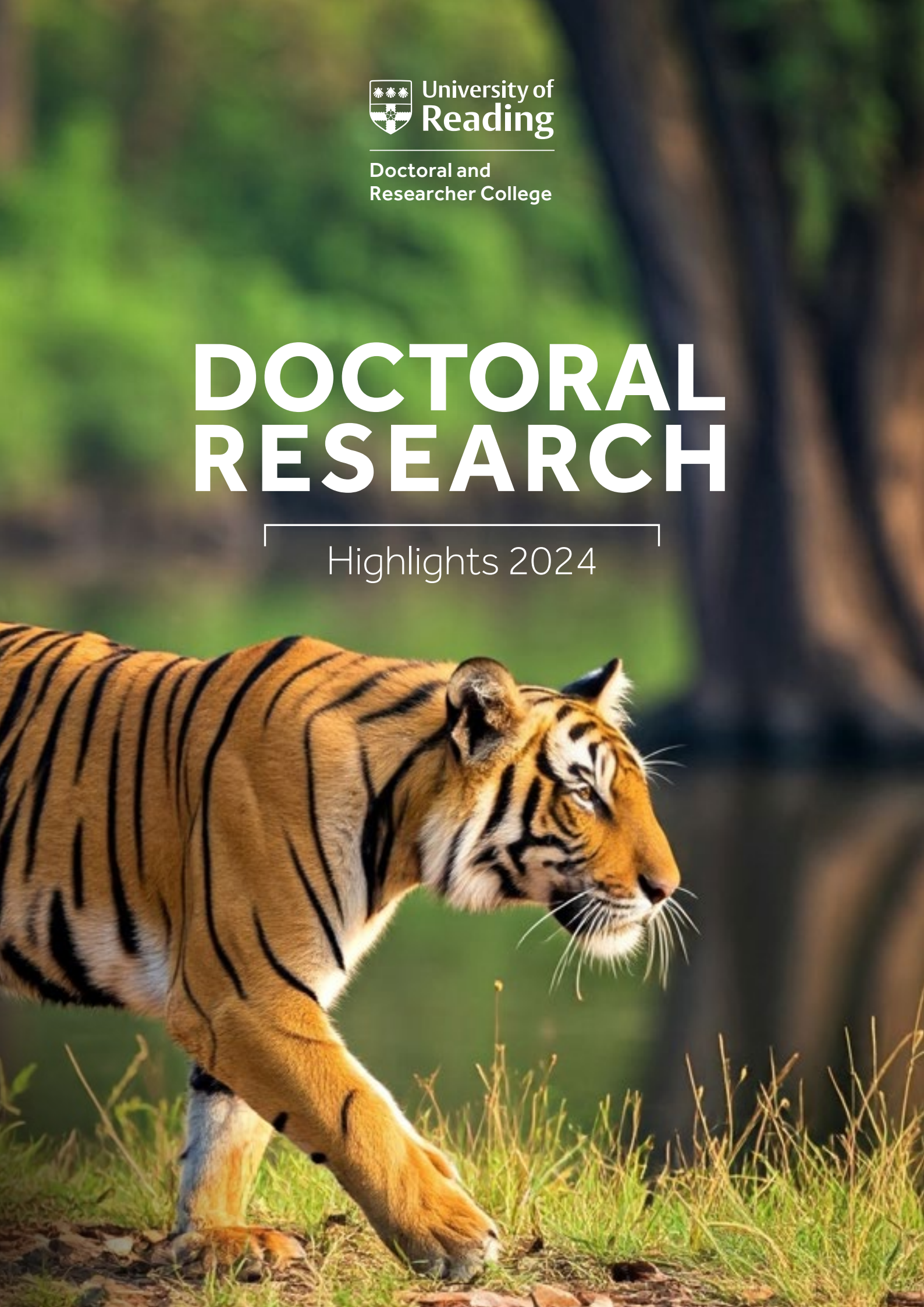
University of Reading

Doctoral and Researcher College

# DOCTORAL RESEARCH

## Highlights 2024



# WELCOME

**PROFESSOR ADRIAN WILLIAMS**
ASSOCIATE PRO-VICE-CHANCELLOR FOR POSTGRADUATE RESEARCH STUDIES AND RESEARCHER DEVELOPMENT

**Welcome to our 2024 Research Highlights**.

Welcome to our annual review of some of the excellent research and community engagement work undertaken by our highly talented doctoral research students. A great privilege of my role as the Associate Pro-Vice-Chancellor for Postgraduate Research Studies is hearing about the wide variety of research that our doctoral researchers are undertaking. The breadth, as well as depth, of doctoral research is truly astonishing, spanning a real A to Z from art to zoology, and so much in between. Sadly, we cannot highlight all doctoral research in this edition, but the examples here reflect the range and quality of the work undertaken by all.

Inside you will find research spanning ages as well as disciplines, from exploring ancient cosmetics to new approaches in forensic science using mites to determine timings of murders or developing 'smart' materials that can adapt to their environment. We remain committed to researching difficult topics, such as examining the origins of gender violence in India and rehabilitative justice for ex-offenders in business careers.

We report on the outstanding annual Fairbrother Lecture, given by one of our doctoral researchers, which this year took place at the Reading Biscuit Factory. The lecture considered the impact of climate change on ocean currents and asked whether we are approaching a tipping point that could cause environmental catastrophe. Our annual Doctoral Research Conference goes from strength to strength with over 350 attendees listening to presentations from the finalists of the Research for a Better World, Three Minute Thesis, Your Research as a Bedtime Story and Poetry, Rhyme and Rap competitions. In addition, the Research Poster, Research Image and Research Object exhibitions gave doctoral researchers a chance to network with fellow delegates.

Beyond the projects, research papers and conference presentations, we were thrilled to host social events and training workshops, giving our doctoral researchers the opportunity to network and develop skills to support them in their doctoral studies and beyond.

I hope you enjoy reading these highlights.



