presence of drunk tanks means that intoxicated people are treated away from other patients, there is still the issue of these people being a burden on our emergency services," said Dr Boyle. "These treatment centres need to be staffed which means they are still using up valuable resources. I look forward to seeing the findings of Professor Moore's study."

Both Dr Boyle and Professor Moore feel that their line of work has influenced their attitude towards alcohol. Dr Boyle concluded, "I don't think getting drunk on a night out should be a rite of passage for young people in the UK.

After a lifetime of treating the consequences of binge drinking, I have certainly become more interested in effectively stopping people from falling into the river than trying to drag out drowned people downstream.

"After a lifetime of treating the consequences of binge drinking, I have certainly become more interested in effectively stopping people from falling into the river than trying to drag out drowned people downstream. I certainly used to enjoy a drink, but being the sober doctor to drunk patients has put me off excessive drinking."

Professor Moore added, "There is a certain point in young adulthood where people just want to shed the perceived shackles imposed by parents and have fun. This has not changed for generations. But what we have today is a predatory alcohol industry pushing the idea that young people can do this by drinking a particular brand of alcohol to excess. This industry has commoditised fun and sold it in pints, bottles, hangovers and trips to A&E.

"There is a valued place for traditional pubs, such as those that host live music or cater for families. This, more than anything, reminds me that alcohol has traditionally played an important role in our communities. One of the greatest determinants of health, particularly in the elderly, is lack of social contact.

"My attitude has evolved to one that recognises the need to target those who drink to excess but at the same time recognising the need to retain the unique place of the well-run British pub where people from all walks of life can put the world to rights."

In conversation with...

Challenge Cardiff spoke to Professor Mary Heimann to discover how her research is helping us to 'learn from the past to protect our future'.

We are living through turbulent times. From the recently-revealed treatment of Windrush Generation citizens to world leaders using social media to threaten nuclear war, each day brings bleaker headlines and our collective future starts to look very unsettled.

What can historical research bring to bear on our current situation and can it help us to avoid remaking the mistakes of the past?

Professor Mary Heimann, Chair of Modern History in the School of History, Archaeology and Religion, is an historian specialising in Czechoslovakia, Victorian Catholicism, and Christianity in Eastern Europe during the Cold War. Describing herself as an historian of ideas, her research seeks to recover and make sense of how people, living at different times and in different places, conceptualize their own and rival religious faiths, scientific paradigms, national identities and political utopias.

She said: "The approach I take to the history of ideas is rather like that of an anthropologist. I treat the past as a series of foreign cultures whose mental outlooks, prejudices and assumptions are different from our own.

"Historical research is not a predictive science: it can't tell us what the future holds. Researching the past can, nevertheless, help us to make sense of current problems by giving us an understanding of the background and complexities. Without historical analysis, we are liable to oversimplify."

Learning lessons from this history enabled Professor Heimann to contribute policy recommendations for regional stability through NATO's Partnership for Peace.

Professor Heimann is a leading authority on the history of Czechoslovakia, a country that was set up as a democratic, liberal and multinational state, but fell prey to ethnic chauvinism, dictatorship, and both Fascist and Communist rule. Learning lessons from this history enabled her to contribute policy recommendations for regional stability through NATO's Partnership for Peace, an example of how historical expertise can be used to aid policy-makers.

"Historians can sometimes offer policy-makers useful precedents, warnings, or models. To take an example from my own research, analyzing Czechoslovakia's peaceful separation into independent Czech and Slovak republics in 1993 was helpful to policy-makers wanting to promote regional stability in the Caucasus in 2015. Although two situations are never exactly alike, we can nevertheless learn from other times and places. The danger arises when false or simplistic analogies are used for propagandistic purposes, for example by invoking the Munich Crisis to justify aggression in Iraq."

In May 2018, Professor Heimann brought Czech and Slovak diplomats, NATO and Welsh Government policy-makers, academics and research students to Cardiff to mark the centenary of the founding of the Czechoslovak state in 1918. The Czechoslovakia100 Study Day included an expert roundtable discussion designed to draw out policy implications for today from the Czechoslovak state's often troubled past.

