Biology News

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UNIVERSITY OF OXFORD

Department of Plant Sciences
Department of Zoology

George Ratcliffe

Head of Department of Plant Sciences

Credit: John Baker

It's difficult to imagine a more awkward time to be writing a few paragraphs for Biology News. The University and Departments are grappling with what can and cannot continue as the coronavirus pandemic takes hold, and any summary of what we're doing now will certainly be out of date by the time I've written it. It also doesn't feel like the time to be celebrating the exciting science that we have been doing, although you can read about some of this elsewhere in this issue; or indeed to update you on progress on the design of the £200m+ Life and Mind Building that will house the Plant Sciences and Zoology in a new Biology department sometime in 2024.

Only time will tell how disruptive the health emergency will be to our normal activities, and in that regard, we are in exactly the same position as all our readers.

Against this backdrop, I would like to highlight the contribution that the non-academic members of staff make to the teaching and research enterprise in Plant Sciences. Former graduate students amongst the alumni will have been more aware of this group than former undergraduates, but everyone will have benefited either directly or indirectly from their work.

We have a small administrative team, led by a microbiologist, Dr Roni McGowan, that includes the Teaching Office for the undergraduate degree course and a Graduate Studies Office.

It falls to this team to pilot our current students through the uncertainties that we now face in the delivery of teaching and examinations. Also, in this team is one of our longest serving members of staff, John Baker, who will be known to many through his photography and whose links with the Department go back to the 1970's when he joined the Department of Agricultural Sciences. Rumours that he is contemplating retirement always turn out to be false.

We also have a small and equally dedicated team of research technicians, led by our Buildings Manager, Mr Rob Bryant. This group ensures the orderly and efficient running of the research labs, and without the likes of Julie Bull for example, who presides over the Langdale and Kelly labs, we would be hard pressed to maintain are standing as a leading plant biology research centre.

Finally, any account of the Department's enablers must also include Dr Eric Belfield, whose technical knowledge has been essential in maintaining and improving our all-important plant growth facilities over the last decade or so; Caroline Benfield, who first joined the Department as Senior Secretary to the Forestry Institute in 1985; and Rosemary Wise, the celebrated botanical artist and winner of the Sibthorp medal, whose extraordinary contribution to the Department is without equal.

Credit: Rosemary Wise

Professor George Ratcliffe

Professor of Plant Sciences

Tim Coulson

Joint Head of Department of Zoology

Our faculty continue to conduct research that impacts national and international policy. In particular, work in the department on human and livestock disease has contributed to two attempts to manage, and hopefully eradicate, two nasty diseases.

A number of our faculty and researchers have been heavily involved with trying to understand the spread of coronavirus, and to design policy to help contain it. Moritz Kraemer, Nuno Faria, and Oliver Pybus have analysed data from China and demonstrated that attempts to contain the virus effectively slowed its spread. They have used these insights to brief the World Health Organisation on actions that should help slow its spread. The disease group has a strong track record in working with, and containing, both emerging and established diseases. It is no surprise they are playing such a key role around the coronavirus pandemic.


Credit: John Cairns

The control and management of livestock disease does not always move as quickly as the UK government's response to coronavirus. For many years now I've worked alongside a number of our faculty, including John Krebs, Charles Godfray, and David Macdonald, to provide scientific advice around the UK's badger cull. DEFRA have recently announced plans to phase out the cull given its relative lack of success and advances in vaccination strategies for cattle. Hopefully this new phase in controlling bovine TB will work, and, in time, this disease too will be eradicated from our shores.

Back in Oxford, since we last wrote, we have continued apace with the exciting developments around our new building, teaching the first year of the new undergraduate Biology course, and the merger of Plant Sciences and Zoology to form a new Biology Department.

In order to help deliver the new course, we have welcomed Professor Tom Richards and Associate Professor Berta Verd onto our faculty, and are delighted to have appointed Associate Professor Katrina Davis who will start with us on July 1st. These new appointments join Professor Tim Barraclough, Associate Professor Michelle Taylor and Associate Professor Sarah Knowles who all started at the beginning of the new academic year.

These appointments, along with a new one in Plant Sciences, mean that by the summer we will have appointed the faculty required to support the increased undergraduate population associated with the new Biology degree.

The faculties in Zoology and Plant Sciences have now agreed a structure for the new department, and we are currently taking this through the University governance process. The new department will consist of four centres – Biodiversity, Molecular Plant Biology, Organismal and Evolutionary Biology, and Microbial and Disease Biology. These centres allow us to combine our talents from across the two existing departments while retaining distinct areas of historical expertise.

Later in this issue, we describe how the design phase of the new building is progressing and I will not dwell upon it further here, other than to say that we continue to fundraise apace both within the UK and overseas.

Professor Tim Coulson

Professor of Zoology

Our new future in the Life and Mind Building

At the time of writing, we're all managing enormous new challenges to our lives and how we work because of the Covid19 pandemic. This hasn't prevented progress on the demolition of the Tinbergen Building, and the ongoing process of designing the replacement building.

The contractors responsible for the demolition (Erith) completed the largest asbestos removal project in the UK on time, and demolition of the superstructure has continued on schedule despite the challenges of social distancing on the site. Of course, the emptiness of the streets of Oxford, and the lack of Oxford's seemingly continuous rush hour has made the process of removal of rubble and waste much simpler, and the demolition has interrupted far fewer revision sessions than might have been the case. As things stand, the site will be cleared by late 2020, and those of you revisiting Oxford will see a dramatic change to the South Parks Road landscape which really brings home the scale of the building.

Meanwhile, the process of designing the replacement – with the working name of the Life and Mind Building – continues apace, with increasingly detailed plans developed through many hundreds of hours of online review sessions with lead architects NBBJ, as we work towards submitting the formal planning application in June 2020. The resulting building, which will, if planning permission is granted, house almost 1000 academic, support, research staff and students, and be the main teaching location for around 1000 undergraduates, will be a spectacular development for Biology in Oxford. For too long, Biology has been without an obvious focal point in the University, and this building will provide this, catalysing the kind of new interactions that will define the science locally and globally for the coming century.

