

THE JOURNAL FOR SCIENCE, ENGINEERING AND TECHNOLOGY

advances

WALES

Unveiling Alzheimer's link to the immune system

Welsh researchers reveal the genetic differences that could contribute to an increased risk of developing Alzheimer's disease in later life



14 Monitoring ocean warming with help from Antarctic seals



20 Welsh-led project helps search for life on Mars



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3 News

6 8 9 10 Medicine

Studying women's physical health in extreme environments
Combating infectious diseases through robotics
Unveiling Alzheimer's link to the immune system
Analysing gut health through at-home stool tests

11 Earth Sciences

Unveiling how bats get back home to roost

12 13 Agriculture & Food

Exploring a sustainable solution for potato blight
Strengthening clovers' potential to cut nitrogen fertiliser use

14 16 18 Environment & Energy

Monitoring ocean warming with help from Antarctic seals
Advancing renewable energy through industry-academia collaboration
Recycling coal ash for sustainability in construction

19 20 Engineering & Materials

World-first in-orbit and return to Earth manufacturing service
Welsh-led project helps search for life on Mars

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Welcome to the latest issue of **Advances Wales**, where we explore the intersections of innovation, sustainability, and science.

In this edition, we examine how clover may hold the key to reducing industrial fertiliser use, and we plunge into the icy waters of the Antarctic with Weddell seals to help scientists to understand the extent of ocean warming. The quest for green solutions continues as we explore the potential of chlorophyll by-products in tackling the global challenge of potato blight.

From the microcosms within us to the vastness of space, we examine a kefir firms' novel approach to analysing microbiomes, and we share the inspiring story of two female firefighters who push the limits to study the effects of extreme endurance activities on health.

Robotic innovation takes a leap forward with the next generation of disinfection robots, while breakthrough discoveries draw new connections between Alzheimer's disease and the immune system. We'll look at how bats' navigational abilities could inform our own technology and unveil Space Forge's patent-protected design for a planet-friendly reusable reentry system.

As we consider the future of energy, we examine methods to repurpose coal byproduct waste. Lastly, we look toward the stars with a Welsh-led project that will help with the search for life on Mars.

We are working hard to make Advances Wales a greener more sustainable publication in line with Welsh Government's commitment to Net Zero. For this reason this issue will be the last print edition. While our content and style will remain the same, we will be moving to a digital format for future issues. Please register now to receive your digital copy of future magazines.

Gwyn Tudor
Editor

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Eco-project setting the standard for sustainable living

The Tŷ Gwyrddfai project led by Adra housing association, in collaboration with Busnes@LlandrilloMenai and Bangor University, seeks to revolutionise the way homes are insulated using traditional materials like wool to enhance energy efficiency.

The project, intends to support thousands of homeowners in North Wales, struggling with energy bills, by incorporating materials that have stood the test of time. The project not only capitalises on the rich heritage of the region but also paves the way for a greener future.

At the heart of the Tŷ Gwyrddfai project is the Decarbonisation Hub - a facility dedicated to

upskilling individuals in the art of decarbonisation and retrofitting homes. The facility will serve as a testbed for new products and materials aimed at reducing carbon footprints in homes.

One of the most notable innovations to emerge from the research facility is insulation boards crafted from sheep's wool, a testament to the project's commitment to harnessing natural resources.

By 2030, Tŷ Gwyrddfai aims to decarbonise Adra homes, integrating wool and slate into the fabric of properties across Gwynedd.



“The project not only promises to revolutionise the construction sector by equipping local businesses with the necessary tools for decarbonisation and housing retrofit but also stands as a model for community and business collaboration over the next decade in the journey towards a more sustainable future.”

Julie Stokes-Jones

Business Manager

Tŷ Gwyrddfai Decarbonisation Hub,

www.adra.co.uk

Changing the way prosthetic users view themselves and their prostheses

Founded in 2018 by former Paralympic swimmer and medallist Mark Williams PLY, the North Wales company Limb-art has embarked on a mission to boost confidence, pride, and joy among those who use prosthetic limbs.

Prosthetic technology has advanced significantly in recent years, focusing primarily on improved functionality. However, the aesthetic aspect has often been neglected. Limb-art fills this gap by offering leg covers that enhance the user's silhouette, making a statement of style rather than attempting to conceal or blend in. These covers are made from durable and recyclable high-grade nylon and utilise the latest digital manufacturing processes.

The inspiration behind Limb-art stemmed from Mark's own experiences. Winning medals at the Seoul Paralympics in 1988 and the Miami World Championships in 1989 taught him the value of focusing on abilities rather than limitations.



A turning point came in 2017 when a child complimented him on the cool appearance of his prosthetic leg, which he had customised with a bright green cover and flashing LED lights. This encounter motivated Mark to create the company to help others “Stand Out and Stand Proud.”

This approach has led to a partnership with the NHS in England and Wales, making these distinctive covers available in the UK. But with an estimated 1.5 million people undergoing amputations annually worldwide, and the demand for prosthetic services set to rise.

www.limb-art.com

New app helps combat hate graffiti

A social scientist from Swansea University and her team have developed a new app that could revolutionise the way communities track and report hate graffiti.

Developed for use by police, youth workers and council staff StreetSnap allows users to photograph hateful graffiti and report it instantly to the relevant authorities. Street cleaning teams can then be notified to remove the offending artwork.

“StreetSnap aims to get to the heart of community tensions: we can use graffiti to understand what issues may be arising within communities. Through this trial, we’ve found that engaging with young people on the topic of graffiti often reveals their lack of awareness about its meaning. Without StreetSnap, we may never have these conversations, or be able to dig deeper to uncover the true intention behind the graffiti.”

Dr Lella Nouri,
Swansea University



Further interventions can include youth education sessions in schools, youth groups, and social clubs, aiming to understand the motivation behind the hateful graffiti and encourage those creating it to consider their actions more closely. Long-term, it is hoped these intervention efforts, combined with efficient removal, will lead to the eradication of visual hate crime.

Matthew Rowlands, Bridgend County Borough, explains how the app is set to serve a purpose within the community. He said: “As street-based youth workers, we encounter graffiti incidents across the county borough. The app can greatly

assist in quickly capturing and reporting incidents for prompt removal, reducing public offence. It will also enable us to understand and address underlying issues in specific areas and communities, enhancing our engagement with young people.”

Inspector Richard Gardiner, South Wales Police, said: “This initiative enables us to document the occurrences and locations of incidents, aiding in our prevention efforts. This technology offers a targeted approach to enforcement and engagement.”

 www.swansea.ac.uk

IN BRIEF

Tackling terrorist content online

Experts from Swansea University and Dublin City University have co-authored a new report addressing the dual promise and pitfalls of deploying AI to combat terrorist content online. As part of the Tech Against Terrorism Europe project, the report provides guidance for effectively and responsibly mitigating terrorist narratives in digital spaces. The necessity of AI tools in sifting through the vast volumes of online content is underscored in the report. With social media platforms now legally obliged under the EU's 2021 Terrorist Content Online Regulation to rapidly remove terrorist material, the adoption of AI and automation in content moderation has become increasingly prevalent. However, the report also highlights the limitations of over-reliance on automated systems. Issues such as the creation of appropriate datasets for algorithm training, the need for cultural and linguistic sensitivity, and the potential for inadvertent targeting of marginalised communities are brought to the fore. This underscores the indispensable role of human oversight and the establishment of robust accountability frameworks to complement AI technologies.

New vision for healthcare delivery

The Allied Clinical Health Hub has been launched at Cardiff Metropolitan University. The facility is designed to foster a collaborative environment where the next generation of health practitioners from various disciplines, including Dietetics, Podiatry, Speech and Language Therapy, Healthcare Science, Clinical Psychology, and Dental Technology, learn and work together to provide both NHS and private healthcare services. Students at the Hub will gain real-world experience by actively organising and delivering patient care, under the guidance of practice supervisors. This integrated approach aims to streamline the patient experience, significantly reducing waiting times for referrals across different health teams and offering a seamless care journey.