> An environment in which policy decisions with serious implications for real people are made in response to a misleading newspaper headline, or for the sake of a riposte in parliamentary debate, or at the whim of a tweet is not a safe environment for anyone.

Professor Heimann's book *Czechoslovakia: The State That Failed*, published by Yale University Press, has been influential in overturning some of the historical myths surrounding Czechoslovakia as a 'victim' country. In revealing how this sense of victimhood allied with intolerant nationalism led to discrimination against and persecution of minorities, her work reinforces the dangers to all states of promoting self-serving national myths dressed up as history.

Discussing her book, she said: "My Czechoslovakia book tried to complicate simplistic notions of Czechoslovakia as a `victim' country by showing the former Czechoslovak state to have been a perpetrator, as well as a victim, of the state-sponsored persecution of minorities. The trouble with perpetuating a national sense of victimhood – as is common among many modern European nations – is that it keeps alive nationalist grievances. States that are officially aware of their own complicity are more likely to tolerate their neighbours and their minorities, just as people who are aware of their own flaws are less likely to condemn others."

Last year she was invited to speak at TEDxCardiff and warned in her talk that, although Europe still bears the scars of Nazism and Stalinism, the world again seems to be sleepwalking into totalitarianism.

On parallels between the 1930s and the present-day, she said: "The parallels with the 1930s are there for everyone to see. So much looks familiar: the sense of impending crisis, the discrediting of liberal values, the rise of dictators, the economic protectionism and political isolationism, the scapegoating of

refugees and migrants, the stimulation of racism by politicians and the press, the bypassing of normal political and diplomatic conventions. Everyone can feel that there is a deep change underway, that the political status quo is under threat, just as everyone could feel it then."

When asked if atrocities could happen again, she said: "Genocides, forced expulsions, mass killings of civilians, concentration camps, gulags are all atrocities that happened here, in Europe, within living memory. There is every danger that they could happen again. A political climate in which immigrants, refugees, foreigners, and minorities are discussed as if they were different to 'us', or as if they were a 'problem' is deeply worrying. An environment in which policy decisions with serious implications for real people are made in response to a misleading newspaper headline, or for the sake of a riposte in parliamentary debate, or at the whim of a tweet is not a safe environment for anyone.

"Steps need to be taken to ensure that, for example, forced-detention centres and camps for refugees and illegal immigrants in the UK are held to international humanitarian standards. It will be even more important for ordinary people to speak up to defend refugees, asylum seekers, migrants and foreign nationals after the UK leaves the EU. The way in which even legal residents, such as EU nationals, have been treated since the referendum is shaming. The latest Windrush scandal is shocking beyond words. The danger is that people stop feeling and reacting to repeated shocks – that our sense of justice becomes blunted."

In her TEDx talk, Professor Heimann spoke about how totalitarian regimes are not imposed overnight – public opinion is gradually softened up and dictatorships need to be able to claim a form of legitimacy in order to entice people. The Fascist and Communist regimes that dominated Europe in the 20th century relied on everyday human flaws – envy, gossip, malice, careerism – to tempt ordinary people voluntarily to police and report on one another. Propaganda plays an important role in this.

Professor Heimann's work on the Czechoslovak secret police archives in Prague taught her a lot about how 20th-century authoritarian regimes – on both the political Left and the political Right – worked in practice:

"These regimes did not normally force citizens to comply, because they did not have to. If the state signals that certain groups of people are unwanted, official ruthlessness and spontaneous persecution usually follows. Once certain parameters and norms have been set, enough ordinary citizens can usually be relied upon to police one another, to inform upon each other, to seek to overtake or harm one another, not because they have any interest in politics, or even in ideas as such, but simply because they want a pay rise, or a new house, or to get even with a rival, or to impress someone.

"The convenience of ideology is that it enables ordinary people to justify their otherwise shameful behaviour in lofty terms.

"The very human desire to conform – sometimes through fear and sometimes through self-interest – is what props up inhumane policies and dictatorial regimes. The opposite is also true: our instinctive understanding of decency, kindness, fairness can prevent the implementation of cruel policies, just as it was possible for Denmark or Bulgaria not to implement the 'final solution'. The great majority of Nazi-occupied states tolerated or colluded in the Holocaust, sometimes exceeding Nazi expectations, which we should take as a warning."

