Biology News

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UNIVERSITY OF OXFORD

Department of Plant Sciences
Department of Zoology

George Ratcliffe

Head of Department for Plant Sciences

Professor Liam Dolan stood down after the usual five year stint as Head of Department last autumn and it fell to me to take over the reins. Liam, whose leadership in the wake of the loss of the Tinbergen Building has been highly commended by the University, continues as the department's Director of Innovation and Development. So we shall continue to benefit from his wisdom and insight as the projects initiated during his term of office come to fruition.

I am pleased to report that the Department is in good shape. This is not just a 'well he would say that' declaration, but the opinion of the periodic joint review of the Departments of Plant Sciences and Zoology that reported towards the end of last year. The panel looked in forensic detail at teaching, research and operational matters, and on the whole were very impressed by their findings. It is pleasing to have a seal of approval, but we are taking this as a signal to build on our strengths rather than to continue as we are, and two matters are under intense discussion.

First, with our colleagues in Zoology, we are planning to replace the existing course with a four year degree that will better equip our graduates for life after Oxford. Many will recall the difficulty of shoe horning their project into the constraints of the current course, and one of the purposes of revising the course is to eliminate this difficulty by having a project-based fourth year. Lindsay Turnbull and Renier van der Hoorn, two relatively new members of the Department, have been leading the discussions from the Plant Sciences side and both would testify to the complexity of achieving what would appear to be an entirely straightforward evolution of the course. Given a fair wind I hope that we shall have agreement from both the University and the Colleges to make this change in time for the next Admissions round.

Secondly, again with Zoology, we are exploring the possibility of Plant Sciences moving into the building that is expected to replace the Tinbergen Building. It seems that a replacement building could house three or four Departments, not just Experimental Psychology and Zoology, and there would be clear benefits in bringing two organismal biology Departments under the same roof. Will this happen? We shall have to wait and see, but the clock is ticking on the time-limited temporary accommodation that is being made available for Experimental Psychology and Zoology, and there is a great incentive to develop a plan that will make the best use of an unprecedented opportunity to enhance research and teaching in Oxford Biosciences.

Notwithstanding these distractions, life in the Department continues much as usual. My colleagues continue to excel in their research, publishing findings of great significance across the full range of plant biology; and in a metrics-driven world three of them – Andy Hector, Lee Sweetlove and Renier van der Hoorn – were again identified as Highly Cited Researchers by Clarivate Analytics, indicating exceptional impact in their fields of research. We have also converted the former Forestry library into a much-needed computer teaching room, and amongst the staff our first apprentice – James Ritchie – completed his training in plant specimen conservation in the Herbaria. Of course all this is old news and you can keep in touch via our website and social media channels.

George Ratcliffe
Professor of Plant Sciences

Ben Sheldon

Head of Department for Zoology

The past year has been an exciting one for the Department of Zoology: a year with challenges to overcome, successes to celebrate, and most of all, new directions and initiatives to plan and develop. When I wrote this piece last year, we were dealing with the immediate aftermath of the sudden closure of the Tinbergen Building, which had been home to the Department for more than 45 years, and within which many of you will have had the majority of the lectures and practicals on the undergraduate course. An enormous amount of work has gone into managing the response to this unprecedented event, both within the department, but also across the wider University.

As you can read elsewhere in this Newsletter, we have been able to open new modular teaching laboratories behind the Tinbergen building. While temporary, these are of an impressively high quality, and have been used by undergraduates since November. In addition, extensive building and refurbishment has taken place out at Wytham Field Station, and a 3000 m2 modular research building is nearing completion, close to the other science buildings, in the heart of the city. There has been a tremendous spirit throughout this difficult time, and we have benefitted from many offers of help from colleagues across the University. Indeed, in her annual oration, the Vice-Chancellor highlighted the response to the Tinbergen closure (or 'Texit' as it has been named by an undergraduate wit) as a prime example of the 'One Oxford' theme that illustrates the resilience of this University.

Throughout the challenges of the past 12 months, research and teaching has gone on as normal, and students and members of the department continue to expand the boundaries of biological knowledge. Whether using machine-learning and citizen science to find new ways to study penguins, uncovering the causes of the sudden death of 200 000 saiga antelope in Kazakhstan in 2015, showing how hunting peregrine falcons and cruise missiles have independently derived the same guidance mechanisms, or revealing the details of the spread of Zika and yellow fever viruses, much of the work in the department has close relevance to pressing challenges facing humans and other life on this planet.

We held a special alumni event at the Reform Club in London in September which enabled us to meet more than 80 alumni and talk about our scientific and academic mission. This was a new departure for us, but the demand was large, the evening a huge success, and we are keen to run similar activities away from Oxford in the future.

Members of the department have achieved notable recognition in many areas this year with, for example, Ashleigh Griffin awarded the Zoological Society of London Scientific Medal, Kayla King awarded the Philip Leverhulme Prize in Biology, and Charles Godfray knighted for services to science and policy. Sir Charles has moved on to become the Director of the Oxford Martin School, the latest example of many where senior members of the department have contributed to leadership in science and policy development.