Stepping up research into biological threats can help us plan for the future. More than ever, we need to work together to conduct high-quality, innovative research that will allow us to change the world for the better.

Credit: Ben Sheldon

> ***"For too long, Biology has been without an obvious focal point in the University, and this building will provide this, catalysing the kind of new interactions that will define the science locally and globally for the coming century."***

Gathering world-class psychologists and biologists under the roof of the state-of-the-art Life and Mind Building provides an exciting opportunity for interdisciplinary research that meets the emerging challenges of the 21st century.

Although the building is not yet open, psychologists and biologists are already joining together to create research hubs. These hubs will identify and research pressing issues that are biological in nature, but where the solutions require an understanding of human behaviour.

The hubs in development include: Animal communication; Antimicrobial Resistance; Conflict and Cooperation; Digital Life; Feeding the Planet; Healthy Ageing; Improving Global Health; Natural Intelligence; Nature-based Solutions; and Networks.

Credit: Ben Sheldon

The fight against COVID-19, and our researchers on the frontline

From genomic sequencing to epidemiological modelling, researchers at the Department of Zoology have been contributing to global COVID-19 research since the start of the year.

The COVID-19 pandemic has dominated the news headlines and our daily lives for the past six months. It has ground our world to a halt in unprecedented fashion, and has scrambled researchers from many disciplines to frontline research studying the virus and its epidemiology in the hopes of creating a vaccine against future infection.

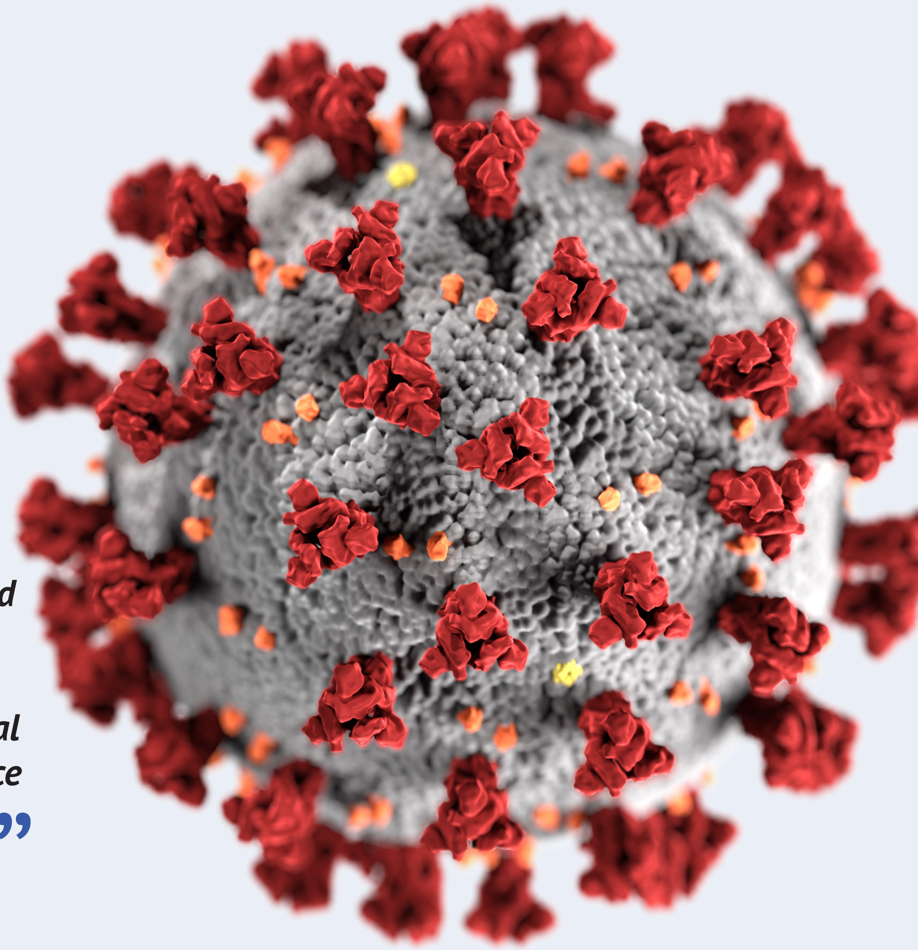
COVID-19 spread rapidly from its origin (believed to be in Wuhan) to almost all provinces in China, and then globally. The case numbers continue to rise and most countries around the world have now implemented travel restrictions and strict so called non pharmaceutical interventions. We are witnessing a once in a generation event.

SARS-CoV-2 is an RNA virus that can spread between humans. It was first shown in late January that human to human transmission was possible and data initially in the epidemic showed that most infections are mild (at least in the early phase after infection) and some even asymptomatic. Virus spread mostly occurs as a result of close contact (i.e., households, hospitals, care homes, workplace).

Our team in Oxford's Department of Zoology is primarily concerned with understanding the population dynamics of geographic spread of the virus. As part of that effort we are co-leading a team to collate a globally comprehensive and geographically precise dataset on infected patients. Pairing these data with global human mobility data allowed us to understand the early spread and dynamics in provinces in China. We found that about 30% of all recorded infections travelled after symptom onset, indicating that the spread was driven by mild infections in travellers.

Further, we found that early implementation of travel restrictions can play a major role in reducing spread of COVID-19. Those findings provided an early insight and rationale for the implementation of travel restrictions to mitigate and contain the epidemic. For example, New Zealand was successful in controlling the spread of COVID-19 mainly due to the implementation of interventions early.

"The case numbers continue to rise and most countries around the world have now implemented travel restrictions and strict so called non pharmaceutical interventions. We are witnessing a once in a generation event."