Politicians and the media use the language of democracy when justifying support for particular agendas – 'the will of the people', for example, is a phrase we hear a lot in reference to Brexit.

The language we use can play an important role in spreading or combatting propaganda. Politicians and the media use the language of democracy when justifying support for particular agendas – 'the will of the people', for example, is a phrase we hear a lot in reference to Brexit.

But this is often nothing more than empty rhetoric and Professor Heimann has seen from the past how simplistic slogans and repeated phrases are used to soften up public opinion.

She said: "It's not just politicians and the media, dictators also claim to represent the 'will of the people' (or the 'nation'; or the 'working class'; or some other collective noun) and use referenda and polls, once they are certain of getting the correct result. The phrases in themselves guarantee nothing. Democracy, though less awful than other systems of government, is not a panacea.

"One of the best ways for citizens to protect themselves against tyrants is to call things by their real names, not to fall for lofty phrases and euphemisms, and to keep focussed on the rights of individuals, not collectives."

If we are indeed sleepwalking again into something all too horribly familiar, what can we as individuals do? Can we use the lessons of history to avoid making the same mistakes again?

"One of the best ways for us to avoid repeating the same mistakes is to stop reproducing the same old clichés and popular myths, which serve to inflate a sense of national self-importance. We need to allow historians, not politicians, to determine what lessons, if any, might be learned from history; what history topics should be taught in schools; and what avenues of research should be funded by the research councils.

"Academics and students from around the world should be welcomed to the UK, if only to prevent intellectual life from becoming too insular. Fatuous schoolboy history of the kind first satirised in 1930 as *1066 and All That: A Memorable History of England, comprising all the parts you can remember, including 103 Good Things, 5 Bad Kings and 2 Genuine Dates* should have no place in Home Office publications like the UK Citizenship Test (the test anyone who wants to become a British citizen is required to pass).

"Historically speaking, the regimes that scarred Europe for generations have barely passed away. Before the last people have died who suffered through all of that, we seem to be heading in the same direction again. It's tempting to blame a particular politician and to forget that the power they wield is only as strong as we collectively allow through our silent complicity. We will not change society by exchanging one leader for another or even one ideology for another. Our most powerful defence as human beings against the new forms of oppression which I fear are coming is to call things by their real names, to judge from experience rather than hearsay, and always remember to consider actual human beings, not abstractions."

The world's oldest and most complex trees

The first trees to have ever grown on Earth were also the most complex.

Fossils from a 374-million-year-old tree found in north-west China revealed an interconnected web of woody strands within the trunk of the tree that is much more intricate than that of the trees we see around us today.