# Contents



# HIDDEN IN PLAIN SIGHT:

# Uncovering the forensic power of mites




**Mites are microscopic arachnids resembling spiders. They can be found almost everywhere and live in every imaginable terrestrial and most aquatic habitats. Due to their minute size, they live on and amongst humans, mostly unnoticed. Individual species of mites are habitat specific; for example, the mite species found on bed linen will be different to the species living inside the mattress. Because of their prevalence, mites are used as trace evidence in forensic investigations.**

*Caitlin carrying out her research with her tutor*

Following a homicide, perpetrators often attempt to conceal the body to destroy evidence which may delay or completely prevent the discovery of the victim. Concealment may consist of wrapping, burying or placing the remains in containers such as suitcases or rubbish bins, placing in water or using corrosive chemicals, amongst many other methods. Homicide cases involving concealment are extremely problematic as the time between death, body disposal and discovery is often extended, meaning that the body is often severely decomposed and/or damaged by the concealment method which makes it more difficult to identify the victim and to discover the cause of death. Insect evidence is the most common tool to indicate the time of death (the interval between death and corpse discovery). However, concealment often limits or completely restricts insect access, meaning it can often be challenging to calculate timelines.

Mites are microscopic arachnids resembling spiders.

Mites have been identified as a potential solution in these cases as they are found almost everywhere and are generally always present in concealed bodies or remains due to their microscopic size. Mites are easily transferred and retained on surfaces like clothing, or over a body and are small enough to access microscopic holes in fabrics or sealings of concealment, such as the small openings in plastic bags. Therefore mites can be used as trace evidence in concealment cases.

The habitat specificity of different species of mites also makes them useful location markers. Mites particularly thrive in warm, humid environments caused by intentional concealment. A single founder mite can grow into a large colony, visible to the naked eye as a layer of mobile dust. Analysing these mite communities can provide general timeline estimations as well as a geographic origin - which can suggest if a body has been moved after death or provide clues as to the original location of the body.

The use of mites as trace evidence in concealment cases is the focus of my doctoral research. My initial research investigated how mites develop in cases of concealment following infanticide. Children under the age of one year have the highest homicide rate of all age groups worldwide. My experimental work aimed to understand how mite colonies develop in different cases of concealment by replicating concealment scenarios, using pig carcasses as a proxy for human remains. We hope to demonstrate that the use of mites in forensic investigations can be an additional source of evidence in these uniquely challenging and distressing cases.

At the present time there is no timeline indicator for remains found in water environments, as most forensically important insects cannot survive in water. Therefore future research will explore the effect of water immersion on mite colonisation. Further studies will investigate other methods of concealment such as the use of corrosive chemicals e.g. bleach.

My research to investigate the use of mites as trace evidence in concealment cases is conducted in both the United Kingdom and in Argentina to provide a species comparison between hemispheres. It is hoped that this research will increase the reliability of mites as evidence in forensic concealment cases, helping to bring justice to victims and their families.

CAITLIN WALTON IS A PART-TIME DOCTORAL RESEARCHER IN THE SCHOOL OF BIOLOGICAL SCIENCES


# FACING UP
## to deeply rooted bias

**Doctoral researcher in Economics, Sayantani Ghosh, unpicks whether India's rates of gender violence have their source in deep-rooted gender discrimination and bias.**

Despite being recognized by the UN as detrimental to the socio-economic welfare of a country, violence against women stubbornly persists in many nations, developing and developed alike. In the last few Global Gender Gap Index[1] reports, an annual benchmark of gender parity across a range of measures, India has ranked among the lowest for women's health and survival (life expectancy and mortality).

> Exploring the causes of stubbornly high rates of violence against women.

According to the 2023 National Crime report, 51 cases are registered every hour across India. Horrific and high-profile cases repeatedly highlight the gravity of this issue in the country, including the 2012 case dubbed Nirbhaya[2] and the 2024 Abhaya case[3]. Both of these cases occurred in metropolitan cities and the victims were well educated and financially independent young women. Sadly, such crimes persist despite increasing media reach, the rise of non-profit welfare organisations and stringent laws intended to make women feel safer and more empowered.

In my doctoral research I examine whether the root of these crimes lies in the deep-grained notion of females being the inferior sex and whether the scenario can be improved by addressing this inherent social gender bias towards males. Previous research has assessed gender inequality and gender norms as potential causes of violence against women, focussing on different aspects of this problem. I add to the existing literature by empirically investigating the dynamics of this association through primary and secondary data analyses.

One strand of my research uses secondary data to explore associations between rates of domestic abuse and gender disparities in various spheres of domestic life, including employment, health and household decision-making. In another strand, I use secondary data spanning 18 years to study the relationship of gender norms such as male child preference with different kinds of violent crimes against women, both domestic and public. The main finding was that women in general face significantly more violence when they are seen to oppose patriarchal norms, e.g. by preferring daughters over sons. This finding opens the possibility that male violence includes a component of backlash against empowered women. Interestingly other results in my study also suggest that women face more violence where there are more male births on average than female births in the same district. Both of these findings point to patriarchal norms significantly relating to crimes against women.

Finally, I completed a field experiment in the Indian city of Kolkata studying the effect of movies on gender-biased norms and viewers' views about violence against women. Screening centres were set up in different locations and participants were divided into two groups. A treatment group was shown movies breaking traditional gender norms and featuring relatable tales of women empowerment while a control group was shown movies on more general themes. Participants were encouraged to provide reflections on the movies afterwards. Treatment groups reported witnessing and experiencing violence less than before in comparison to the control group participants. I interpret this as a suggestion that some level of gender sensitisation and awareness about the women's perspective on their experience could be taking place through the movie sessions.

The main policy implication arising from this research is that, along with other measures, in order to effectively reduce these crimes, policy-makers must target deep-rooted bias and gender discrimination on a continuous basis through mass awareness and educational programmes for adult citizens.

SAYANTANI GHOSH IS A DOCTORAL RESEARCHER IN THE SCHOOL OF PHILOSOPHY, POLITICS AND ECONOMICS

1 weforum.org/publications/global-gender-gap-report-2024/

2 en.wikipedia.org/wiki/2012_Delhi_gang_rape_and_murder

3 economictimes.indiatimes.com/news/india/kolkata-doctor-rape-murder-case-rg-kar-the-campus-was-victims-second-home/articleshow/112601112.cms?from=mdr

# TIMELESS BEAUTY

## - exploring ancient cosmetics and adornments

In the ancient Near East (the modern Middle East), the achievement of beauty was not the only, or even the primary, consideration in cosmetic adornment.