High Value Manufacturing Catapult launch

The High Value Manufacturing (HVM) Catapult, set to open its doors in Baglan, Southeast Wales, is a collaborative venture between the UK HVM Catapult and the Welsh Government. The Catapult will be home to an innovative office space and a digital factory hub designed to propel manufacturing companies forward by providing access to support, tools, techniques, and advice aimed at enhancing their capabilities. The initiative will be managed by HVM Catapult, while AMRC Cymru will oversee the digital factory hub. With an injection of £1.5 million innovation funding from the Welsh Government, AMRC Cymru, will be able to demonstrate the latest advancements in research, development, and innovation, facilitating a space for broader engagement and collaborative efforts with stakeholders.

Dolphins, voles, bees and salmon benefit from nature fund

In a move towards conserving biodiversity, the Welsh Government has announced a new round of funding under the Nature Network Fund, aimed at supporting a variety of wildlife. This initiative is part of the broader Nature Network Programme, which was launched in 2021 to align with the Global Biodiversity Framework's ambitious 30 by 30 goal. This goal seeks to protect and effectively manage 30% of the planet's marine, freshwater, and terrestrial environments by 2030. The fund, delivered in collaboration with The National Lottery Heritage Fund and Natural Resources Wales, focuses on enhancing the resilience of Wales' network of protected land and marine sites. It supports nature recovery efforts and fosters engagement with local communities. Projects benefiting from the latest funding round range from investigating insects on coal spoils to reintroducing voles to the Newport wetlands and studying dolphin diets off the coast of West Wales.

How freshwater from the Arctic will change our weather

As the Arctic undergoes dramatic changes, losing millions of tons of ice into its seas, researchers at Bangor University are spearheading an international effort to decipher the implications of this massive freshwater influx on our climate and weather patterns. This phenomenon is identified as a potential climate tipping point, signalling an irreversible shift in the Earth's systems crucial for our survival. Freshwater, being lighter than saltwater, could significantly alter ocean current movements and water mixing layers, potentially impacting the jet stream and, consequently, our weather systems. The full impact of a large-scale release from the Arctic remains uncertain. Professor Yueng-Djern Lenn, Bangor University, heads the project, collaborating with transatlantic experts to enhance understanding and prediction models. These models aim to capture the effects of the freshwater on ocean layering, circulation, and the northward transport of ocean heat within the Atlantic. Lenn and her team are utilising data from buoys and profiling floats across the Atlantic to improve sophisticated simulation models.

Powerful showers better for the environment

A more vigorous shower routine in the morning might not only invigorate the senses but also contribute to environmental conservation, a recent study from Swansea University suggests.

The research introduces a compelling argument: stronger showers could encourage quicker showering times, thus reducing overall water and energy consumption, especially when paired with a shower timer.

Environmental Psychologist Professor Ian Walker, alongside teams from the University of Surrey and the University of Bristol, have investigated the dynamics of water pressure

and its influence on bathing habits. They installed sensors in 290 showers across a university campus, monitoring shower durations over 39 weeks and analysing over 86,000 shower instances. The research suggests that individuals conclude their showers based on achieving a certain feel rather than completing a routine set of tasks – a finding that could influence how we approach water conservation.

The study highlighted the role of shower timers in curbing water use. By comparing showers with visible timers to those without, researchers found that timers could reduce water usage by as much as 53%.

Professor Walker explains the inverse relationship between water pressure and consumption. He pointed out, "An invigorating, stronger shower could be more eco-friendly than a feeble one." He emphasises the substantial environmental benefits with high-pressure showers equipped with timers reducing water consumption from an average of nearly 61 litres to less than 17 litres.

The findings are particularly important as the UK prepares for the environmental challenges of the future, including hotter, drier summers, leading to increased drought risk and significant water deficits.

 www.swansea.ac.uk



How walking football helps female players during menopause

Walking football, a sport gaining traction since its inception in 2011, is making a significant impact on the mental and physical health of female players, especially those navigating the challenges of menopause. This insight emerges from research conducted by the University of South Wales (USW), highlighting the game's benefits during this transitional phase in women's lives. Lyn Jehu and Mandy Gornicki, prominent figures within the sport, have observed firsthand the positive changes in female players. The sport, emphasising walking over running, provides an inclusive environment for women over 40, allowing them to engage in physical activity without the intensity of traditional football. Research reveals walking football's holistic benefits. Participants reported enhancements in psychological, social, and physical well-being, with the sport serving as a crucial support system for those experiencing menopause or perimenopause.

Blockchain tech firm delivers Challenge Fund success

Welsh blockchain technology firm Finboot has had significant success in the Technology Connected Challenge Fund. An initiative that pairs challengers with solution providers to devise and implement technology solutions that streamline processes. Finboot was victorious in four out of the eight categories in the initial year and secured another win in the following year. Finboot's blockchain traceability solution, MARCO, allows companies to track and manage their products and services, ensuring that they are complying with rules and standards for sustainability and ethical practices. Finboot's success stories include collaborations with Amey Ltd to use blockchain for efficient railway access planning. Their work with TrakCel enhanced database immutability for healthcare, while a digital finance passport project was developed with Delio. Another notable project with Amber involved tracing the origins of renewable energy for ESG regulation compliance.

Engineering school funding to investigate hydrogen compression

Cardiff University's School of Engineering, in collaboration with the Gas Turbine Research Centre, has received a grant from Ofgem's Strategic Innovation Funding for research into hydrogen gas networks. This innovative project will develop a micro-scale high-pressure hydrogen gas network, utilising a unique compression technique involving a modified gas turbine. This venture is a collaborative effort, including partners such as the National Gas Transmission, Siemens Energy, and several others. The project has the potential to advance the use of hydrogen in achieving Net-Zero targets and demonstrate hydrogen's viability as a sustainable and cleaner energy source. Scheduled to conclude in December 2026, this research represents a step towards the UK's energy transition. Alongside Cardiff University, the project consortium includes the National Gas Transmission, Siemens Energy, DNV Services UK, Cullum Detuners Ltd, Northern Gas Networks, Southern Gas Networks, and Premtech.

NE Wales decarbonising masterplan

A £1.1m injection has been made to develop a new masterplan for decarbonising the North East Wales industrial region. It will see the formation of an official regional Industrial cluster, which in turn, will provide a baseline for accelerating North East Wales' response to the climate emergency. Net Zero Industry Wales will develop the plan in conjunction with several regional partners including Wales & West Utilities, Bangor University, Uniper, Net Zero Energy Systems and SP Energy Networks. The partners will begin the project by identifying required industrial decarbonisation measures in the cluster – before shaping a comprehensive delivery plan for significant greenhouse gas reductions by 2030 and full decarbonisation by 2050. The project will kick-start in 2024 following £711,000 in newly awarded funding from Innovate UK, supporting an existing investment of £389,000 through industry in the region.

New hub combating plastic pollution

P3EB (Preventing Plastic Pollution with Engineering Biology), a new research hub is pioneering an innovative approach to combating plastic pollution. With funding from the UK Research and Innovation's Technology Missions Fund and additional support from the Biotechnology and Biological Sciences Research Council, this initiative aims to revolutionise plastic recycling. P3EB brings together a consortium of experts from seven prestigious UK institutions. This includes significant contributions from Bangor University. Over five years, the P3EB Mission Hub will focus on the use of enzyme-based technologies for transforming plastic waste into valuable materials and chemicals. Spearheaded by Professor Peter Golyshin at Bangor University, the team's focus is on extracting novel enzymes from extreme environments to develop efficient, industry-ready solutions for plastic degradation and upcycling, addressing the critical environmental issue of plastic waste.