Credit: CDC/ Alissa Eckert, MS; Dan Higgins, MAM

Moritz Kraemer

Branco Weiss Reseach Fellow

An Apollo project for agriculture: The C_4 Rice Challenge

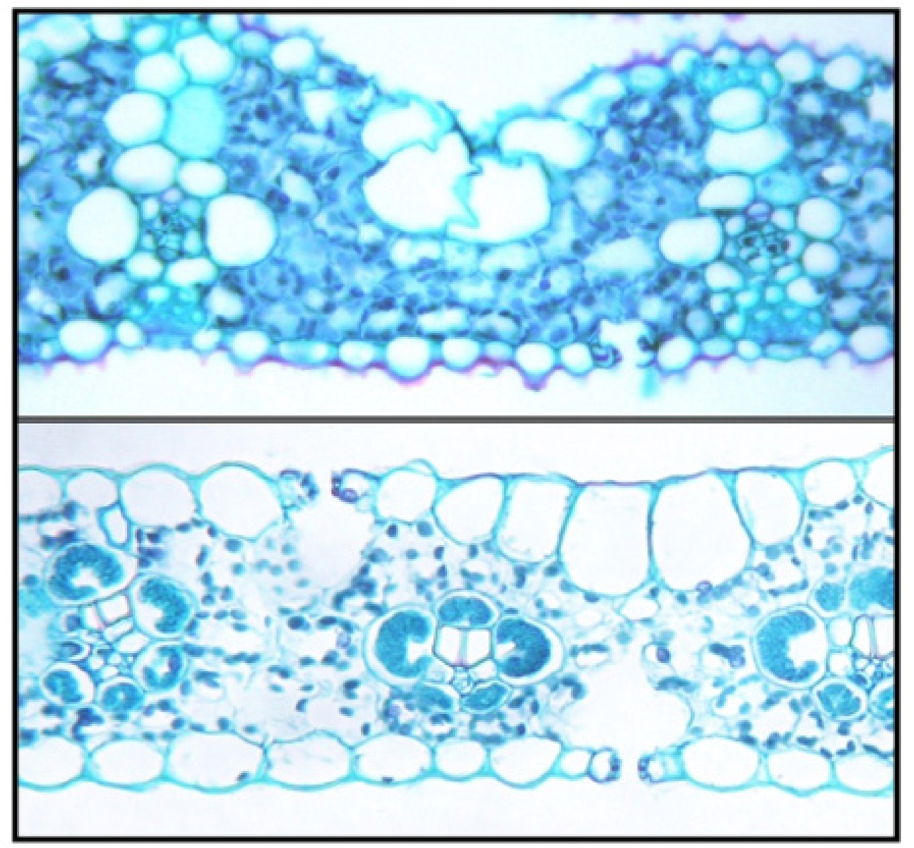
Having been established over a decade ago, the C_4 Rice Challenge represents one of the most plausible approaches to enhancing crop yield and increasing resilience in one of our most important food groups.

Underpinning virtually all life on earth is the process of photosynthesis, whereby plants, algae and photosynthetic bacteria use light energy to fix inorganic carbon dioxide (CO_2) into organic sugars. C_3 photosynthesis, in which CO_2 is fixed into a three-carbon compound, is the most common form, but C_4 photosynthesis is the most productive. Despite comprising just 3% of flowering plant species, C_4 plants contribute 25% of terrestrial primary productivity. Of our top three food crops, wheat and rice utilize the C_3 pathway whereas maize uses C_4.

3 billion people, almost half of the world's population, rely on rice for survival. In Asia, due to predicted population increases and a general trend towards urbanization, land that provided enough rice to feed 27 people in 2010 will need to support 43 by 2050. Traditional breeding programs are not on track to realise the yield gains that are needed to achieve this. However, introduction of the C_4 pathway into rice could increase photosynthetic efficiency and yield by the required 50%. In addition, the transition would improve nitrogen use efficiency and double water use efficiency, reducing reliance on nitrogen fertilizers and enhancing drought tolerance. But is the goal realistic? Can we use our understanding of how the C_4 pathway functions in maize to engineer components into rice?

The C_4 pathway evolved from the ancestral C_3 pathway on over 60 independent occasions, providing optimism that the transition could be relatively straightforward to engineer. However, the scale of the challenge should not be underestimated. The evolutionary transition from C_3 to C_4 metabolism required the modification of at least eight genes encoding enzymes and transporter proteins. In each case, genes that play general housekeeping roles in all cells of C_3 plants were re-regulated to perform a modified role in one of two photosynthetic cell-types in C_4 leaves.

Over the last few years, the full complement of genes required for the C_4 pathway in maize has been identified. The parts needed to engineer C_4 metabolism are thus known, but a major hurdle remains. Although both maize and rice exhibit strap-shaped leaf blades characteristic of the grasses, because C_4 metabolism is compartmentalized between two photosynthetic cell-types, internal leaf anatomy differs between the two species.



Distinct leaf anatomy in rice (top) and maize (bottom). Leaf veins are spaced closer together in maize and cells encircling the veins contain chloroplasts.

Unlike our understanding of C_4 metabolism, we are only just beginning to discover which genes regulate leaf anatomy in maize. A partial transition to C_4 could be achieved in the context of existing rice leaf anatomy but full conversion requires that we identify developmental regulators in maize and then use them to alter leaf anatomy in rice. At current estimates, the activity of 15-20 genes will need to be modified to engineer the metabolic and anatomical changes required to generate C_4 rice.

The C_4 Rice Project (www.c4rice.com) represents one of the most plausible approaches to enhancing crop yield and increasing resilience in the face of reduced land area, decreased use of fertilizers and less predictable supplies of water. Started in 2008, with an award from the Bill & Melinda Gates Foundation to the International Rice Research Institute in the Philippines, the project brought together a consortium of researchers from 12 countries.