As we have dealt with the Tinbergen Building closure, and ensured that we can pursue normal activities, so we have begun the work of determining the next steps for the department, and for Biological Sciences. An extensive process has been underway to find the best way to plan the future of the subject, and while details are not finalised, there are radical and exciting plans afoot, both for new buildings to provide a centre for Biology in Oxford for the 21st century, and for a new way to teach the subject in these changing times. We are always delighted to welcome alumni back to Oxford, or to meet elsewhere, and look forward to sharing some of these new initiatives as they develop over the coming months and years.

Ben Sheldon
Luc Hoffmann Professor of Ornithology,
Director of the Edward Grey Institute

Tracking the origin and spread of emerging epidemics

Jaqueline de Jesus and I sequencing Zika virus genomes using the MinION nanopore platform outside the main public health laboratory in Joao Pessoa, Paraiba, Brazil, with the ZiBRA bus behind us

Marta Giovanetti and Ingra Claro preparing sequencing libraries inside the ZiBRA bus

Entomologist in the search of Zika virus in Aedes mosquito populations across the northeast of Brazil

> *“What started as a pilot project is now expanding towards a global system of genomic pathogen surveillance in human, insect and animal populations.”*

The Zika virus dominated news headlines when it spread through the Americas in 2015. Nuno Faria spent a few weeks in Brazil designing and implementing the ZiBRA project to trace the virus' evolutionary history and rapid transmission across the continent.

It took just a few months for Zika to spread across over 50 countries and territories in the Americas. The virus was first detected in the continent in May 2015, following a series of explosive outbreaks in the Pacific islands. But where and when did the recent epidemic begin, and how rapidly is the virus evolving? Were the birth defects seen since October 2015 the consequence of newly acquired virus mutations?

To answer these and other questions we designed the ZiBRA project and set out to trace the evolutionary history of Zika across the Americas, identify the origins of the epidemic and track patterns of virus transmission in the most severely affected areas. In June 2016, our team equipped and drove a mobile molecular and genomic laboratory for 2,000km across the Atlantic coast of Brazil. In two weeks we tested 1,400 samples from pregnant women and their newborns in the main central public health laboratories.

We used a new pocket-size genome sequencing device, called a MinION, developed by Oxford Nanopore Technologies (a spin-out company of Oxford University). This revolutionary piece of kit allowed us to share analyses of whole virus genomes with local and national public health agencies in less than 48h upon arrival to a new laboratory. When combined with epidemiological and climatic data, our genetic analyses revealed that Zika was first established in the northeast Brazil at least one year before its detection in the country. We found that temperature and humidity determine the abundance of the urban mosquitoes that transmit Zika, and that we should expect a lag of approximately five months between peaks in Zika infection and microcephaly incidence. We have also identified a small set of candidate mutations that are unique to the Zika virus strain in the Americas.

What started as a pilot project is now expanding towards a global system of genomic pathogen surveillance in human, insect and animal populations. The ZiBRA team has now generated more than half of all publicly available Zika virus genome sequences and trained over 50 young researchers in Brazil. The project pioneered real-time data sharing, and our interdisciplinary team brings together researchers from the University of Birmingham, reference institutes in Brazil, Ministry of Health (MoH) of Brazil, Angola, Cabo Verde and Mozambique, and the World Health Organization.

The world is becoming increasingly connected through air travel, road networks and commercial shipping. My main scientific aim is to improve outbreak prevention and prediction of virus epidemic spread – by building a framework capable of incorporating mobility and ecological suitability measures with insights from a synchronized genomic surveillance in areas at risk for disease emergence.

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Dr Nuno Faria,
Sir Henry Dale Research Fellow

Metabolic regulation in plants: ensuring flexible responses in a fluctuating environment

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Dr Nick Kruger,
Associate Professor of Plant Sciences

How are plants adapting and regulating their sugar and starch levels to suit our ever-changing environmental demands? Nick Kruger explains how exploiting Fru-2, 6-P2 can be used to demonstrate the flexibility of plant metabolism in response to relative availabilities of different resources.

Sugars and starch are the major respiratory substrates in plants, providing both the energy and metabolic precursors needed for growth. We are interested in understanding how the synthesis and degradation of these carbohydrates are regulated to meet the varying requirements of the plant (and humans) in response to changing environmental and developmental demands.

Part of our work focuses on the signal metabolite fructose 2,6-bisphosphate (Fru-2,6-P2) which is an important regulator of carbohydrate metabolism in all eukaryotes. In green plants Fru-2,6-P2 contributes to control of photosynthetic carbon assimilation by inhibiting the first step in the pathway of sucrose synthesis in the cytosol. Changes in the amount of Fru-2,6-P2 allow the rate of sucrose production to be coordinated with the rate of carbon dioxide assimilation, and also control the partitioning of carbon between photosynthetic products, sucrose and starch.