**In the 21st Century, we consider visual aesthetic improvement as the primary motive for cosmetic use. However, in the ancient Near East (the modern Middle East), the achievement of beauty was not the only, or even the primary, consideration in cosmetic adornment. It is possible that practical needs (such as protection from the intense sun), signs of high status or power, or conformity to cultural norms following wars and immigration were involved in the widespread use of ancient cosmetics.**

Our research focuses on the chemical analyses of ancient cosmetic artefacts, such as kohl pots, cosmetic shells, cosmetic palettes and mortars. We examine how these artefacts were used in Near Eastern societies throughout ancient times. Chemical analysis of 78 cosmetic artefacts, from museums in the United Kingdom, Jordan, Iraq and the United States of America, indicated that plant material, animal fats and minerals were used throughout the last 9,500 years for possible cosmetic adornment.

Chemical analysis enabled us to link compounds from artefacts from different archaeological sites, further broadening our understanding of how and where cosmetic adornment has evolved over millennia. This chemical analysis also demonstrated that cosmetic preparations from the Neolithic to the Roman period (7,600 BCE – 350 CE) frequently contained toxic minerals such as arsenic, lead and copper - which we now know to be harmful to our skin. In addition, we identified ingredients such as zinc, talc, gypsum and ochre, which are still used in beauty products today.

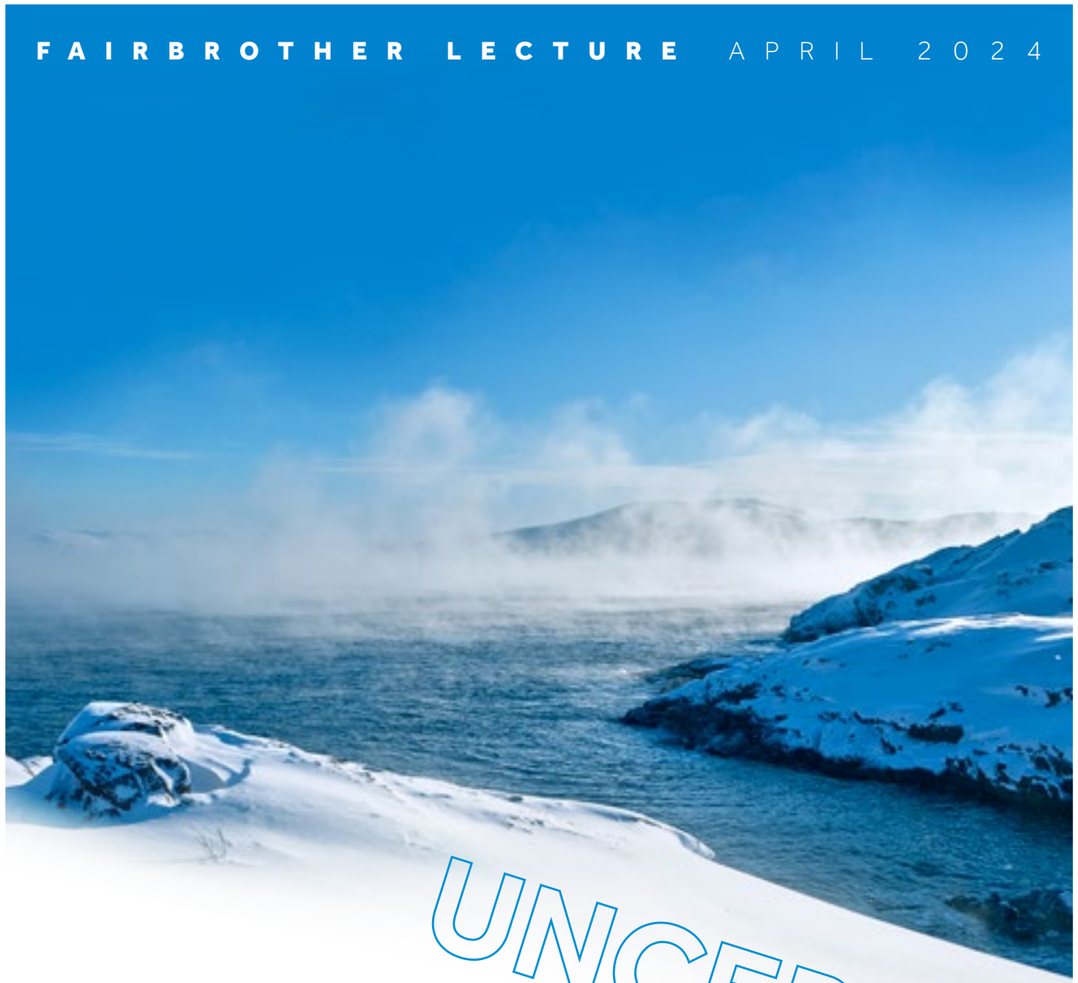
Material extracted from artefacts discovered in Egypt, Iraq and the Southern Levant were subjected to advanced chemical analysis to produce a 'fingerprint' of their chemical and mineralogical composition. These chemical fingerprints will be cross-referenced with the artefact's age and used to build a 'cosmetic map' of trade routes to show where ancient inhabitants may have procured their cosmetic ingredients.

Another aim of this research is to discover how early inhabitants of the ancient Near East used cosmetic adornments and tools. It is widely recognized that shells have in the past been used to hold cosmetics - like a modern-day makeup case. Analysis of cosmetic shells found at Bestansur, Iraq (around 7600 BCE) identified nickel, iron, sulfur, palygorskite and magnesium minerals. The cosmetic shells' residue contained pigments with plant and animal fats/oils, representing a sustainable, portable method of keeping cosmetic compounds over time. These results have been replicated with our analysis of later cosmetic shells found in Mesopotamia, Iraq (2500 BCE) and the Southern Levant (300 CE).

Early 20th century archaeologists in the Near East believed that cosmetic palettes and other cosmetic tools were only used by elite-status members of society. Preliminary examination of the distribution of goods in the graves at the site of Abu Salabikh, Iraq found the presence of potential cosmetic shells and cosmetic containers in the graves of all genders. This finding therefore supports the theory that a broader segment of ancient Near Eastern populations used cosmetic adornment.