Since 2015 the project has been co-ordinated from Oxford, and with funding recently renewed for a fourth phase (2020-2025), prospects look good. But with a projected completion date of 2034, success requires the long-term investment of resources, significant advances in our understanding of fundamental plant biology, and substantial changes in the pipeline from research lab to farmer's field.

Professor Jane Langdale

Professorial Research Fellow

Bugs in the System

Professor Owen Lewis
Professor of Ecology

The Community Ecology research group have been looking into insect communities in natural and agricultural habitats, aiming to understand the wider consequences of changing insect populations.

Insects make up more than half of all species on our planet and are a crucial part of most food webs. They provide important 'ecosystem services' for people, for example by pollinating our crops and recycling nutrients within the soil.

Recent scientific studies reporting reductions in the abundance of insects have attracted considerable media attention, with headlines warning of an 'Insect Apocalypse' and 'Ecological Armageddon'. Climate change, habitat degradation and pesticides have all been blamed, but there is considerable uncertainty about the extent of insect declines, the likely causes, and the consequences for other species (including *Homo sapiens*).

Within the Community Ecology research group (cero.zoo.ox.ac.uk) we have been researching the ecology and functioning of insect communities in natural and agricultural habitats over many years, with much of our work focusing on tropical habitats such as rainforests and savannas.

A major focus of our work is on the complex web of feeding interactions among species, linking insects to the plants that they consume, and to their predators. Combining traditional entomological fieldwork and modern molecular methods, we are able to find out 'who eats who' and often 'how much of X is eaten by how many of Y' for large numbers of species.

In Panama, for example, we have been able to document the complex web of feeding interactions between hundreds of species of rainforest trees and the highly specialised moths and beetles that consume and kill their seeds. Our field experiments have shown that excluding these insects – and fungal pathogens, another important source of plant mortality – can lead to marked changes in the diversity and composition of rainforest vegetation.

We can also study subsets of insect food webs experimentally in the field and in the laboratory. To understand how networks of interacting species are likely to respond to climate change we are studying wild Drosophila fruit flies from the rainforests of Queensland, Australia, along with the tiny parasitic wasps that attack their larvae and pupae. We can recreate food webs of ten or more interacting species in the laboratory and investigate how their populations and interactions change as species invade or go extinct, or as we change the climate.

Meanwhile, in the Atlantic Forest of Brazil, DPhil student Beth Raine has even documented networks of feeding interactions between dung beetles and the faeces of different mammals – work that recently featured in The Economist.

Of course, as well as 'ecosystem services' like burying dung, insects can bring 'dis-services' too: damaging our crops and vectoring diseases like malaria. Our new project in Ghana is investigating food webs centred on *Anopheles gambiae*, a mosquito that transmits malaria between people. As new insect control techniques are developed to target A. gambiae, we want to understand how eliminating or greatly reducing its abundance could affect other plants and animals including predators like bats, birds and fish. In this and many other areas of interest, insect food webs are proving a valuable tool to answer fundamental and applied questions in ecology, and to understand the wider consequences of changing insect populations and communities.

> ***"We can recreate food webs of ten or more interacting species in the laboratory and investigate how their populations and interactions change as species invade or go extinct."***

Credit: Owen Lewis

Growing together: on unexpected collaborations

A microbiologist and an ecologist walk into a bar... Are academic collaborations and symbiosis more similar than we think?

I arrived in Oxford in September 2013 and I still feel like a newbie. Moving to a new city – in my case in a different country, albeit one that I can call home – inevitably takes considerable effort, an effort that many senior academics are rather reluctant to undertake. But moving to Oxford was a great decision for me.

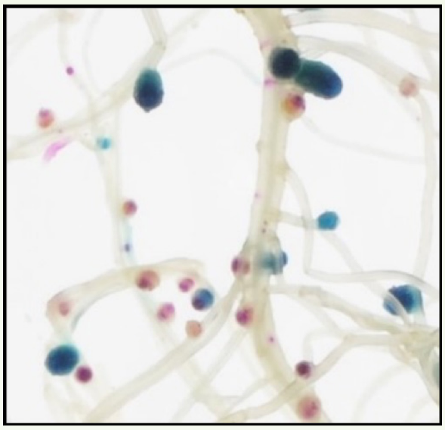
Moving to a new place forces you to talk to new people. Better, you mostly have no idea what they research until you actually strike up a conversation and this can often result in you chatting to people who work on very different things. One of my fellow 'newbies' was Phil Poole, who had joined Oxford from The John Innes Institute in Norwich. Phil is a microbiologist, with a special interest in nitrogen-fixing bacteria, so what could he and a plant ecologist possibly do together?

One of the defining characteristics of the inhabitants of our planet is that they have a strong tendency to work together. Called 'symbiosis', pairing up with other organisms occurs because reinventing things from scratch is hard in evolutionary terms, whereas co-operation is relatively easy. Of course, co-operation doesn't automatically happen – both partners have to provide something that the other wants, and the system needs to be protected against cheats, who might take the benefit, but not pay the price.

Legume plants have struck up an arrangement with symbiotic bacteria, called Rhizobia, that live in soil. The plants offer the bacteria a home inside specialised structures called nodules within their roots. Within the nodules, the bacteria multiply up and are supplied with sugar that the plant finds easy to make. In return, Rhizobia fix atmospheric nitrogen, something that plants cannot do for themselves.

But this system is susceptible to cheating. A plant will usually have many different nodules and each is infected by a different strain of bacteria. This makes it easy for a cheat to prosper, as one of the bacteria could fail to fix nitrogen, but still take sugar from the plant. So, to prevent cheating bacteria from stealing their precious sugar, plants have to police their symbionts.