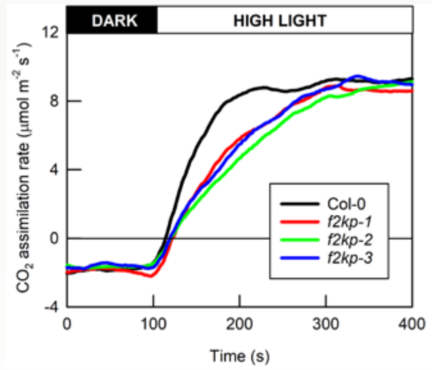
> *“In green plants Fru-2,6-P2 contributes to control of photosynthetic carbon assimilation by inhibiting the first step in the pathway of sucrose synthesis in the cytosol.”*

Exploiting mutant plant lines lacking Fru-2,6-P2, we found that Fru-2,6-P2-deficient plants produce more sucrose and less starch than regular plants, but surprisingly they have normal rates of photosynthesis under steady light conditions. This behaviour demonstrates the flexibility of plant metabolism to adjust to changes in the relative availability of different resources. However, if the lack of Fru-2,6-P2 has no appreciable effect on the overall rates of photosynthesis or growth, why do plants continue to produce and degrade this compound?

Plants lacking Fru-2,6-P2 take longer to accumulate photosynthetic intermediates, thereby extending the length of the lag phase. This effect is trivial under constant daytime conditions, however, a compromised ability to respond to changes in light intensity becomes more important in conditions in which photosynthesis has to adjust to more frequent environmental variations. Indeed, Fru-2,6-P2-deficient plants grow more slowly than standard plants when exposed to controlled continuously fluctuating light or temperature. Similarly, plants lacking Fru-2,6-P2 produce 20–30% fewer seeds than standard plants when grown in natural day/night cycles at ambient temperature, implying a decrease in Darwinian fitness.

Our studies highlight the important role of Fru-2,6-P2 in allowing photosynthesis to respond effectively to rapid changes in the conditions faced by the plant, and indicate that “regulatory” properties may be involved in the speed at which metabolism adjusts to external conditions. In continuously varying natural environments the capacity to respond rapidly in order to optimise the metabolic activities of the system may be critical. These findings suggest that the physiological roles of metabolic regulators should be examined in fluctuating environments rather than the constant conditions used in most current studies.

Growth of Arabidopsis plants lacking fructose 2,6-bisphosphate is compromised in a fluctuating environment



Adjustments in photosynthesis after changes in light intensity are delayed in Arabidopsis mutants lacking fructose 2,6-bisphosphate

Island Life: Evolution in splendid isolation

The existence of different, and often unusual, species on islands has fascinated generations of biologists, with famous examples including the extinct dodo of Mauritius and spectacular radiation of Darwin's finches in the Galápagos. Sonya Clegg is interested in the evolutionary processes that generate diversity of island forms, with a focus on birds of the southwest Pacific.

Silvereye, Zosterops lateralis

© Sonya Clegg

From the time of Charles Darwin's voyage of the Beagle in the 1830s, the study of island-dwelling forms has played a central role in the development of evolutionary and conservation biology principles. Islands harbour relatively few species; successful colonisation can be limited by dispersal capacity, the ability to exploit a new environment and chance. Those species that succeed live in a community with fewer competitors, predators and parasites, and as such, novel selective pressures can rapidly generate new evolutionary outcomes in 'splendid isolation.'

However with diversification potential comes the vagaries of chance events such as extreme weather or the introduction of a new disease. My group and I exploit island systems to study the underlying evolutionary processes of divergence and to understand how small and often isolated populations persist and diversify.

An interesting feature of island fauna is that we often see repeated patterns of change in a range of characteristics that form the so-called 'insular syndrome.'

Repeated changes are seen in behavior, such as increased tameness; ecology, such as having a wider ecological niche; morphology, such as changes in body size; life history, such as having fewer offspring but living longer; and population-level characteristics, such as having high population densities.

We are interested in understanding why island living produces these repeated patterns. Silvereyes, of the white-eye bird family Zosteropidae, show several features of the insular syndrome. The species is a prolific natural coloniser of southwest Pacific islands, conveniently producing a suite of island populations of different ages from very recent (~100 years) to very ancient (>100 thousand years).

> *"We use these island colonists to investigate the rate and patterns of change and have found that colonisation of islands produces rapid evolutionary shifts early on in the colonisation history."*

Members of the white-eye bird family from Lifou, New Caledonia

© Sonya Clegg

We use these island colonists to investigate the rate and patterns of change and have found that colonisation of islands produces rapid evolutionary shifts early on in the colonisation history. Island birds grow more slowly and for longer than mainland birds, given their limited island resources. This strategy is suited to low predator environments that islands provide, where the selective pressure to fledge quickly and avoid predation in the vulnerable nestling phase is removed.