BETTY ADAMS IS A DOCTORAL RESEARCHER IN THE SCHOOL OF ARCHAEOLOGY, GEOGRAPHY AND ENVIRONMENTAL SCIENCE.

*Common Era (CE) and Before the Common Era (BCE) are alternatives to the original Anno Domini (AD) and Before Christ (BC) notations used for the same calendar era.*




# UNCERTAIN CURRENTS

Doctoral researcher in Mathematics Reyk Börner describes the uncertainties of predicting precise climate tipping points and his experience of delivering the 2024 Fairbrother Lecture.

## Predicting tipping points in our ocean and climate

**Standing in the darkened cinema of the Reading Biscuit Factory, Reyk Börner gently nudges a bottle of water until it quivers dangerously. It almost falls but returns to its standing position. He tilts it again and repeats the exercise to his live audience. Up to a certain angle of tilt, gravity returns the bottle to the centre. But past a critical angle, gravitational pull makes the bottle tilt even further until it inevitably falls, perfectly demonstrating the concept of a tipping point.**

**In a Fairbrother Lecture that made the mathematics of climate digestible, Reyk Börner walked a local audience through the complexities of understanding climate tipping in a huge system of ocean currents, the Atlantic Meridional Overturning Circulation (AMOC), which is responsible for Europe's relatively mild climate. Past climate patterns show that these currents can switch abruptly between today's vigorous flow and a much weaker flow state. A future shutdown would have potentially devastating consequences in the UK and around the world. Media stories often paint a catastrophic picture of possible climate futures, with runaway ice sheet collapse, abrupt sea level rise and rainforest dieback, possibly triggered as early as this decade. But how close are we really to these tipping points?**

One issue I hoped to convey in my Fairbrother lecture is that we are dealing with multiple layers of uncertainty in attempting to answer this question. Uncertainty is a difficult message and people understandably seek answers to important questions about their future: how close are we are to tipping? Or at what level of global warming will we cross the tipping point (1.5 degrees, 2 degrees, etc.)?

Some of the uncertainty involved includes data uncertainty – we only started to systematically measure the ocean current 20 years ago. So we have to reconstruct the AMOC strength of the past from so-called fingerprints, such as sea surface temperatures. Another layer of uncertainty exists in the way we build models and how we apply mathematical theories. However, these types of uncertainty can be reduced by getting more data and improving our models continuously.

But there is yet another kind of uncertainty – the climate itself is a chaotic system. Perhaps you have heard of the butterfly effect by which, metaphorically, even a tiny change like a butterfly flapping its wings can change the course of global weather. This is why weather forecasts don't extend much farther than two weeks or so. Our research shows that chaos becomes particularly important when you get close to a tipping point, making the climate's long-term evolution highly unpredictable.

What do we do in light of this intrinsic uncertainty? I see this something like a game of climate roulette. Imagine you have two guns, each with many bullet chambers. One gun is loaded with many bullets, representing a future with high greenhouse gas emissions. The other has fewer bullets and corresponds to a world where we have curbed emissions. Which gun would you play with? Though there is no certainty about whether the gun will go off in either case, having more bullets inside significantly increases the risk of the gun firing a live round.

Uncertainty can be paralysing, but the truth is that we make decisions under uncertainty every day. Take the example of a house fire. We cannot predict with certainty if and when a house will burn but we still manage the risk through measures like smoke alarms and fireproof materials. I believe the best risk management available to us is to swiftly reach net zero emissions to stabilise the future of our planet. Even without tipping, the climate crisis is already one of the greatest threats of our time.

My hope is to reveal a path between climate change denial and 'doomism' to help make sense of climate tipping points. Crossing a tipping point would have serious consequences and we must both prepare for the possibility and mitigate the risk. Despite uncertainty, we still have agency to steer towards a safer and more just future.

VIEW THE FULL LECTURE AT **YOUTUBE.COM/WATCH?V=LJWHSMYVEAO&T=609S**

Henley Business School doctoral researcher Ananya Sengupta asks whether businesses miss out when individuals with a history of offending are excluded or ignored.

# From second chance to FIRST IN COMMAND

**Recent studies on strategic leadership have taken an increasing interest in how events in the private lives of Chief Executive Officers (CEOs) such as marriage, parenthood or bereavement, can influence their professional choices and decisions. There is little research on how less socially desirable choices, and mistakes that they may have made in the past, could shape their professional life trajectories, including their leadership qualities and behaviours.**

Post-traumatic development theories suggest that some people experience transformative growth following adversity. Our research explores this in the context of CEOs with criminal and addiction histories who overcome potentially overwhelming odds to become successful. The research uses discourse analysis techniques to explore the experiences of four such CEOs through their published autobiographies.