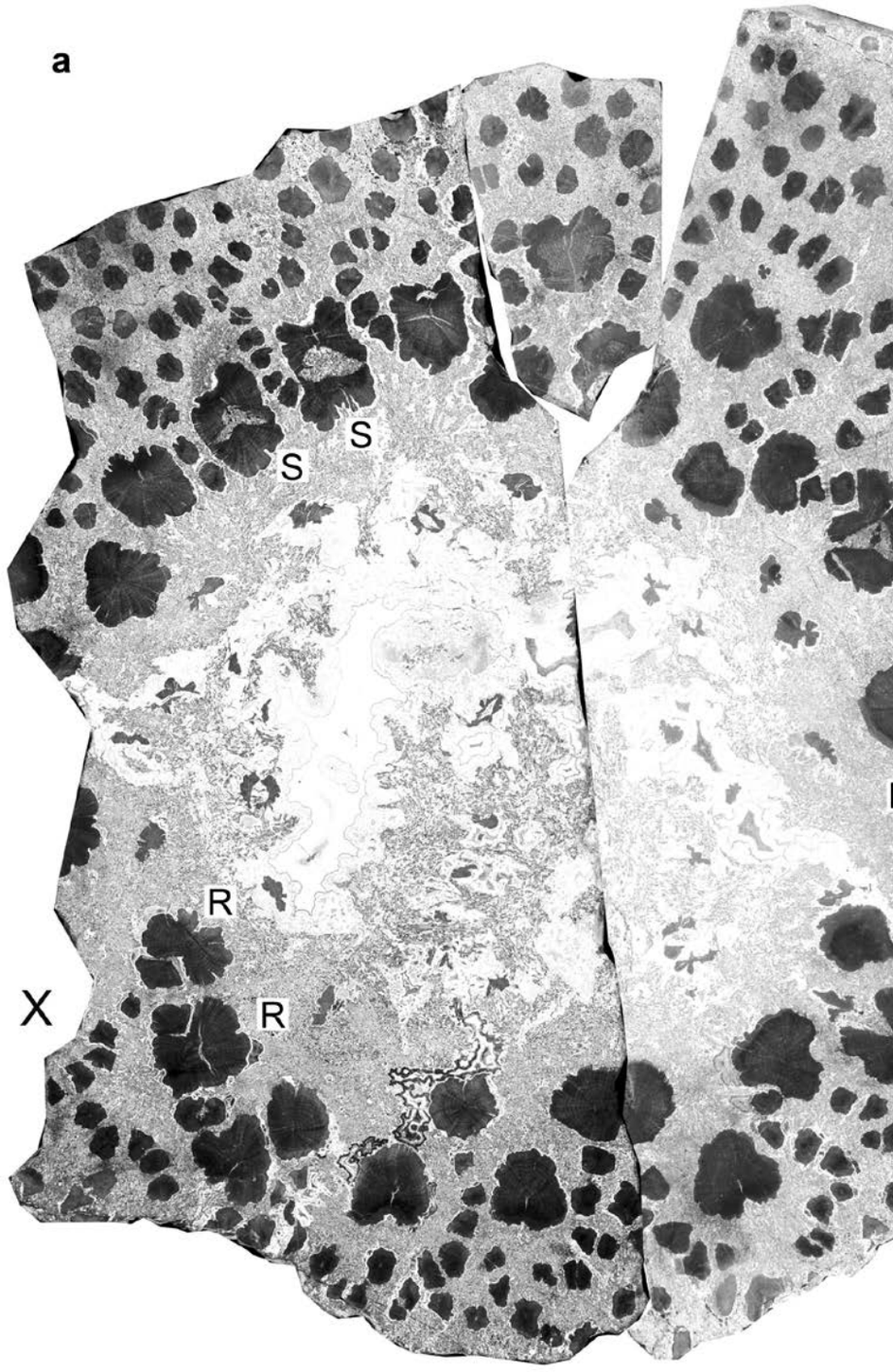
The strands, known as xylem, are responsible for conducting water from a tree's roots to its branches and leaves. In the most familiar trees, the xylem forms a single cylinder to which new growth is added in rings year by year just under the bark. In other trees, notably palms, xylem is formed in strands embedded in softer tissues throughout the trunk.