We are currently characterising the genomic changes that accompany island colonisation in these birds using populations of different ages as proxies for stages of the speciation process. From this work, we ultimately aim to map phenotypic changes to genomic changes and link evolutionary pattern and processes via genomic and environmental mechanisms.

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Dr Sonya Clegg,
Departmental Lecturer in Evolutionary Ecology

Sonya will take up an Associate Professorship in Evolutionary Ecology in September 2018

Making a future from the past: Oxford University Herbaria

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Dr Stephen Harris,
Druce Curator and Research Lecturer

Curator Stephen Harris talks about the vital role Herbaria play in the identification of global diversity hotspots. Specimen-based information contributes to contemporary challenges such as environmental change, deforestation, conservation, habitat restoration, sustainable uses of natural resources and human well-being.

Inside the Department of Plant Sciences, there is one of the world's great scientific collections – Oxford University Herbaria. Herbaria are permanent scientific records of plant variation; fundamental tools for investigating plant evolution and teaching about plant diversity.

Worldwide, there are approximately 2,600 herbaria containing some 300 million specimens. Each specimen represents a data point locating a species in space and time. Oxford University Herbaria contains more than one million specimens collected from across the planet; some specimens are more than 400 years old.

Thousands of people have contributed specimens to the Oxford collection. Some collectors, such as Carolus Linnaeus or Charles Darwin, are very well known. Most contributors, such as Richard Spruce or Frank White, are unknown outside of botany.

Scientifically, types are among the most important specimens in a herbarium; Oxford University Herbaria contains approximately 40,000 types. Detailed comparisons among type specimens are essential when describing new species.

In 1990, three Australian biologists asked a provocative question about herbaria: 'what would be lost if label data were recorded, a careful selection of sheets kept and the rest pulped?' Three decades on, technology means herbarium curators can answer that herbarium specimens are irreplaceable international cultural assets with enormous research and teaching value across many disciplines.

Herbaria are central to conserving plant diversity in the face of major, urgent environmental change. Collections provide scientists with the raw data and evidence to demonstrate issues addressed by policymakers and provide baseline data against which the outcomes of policies can be measured.

> *"Software such as BRAHMS, developed in the Department of Plant Sciences, is now used by herbaria worldwide for the management, analysis and display of plant diversity data."*

Developments in information technology have meant the potential of data contained in herbaria has become visible to many researchers and those data have become accessible. Software such as BRAHMS, developed in the Department of Plant Sciences, is now used by herbaria worldwide for the management, analysis and display of plant diversity data. Creating an on-line digital resource for the Herbaria is essential to ensure data are made available to anyone who needs it. Currently about 15% of Oxford's specimens are available on-line. The challenge is to make the remaining 85% available in a timely fashion.

My job is to ensure researchers have access to the specimens and data they need to create new knowledge without compromising the research potential of the collection for tomorrow's researchers. After all, when Augustus Lippi collected specimens in early eighteenth-century Egypt he could not have imagined that one day his specimens would be used to calibrate carbon-14 dating models investigating chronologies of ancient pharaohs.

Herbaria specimens – Oxford University Herbaria specimens collected from the seventeenth century to the present day

DPhil Student Projects

Avoiding predation while seeking food: Baboon navigation in a complex landscape

Lynn Lewis-Bevan, St John's

The goal of my project is to understand the environmental drivers and physical consequences of navigation decisions in a complex environment. I will combine traditional behavioural and hormonal data collection with technology such as GPS tracking, accelerometer data and aerial photography to examine baboon (*Papio ursinus*) movement and decision making in Gorongosa National Park, Mozambique, an area of heterogeneous landscape that contains over 200 unstudied troops. Ultimately, I will use this information not only to understand the adaptations of primates in Gorongosa, but as a proxy for how early hominins similarly would have navigated, and help expand the current knowledge of the wildlife of Gorongosa as part of the budding Paleo-Primate Project.

Engineering biofertilisers

Kyle Grant, Wadham College

I aim to contribute to the engineering of biofertilisers that could alleviate the use of inorganic fertilisers in the developing world. Inorganic fertilisers are environmentally detrimental and expensive to farmers. To create a biofertiliser I am using the bacterium *Azorhizobium caulinodans*, a nitrogen-fixing and known plant endophyte, as a chassis for genetic manipulation. Genetic circuitry and a 'toggle switch' are used to control expression of core enzymes in the nitrogen assimilation pathway of the organism. Using crop plant specific inducers, the bacteria will perform a phenotypic switch from a normal to ammonia-secreting phenotype. In doing so the growth of nearby crop plants will be enhanced and additional fertiliser will not be required.

Urban ecology of Black Kites Milvus migrans in Delhi (India)

Nishant Kumar, Somerville College

I study the urban ecology of the Black Kite *Milvus migrans* in Delhi, a heterogeneous capital and the fastest growing mega-city with 25 million human inhabitants. Kites, a human commensal bird of prey in the Subcontinent, offer a unique opportunity to study the urban adaptations of a top trophic predator (e.g. population ecology, behavioural ecology, spatial ecology, ethnic relations). Two aspects of Delhi are important for human-kite synergy: First, large areas, usually overlapping with dense human settlements, are characterized by poor solid waste management, which affords abundant food such as carrion and organic refuse associated animals (e.g., rodents, crows, sparrows, pigeons). Secondly, people (primarily in Muslim communities) engage in a centuries-old practice of feeding meat scraps to kites.