Studying women's physical health in extreme environments

Cardiff Metropolitan University has joined forces with two Welsh female firefighters to gather data that will help researchers understand more about women's physical health in extreme endurance environments.

The study follows their journey on a skiing expedition from the coast of Antarctica to the South Pole, covering a total of 702 miles (1130 kilometres), and in temperatures as low as -50c – some of the harshest in the world.

As part of the expedition, the participants Georgina Gilbert and Rebecca Rowe ski ten hours every day for a duration of 45 days. Adding to the challenge, they only take breaks for daily necessities such as eating and sleeping and are pulling supply sleds weighing over 85kg.

The research aims to provide insights into the physical responses and performance of mature female endurance athletes navigating challenging environments.

Throughout the expedition, a range of digital devices, including menstrual trackers, fitness monitors and adventure smartwatches, will be used to monitor these responses.

Speaking about the importance of the study, Dr Fiona Carroll, Cardiff Metropolitan University, commented: "We only have very limited knowledge of how the female body responds and performs in extreme environments. It's hoped that this incredible expedition will fill the gap and provide key data to help us understand more about how far the female body can be pushed and how it responds in extreme conditions."



Dr Isaam Damaj, Rebecca Rowe, Georgina Gilbert and Dr Fiona Carroll



As firefighters, Rebecca and Georgina are no stranger to challenging environments. They also both share a love for competitive and elite sport and have vast experience in extreme environments. Georgina has scaled both Mount Elbrus and Mount Kilimanjaro, while Rebecca has experience competing for Wales in both the Rugby World Cup and Six Nations.

The ultimate goal of the study is to shed light on this vastly underrepresented area, as well as inspire other girls and women to follow in the footsteps of Rebecca and Georgina.



“The only contact we will have with the outside world is with a satellite phone, so we really are risking our lives to drive our point home, that girls and women can challenge the gender stereotype and find their courage to achieve despite societal barriers.”

Georgina Gilbert
Principal Investigator

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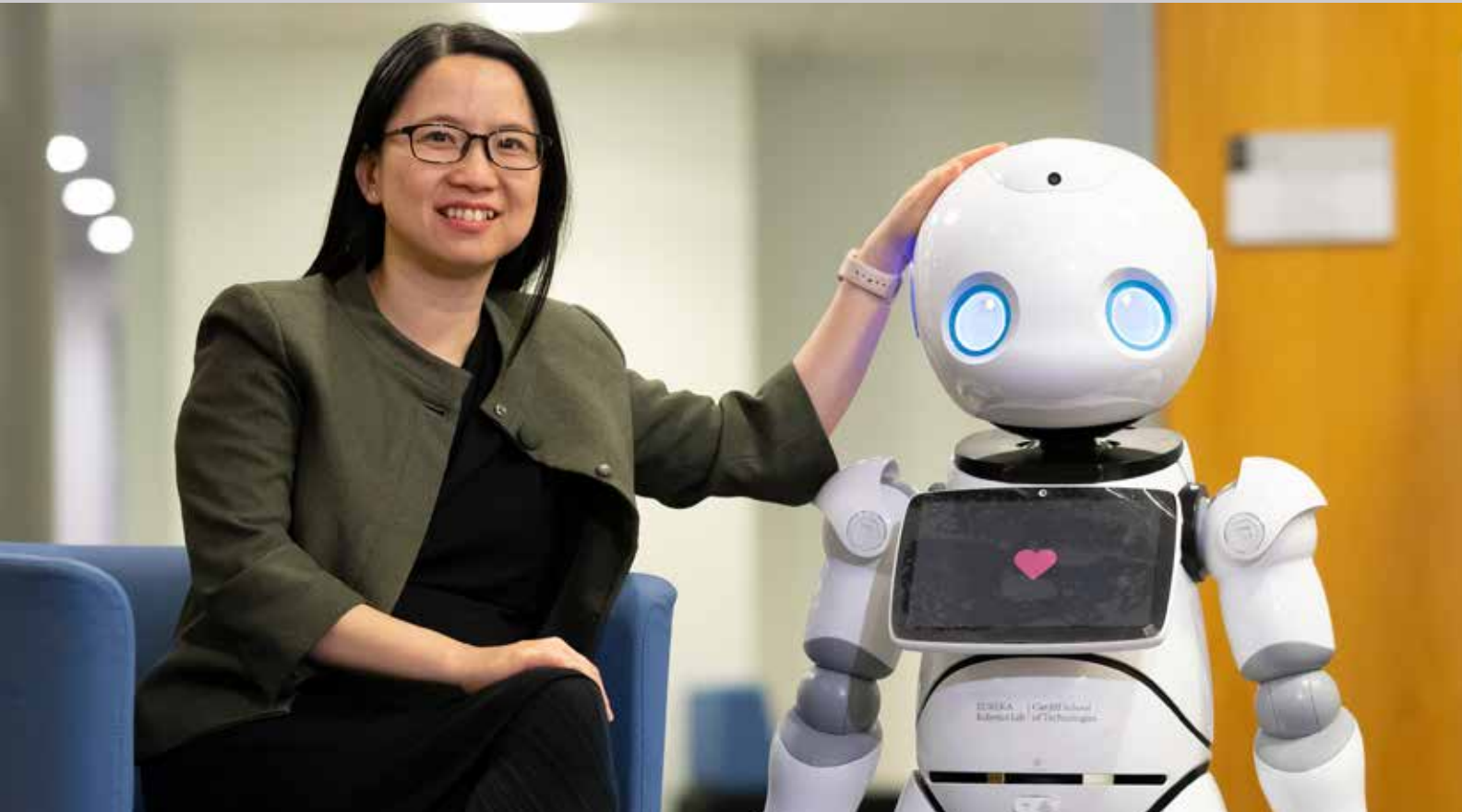
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CARDIFF

Combating infectious diseases through robotics

Research conducted at Cardiff Metropolitan University has the potential to change the world of infection control through the use of robotic technology.



Dr Esyin Chew, Department of Applied Computing and Engineering, Cardiff Metropolitan University, EUREKA Robotics Centre

UV-C disinfection robots have been increasingly deployed in settings such as hospitals and airports as a result of the COVID-19 pandemic. These robots emit UV-C light to irradiate surfaces, effectively destroying the DNA and RNA of microorganisms, rendering them inactive and unable to reproduce and spread.

While traditional UV-C disinfection methods have shown remarkable effectiveness in reducing harmful pathogens, as demonstrated in high-profile locations like Heathrow and Doha airports, the prohibitive costs and health concerns associated with prolonged human exposure to UV-C light have limited widespread adoption of this technology.

Addressing these challenges, the researchers have developed a new, safer and more economical UV Disinfectant Robot to help hospitals bolster infection control measures. By reducing the cost of these robots by 50-80%, they've made them accessible to hospitals, schools, and hospitality venues. Notably, the new technology is safe for use when humans are present, addressing the health concerns posed by exposure to UV-C light.

A prototype disinfection robot is now deployed at Llandough hospital in South Wales. Assistant nurses have been trained to operate the robot, alleviating high-risk tasks such as daily disinfection. So far the new technology has received positive feedback.



The next steps of the project involve further development and commercialisation. Through this, the team hope to create a Welsh and UK robotics first that will be used as a reference by countries around the world.

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CARDIFF

Unveiling Alzheimer's link to the immune system

Cardiff University researchers have revealed that genetic differences may contribute to an increased risk of developing Alzheimer's disease in later life.

The EphA1 gene is known to play a role in immune cell recruitment, in particular for its involvement in the development and function of the nervous system. Additionally, this gene has been implicated in various physiological and pathological processes outside of the nervous system, such as immune response regulation.