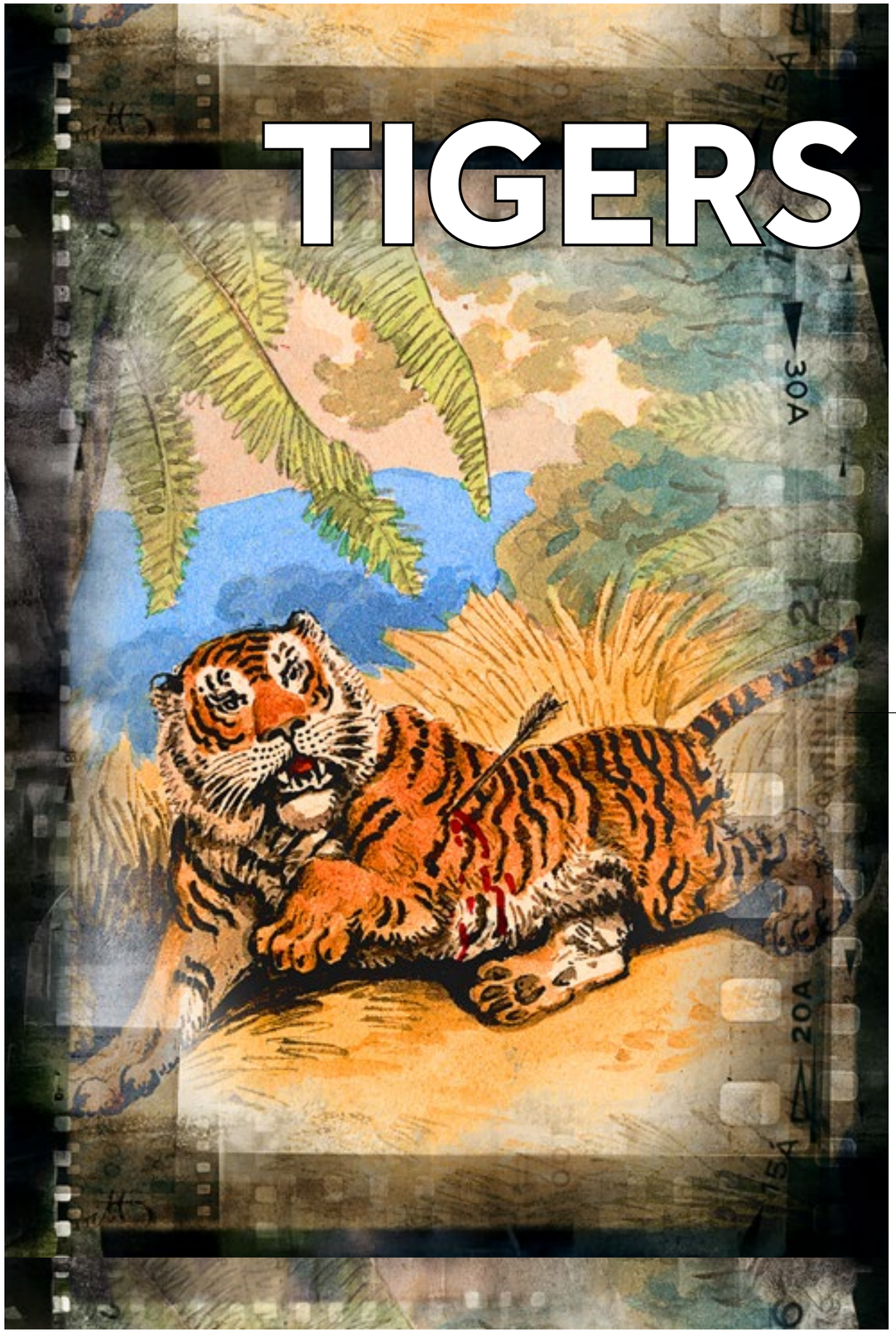
Several novel insights arise from the narratives in the four autobiographies, which are sometimes counter-intuitive but surprisingly consistent. For example, we found that all four CEOs valued trust, honesty and building deep relationships in both their personal and business lives. While these qualities might be unexpected from people with criminal backgrounds, the CEOs stress that even criminal operations function on trust and relationships. These imperatives continue in the CEOs' lawful ventures. Their narratives also suggested high levels of determination, motivation, resilience, and the ability to handle risk and pressure.

We highlight the ways in which experiences of transformation helped the CEOs to develop a range of effective leadership qualities. These include a propensity towards purposefully inclusive, empathetic and collaborative behaviours leading to better outcomes for their employees and organisations. We also found that all the CEOs experienced intense and enduring feelings of gratitude, both towards people who helped and supported them through their turnaround as well as to luck, good fortune and sometimes God. At the same time, they experienced feelings akin to survivor guilt because they were given a second chance while many others were not.

Two dynamics can be seen in their approaches to leadership. First, they use the credibility gained from their professional success and expertise as a platform, often then employing others who need second chances and using corporate social responsibility, philanthropy or activism to tackle systemic inequities. Secondly, they use their personal life stories and particularly their experience of facing inequities and living on the wrong side of the law to inspire vulnerable people, with a focus on preventing them from making the same mistakes.

In an environment where governments grapple with how to reduce rates of imprisonment and reoffending, our study offers insights on how businesses could contribute to this effort. During the Covid pandemic, many people left their jobs in what became known as the "great resignation," leading to staff shortages in many organisations. Ironically, according to Harvard Business School and Accenture, there are about 27 million "hidden workers" in the US – people, including those who were previously incarcerated, who are often overlooked due to hiring policies. Similar proportions are found in the UK and Germany. Our study highlights the positive leadership potential of ex-offenders and strengthens the case for mainstreaming broad-based diversity and inclusion policies in organisations. In effect, this is a call to arms to organisations, both large and small, to lead the way towards rehabilitative justice.

ANANYA SENGUPTA, HENLEY BUSINESS SCHOOL DOCTORAL RESEARCHER




# IN FILM:

## Past, Present and Future Perspectives

**Did you know that the tiger is a symbol of both colonial oppression and national pride in India? From being the hunted prey of British colonists to embodying post-independence strength and resilience, the tiger's journey mirrors India's transformation through history.**

Tigers have long fascinated human imagination, appearing in diverse cultural narratives, art, and cinema. My research investigates tiger representations from the 16th to 20th centuries through an interdisciplinary approach combining art history, anthropology, material culture, and film studies. By analysing static and moving images, I explore how tigers evolved as symbols of power, danger, and identity.

> Exploring the intersection of cultural identity, colonial legacies, and visual storytelling.

As apex predators, tigers play a critical role in East and Southeast Asia, where their habitats, including the Bay of Bengal, sustain significant biodiversity loss. Globally, their population is now 5,574, with 3,167 in India. The six subspecies of tigers: Bengal, Amur, Sumatran, Indo-Chinese, Malayan, and South China all originate in Asia, where they hold ecological and cultural significance. Tigers have symbolised power and bravery in art across the region. In Korea, the "tiger map" linked tigers to resilience; in China, elite soldiers exchanged tiger paintings as symbols of courage. In Japan, where tigers were not native, their imagery borrowed from Chinese art, while in Southeast Asia, tigers were revered in folklore and temple architecture as protectors of the natural world.

In India, tigers have been iconic, deeply entwined with the country's history, culture, and mythology. Associated with royalty, tigers featured in Mughal (16th –19th century) hunting scenes, where they symbolised valour. Aristocratic women also engaged in tiger hunting, further highlighting their role in royal identity. In Hindu mythology, the goddess Durga rides a tiger, symbolising strength and protection. This spiritual significance transformed during British colonial rule, when tiger hunting became a symbol of conquest. The British reframed tigers as ferocious predators to be subdued, with trophy hunting promoted as a mark of bravery and domination.