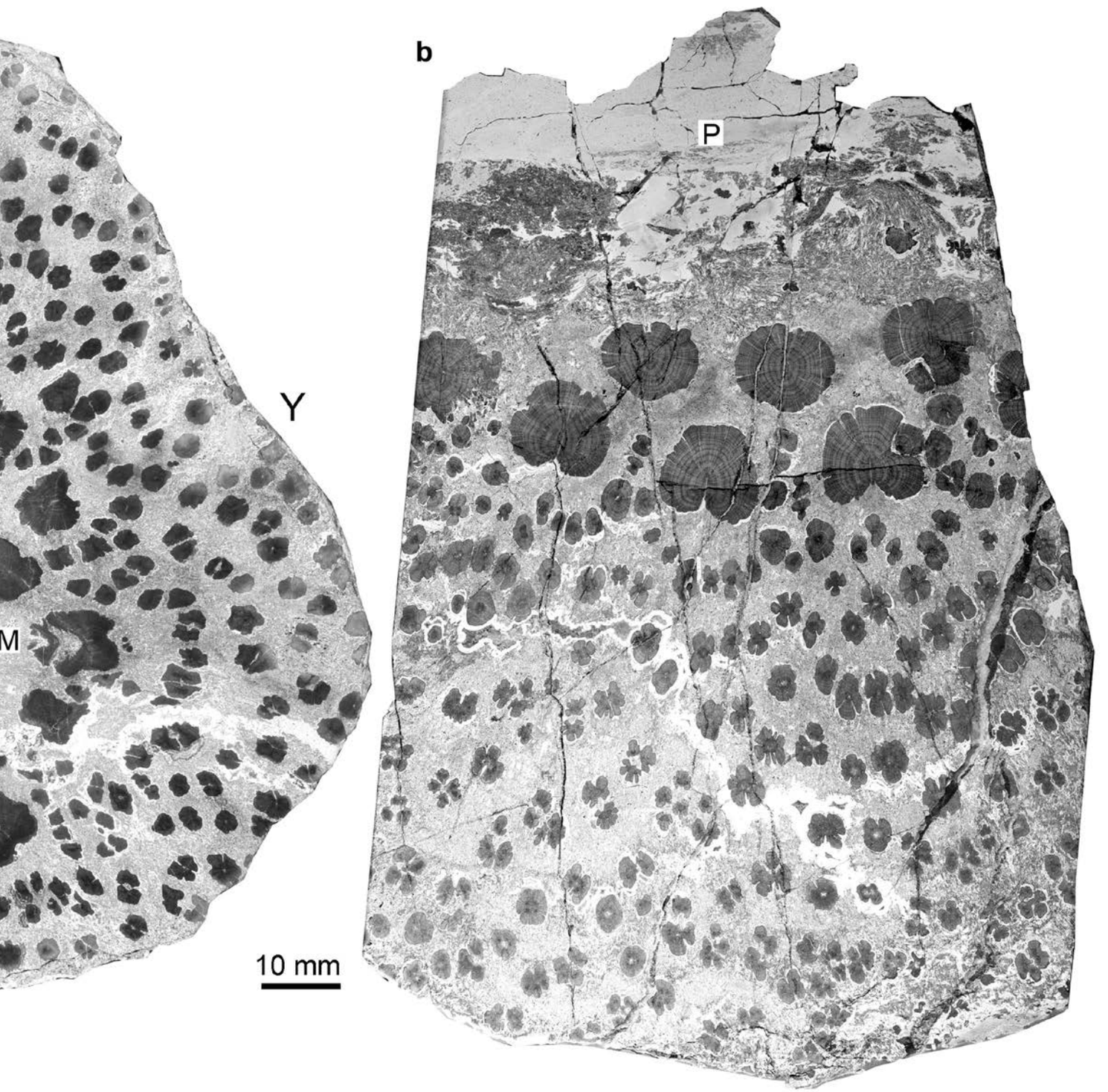
Dr Chris Berry from the School of Earth and Ocean Sciences is part of the research team which also includes academics from Nanjing Institute of Geology and Palaeontology, and the State University of New York. Dr Berry has studied cladoxylopsids (a group of plants known only as fossils thought to be ancestors of ferns and horsetails) for nearly 30 years, uncovering fragmentary fossils from all over the world.

"By studying these extremely rare fossils, we've gained an unprecedented insight into the anatomy of our earliest trees and the complex growth mechanisms that they employed. This raises a provoking question: why are the very oldest trees the most complicated?"

"Previous examples of these trees have filled with sand when fossilised, offering only tantalising clues about their anatomy. The fossilised trunk obtained from Xinjiang was huge and perfectly preserved in glassy silica as a result of volcanic sediments, allowing us to observe every single cell of the plant," Dr Berry said.

The overall aim of Dr Berry's research is to understand how much carbon these trees were capable of capturing from the atmosphere and how this affected the Earth's climate.




b
P
Y
M
10 mm

WHAT MADE ME CURIOUS

Curiosity is at the heart of human existence. It is what drives us to better ourselves and the world around us. This is the belief of Professor Rudolf Allemann, Distinguished Research Professor in the School of Chemistry and Pro Vice-Chancellor and Head of the College of Physical Sciences and Engineering at Cardiff University.

When talking to Professor Allemann, it's hard to see curiosity as anything other than natural, something we are all born with. "It is one of the most wonderful aspects of human nature." Growing up in Switzerland, he describes himself as an "enthusiastic and excitable student who liked exploring new ideas and was never afraid to be bored for the sake of creativity".