Through large-scale studies, the researchers have identified a connection between variants of the EphA1 gene and Alzheimer's disease. One specific variant, P460L, is linked to an increased risk of late-onset Alzheimer's disease.

The researchers hypothesised that this variant might affect EphA1 activity, influencing inflammation in the brain and potentially increasing the risk of developing Alzheimer's disease. They used cellular models to investigate how the variant affects the activity of EphA1 in both T cells (a type of white blood cell that helps the immune system fight infection) and endothelial cells (a single cell layer that lines all blood vessels and regulates exchanges between the bloodstream and the surrounding tissues) of the blood-brain barrier.

Normally, EphA1 is involved in T cell immune response in the brain. The study found that the variant disrupts this normal behaviour and affects immune responses and blood vessels in the brain.

The findings suggest that the P460L variant alters EphA1-dependent signalling, which in turn affects the function of the blood-brain barrier. The researchers plan to further investigate the role of the variant in T cell biology to understand its impact on T cells and the blood-brain barrier.



"This work will help to inform whether targeting P460L activity has therapeutic potential for treating late-onset Alzheimer's disease in the future."

Helen Owens
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CARDIFF

Analysing gut health through at-home stool tests

A kefir company from South West Wales has launched an innovative service aimed at enhancing gut health through stool sample analysis.

Stool analysis can provide important information about gut health. It offers insights into the composition of the gut microbiome, digestive function, presence of pathogens, inflammatory markers, and the absence of blood. By examining stool samples, scientists can identify imbalances in the microbiome, detect digestive disorders, diagnose infections, monitor inflammation, and screen for serious gastrointestinal conditions.

Partnering with the University of Cambridge, Chuckling Goat Ltd has introduced an at-home microbiome test kit. By examining customers' stool samples, the service aims to provide customers with personalised recommendations to enhance their gut microbiome. The idea to provide gut health tests began when customers approached the company to ask for solutions to medical problems.



“When we saw that there was a microbiome test available that gave us an evidence-based starting point to improve people's gut health, I was excited because I thought this is going to make my job a lot easier.”

Shann Jones
Co-founder
Chuckling Goat Ltd

The company spent over two years working with the University to develop the new test. Customers order the kit online and submit their stool sample by post. Once received, a team of scientists analyses the sample to identify which bacteria are present. Using DNA sequencing technology, the team generates a

detailed list of bacteria and how many times they've been detected.

These insights are then used to address any health concerns the customer may have. By using this data, the company can suggest solutions designed to optimise gut health.

Rhodri Griffiths at the Life Sciences Hub Wales explains: "Advancements in technology are increasingly applicable to healthcare, promising significant benefits by enabling individuals to receive care within their homes and reducing reliance on hospital services. This not only improves public health but also holds economic advantages. In 2022, the life sciences industry contributed £2.8 billion to the Welsh economy."



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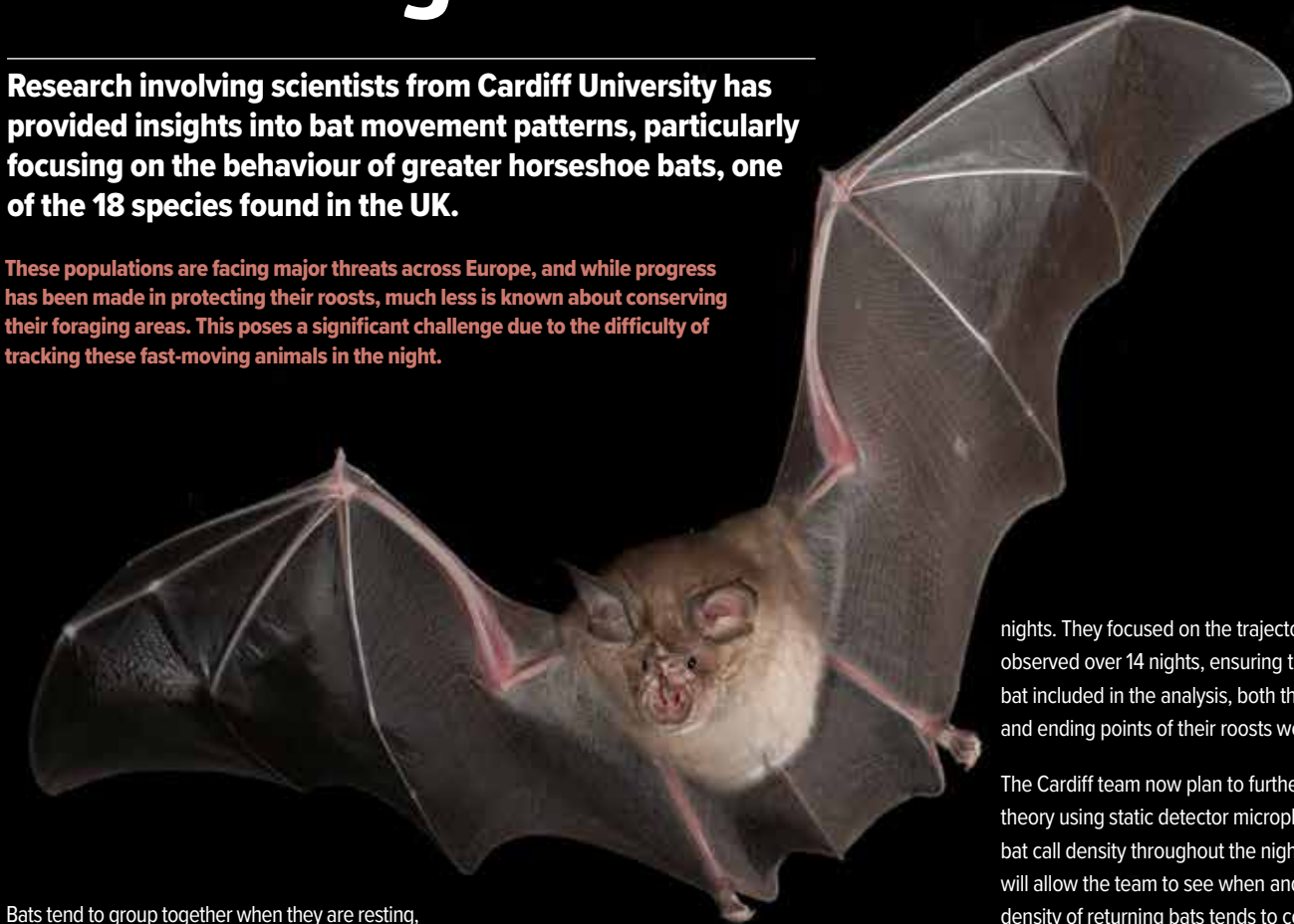


LLANDYSUL

How bats get home to roost

Research involving scientists from Cardiff University has provided insights into bat movement patterns, particularly focusing on the behaviour of greater horseshoe bats, one of the 18 species found in the UK.

These populations are facing major threats across Europe, and while progress has been made in protecting their roosts, much less is known about conserving their foraging areas. This poses a significant challenge due to the difficulty of tracking these fast-moving animals in the night.



Bats tend to group together when they are resting, a phenomenon also found in species like bees and ants. However, to avoid competing with each other, they need to disperse away from this location to feed.

Understanding how bats navigate their environment has long been a mystery, but recent research from Cardiff University and the University of Sussex has shed light on this important behavioural pattern.

The study reveals that bats return to their roosts in a "leap frogging" motion so they can stay out as long as possible foraging for food. Understanding these movement patterns is crucial for conservation efforts, especially for protecting the foraging areas of threatened bat species like the greater horseshoe bat.

The researchers developed a model based on trajectory data to understand how these bats move and interact with their environment. The study reveals that bat motion can be divided into two phases: an initial spread phase and a return phase.