After India's independence, the tiger evolved into a symbol of national pride and resilience. The Project Tiger initiative, launched in 1973, marked a turning point, positioning the tiger as a representation of India's commitment to conservation. Organisations like Panthera and WWF have further emphasised the tiger as a global conservation icon, advocating its ecological importance as a critical species.

In visual media, Mughal art celebrated tigers as majestic and harmonious creatures, contrasting with colonial portrayals that framed them as threats. Early films such as The Indian Tomb (1921) and The Jungle Princess (1920) reinforced these colonial stereotypes, depicting tigers as dangerous and exotic. In The Indian Tomb, tigers symbolise dominance and punishment, while The Jungle Princess shows them as menacing invaders. Wartime films like Tiger Fangs (1943) added another layer, portraying tigers as victims of human manipulation during wartime sabotage. Post-war films such as The Maneater of Kumaon (1948) introduced themes of ecological awareness, showing human encroachment as the root of tiger-human conflict.

Postcolonial cinema shifted tiger portrayals, emphasising coexistence and conservation. A Tiger Walks (1964) presented tigers as creatures deserving empathy, promoting friendship between humans and wildlife. Roar (1981) marked a turning point, breaking predator stereotypes and portraying tigers as companions, even assigning them human names to individualise them. Tiger Love (1977) went further, depicting the tiger as a father figure, symbolising emotional and familial bonds.

These shifting depictions reflect changing attitudes toward human-animal relationships and colonial legacies. While colonial narratives emphasised control and exploitation, postcolonial films challenge these stereotypes, advocating for coexistence and environmental stewardship. By tracing tiger representations, this research highlights how this iconic animal mirrors broader societal shifts, serving as a powerful symbol of identity, resilience, and conservation.

FARAH BENBOUABDELLAH IS A PHD RESEARCHER IN THE SCHOOL OF ARCHAEOLOGY, GEOGRAPHY AND ENVIRONMENTAL SCIENCE.

# BLACK SWANS OR SITTING DUCKS?

## Enhancing humanitarian imagination and preparedness to unprecedented extreme weather

**In October and November 2024, six consecutive typhoons hit the Philippines in less than 30 days, affecting over 13 million people. Six consecutive typhoons in such a short period was unprecedented for the country, and posed specific challenges for local early warning and disaster response systems, notably because there was little time to recover between shocks. Could we have imagined and foreseen this season? Could we have prepared for it differently? If so, how?**

My research explores how the humanitarian sector can better imagine and prepare for unprecedented extreme weather. It is easy to think that most disasters are driven by the huge "Black Swan" hazards that we could not have foreseen or prepared for. In fact, sometimes all it takes is for extreme weather to be slightly different from past events for local disaster preparedness systems to fall short, causing devastating humanitarian impacts. My work is focused on these unprecedented extreme events which should be imaginable and foreseeable. There are many places in the world that can be considered "sitting ducks" for these types of events: they are at risk but do not know it[1]. They may have always been at risk but have simply been lucky, or their risk may have recently emerged, for example because of climate change. What if we could identify these sitting ducks and better prepare?

In autumn 2024, I published the first paper of my PhD that aims to give disaster practitioners and scientists a common framing to talk about this question (Heinrich, Stephens, and Coughlan de Perez, 2024[2]). My initial findings suggest that there are gaps in the usability of current science on unprecedented weather – we are not necessarily asking all the right questions. In the paper, we find that there is an overwhelming focus of academic research on events of unprecedented magnitude, but that disaster managers are concerned about much more than this - in a given location, extreme weather can be unprecedented in degree (magnitude and intensity) but also in time (duration, timing in the year, frequency, speed) and space (location, extent, pattern). We also need to think about how far back our memories go – something might be unprecedented in all of geological time, or it may simply be unprecedented in recent experience, community memory, or personal experience.

All these dimensions have significantly different requirements for disaster preparedness. For example, storms that happen out of season require systems to be reactivated during what is often a maintenance period; a longer lasting tropical cyclone may deplete internet provisions which are critical for communications and require evacuation shelters to be kept open for longer; unprecedented windspeeds and storm surge may cause significantly more damage and require larger stockpiles of first aid.

As scientists, if we want to make our research as useful as possible for people planning for these sorts of scenarios, we need to be precise in our use of the term "unprecedented" and we need to look at more diverse dimensions of hazard risk beyond simply magnitude.

In the next phase of my research, I am looking specifically at this typology for tropical cyclones. I am exploring how existing approaches of modelling and forecasting can be used to identify diverse risks of unprecedented storms. We are comparing storm records with datasets derived from statistical models, hindcasts, and other approaches, pulling out specific scenarios of unprecedented, yet highly plausible, events. We aim to use these storylines to identify sitting ducks, help disaster managers in these places understand these risks and find ways to prepare effectively.

Fundamentally, I think that unprecedented weather poses a challenge of imagination[3]. We need to be able to imagine these risks in order to ask the right questions, to better prepare and to ensure that unprecedented hazards do not create unprecedented disasters. I see large potential for collaboration between researchers and disaster practitioners to produce science that is useful, usable, and used to save lives, and hope that my PhD can contribute to this.

DOROTHY HEINRICH IS A SECOND-YEAR PHD STUDENT IN METEOROLOGY AND A TECHNICAL ADVISOR AT THE RED CROSS RED CRESCENT CLIMATE CENTRE.

1 Read more about this concept here - Masukwedza et al. 2024. **journals.ametsoc.org/view/journals/bams/aop/BAMS-D-23-0297.1/BAMS-D-23-0297.1.xml**

2 See **sciencedirect.com/science/article/pii/S2468312424000178**

3 See this great paper by other Reading colleagues – Ommer et al. 2024. **nhess.copernicus.org/articles/24/2633/2024/**

> Unprecedented weather poses a challenge of imagination.







Save the date: The 2025 conference will take place on Wednesday 18 June.