The Phylogeny, Ecology and Conservation of the Himalayan Wolf

Geraldine Werhahn, Lady Margaret Hall

An ancient and unique wolf lineage is roaming the remote Asian high-altitude landscapes of the Himalayas and the Tibetan Plateau. The Himalayan wolf (proposed as Canis (*lupus*) *himalayensis*) has been overlooked by science and conservation to date. My research builds an ecological and phylogenetic database to understand and conserve the Himalayan wolf, and to gain insights into canid evolutionary history. Why has the Himalayan wolf evolved as a lineage distinct from the today dominant Holarctic grey wolf? I attempt to understand this by exploring potential adaptive mechanisms related to the high-altitude environment and biogeography of the region.

Evolutionary diversification of *Ipomoea*

Tom Carruthers, Wolfson College

My research focuses on the evolutionary diversification of *Ipomoea*, a large tropical genus of around 800 species and the focus of recent taxonomic effort in Oxford. The large size and widespread distribution of *Ipomoea* make it valuable for investigating factors controlling patterns of evolutionary diversification – a research aim facilitated by two field trips I have undertaken in South America. In addition, the scale of the molecular data we have for *Ipomoea* means that theoretical questions can be investigated about the limits of what can reasonably be inferred about historical evolutionary events. This is also a central component of my research.

The Biomechanics of the Dipteran Flight Motor

Jonathan Page, Lady Margaret Hall

Dipteran insects (the flies) are some of the most aerobatic species on the planet, as anyone who has tried to swat one can attest. However, we don't fully understand how these insects control their wings. My DPhil aims to understand the mechanisms that allow this control. Using high-speed cameras and four-dimensional CT images, I have visualised the movements of the exoskeleton and muscles within the thorax. The results of this project will enable us to design artificial mechanisms which take inspiration from those found in insects. My work is funded by the EPSRC, Department of Zoology, and Lady Margaret Hall.

Understanding the regulation and utilisation of plant nutrients

Fiona Jamieson, Corpus Christi College

Modern crop varieties require large amounts of fertiliser to maintain a high yield. In the long term this is unsustainable: it is expensive, energy intensive, uses finite resources, and excessive fertiliser application is environmentally damaging. My research uses molecular and genetic approaches to further understand how these nutrients, specifically nitrogen and phosphorus, are regulated in plants, and how this regulation is different in plants carrying mutations that affect growth. This research will contribute to improving our knowledge of plant nutrient use, and how this relates to growth – necessary if we are to improve crop nutrient use efficiency.

The Social Lives of Plants

What does a cooperative plant look like? And where can we expect to find them? Jay Biernaskie describes how his research aims to understand plant cooperation in agriculture and in nature.

Most people would not think of plants as social organisms. But sociality simply means that individuals live and interact in groups. Plants are certainly group-living, and they compete with their neighbours for vital resources. Moreover, neighbouring plants would often benefit by cooperating, or competing less. In fact, the key food crops of the world have been bred to be dwarfed, allowing plants to spend less energy on being tall competitors and more on making grains. In agriculture, dwarfism is particularly useful in genetically uniform crops that exclude taller competitors. Similarly, in nature, cooperative plants could be favoured when neighbours share genes for a cooperative trait.

> *"We found that plants growing alone do best when they have genes for being large; in contrast, plants in groups do best with genes for being small."*

The aim of my research is to create a two-way dialogue between agriculture and evolutionary biology. On the one hand, we can use our knowledge of how cooperation evolves in nature to harness even more cooperation in agriculture. On the other hand, we can use what we know from agriculture to look for cooperation among plants in nature.

My recent work has examined the potential for cooperative traits in *Arabidopsis thaliana*. *Arabidopsis* is an excellent study organism because of its genetic tools for examining variation in plant growth. I took advantage of a synthetic population that mixes up the variation from 19 different *A. thaliana* genotypes in nature. With collaborators at Aberystwyth University, I asked: what traits maximize reproduction when plants grow alone versus when they grow together, in genetically uniform groups? We found that plants growing alone do best when they have genes for being large; in contrast, plants in groups do best with genes for being small. These results suggest a fundamental trade-off in nature: traits/genes that promote individual self-interest are not always best for the group.

I am building on these results in two ways. First, with collaborators at the National Institute of Agricultural Botany (NIAB),


© Jay Biernaskie

Lab experiments using groups of Arabidopsis thaliana (above) are being scaled up to field trials using winter wheat (below)

I am performing a scaled-up version of my recent *Arabidopsis* work, using winter wheat in an agricultural setting. We are aiming to find novel cooperative traits/genes that have been missed by past breeding. Second, to follow up on the benefits of being small, I am studying naturally-occurring *Arabidopsis* genotypes that carry the same dwarfing mutations as modern crops. Ultimately, I want to know if dwarfism is favoured by natural selection for the same role it plays in agriculture—that is, as a cooperative trait that promotes the collective productivity of groups.