As a teenager he was inspired by people with strong and determined views; those who directed that determination to solving some of the most challenging problems. Albert Einstein was a big influence, as was Erwin Schrödinger and his monograph *What is Life?*.

"I liked people who had a great idea and pursued that idea against the odds. When I was 15 I visited the Albert Einstein museum in Bern. It was a really sobering, almost spiritual experience that had a big impact on me."

It was perhaps this sense of determination which ensured that, despite growing up in an industrial environment, he always knew he would pursue a career in academia.

"It was never in question. I always knew I wanted to be an academic. What I love about academia is that if you have good ideas and passion for a subject, you can spend your whole career on a journey of discovery.

"I feel very lucky to be able to do what I do."

After spending his high school years "exploring everything", he focused on chemistry as an

undergraduate at ETH in Zurich before moving to Harvard to start his PhD, which he later completed in Switzerland.

He first moved to the UK in 1989 to take up a Royal Society/Swiss National Science Foundation sponsored fellowship at the National Institute for Medical Research. He joined Cardiff University in 2005 after periods of teaching and research at ETH and the University of Birmingham.

As someone who has benefited from a career spanning many international borders, he is philosophical about the impact of Brexit on academia: "I worry a little but not a huge amount. I've always seen the UK as an open society and Brexit will not change this underlying sentiment.

"To me Brexit is a symptom of some of the current issues in societies around the globe, for example how communities are dealing with the effects of globalisation. I'm confident that we will return to the realisation that movement of people is a good thing and can bring many benefits to all members of society. To be successful you always need the best people, no matter where they come from and to address the great challenges in our world we must work together."

Interdisciplinarity has always been at the heart of his career, but is not something he thinks too much about. "The interests I have are not really defined by a particular academic field. Many of the most exciting problems and solutions sit at the interfaces between core disciplines. Working together to solve problems is what it's all about, so interdisciplinarity happens naturally."

Professor Allemann is keen to see greater collaboration reflected in the student experience.

"Of course, the technical aspects of our programmes are critically important but in addition to this, we need to recognise the importance of teaching our students how to work collectively to solve problems. This is where the real impact will be made."

When asked if he's concerned about how curiosity fits with the digital generation, Professor Allemann sees only new possibilities.

"Search engines such as Google will only give you an answer if you have a question and what they give you is just data, not a fully informed answer. What is important is what you do with the data to answer your questions or solve problems. In many ways curiosity is more important than ever because a lot of data is out there waiting to be used; we now have to focus on how we can use it to generate viable solutions."

His own research focuses on the application of a wide range of chemical and physical techniques to answer questions relating to the extraordinary catalytic power of enzymes. With his research group he develops and applies chemical tools to probe and control biological processes in the laboratory and in live cells.

Recent breakthroughs include getting insight into how enzymes speed up reactions and using this knowledge to discover valuable bioactive reagents, for instance by creating novel molecules based on naturally occurring agents that can replace often toxic insecticides.

> What I love about academia is that if you have good ideas and passion for a subject, you can spend your whole career on a journey of discovery.

"We're at a really exciting time," said Professor Allemann. "Not only can we now understand how nature's molecules work, we can change them and apply them to create useful products that don't exist in nature."

He is keen to delve deeper into this in the future. "I want to further explore living systems in nature so that we can redesign nature from first principles.

"Of course, some people are already doing this, for example creating cells in a test tube, but they are only using natural molecules. A chemist's test of understanding a system is whether we can completely redesign it from first principles and make it work in a way that nature has never done."

When he describes the application of his research and the possibilities for the future, it's hard not to get excited. But with the number of students studying chemistry in the UK slowly declining, what more can be done to ignite people's interest in this far-reaching subject?

"Chemistry is absolutely essential to our everyday lives. It is everywhere. Chemists haven't done a very good job of getting that message across and therefore chemistry is often labelled as the cause of many problems rather than the solution.

"Yes, chemicals can cause problems, such as the fumes that come out of our car exhausts. But chemistry is also key to finding the solution to these problems. We can now generate energy in increasingly clean processes and much of that is down to chemistry in general and catalysis in particular.

"As a subject it is misunderstood because we have let people misunderstand it. You can't do much without chemistry. We mustn't forget that."

And how do we counter this misconception?