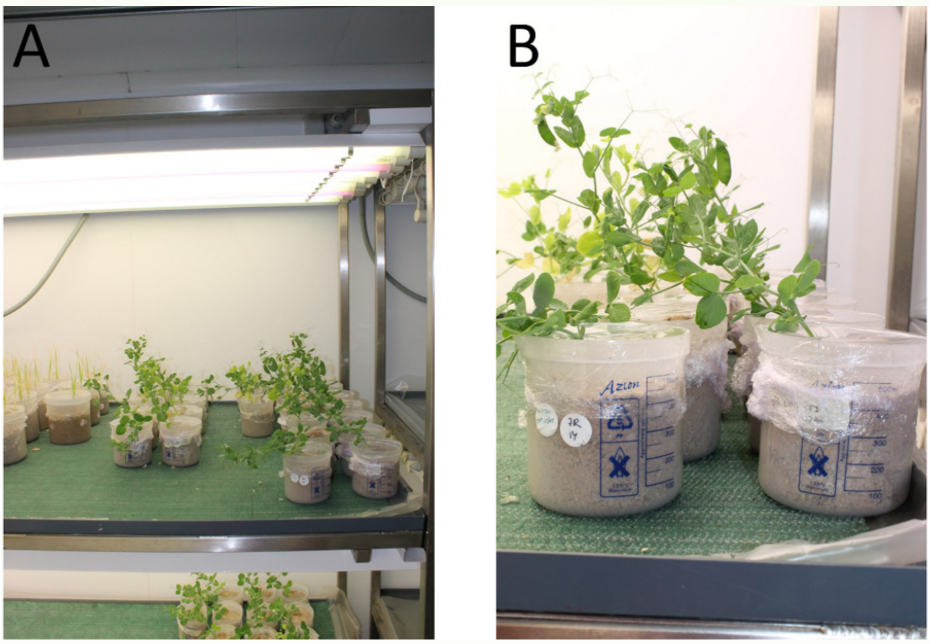
> ***"Of course, co-operation doesn't automatically happen – both partners have to provide something that the other wants."***



Details of a pea-plant root system showing nodules stained with different dyes that reveal which bacteria is inside. In this case, the blue nodules contain a wild-type strain that fixes lots of nitrogen, while the magenta nodules contain a non-fixing mutant.

Phil and I worked with DPhil students Annet Westhoek and Laura Clark to discover more about how the plant keeps control of potentially wayward bacteria. By creating strains that differ in just one or two genes, we have demonstrated that plants crack down hard on bacteria that just aren't providing enough nitrogen, although they seem to be less concerned about how much sugar they have to give in return.

Other collaborations will have to wait for the next article I'm asked to write, but working on symbiosis with new academic partners has opened my eyes to a whole new aspect of biology and made me realise that moving around is sometimes worth the disruption.



Pea plants growing in the growth cabinets with different strains of nitrogen-fixing bacteria.

Professor Lindsay Turnbull
Associate Professor

Hesperiid butterfly
Credit: Owen Lewis

The Secret Life of (honey)Bees

In a complicated world, how do bees navigate towards, and select for, the nutrients they need to thrive?

Professor Geraldine Wright

Professor of Comparative Physiology/Organismal Biology

Humans have benefited from and depended on the work of honeybees for millennia. Many ancient civilizations revered bees for their valuable production of honey and wax; bees were often associated with royalty and used as motifs of rulers or deities. Domestication of honeybee began as early as the ancient Egyptians who used clay tubes to keep bee colonies and harvest honey. Bees also contribute to food production in modern agro-ecosystems. Many of the fruit and nut crops we consume in our daily lives depend on domesticated honeybees for pollination.

A honeybee colony is a complex eusocial society, with one queen, thousands of her sterile, female progeny, and a few hundred of her sons (drones). The sterile workers create the wax comb, rear the brood (larvae), feed the queen, guard and clean the nest, and collect all the food. Honeybees visit flowers to collect floral nectar and pollen which they use as their sole sources of food. Nectar is their source of carbohydrates and pollen is their main source of protein, fat, and micronutrients.

Intensification of land use has reduced flowering plant diversity and abundance, resulting in poor or insufficient nectar and pollen for honeybees, especially in agricultural landscapes where plant diversity is low.

The bee lab at the John Krebs Field Station at Wytham is investigating how bees learn about, select, and consume the appropriate nutrients they require. In conjunction with our collaborators in Israel and at the Royal Botanic Gardens (Kew), we have developed methods for measuring how whole bee colonies regulate their intake of essential nutrients including protein, fats, and carbohydrates. Using this information, we have successfully created a livestock feed for bees (i.e. a pollen substitute) that will be marketed to beekeepers worldwide. We are continuing to study how specific nutrients in a diet impact bee health and queen fecundity.

My lab also studies the bee's sense of taste and its ability to learn and remember floral cues associated with food. We have found that bees possess gustatory mechanisms that enable them to encode information about the specific identity of sugars. Some of our notable research has shown that certain compounds found in nectar with pharmacological targets in the bee's brain, such as caffeine or nicotine, amplify the rewarding properties of nectar in the memories of bees. Bees that consume drug-laced nectar are likely to learn and remember the floral traits (e.g. scents) associated with this nectar. We have recently identified that if bees are exposed to these compounds for several days, they begin to exhibit behavior that could be classified as addiction.

> ***"Intensification of land use has reduced flowering plant diversity and abundance, resulting in poor or insufficient nectar and pollen for honeybees."***

Credit: Geraldine Wright

Derailing plant development to accelearate plant breeding

Can food supply challenges be solved by persuading pollen grains to develop into embryos?

Professor Hugh Dickinson

Emeritus Professor of Plant Reproductive Biology

Estimates differ, but the world is in agreement that we shall need massive amounts more food if our way of life is going to continue. Key to this will be the generation of more plant varieties capable of surviving in saline, dry or other stressful environments. A major barrier to achieving this is the prohibitive cost of generating the large numbers of true-breeding crop hybrids. This process involves several rounds of self-pollination and selection that, for key crops like maize, can take several years.