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Dr Jay Biernaskie,
BBSRC Future Leader Fellow

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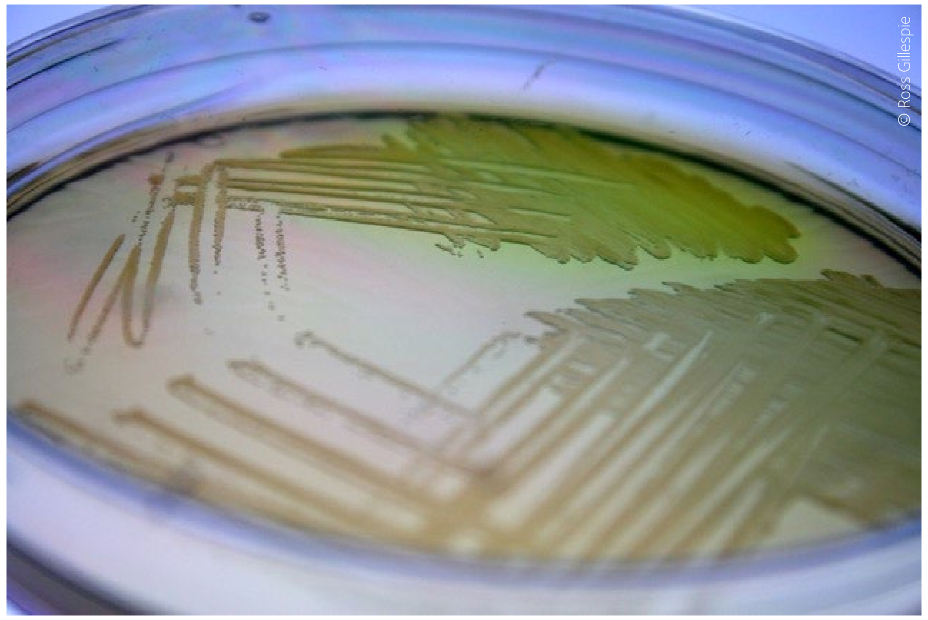
Of Meerkats and Microbes

What do the worlds of meerkats and bacteria have in common? Ashleigh Griffin explains how studying both can provide clues as to how social behaviours evolved across taxonomic boundaries.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When people ask me about my research, I have to make a quick decision. Do I want to convince that I'm doing something "useful", like our work on bacterial infections, or describe something relatable from nature documentaries, like our work on meerkats and birds? Even though meerkats and bacteria make an unusual combination; to an evolutionary biologist it makes sense. All life on earth is shaped by the same evolutionary processes and in my research group we are interested in the processes responsible for social behaviour. For this it is often very helpful to think across taxonomic boundaries.

> *"How do bacterial experience life inside a lung? Why do only some move? Why are some covered with slime?"*

People tend to assume that it is much easier to study the behaviour of a bacterial cell cultured in a lab than the behaviour of a wild animal roaming the desert. But not if you are interested in adaptation. We can go to the Kalahari and watch animals forage, interact, defend themselves; we can experience the environment in more or less the same way as they do. Now try the same exercise for a bacterial cell that is infecting a human lung. How do bacterial experience life inside a lung? Why do only some move? Why are some covered with slime? This is why microbiologists call bacteria in their lab "isolates", because to observe their behaviour we isolate them from their natural environment - a bit like trying to understand a polar bear from its behaviour in a zoo.

A breakthrough came from finding the clues we needed in the bacterial genome. The genome carries mutations that have been favoured inside the host, and so contain clues about selection pressures faced by bacteria in their natural environment. By analysing the sequences of hundreds of isolates, sampled over decades of infection from patients, we have been able to identify signatures of social interactions between bacterial cells. As an infection progresses, cells become increasingly slow growing and lose the ability to contribute to the shared supply of secreted products they depend on for growth and survival. Our analyses revealed that this pattern is a result of a cheat invasion: cells that do not contribute to the pool of resources exploiting more cooperative neighbours to extinction, and becoming more poorly adapted to the lung environment as a result. This discovery provides a rare insight into how the environment inside our bodies shapes behavioural changes in infection; and shows how research into social behaviour of animals such as meerkats can help us understand social interactions across the tree of life.


© Andy Young

Ashleigh Griffin,
Professor of Evolutionary Biology and Tutorial Fellow in Biology at New College

A comparative population ecologist joins the Department of Zoology and Pembroke College

We are delighted to welcome Rob Salguero-Gómez to the Department after a successful early career spent researching across three continents. His SalGo research group are currently examining the mechanisms that result in diversification of life history strategies.