"We have to talk to people and do more to raise awareness. When I speak to people outside the discipline about my research they are always interested, sometimes more so than my academic colleagues!

"At Cardiff we are working hard, through our engagement with schools and colleges, to make it clear that a chemistry degree can take you anywhere. The possibilities are endless and extremely exciting."

Professor Allemann's passion and excitement, not just for his subject but for education overall, is clear to see and rather infectious. When he talks about his current role as Pro Vice-Chancellor and Head of the College of Physical Sciences and Engineering, it's sharing this passion for science and the academic endeavour with others that seems to drive him most.

"The best part of my current role is definitely interacting with people. My first 12 months have been great fun and that's down to the excellent people I work with." He admits there is still a lot he has to learn, but of course for Professor Allemann that can only be a good thing.

"We must get the message out what amazing contributions science makes to our lives and remember that only by engaging with colleagues in arts and humanities do we get a fully rounded view that will allow us to really push the boundaries of knowledge and understanding.

"My ultimate goal as Pro Vice-Chancellor is to help the people around me, whether staff or students, to be the very best that they can be."

Data Innovation Research Institute

Over recent years, the scale of data available from scientific experiments, medical imaging, the internet and social media has exploded, and new research areas are becoming Big Data driven. The Data Innovation Research Institute was set up with the goal of establishing a Big Data culture at the University.

The University has a long history of research that requires the analysis and interpretation of large data sets. This includes the identification of black hole mergers in gravitational wave data, identification of cancerous regions in medical images, and real-time analysis of social media data. A large part of the Research Institute's work is to bring together researchers with different backgrounds, expertise and data sets to drive forward new research and new collaborations.

In its first two years, this has been achieved by bringing together data-intensive research groups; developing novel collaborations; training undergraduate and postgraduate students to become the next generation of data scientists; developing a network of highly-skilled research software engineers across the University; and building collaborations locally, nationally and internationally with academic and industrial partners.

Data Innovation researchers have been awarded over £5m in new research awards. These include:

- Supercomputing Wales – this provides computational hardware and expert personnel to underpin future research breakthroughs;
- A Centre of Excellence in Cyber Security Analytics with Airbus;
- Science and Technology Funding Council (STFC) funding for a Centre for Doctoral Training (CDT) in Data Intensive Science, in which students will undertake cutting-edge Big Data research and a six-month industry placement.

The Research Institute has created new collaborations within the University, the GW4 Alliance and with international and industrial partners. It ran a successful Data Innovation Day, attended by over 70 University researchers and a series of GW4 Data Intensive Research Workshops, which attracted attendance from the Office for National Statistics (ONS), the Met Office and Welsh Government. It has strengthened international collaborations with Georgia Tech and Nanyang Technological University. It has also developed and strengthened links with local industry, including the cybersecurity centre with Airbus and Cray, EDF Energy and Oracle, and others as industrial partners on its Data Intensive Science CDT.

The Research Institute also has access to an Internet of Things (IoT) laboratory, which enables data capture from real-time embedded environments. The IoT lab has led to collaboration with local companies (such as United Welsh) and with a recently launched IoT Accelerator for Wales (funded by Innovate UK).

Seed corn funding

To kick-start the research activities of the Research Institute, over £100,000 of funding was awarded in 11 seed corn grants, in subject areas that span the research breadth of the University, covering issues including datafication and society, open access brain imaging and data-driven analytics in online advertising.

One project investigated footfall in Cardiff city centre, creating geospatial models of pedestrian data gathered over the main shopping areas. Historic footfall traffic data was used to model pedestrian flows year-on-year across the city centre with the advantage of being able to compare the quality of the models generated against data gathered before and after the construction of the St David's 2 shopping centre. These techniques have the potential to be used to inform policy makers, councils, the police and local businesses about the changing use of high streets.

Another project was adding features and raising awareness and impact of the Illustration Archive, a crowdsourcing platform which makes over a million book illustrations released by the British Library searchable and reusable.

A recently awarded second round of seed corn funding is supporting research in optimisation of healthcare systems, data-driven citizen science in the rainforests of Brazil, deep learning and text mining, and opinion mining to improve healthcare delivery. These projects highlight the wide variety of data-intensive research across the University.