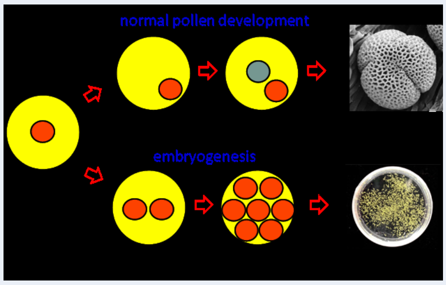
Frustratingly, a shortcut to this breeding cycle has been known for years. Some plants (regrettably not many of them crops) can divert their pollen development to form embryos directly from developing pollen grains; of course, these embryos produced via 'pollen embryogenesis', although viable, contain only one nucleus and are therefore infertile when it comes to seed production.

However, it's possible to double the number of genomes in the nuclei of young embryos using simple chemistry, generating large number of fertile pollen-derived embryos containing two, identical, true-breeding genomes.

Our efforts in the lab are focused on two questions. One, why do only some plants do this, and two, what is the developmental basis of this aberrant switch in pollen cell fate?

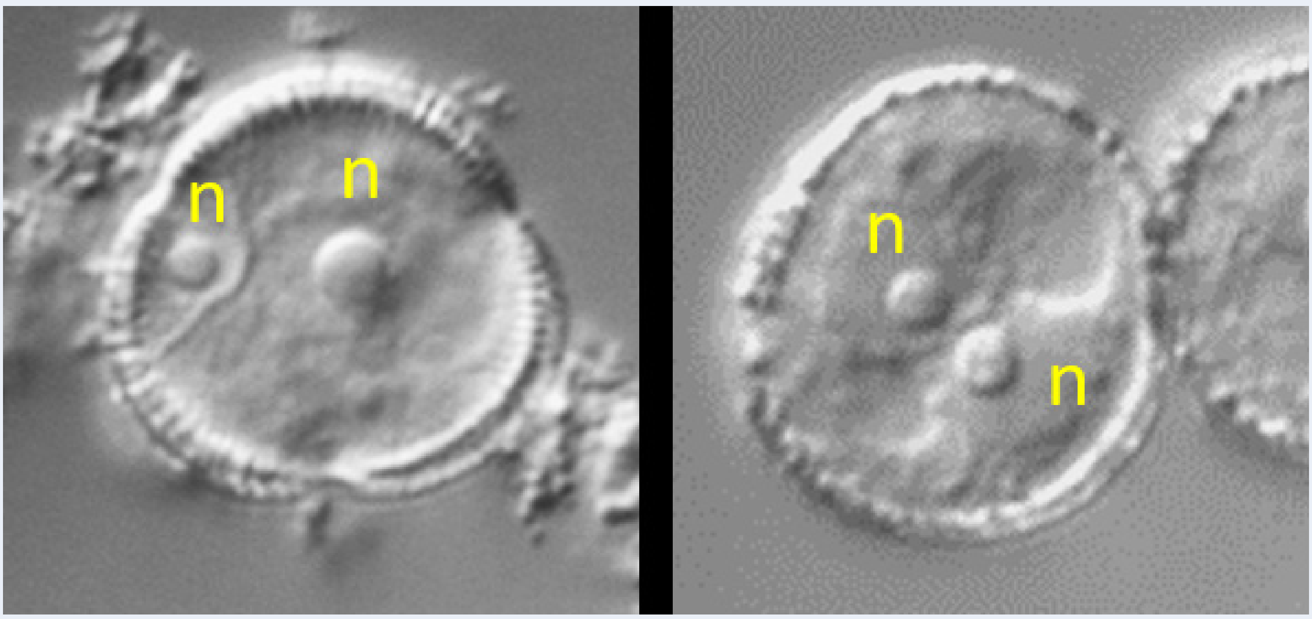
Using information from lower plants such as mosses, where these switching events are much simpler, we are trying to modify the gene networks controlling early pollen development in the model plant Arabidopsis. Firstly we wish to alter the symmetry of the first pollen cell division (which we have already shown to channel more cells into embryo formation), and secondly to unravel the changes in gene expression needed to divert pollen of all species into embryo formation.

Development of such a system would transform current breeding practice, massively cutting down the time and cost of generating vital new plant lines. Unsurprisingly a number a commercial biotechnology companies are in on the act, but they are adopting shotgun approaches - screening astronomical numbers of compounds in a range of embryogenesis assays. Our approach at Oxford is double-headed - combining both a major benefit to mankind, as well as increasing our understanding one of, if not the, most complex fate-switching events in plant biology. Watch this space.



Some plants can divert their pollen development from developing pollen grains

> ***"Our approach at Oxford is double-headed - combining both a major benefit to mankind, as well as increasing our understanding one of, if not the, most complex fate-switching events in plant biology."***



Altering the symmetry of the first pollen cell division during early pollen development in model plant Arabidopsis. Left panel, normal asymmetric division; right panel, aberrant symmetric division. N = cell nucleus

Biology celebrates LGBTQ+ History Month

Aym Maidment

Communications, Outreach, and Alumni Relations Assistant

In February, the Departments of Zoology and Plant Sciences marked LGBTQ+ History Month with a series of talks and by creating a Biology LGBTQ+ Network.

Talks were given by Dr Alex Bond, Senior Curator of Birds at the Natural History Museum, and Dr Clara Barker from the Department of Materials, both discussing their relationship with being LGBTQ+ and how it connects to their science.

The departments also ran a workshop on being a Responsible Bystander, in order to ensure we continue to be a welcoming place to all.

The Biology LGBTQ+ Network currently has 19 people subscribed to its mailing list, hosts a weekly lunchtime meeting, and will host talks and seminars throughout the year. The Network is in the early stages of planning a symposium for LGBTStem day in November, to promote the science of LGBTQ+ members of the departments.