Demography is the study of populations' structure and the dynamics of individual contributions to a population. It is a powerful discipline to explore the drivers of species' extinctions, invasions, and many other current global challenges. My research explores the universal rules (and exceptions) that allow species to persist under variable environments.

I've been with the Department of Zoology as a NERC Independent Research Fellow since May 2017. I'm delighted to have recently accepted an Associate Professorship in Ecology at the Department of Zoology and a Tutorial Fellowship at Pembroke College, starting September 2018.

Born and raised in Southern Spain, I cultivated a fascination for arid ecosystems from an early age. I have been, and remain, puzzled by how life not just persists but often thrives under harsh conditions. Understanding the key strategies that allow for its persistence is particularly important in the light of climate change.

One of my main research interests lies in the search for ecological and evolutionary generalities in life history strategy amongst plants and animals. During my postdoctoral research at the Max Planck Institute for Demographic Research, I co-developed the COMPADRE Plant Matrix Database and the COMADRE Animal Matrix Database. These repositories are open-access databases (**www.compadre-db.org**) that contain high-resolution demographic, biogeographic, ecological and phylogenetic information for hundreds of organisms around the globe.

"I have been, and remain, puzzled by how life not just persists but often thrives under harsh conditions."

The SalGo Team is currently focused on further examining the mechanisms that result in diversification of life history strategies, and identifying the life history strategies that are most/least resilient to environmental change. Through examining population ecology with COMPADRE and COMADRE, we have pointed out some strong taxonomic and biogeographic sampling biases. To that end, the SalGo Team examines 'odd' life histories such as plants that behave like animals (carnivorous or parasitic plants), animals that demographically behave like plants (corals, sponges), or organisms that display extreme investments in reproduction (orchids), or longevity (albatross).

I am very excited to continue my association with the University of Oxford through this new position. My time here thus far has been most intellectually rewarding, and I am looking forward building further interdisciplinary collaborations across Zoology, Plant Sciences, Geography, the Institute for Population Ageing, and the Oxford Big Data Institute, among others.

Dr Rob Salguero-Gómez,
NERC Independent Research Fellow

London Alumni event a huge success

In September 2017, the Zoology Department held its first external alumni event at the Reform Club in London. Over 80 alumni enjoyed presentations from Professors Peter Holland, Graham Taylor and Nathalie Seddon about research in the Department, and were updated by Professor Ben Sheldon about the developments with the Tinbergen Building. Alum James Pulsford deserves particular thanks for hosting us at the Club, and we are grateful to others for travelling to the city to join us on the evening. We are seeking to expand events like this in the future, and can support events at other locations where there are clusters of alumni. Please contact Caitlin Hamilton if you would be interested to help or host such a future event.

"I hugely enjoyed the fascinating talks and it was a treat to find that there were so many of my 1981 cohorts in attendance many of whom had very impressively stayed in the field!"

Widening outreach across biological sciences

Dr Tom Hart talks penguins with young enthusiasts

© Ian Wallman

With a newly appointed Communications and Outreach Officer for Zoology and Plant Sciences, there has been a new focus on outreach and widening access across Biological Sciences. The three University-wide Open Days last year were held in the inspiring Oxford University Museum of Natural History and we hosted 20 students at the annual UNIQ summer school, an initiative to offer students from disadvantaged socio-economic backgrounds a realistic view of life as an Oxford University student.

The WildCRU team enact 'Leo the Lion'

© Ian Wallman

For the first time, Oxford hosted the 'Curiosity Carnival' – an outpost of the European Researchers' evening – that attracted thousands of visitors to locations across the city. Researchers across Plant Sciences and Zoology hosted interactive sessions that contributed to a reach of 9,400 members of the public!

Both departmental websites saw redesigns in late 2017, and are much more visual and streamlined in appearance whilst maintaining a wealth of research, event and faculty information. Visit them at **plants.ox.ac.uk** and **zoo.ox.ac.uk**.

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Caitlin Hamilton
Communications and Outreach Officer
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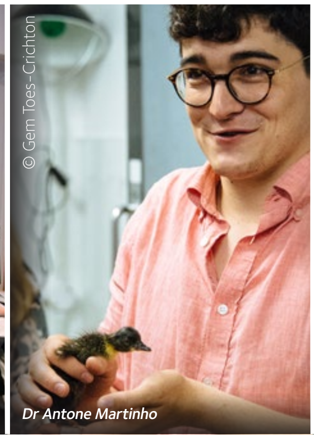
New biology teaching and research facilities


© John Baker
Teaching labs


© Gem Toes-Crichton
Flight building


© John Baker
Computer suite


© Gem Toes-Crichton
Dr Antone Martinho


© Gem Toes-Crichton
Ruby the harris hawk

This past year was a challenging one for biology with the sudden closure of the Tinbergen Building in February 2017. As many of you know, the building hosted teaching and research facilities, and staff offices for Zoology and Experimental Psychology.

However in the year that followed, and with thanks to the hard work and dedication of all staff, we have been delighted to welcome several brand new, state-of-the-art teaching and research facilities across town. We are proud of this illustration of the University's commitment to sustain our departments and the subjects that they teach.