During the initial spread phase, bats disperse to find suitable foraging areas, while during the return phase, they make their way back to their roosts. The researchers observed a "leap frogging" pattern, where bats furthest from the roost begin their return journey first, followed by those closer to the roost, creating a cascading motion.

Dr Thomas Woolley at Cardiff University said: "The return phase is much harder to understand not least because the data is extremely difficult to obtain. And so, until now, there doesn't appear to be any work on modelling this type of roost-bound journey, which could be vital to conservationists who are working tirelessly to combat population decline."

The researchers used trajectory data collected by the University of Sussex who conducted a radio-tracking survey to monitor the movements of 12 greater horseshoe bats over the course of 24

nights. They focused on the trajectories of 7 bats observed over 14 nights, ensuring that for each bat included in the analysis, both the starting and ending points of their roosts were the same.

The Cardiff team now plan to further test their theory using static detector microphones to track bat call density throughout the night. This data will allow the team to see when and where the density of returning bats tends to concentrate.



"By better understanding bat movement, we can more accurately predict roost locations and, in doing so, aid conservation efforts. This is important because bats are legally protected in the UK, and many are suffering population declines due to habitat loss."

Dr Thomas Woolley
Cardiff University

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CARDIFF

Exploring a sustainable solution for potato blight

Bangor University scientists are collaborating on a project aimed at exploring whether a by-product of chlorophyll could present a sustainable answer to the problem posed by late potato blight.

Potato blight, also known as late blight, is caused by a fungus-like organism (*Phytophthora infestans*) that leads to leaf and stem damage, ultimately resulting in potato rot. It is the most serious and damaging disease affecting potatoes and can rapidly spread among crops, particularly in warm, wet weather. Potato blight can lead to significant yield losses if not managed effectively. Warmer temperatures, due to the impacts of climate change, mean that the risk of diseases such as potato blight are likely to increase.

As a result, late potato blight continues to be a major concern for potato growers worldwide, requiring vigilant monitoring and management strategies to mitigate its impact. In the UK alone, it accounts for up to £50 million in losses for farmers annually. The main treatment options for late potato blight involve regular application of antifungal chemicals. However, the *Phytophthora infestans* organism is now resistant to most synthetic fungicides, many of which are also

being phased out due to the potential hazards posed by overuse. Excessive application not only poses risks to plant, animal, and human health but can also have a negative impact on an ecosystem by accumulating in soil and watercourses.

It has been noted that as much as 20% of greenhouse gas emissions associated with potato production stem from the energy-intensive processes involved in manufacturing and applying fertilisers and synthetic fungicides. This 12-month project, part of a collaboration with Blankney Estates, Western Europe's largest producer of chlorophyll, aims to investigate whether the large amount of grass wax it produces as part of its chlorophyll production process – currently a waste by-product – could be used as a more sustainable alternative to current fungicide controls for late potato blight.

The project aims to offer a more environmentally friendly way to tackle this growing issue in order to better protect one of the most important food crops globally.



“Biocontrol agents are an alternative and potentially, a more sustainable alternative, to the synthetic fungicides used to combat plant pathogens. This project could also contribute towards the commitment to reach net zero emissions by 2050 by reducing input costs for new biobased potato blight treatments using the circular economy approach by making use of this otherwise wasted product.”

Adam Charlton
Biocomposites Centre
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BANGOR

Strengthening clovers' potential to cut nitrogen fertiliser use

Scientists from the IBERS research institute at Aberystwyth University are aiming to increase the potential of clovers and other legumes to reduce the use of inorganic nitrogen fertilisers and emissions from livestock agriculture.

In the UK, sheep and cattle production relies on grass-based pastures, which are fertilised with inorganic nitrogen to promote the grass growth, which serves as feed for the animals. However, the process of manufacturing one tonne of inorganic nitrogen fertiliser can emit up to eight tonnes of carbon dioxide, resulting in a significant carbon footprint.

Clovers and other legumes can capture nitrogen – an essential nutrient for growing grass – from the air and convert it into a form that can be used by plants as a nutrient – offering a natural, cost-effective alternative to inorganic nitrogen fertilisers. This process is known as nitrogen fixation. Nitrogen fixation is carried out by symbiotic rhizobia bacteria, which live on specialised structures called root nodules.

Once fixed, the nitrogen is stored in the nodules on the roots of these plants. Additionally, these legumes can release some of this fixed nitrogen into the soil, where it becomes available to neighbouring grasses, effectively enriching the soil with nitrogen and supporting the growth of surrounding vegetation.

As part of the project, the scientists will examine the ability of red and white clover and another legume, Birdsfoot Trefoil, to improve the

productivity of livestock whilst reducing dependence on inorganic nitrogen fertiliser.

Members of the project team have developed new legume varieties that are more resilient to grazing by cattle and sheep and can withstand extreme weather conditions resulting from climate change. Specifically, Birdsfoot trefoil, one of these legume varieties, contains compounds called tannins, which have the potential to reduce methane emissions from cattle and sheep.

Along with project partners, they will be working collaboratively with commercial farmers to explore how to best take advantage of the natural ability of legumes to fix nitrogen, thereby reducing reliance on inorganic nitrogen fertilisers, a major source of greenhouse gas emissions.

To meet the government net zero targets by 2050, greenhouse gas emissions from livestock farming need to fall by 78% by 2035. Alongside this, the world's population is set to reach 10 billion people by 2050, with demand for food predicted to increase by 70%.

The project will look to establish a threefold increase in the capacity of clovers to fix atmospheric nitrogen up to 300 kg nitrogen per hectare per year. The aim is to transform grassland farming in the UK and globally, offering a solution to both cut emissions and support farm profitability.



“This project could really help cut the use of nitrogen fertilisers and agricultural emissions. The aim is to make the most of the ability of clovers and other legumes to increase nitrogen levels naturally in UK grasslands. We are really looking forward to working together with livestock farmers to understand how best to use these new legumes within real farming systems. There is so much potential in these adaptations to some of our native plants, as we, as a society, undertake a wider collective effort to tackle climate change”.

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ABERYSTWYTH

Monitoring ocean warming with help from Antarctic seals

An Aberystwyth University researcher has embarked on a voyage of the RRS Sir David Attenborough to monitor ocean warming in the Antarctic, where he will be helped by a special research team – seals.

How far and how fast the warm current is flowing under Antarctic glaciers, melting them from below, affects how quickly they collapse. Their disappearance could lead to a catastrophic sea-level rise, leaving major coastal settlements across the world underwater. Understanding and monitoring the flow beneath Antarctic glaciers is crucial for assessing and mitigating these risks.