The Pride and Progress flags were also both displayed in the Zoology reception and above the door to the Plants Sciences building, to celebrate the progress that has been made for LGBTQ+ people whilst pointing towards the work that is yet to be done.

> *"This Febuarary will be one I won't forget - totally inspirational!"*

In Memory of Professor Lord Robert May of Oxford

It was with great sadness that we learned that Professor Lord May of Oxford died on April 28. Bob - as he was known to all - joined the Department of Zoology as a Royal Society Research Professor in 1988.

During his time here, he collaborated with, and was a close friend to, many members of the department. He continued to work in the department until late 2016 when declining health no longer made this possible.

Bob was a towering figure in Science, who made extraordinarily influential contributions which changed entire fields in population, community, and ecosystem ecology, and in mathematical biology and epidemiology. In addition, he made significant advances in theoretical physics, mathematics, and economics.

His scientific contributions are matched by his distinguished record of service in scientific leadership and policy. Between 1995 and 2000 he was the Chief Scientific Advisor to the government, and between 2000 and 2005 he was President of the Royal Society.

He received numerous accolades for his research and scientific leadership, including FRS (1979), Foreign Member of the National Academy of Sciences (1992), Knight Bachelor (1996), The Crafoord Prize (awarded in fields not recognised by the Nobel Prizes, 1996) Life Peer (2001), and the Order of Merit (2002).

Bob will be greatly missed by those who knew him; it is a great shame that many of our newer faculty did not have the chance to interact with him.

> *"Bob was a towering figure in Science, who made extraordinarily influential contributions which changed entire fields in population, community, and ecosystem ecology, and in mathematical biology and epidemiology."*

Two top wins for Biology at MPLS Impact Awards

We are delighted to announce that two biology academics were named winners at the MPLS Impact Awards. The annual Awards aim to foster and raise awareness of impact by rewarding it at a local level, and preparing the ground for the impact case studies that will be needed for REF 2021.

Dr Lindsay Turnbull was awarded The Social Impact Award for her work on the Aldabra Clean Up Project. Of her award, Lindsay said: "It is great for the Aldabra Clean-Up Project to be recognised in this way. The Seychelles Government have signed up to further international commitments to reduce maritime pollution, as a direct consequence of this project, so we're delighted that this project led to real political change."

Dr Cedric Tan was awarded The Public Engagement with Research Impact Award. He said: "Winning this award has inspired me to continue innovating and assessing my public engagement activities. Very often we forget to assess the impacts of our outreach activities and I believe that assessment is important to listen and collaborate with the public."

"Thank you to my collaborators Amy Hong, Ran Peleg and Jennifer Spencer who have contributed substantially to these public engagement activities. The University's Public Engagement with Research Seed Fund and Knowledge Exchange Seed Fund have supported these outreach activities and I would like to thank these funding schemes."

Cedric Tan and Lindsay Turnbull receiving their MPLS Awards earlier this year

Professors Ben Sheldon and Kayla King recognised by Linnean Society

Congratulations to both Professor Ben Sheldon and Professor Kayla King who have been recognised by the Linnean Society for their contributions in the world of biology.

Professor Sheldon has been awarded The Linnean Medal expression of the Society's esteem and appreciation for service to science in the field of Zoology.

Of his award, Ben said: "I'm delighted to receive this award from the Linnean Society, which recognises and celebrates the central importance and ongoing relevance of Natural History as a field to make sense of Biology. Any success I've had is really due to the support I've had throughout my career from mentors, colleagues and students who have been such a rewarding community to work with."

Meanwhile Professor King has been awarded The Linnean Society Bicenterary Medal in recognition of excellent research in the natural sciences.

Kayla said: "I am honoured to receive this prestigious award. Everything we have achieved in my group is due to our fascination with the major (and sometimes bizarre) impacts that parasites and other microbes have on hosts across the tree of life. It is a joy to see our research recognised in this way."

Professors Kayla King and Ben Sheldon

DPhil Student Projects

Mark Wong

How are different species put together in ecological communities? My DPhil research seeks to identify general rules governing the assembly of species in communities. To achieve this, I study diverse communities of ants in tropical Asia, using a combination of field observations and experiments. By meticulously documenting the ecological attributes of individual ant species, such as their body plans, diets and behaviour, I aim to characterise their niches, and understand how multiple species partition limited resources to coexist in communities. Focusing on ecological attributes has also allowed me to identify particular groups which are susceptible to growing threats such as invasive species. Ultimately, I hope the research will advance our understanding of how insect diversity is assembled, maintained, and responding to environmental change. Such knowledge will be vital for conserving insects, which are among the most ecologically and economically important organisms on the planet.

Friederike Hillemann

Mixed-species groups, where members of different species interact and move together, are common across animal taxa, but inter-species interactions have often been a point of secondary interest in the study of animal sociality. I investigate how mixed-species groups are formed and maintained, using combined observational and experimental approaches to study flocks of individually marked songbirds (Paridae) in Wytham Woods as a model system. I developed a framework that is based on concepts of optimality to link processes of group formation to signalling theory and information use, and compared observed pattern of individuals' social decisions to simulated processes for hypothesis testing. Participation in mixed-species flocks is a complex balance of competition cost and grouping benefits, mediated by both individual phenotype and environmental conditions. My thesis contributes experimental evidence for the importance of positive, mutualistic interactions in community ecology, and justifies recent advances of linking individual behaviour to community processes.

Lois Ogunlana

The increasing prevalence of antibiotic resistance in pathogenic bacteria is a serious threat to human health. My research focuses on Colistin which is a last resort antibiotic against gram-negative pathogens. Mobile Colistin resistance (MCR) genes have been identified in multiple agricultural and clinical bacterial populations. Although their plasmid localization allows rapid spread via horizontal gene transfer, MCR gene expression comes with a large fitness cost which reduces the competitive ability of bacteria in the absence of colistin. Genetic variations have been found in the structural and regulatory elements of these genes. I use genetic engineering tools to reconstruct these variants in the lab where I study their impact the fitness and resistance of bacteria carrying MCR genes. My research allows us to understand how this gene is evolving and if occurrences of compensatory evolution (variants which give increased fitness but similar levels of resistance) can be found in natural settings.