A recently supported study is investigating "bottom up" involvement in the co-creation of data capture and analysis infrastructures supporting citizen science in the Guapiruvu forest community (in Brazil). The project was devised with direct assistance and input of community leaders in the Guapiruvu co-operative movement, the local educational and sustainable development ministry and the Sete Barras Mayoral office. The outcome will show how citizens within a local community can capture/record biodiversity data in their area, and subsequently share this with other agencies.

Research Software Engineers

Essential to a Big Data research culture is a community of research software engineers (RSEs), who provide high quality, robust, well maintained software and applications to support cutting-edge research.

As research becomes increasingly reliant on large, complex data sets and computational methods, research software engineers have become a vital part of many research groups and projects. They combine expertise in programming with a deep understanding of their specific research domain. Through a combination of these skills, they are able to develop robust, high-quality, well-maintained software tailored to answering cutting-edge questions. At present, the Research Institute employs two RSEs, working closely with six more working at the University, supported by Supercomputing Wales. The RSEs are involved in numerous projects across the University, including setting up data archiving services for brain imaging scans, optimisation of computational fluid dynamics codes to run on the new GW4 Isambard cluster at the Met Office, and automated image and caption recognition in historical illustrations with researchers in the School of English, Communication and Philosophy.

In April, the Institute's research software engineers arranged the first Cardiff University RSE conference, which attracted more than 30 attendees. The aim was to bring together researchers who write software and/or deal with data of any kind, from across the University.

Dr Unai Lopez, one of the Research Institute's RSEs and co-organiser of the conference, said: "The event gathered many RSEs from all over the University and we had the opportunity to learn about their current projects, day-to-day commitments, and concerns. From the short presentations and the round tables, we managed to get a realistic and up-to-date picture of the overall situation of RSEs in Cardiff."

Professor Stephen Fairhurst

Centre for Doctoral Training

The Research Institute hosts a Centre for Doctoral Training in Data Intensive Science. The creation of the centre is in response to the growing issue of trying to sift through the mountains of data created by modern observational and experimental science facilities.To address this problem, students will utilise sophisticated computational, statistical and programming techniques, including artificial intelligence and machine learning, to extract insights from huge datasets to make new discoveries.

The students will be involved in cutting-edge research problems in particle physics and astronomy. These will be complemented by secondments to national and international partners. During these six-months placements, the students will use their data-intensive research training to address problems of interest to the industrial partners.

"What I find particularly exciting about these CDTs is that we are giving students training in cutting-edge Big Data methods to apply to both our research problems in physics and astronomy, and to real world problems during their industrial placements," said Professor Stephen Fairhurst, Director, Data Innovation Research Institute.

The Research Institute is committed to developing the next generation of data scientists. It is involved in the development and teaching of a suite of data intensive master's courses and has bid for a future Centre for Doctoral Training on Applications and Implications in Artificial Intelligence.

"we are giving students training in cutting-edge Big Data methods to apply to both our research problems in physics and astronomy, and to real world problems"

CARDIFF UNIVERSITY
PRIFYSGOL CAERDYDD

We respect your privacy and adhere to Data Protection Law. If you wish to stop receiving Challenge Cardiff please email **challengecardiff@cardiff.ac.uk**

Cardiff University Brain Research Imaging Centre (CUBRIC) – housing a combination of neuroimaging equipment unique within Europe

Find out more about the impact of our research

www.cardiff.ac.uk/research

KEEP IN TOUCH

/CardiffUni

@CardiffUni

@cardiffUni

To request a copy of *Challenge Cardiff* in large format contact Communications on 029 2068 8776, email challengecardiff@cardiff.ac.uk

Comments regarding *ChallengeCardiff* are welcome and should be sent to **challengecardiff@cardiff.ac.uk**

Cardiff Universtity is a registered charity No.1136855

This magazine is printed on environmentally friendly FSC papers from sustainable sources. All inks used are vegetable oil based to reduce any further impact to the environment.

The Queen's ɴniversary Priz

Athena SWAN Silver Award

INVESTORS IN PEOPLE

FSC www.fsc.org MIX Paper from responsible sources FSC® C017574