# Doctoral Research Conference

**The Doctoral Research Conference (DRC), held on 12 June 2024, showcased the excellence and diversity of research undertaken by doctoral researchers from across the University. This highly entertaining event provided a valuable networking opportunity for participants. Along with the conference competitions, delegates watched two research films produced by Reading graduate Dr Matt Greenwell. You can read about Matt's journey from doctoral student to early career researcher on page 22.**


### Research for a Better World Competition

Jeff Da Costa (School of Archaeology, Geography and Environmental Science) won this award on his research to assess the effectiveness of early warning systems in disaster management.


### Three Minute Thesis Competition

Eight finalists competed in this popular competition. Holly Giles (School of Chemistry, Food and Pharmacy) won with her talk entitled 'Stronger for longer with whey protein'.


### Research Poster Competition

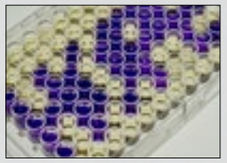
Adel Ternovacz (School of Humanities) won this competition with his poster 'A Roman gem in the Sarmatian Barbaricum'.

### Research in an Object Competition

The judges were unable to choose between the two distinctly different objects submitted to the competition, leading them to award a joint prize to Victoria Robinson (School of Archaeology, Geography and Environmental Science) for her 3D print of gamma radiation survey data and to Chris Pesso (School of Archaeology, Geography and Environmental Science) for his automatic remote controlled boat.


### Research Life in Pictures Competition

The Research Life in Pictures competition was won by Jeff Da Costa (School of Archaeology, Geography and Environmental Science). The caricature of Jeff featured on the front page of a Luxembourg newspaper.

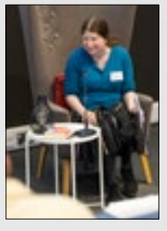


### Research Image Competition

Nikolaos Giannoulis (School of Chemistry, Food and Pharmacy) was awarded the judges' prize for his image 'HOPE for safer and greener food'.


### Poetry, Rhyme & Rap Competition

The prize was awarded to Phoebe Graham (Institute of Education) for her poem 'I can still chant 'amo'. Her research focuses on the potential benefits of school children learning Latin.



### Your Research as a Bedtime Story Competition

This new competition required students to simplify their research topic into a simple bedtime story. Vikki Rose (School of Agriculture, Policy and Development) won with her story 'Why Wanda can't wander', which explored the abundance and species mix of butterflies and moths found alongside hedgerows.

A short highlights film of the DRC can be viewed at **rdg.ac/drc2024**
A full recording of the conference can be watched at **bit.ly/graduate-conference-2024**

# HYDROGELS CAN PLAY PONG ...and get better

**Complex computation is present in a wide variety of forms throughout biology, chemistry and physics. For example, the computational complexity of the brain is derived from signals travelling between biological neurons providing 'computing power'. In machine learning there is a growing desire to improve computational algorithms to understand learning in the biological brain.**

There are many theories that seek to explain biological learning, one of the more prevalent in recent studies conceptualises the brain as a free energy system. In this theory a brain can be thought of as a system that seeks to minimise free energy - the brain has an internal *representation* of the external environment in memory, as information is received about the external environment that differs from this *representation* free energy increases. Through restructuring, the brain minimises this free energy, improving its *representation* of the external environment.

> In machine learning there is a growing desire to improve computational algorithms to understand learning in the biological brain.

The theory of free energy in biological brains was explored in a study using the application of Pong; the classic 1970s 'tennis like' computer game featuring two paddles and a ball[1]. Researchers grew neurons into a network and placed them in a Multi-Electrode Array (MEA), which interfaced with a computer simulation of the game. This research showed that brain cells could be electrically stimulated to play Pong with feedback from the game environment and improve their performance over time.

Other material systems, whose mechanics are also described through the minimisation of free energy and exhibit memory like behaviour, have been identified. One such material is Polyacrylamide hydrogel (a soft flexible material), which is a form of Electro-Active Polymer (EAP)[2]. Our work aimed to adapt the Pong experiment to explore if hydrogels, when interfaced with in a similar way, would be able to play Pong and improve over time[3].

Electrical stimulation caused the movement of ions (charged particles) within the hydrogel. The resulting redistribution of ions minimised free energy and represented the environment information. Therefore, the distribution of ions within the hydrogel could be used to place the paddle to intercept the ball. The hydrogel was continuously stimulated according to the ball's location to provide environmental information. Through experimentation we found that the hydrogel's learning behaviour and its ability to intercept the ball improved over time. The distribution of the ions created a form of 'memory' within the gel and came to represent not only the ball's position but its motion over time. Therefore, hydrogels can achieve similar kinds of memory mechanics as more complex biological neural networks, such as brains.

This research shows that even very simple materials can exhibit complex, adaptive behaviours, typically associated with living systems. This research opens up exciting possibilities for developing 'smart' materials that can adapt to their environment and improving current machine learning algorithms. Researchers plan to further probe the mechanism behind the hydrogels 'memory' and test its ability to perform other tasks.

VINCENT STRONG WAS A DOCTORAL RESEARCHER IN THE SCHOOL OF BIOLOGICAL SCIENCES AND WAS AWARDED HIS DOCTORATE IN FEBRUARY 2024.

1 Kagan, B.J., Kitchen, A.C., Tran, N.T., Habibollahi, F., Khajehnejad, M., Parker, B.J., Bhat, A., Rollo, B., Razi, A. and Friston, K.J., 2022. In vitro neurons learn and exhibit sentience when embodied in a simulated game-world. Neuron, 110(23), pp.3952-3969.

2 Strong, V., Holderbaum, W. and Hayashi, Y., 2022. Electroactive polymer gels as probabilistic reservoir automata for computation. Iscience, 25(12).

3 Strong, V., Holderbaum, W. and Hayashi, Y., 2024. Electro-active polymer hydrogels exhibit emergent memory when embodied in a simulated game environment. Cell Reports Physical Science, 5(9)

# A PHD... BUT WHAT COMES NEXT?

## An interview with Dr Matt Greenwell

**Matt Greenwell was awarded his doctorate in Biological Sciences from the University of Reading in 2021. His PhD focused on the genetic diversity of the Meadow Brown butterfly. He now works as an insect ecologist in the School of Biological Sciences and undertakes fieldwork on a rainforest covered island in the middle of the Panama Canal. This project hopes to answer the question - Why are there so many species of trees in the tropics?**

### How did you find the transition from PhD student to post-doctoral researcher?

My transition was unusual. I submitted my PhD thesis during the height of the Covid-19 pandemic and almost immediately secured a one-year post doctoral position to investigate threats to UK biosecurity. I knew quickly that I wanted to return to ecology, so I took a job as a research assistant within the School of Biological Sciences. From a career progression perspective, one could view this as a backward step. However, it provided me with invaluable fieldwork experience, which ultimately made me a strong candidate for my current post doctoral position within the same research team.