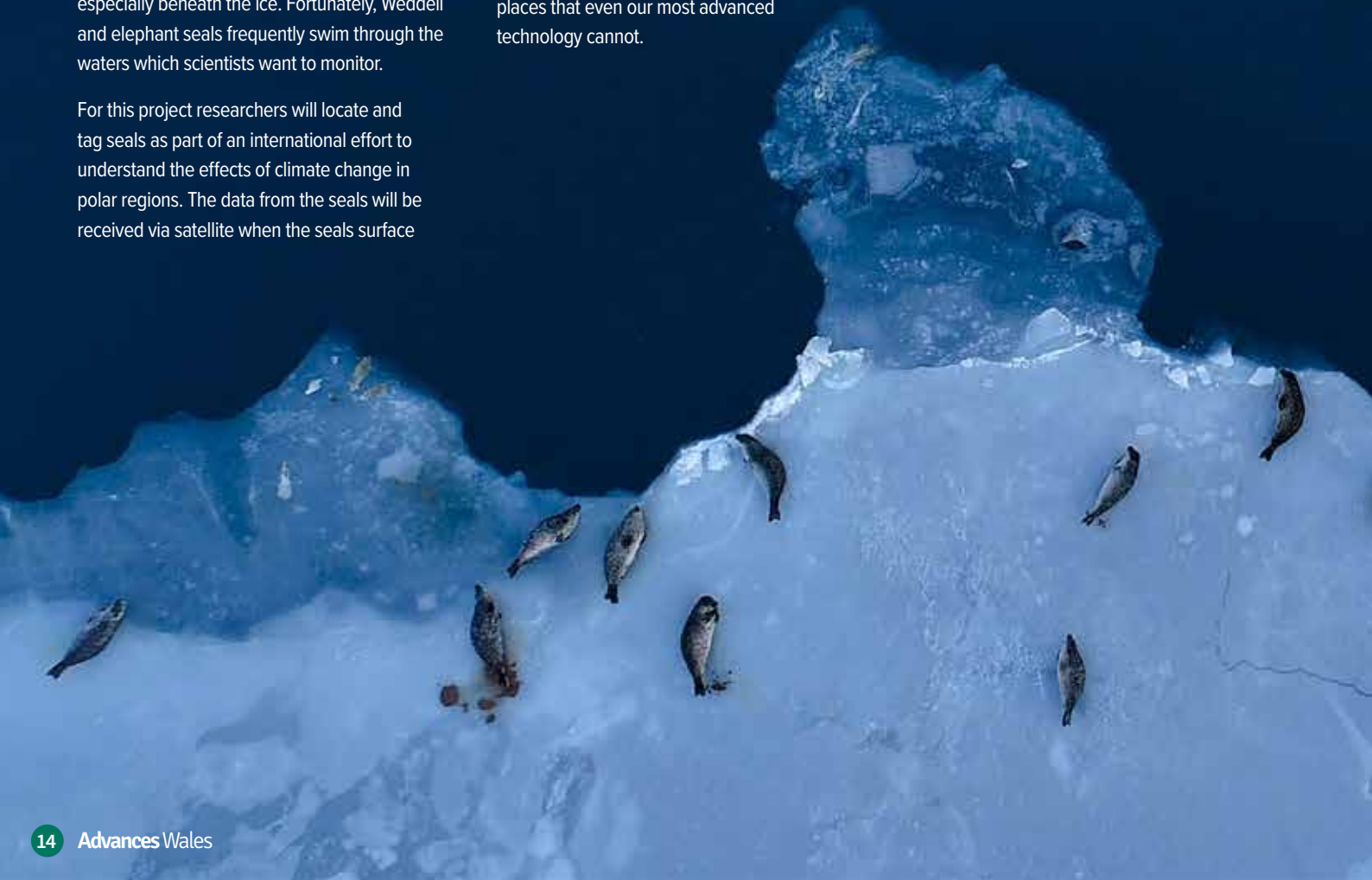
Despite the availability of sophisticated equipment, measuring the temperature of deepwater in Antarctica remains challenging, especially beneath the ice. Fortunately, Weddell and elephant seals frequently swim through the waters which scientists want to monitor.

For this project researchers will locate and tag seals as part of an international effort to understand the effects of climate change in polar regions. The data from the seals will be received via satellite when the seals surface

above the ocean. The seals provide valuable information as they are able to access areas that are particularly difficult for scientists to reach directly.

As part of the project, Dr Guilherme Bortolotto will spend time on the new British Antarctic Survey vessel to survey the ocean near the western Antarctic Peninsula, in the Weddell Sea.

Dr Bortolotto commented: “Understanding the changes in these oceans, including the warming of specific regions, is a vital part of giving policy makers the tools to limit and mitigate the climate crisis. Seals are precious and beautiful creatures and it’s a privilege to work with them. They are like a special, crack research team - reaching places that even our most advanced technology cannot.



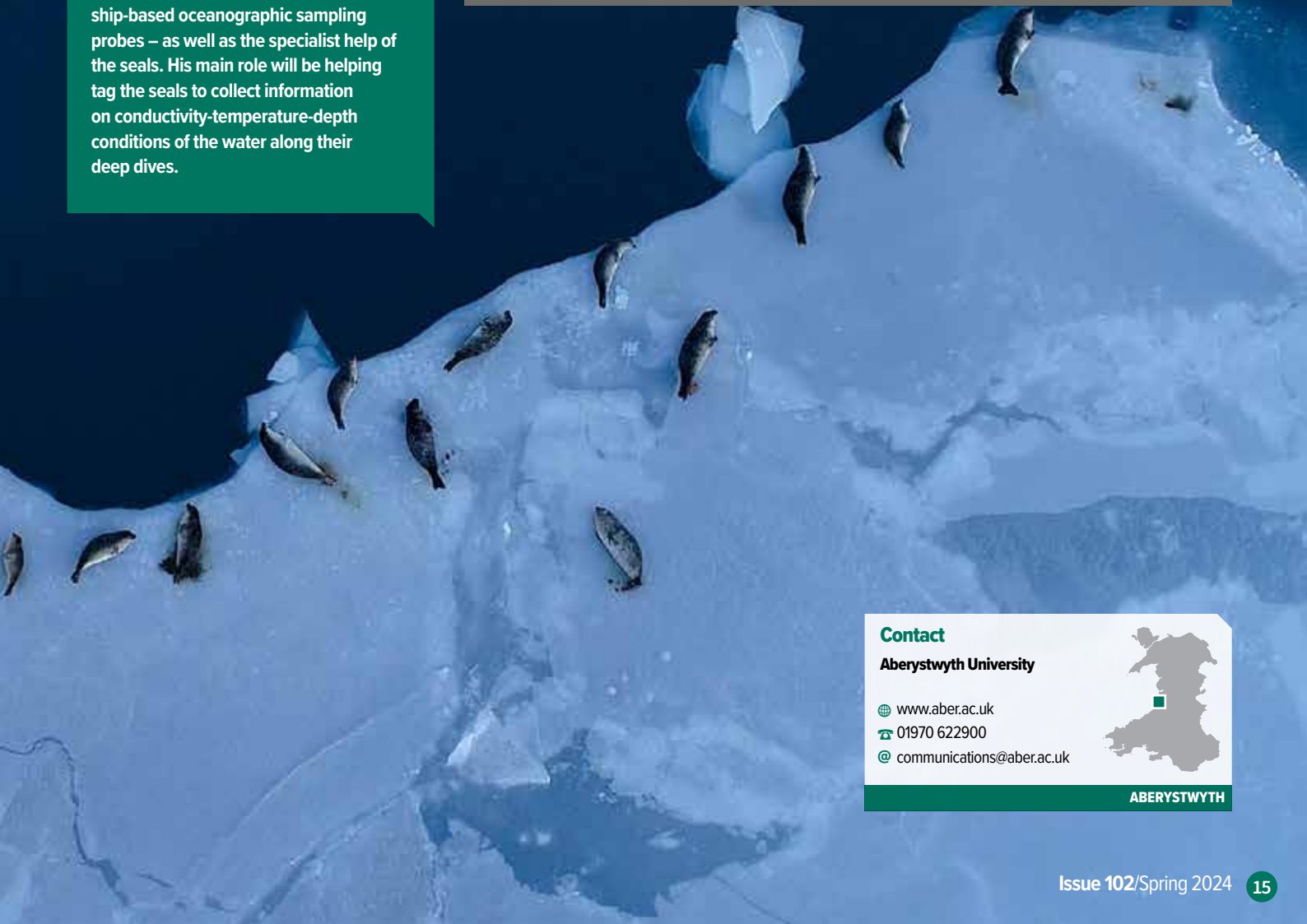
“I am particularly interested in investigating different things about the ecology and behaviour of those seals, such as dive characteristics and the places they prefer to go. Their swimming will hopefully help the world understand the serious impact climate change is having on our planet.”