DPhil Student Projects

Laura Perry

To at least some extent, most conservation work revolves around human behaviour. From bushmeat poaching to artisanal fishing, understanding why people behave in certain ways is key to solving human-wildlife conflict problems. My work focuses on this interface between applied psychology and conservation. Using tools from social psychology, I explore the determinants of human behaviour as it relates to conflict issues in eastern and southern Africa. In particular, I am interested in the role of psychology in determining livestock management, illegal wildlife use, and predator persecution. Currently, I am working to establish a project in Niassa National Reserve, in northern Mozambique. This project is in the very early stages, but will integrate pure biological research (such as mammal camera trap surveys and botanical inventories) with further social and psychological research, and hopefully lay the groundwork for a new, long-term project in this critical but chronically understudied region.

Mukhlish Jamal Musa Holle

Many tropical forests have been extensively converted into another form of land-use, especially through agricultural expansion. Human-modified tropical landscapes have inevitably experienced erosion of both biodiversity and associated ecosystem functions and services. Working in Sulawesi, Indonesia, I am specifically interested in millipedes (Diplopoda) which are a numerically-dominant component of the macroinvertebrate community and are facilitating litter invertebrate decomposition activity. The presence of millipedes on the forest floor contributes to 22% higher cellulose degradation. My project assesses (1) the consequences of land-use change for invertebrate communities and ecosystem functions, (2) functional contribution of millipedes within the litter-dwelling community under altered climatic conditions, and (3) trends in biodiversity and ecosystem function along transects from the forest edge into farmland areas. The outcome of this study is expected to supply empirical evidence on functional interactions within the macroinvertebrate community as well as practical solution for tropical nature reserve management.

Christina Hunt

Most research on invasive lionfish (*Pterois volitans* and *P. miles*) has focused on their consumptive effects, with little work on other aspects of their ecology and behaviour. My DPhil is expanding our knowledge of lionfish habitat use and how lionfish may impact the behaviour of other species. I collect data using observational studies and behavioural lab experiments in Honduras, Central America. Prior to my work, it was assumed that lionfish formed aggregations through social attraction. However, I demonstrated that aggregations form coincidentally through mutual attraction to specific habitat features. This led me to question whether lionfish may compete with other shelter-using species, such as economically important spiny lobsters. I found that both species influenced the behaviour of one another, highlighting the importance of looking at two-way interactions between native and invasive species.

DPhil Student Projects

Mirjam Hazenbosch

"Our land is our life", says Hogoli (pseudonym), a farmer in Ohu village in Papua New Guinea. Hogoli, like 250 million other farmers in tropical countries, relies on her garden for her daily food and income. Nowadays the population in many tropical countries is growing rapidly. To feed the additional mouths, small farmers need to produce more food. However, there is limited land available to expand farms. And many farmers are currently seeing their yields declining due to climate change. The question is how can these small farmers best adapt their practices so they can produce enough food to feed the growing population, but in a way that is sustainable? I have been working with farmers like Hogoli to figure out exactly this. Together we set-up experimental gardens in Ohu in which we tested the effect of soil management techniques such as compost and animal manure on crop yields. I also used innovative interviewing techniques, including a photo project, to better understand what farmers in PNG see as their opportunities and challenges for farming their gardens into the future.

Phoebe Griffith

Big Mama is my favourite crocodilian. Big Mama is a four-metre gharial, a fish-eating crocodilian endemic to the Indian subcontinent, and when we caught her last December it took a team of ten adults to remove her from the river to the beach where we could safely restrain her and attach a radio transmitter to her tail. One of 45 gharial I have tagged as part of my DPhil research, follow-up tracking and observation is providing us with critical data on ecological characteristics of the gharial in Chitwan, Nepal, where the species remains Critically Endangered despite forty years of conservation action. The focus of my DPhil research is to better understand this gharial population through ecological research, as well as social research to understand gharial-human interactions. Most of our tagged adult females have mated and nested this year, and we wait with fingers crossed to observe them doing what gharial do best in the summer – being great parents!

Emily Warner

My research looks at how different reforestation methods influence biodiversity and ecosystem function. In the UK we have increasing reforestation pledges, but little field knowledge of how ecosystems respond and deliver benefits in the early stages of forest growth. I have been conducting a study in recently replanted native forest in the Scottish Highlands. By comparing sites replanted over the last 30 years to surrounding unforested heathland and mature remnant forest, I can quantify the potential benefits or negative effects of reforestation in a predominantly unforested landscape. I have considered aspects of biodiversity, including the plant, carabid beetle and bird communities, and ecosystem functions, such as aboveground and soil carbon storage, and decomposition rates. The results from my work allow a more objective assessment of the effects of native reforestation. Indicating the ecosystem services that may be supported by reforestation and the effect it will have on biodiversity.

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There's a lot happening in the world at present, but the Alumni Relations team are looking to the future. As we prepare for the Departments of Plants Sciences and Zoology to join forces and become the Department of Biology, we're taking this opportunity to think about what our alumni communications are going to look like in the coming years.

We'd love to tell you about all of the exciting new developments happening across Biology at Oxford, from the work of our undergraduate students, to exciting and groundbreaking research.

We're very lucky to belong to a department with very broad and exciting research themes that have such wide ranging real life practicalities, from food sustainability to illegal wildlife trade policy advice. This means that we have lot of news, and we want to make sure that you're hearing about things you care about, in a way that suits you.

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Caitlin Hamilton

Head of Communications, Outreach & Alumni Relations

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