### What research question are you trying to answer and why?

I am part of a project focused on understanding why biodiversity in tropical areas is so high when compared to temperate regions. Specifically, I study the effect of seed-feeding insects on the reproductive success of tropical forest trees. In practice, I collect fruits from the rainforest floor and identify the insects that emerge from them using DNA sequencing. While previous research has been conducted on a small spatial scale, we have expanded our research to a landscape scale, to determine if patterns observed locally in the rainforest also apply over large distances.

### What do you enjoy most about your fieldwork?

Most mornings in the rainforest I wake to the sound of howler monkeys calling and go to sleep to the sound of cicadas chirping. I have seen everything from bullet ants to ocelots and each time I leave camp there is the potential to see something new.

### What aspect of your fieldwork has been the hardest?

Fieldwork is simultaneously the best and hardest part of my post doctoral position. The island terrain is difficult with muddy tracks, steep hills and gulleys to navigate to reach our research sites. The temperature in the rainforest is a constant 30°C with 80-90% humidity, so you are permanently exhausted and drenched in sweat. It is a constant battle not to be bitten by a host of insects, whilst also keeping an eye out for snakes in the undergrowth and crocodiles at the water's edge. It is a challenging environment but worth it!

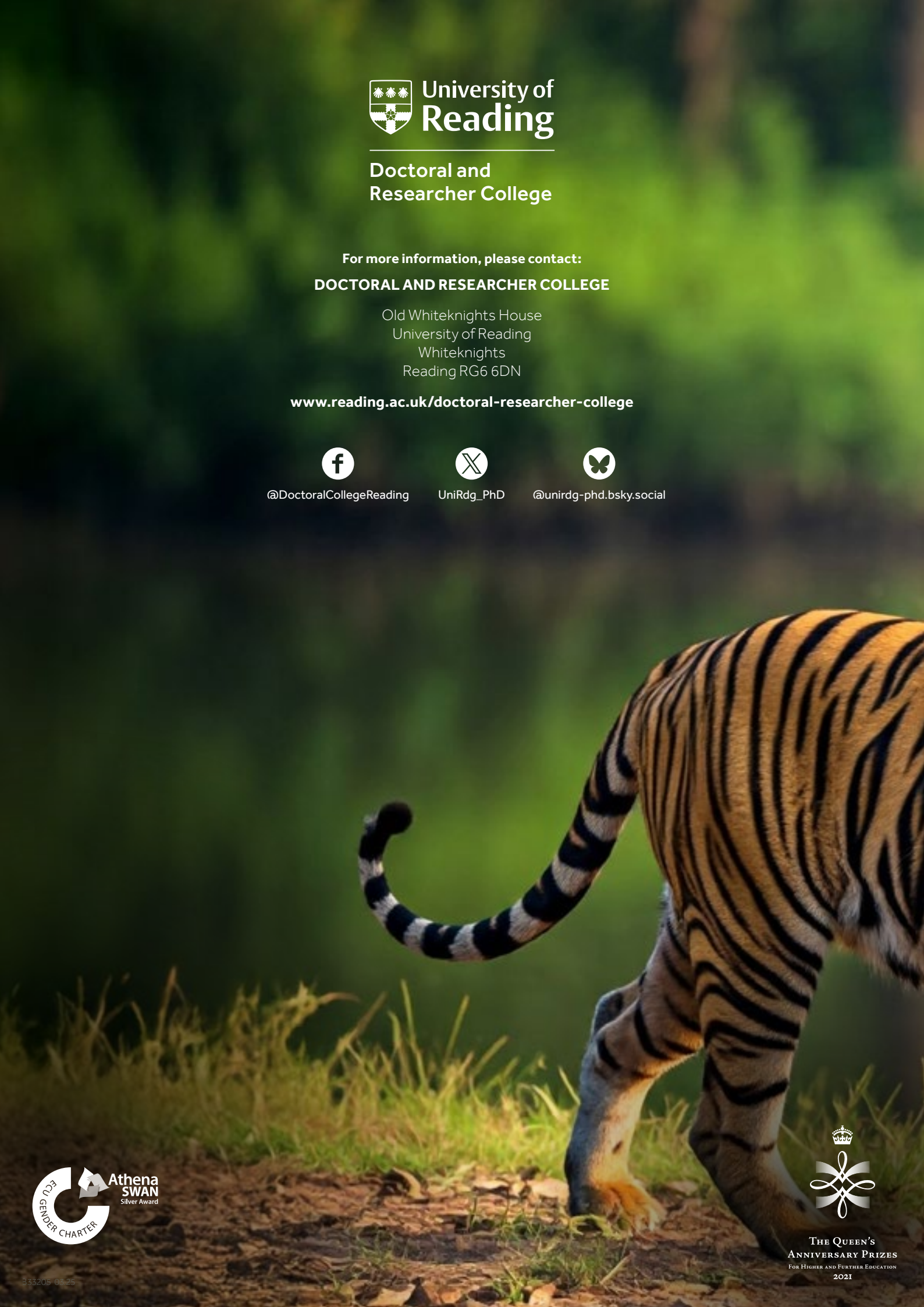
### As an early career researcher, how important do you think it is to network?

Networking is important. The more people you meet and talk to, the more likely that someone has an idea or a suggestion that could help your research or, in my case, make my fieldwork easier. I have made some great friends whilst conducting fieldwork who are based all over the world - these contacts may lead to future research collaborations and job opportunities.

### What is next on the horizon for you?

Next year I hope to secure another research position that will allow me to see more of the world and its wildlife. I would say the cliché about doing something you love is important and one that applies to all stages of a research career. Fortunately, I love my job, and I am excited for what comes next.

The Doctoral and Researcher College is the home of doctoral and early career researchers at Reading. It provides advice, training and professional development opportunities.



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