Throughout the expedition, Dr Bortolotto will be working alongside oceanographers to measure ocean characteristics including currents and circulation features, temperature, and salinity by using multiple types of equipment. This includes sea-gliders, ship-based oceanographic sampling probes – as well as the specialist help of the seals. His main role will be helping tag the seals to collect information on conductivity-temperature-depth conditions of the water along their deep dives.



The RRS Sir David Attenborough ship leaving Portsmouth harbour in England on its way to Antarctica for research



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ABERYSTWYTH

Advancing renewable energy through industry-academia collaboration

Renewable energy technology company Crossflow Energy, help businesses to leverage the power of ‘small wind’ to support the roll-out of clean, reliable energy.

The company has been working with Swansea and Aberystwyth universities on a project aimed at making wind power more accessible as a clean alternative to fossil fuel within the built environment.

Crossflow has developed three new, wind turbines that combine a range of innovative features, including low rotational speed that minimises noise, reduces vibration, and so extends operational uptime and reduces maintenance time. The design is also bird- and bat-friendly, which addresses planning concerns at the ecologically sensitive sites.

A prototype turbine was commissioned together with an array of sensors and a data acquisition system. The Swansea University team assisted in finding an appropriate method for data processing. Together, they deployed an advanced data reduction method that fed data from the turbine sensors into their computational fluid dynamics simulations. By conducting numerical modelling, they were able to formulate an appropriate dynamic response algorithm that allowed fluctuating wind readings of different strengths and source locations to be input. The data gathered enabled the company to better understand the responses and behaviours of its turbine under changing weather conditions.

The company also developed an innovative solution to extracting data from the hybrid energy system units. This enabled the Aberystwyth team to start designing the necessary mobile monitoring software. Their collaborative efforts led to the new software being used on a prototype hybrid energy system, where it was able to successfully monitor activity with information being communicated remotely to both



iOS and Android smartphones. This provided live details of what was happening at the site 24-hours a day.

The wind power technology can be deployed as a standalone entity or combined with solar and battery technology to enhance renewable energy generation in both new build and retrofit applications.

The solutions developed will contribute to providing an affordable renewable energy technology that can reduce fossil fuel dependency worldwide.



As a result of the work, the company has been able to identify a wide range of potential markets. These include commercial and public buildings, road and rail infrastructure, telecoms, and challenging environments such as remote, ecologically sensitive locations. This includes working with one of the world's leading phone companies to apply the turbine technology to self-powered mobile network towers, with the aim of improving rural connectivity across the UK.

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PORT TALBOT

Recycling coal ash for sustainability in construction

New research from the University of South Wales sheds light on the potential environmental benefits of recycling coal ash, a byproduct of burning coal in power stations.

PFA, also known as “fly ash”, is produced by more than 6,000 coal-fired power stations worldwide. When coal is burned to generate electricity, the resulting ash and residue are collected. This ash, consisting of fine particles, is referred to as PFA. While PFA – which comes in the form of a very fine dark grey powder – was traditionally released into the atmosphere, concerns over its impact on air quality mean it’s now captured and stored in landfills.

The global coal mining industry produces a significant amount of waste, raising a number of environmental concerns. Therefore, finding ways to repurpose this waste, including PFA, can have a substantial positive impact. With thousands of landfills worldwide now containing this waste, the environmental implications are considerable.

One crucial aspect highlighted by the research is the potential to reduce carbon emissions associated with cement production.

PFA, when combined with Portland cement – the most widely used type of cement worldwide, as well as a basic ingredient of mortar, stucco, and non-specialty grout – produces concrete.

Around 3.5 billion tonnes of cement are produced every year. However, the production process requires a lot of energy and precious natural resources. Quarrying the raw materials alone is responsible for 622kg of carbon dioxide per tonne of cement.



To reduce these environmental impacts, there’s a need to prioritise sustainable practices. PFA is abundant, inexpensive, and when used properly with Portland cement, it can enhance the strength and durability of concrete while reducing its carbon footprint.

This becomes increasingly important as the global demand for concrete is projected to rise by 43% by 2050 – an increase that is associated with a significant rise in carbon emissions. At least 8 percent of global carbon emissions are caused by cement manufacturing alone. However, as more coal-fired power stations are decommissioned and fewer come into operation across the globe, the researchers caution that there is a pressing need to use the material more efficiently in the future.



Additionally, they highlight that there are other applications for which recycling PFA can be beneficial, for instance to enhance the properties of soils, making abrasives such as sandpaper, and using it in the manufacturing of products such as plastics, paints and rubber.

This underscores the critical importance of ongoing research and innovation in sustainable waste management practices.



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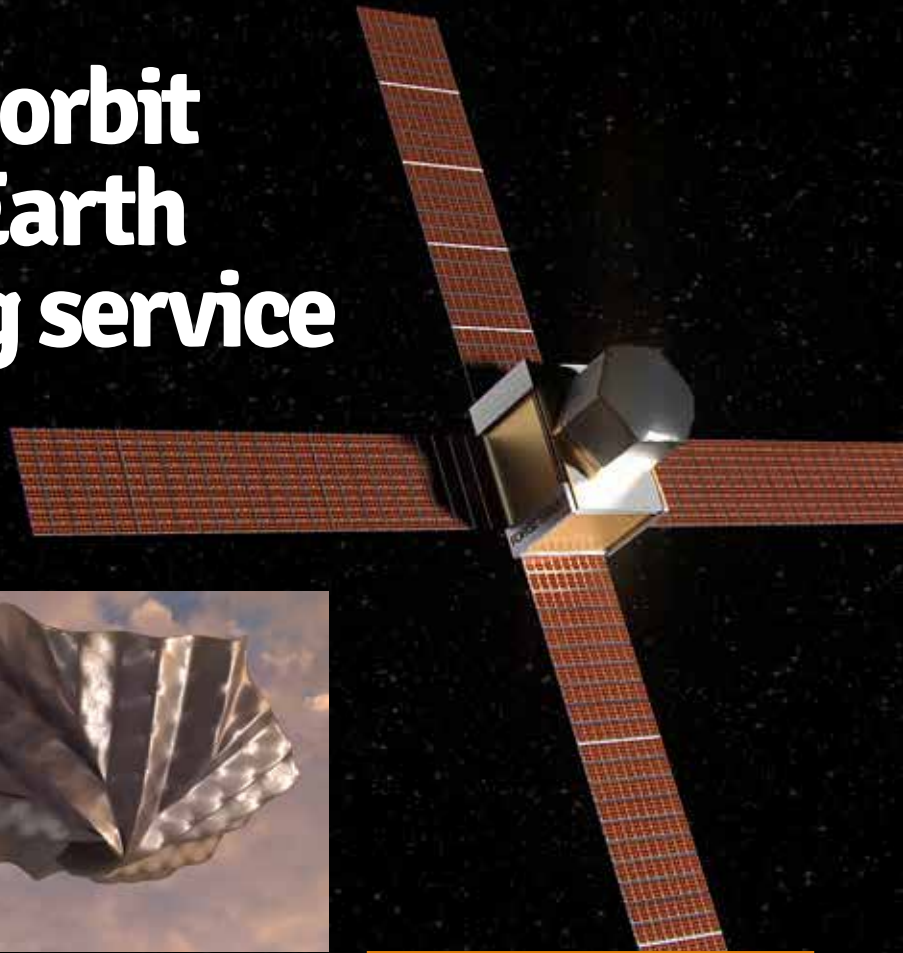
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PONTYPRIDD

World-first in-orbit and return to Earth manufacturing service

Cardiff-based space tech company has developed a planet-friendly reusable re-entry system that allows the low cost and reliable return of satellites to Earth.



The aim of the technology is to revolutionise manufacturing by utilising space to create 'supermaterials' that are impossible to produce on Earth.

While the cost of sending satellites into space has decreased due to advances in reusable technologies, all commercial return vehicles still rely on heat shields, which need replacement after each flight. This adds to the overall cost and complexity of space missions.

During re-entry from Earth's orbit, a spacecraft experiences intense heat due to friction with the atmosphere. A heat shield is necessary to prevent excessive heat transfer into the spacecraft, ensuring the safety of both the vehicle and its contents.

Current heat shield technologies, such as ablative shields used on spacecraft like the SpaceX Dragon, or silica heat tiles used on the US Space Shuttle, have limitations. Ablative shields are generally not reusable, while silica heat tiles are vulnerable to damage and require complex lift control.

Space Forge has developed an innovative new heat shield called Pridwen, which utilises a high-temperature alloy that can withstand the heat of re-entry without burning, making it fully reusable. The shield, designed to radiate away heat effectively, is

larger than the spacecraft, but uses a modified origami technique to fold and fit inside the launcher.

The technology has been in development for over four years and it has completed numerous trials including high altitude balloon drops and sea survival.

In addition to the shield the company has developed a water-based hover net, named Fielder. This unmanned, water vehicle is designed to manoeuvre underneath a re-entry vehicle, to soften the impact of landing and enable quick return to a port. The aim is to help protect high value space made products such as pharmaceuticals and vaccines, which are particularly vulnerable to the shock forces experienced during landing.

The team has successfully built a prototype vehicle and tested it in the UK.

These technologies are now being incorporated into a reusable satellite platform, a world-first in-orbit and return to Earth manufacturing service - the ForgeStar. The service aims to provide rapid, reliable, and reusable infrastructure for in-space manufacturing.

The company aims to harness the potential of space and microgravity to drive innovation and address global challenges through in-space manufacturing and research activities in a sustainable way.



"Pridwen and Fielder are key parts of our plan to develop fully reusable manufacturing satellites that can kick start a new industrial revolution. Supermaterials made in Space will be able to save industries on Earth enormous amounts of energy, limiting their CO2 emissions in a way their terrestrial counterparts can never match. We can also attach Pridwen to other satellites and land them in Fielder nets to bring them back intact to their manufacturers, eliminating space debris and allowing them to be refurbished or recycled to save money and limit their ecological impact. With our innovations, we can now unlock the full potential to help make space work for humanity."

Andrew Bacon,
CTO and Co-founder
Space Forge

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Space Forge

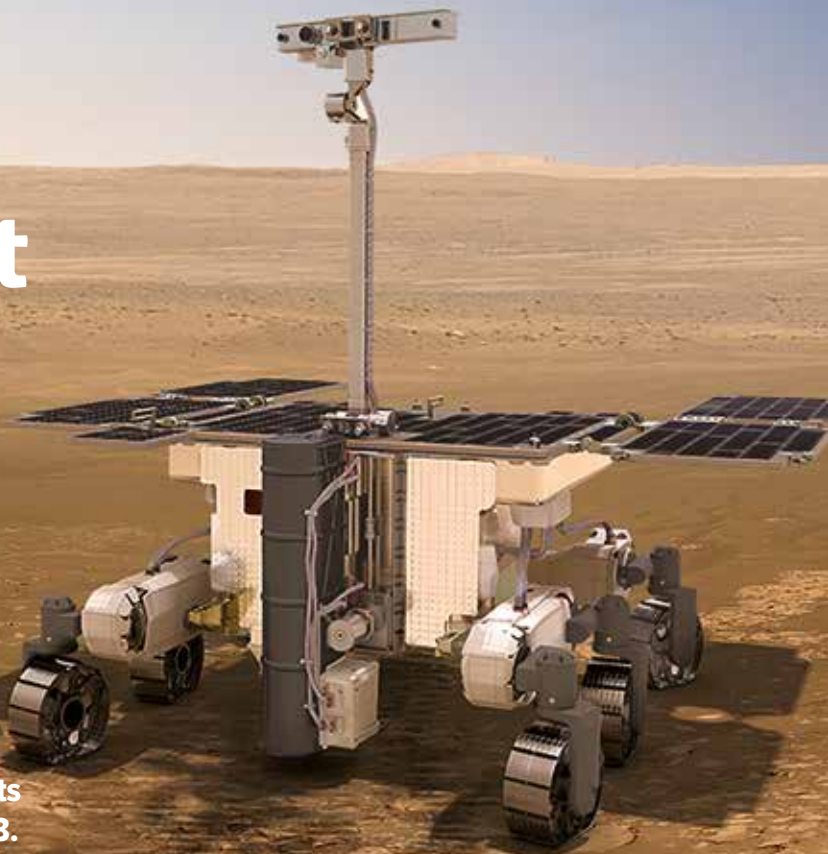
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CARDIFF

Welsh-led project helps search for life on Mars

Aberystwyth University is leading the development of a new scientific instrument to help the ESA ExoMars Rosalind Franklin rover in its search for life when it is launched to Mars in 2028.



The Welsh instrument, named Enfys (meaning 'rainbow'), is an infrared spectrometer designed to identify targets on the surface of Mars for sampling and analysis, which could in turn reveal evidence of life on the Red Planet. It will be mounted on a mast holding the robot's camera platform, known as PanCam, working in unison with high-resolution and wide-angle sensors to survey the Martian landscape. Enfys and PanCam will work together to identify minerals that could harbour evidence for life, enabling the rover to drill for samples to be analysed by other instruments on the Rosalind Franklin rover.

The rover, which was assembled by Airbus in Stevenage, is expected to travel several kilometres across the planet in search of a site with a high potential of evidence of life on Mars. It will collect samples by drilling to a depth of around two metres below its surface, before using next-generation instruments to analyse findings in an onboard laboratory.

Enfys is being built by a UK consortium led by Aberystwyth University and drawing on expertise from Mullard Space Science Labs in Surrey and RAL Space in Didcot. The optical components are being designed and manufactured by North Wales-based Qioptiq Ltd, which has developed the necessary coatings using the Vacuum Thin Film Coating Facility at Wrexham University. The assembled instrument will be tested at Aberystwyth University before being shipped to Italy to be mounted on the rover.

Despite the advanced technology deployed to Mars, definitive evidence of current life remains undiscovered. Scientists have, however, identified indirect signs, such as ancient water flow traces and complex organic molecules, that hint at Mars's potential to support microbial life in the past. Methane detections in the Martian atmosphere also fuel speculation, given methane's biological origins on Earth.

Whilst numerous robotic missions have been sent to explore the Martian surface, the ExoMars Rosalind Franklin rover will be the first to drill down and collect samples from 2m below the surface. At this depth the samples will have been protected from the ionising radiation on the surface which destroys the evidence that life might once have existed there. This gives the Rosalind Franklin mission the best chance yet of finding signs of life.

Dr Matt Gunn from Aberystwyth University, Principal Investigator on Enfys, said: "This is a challenging and complex technical endeavour which has the potential to make a significant contribution to our search for signs of life on Mars. The instrument team, both here in Aberystwyth and in the partnering institutions, are all very much looking forward to receiving measurements from the planet's surface to expand our knowledge of the Mars environment."

Professor Caroline Gray OBE, from Wrexham University, said: "We feel enormously proud that our Thin Film Coating Facility is playing a crucial role in supporting this world-leading, Welsh-led space mission."



Mars varies in its distance from Earth from about 33.9 million miles at its closest to roughly 249 million miles when they lie on opposite sides of the Sun. Journey durations for rovers and spacecraft from Earth to Mars, influenced by trajectory, launch positions, and technological capabilities, have historically spanned six to eight months. Notably, the Curiosity rover's journey exceeded nine months, while the more recent Perseverance rover reached Mars in approximately seven months.

Orson Sutherland, Mars Exploration Group Leader at the European Space Agency, said: "With Enfys on board, the Rosalind Franklin Rover is recovering its full capability to perform the assigned ExoMars scientific mission. The instrument will provide key science data, working in full synergy with the rest of the payloads."

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