Biological Sciences Computer Suite in Plant Sciences

Based in the Department of Plant Sciences, a new computer suite was opened in October 2017. Fitted out in what used to be the old Forestry Library, the suite now holds 60 new thin-client computers. Over 200 undergraduate students use the software to learn about quantitative methods, experimental methods and techniques, and infectious disease modelling.

Biological Sciences Undergraduate Teaching Laboratory

In January of this year we opened our undergraduate teaching laboratory in the grounds of the University Club. A thoroughly impressive modular build, 62 screens have been installed across the work benches to enhance student experience by offering a live-stream of demonstrations taking place at the front of the room. A large preparation area and office space in the centre of the build (shared with our lab neighbours, Biochemistry) makes for an impressive working environment for our laboratory staff. During term time, this laboratory hosts on average 250 students per week for their undergraduate practicals.

The John Krebs Field Station, Wytham

Our facilities out at Wytham have been significantly enhanced over the past year. Our refurbished teaching laboratory was used by roughly sixty students daily during Trinity Term 2017. With the opening of new teaching labs in town this Hilary Term, the space at Wytham is now largely being used by researchers and undergraduate project students.

The Duckling Lab (led by Professor Alex Kacelnik & Dr Antone Martinho) and Molecular Lab (led by Professor Alex Rogers) are now established at the Field Station, and last summer a rolling program of refurbishment of all offices was completed, enabling 60+ desk spaces to be fully functioning. The Meeting Room was also re-equipped with monitors and projection facilities, and the Common Room received equipment and furniture from the Tinbergen Building.

Last summer the Flight Building (led by Professor Graham Taylor) was completed and opened. It is now the proud home of four Harris Hawks, and awaits the imminent arrival of some zebra finches. We are hopeful that summer 2018 shall mark the completion of facilities to home the 'fish, bird and insect laboratory'.

To connect the Field Station to the main science area in town, we continue to run the popular Science Shuttle minibus regularly throughout the day.

Giving back to Biology

Caitlin Tebbit
Senior Development Executive
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From stem cells to conservation, food to climate change, biology is central to the concerns of society. The study of living things has undergone tremendous expansion in recent years, and topics such as cell biology, neuroscience, evolutionary biology, biochemistry and ecology are advancing rapidly. We ask for your support to help us train the next generation of biologists.

The Departments of Zoology and Plant Sciences at the University of Oxford are leading UK centres in research and teaching dedicated to biology. Donations are extremely important to the Departments and have enabled the University to offer the brightest young minds the opportunity to undertake study in Oxford as well as appoint world-leading scientists to academic posts.

Supporting our research and graduate students

Exceptional graduate students are the research leaders of the future. The contribution of graduate students to biological research at Oxford is critical to both developments in fundamental biology and the vitality of innovative life sciences industries in the UK. However, the need for graduate scholarships in Zoology and Plant Sciences has never been greater.

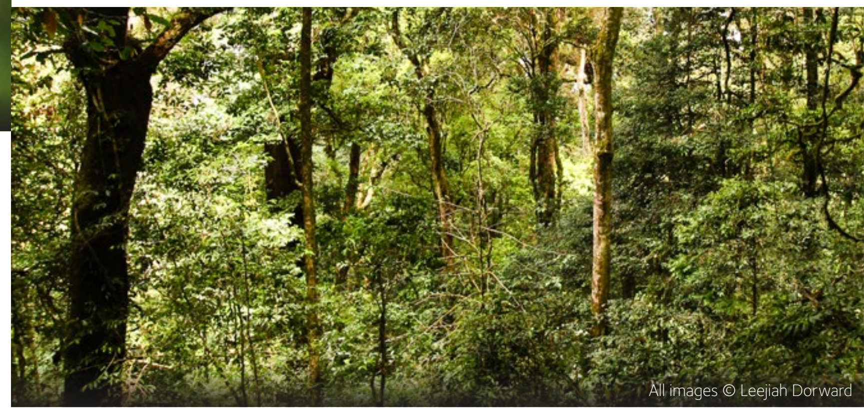
Scholarships enable us to attract the best possible candidates from the UK and internationally regardless of the candidates' financial circumstances. A graduate scholarship could be funded, for example, by 50 alumni and friends donating £40 per month.

Maximising undergraduate teaching

With your help, we also seek to provide much-needed travel bursaries for undergraduates, providing the crucial opportunity for field study during our undergraduate degree course. Five alumni donating just £17 a month would offer a student the chance to attend our tropical biology course in Borneo.

We hope that you have fond memories of your time studying biology at Oxford. If you feel you would like to make a one-off or regular donation to support Zoology and Plant Sciences, Senior Development Executive, Caitlin Tebbit would be happy to talk further with you.

Alternatively, gifts can also be made online at **www.campaign.ox.ac.uk/plant-sciences** or **www.campaign.ox.ac.uk/zoology**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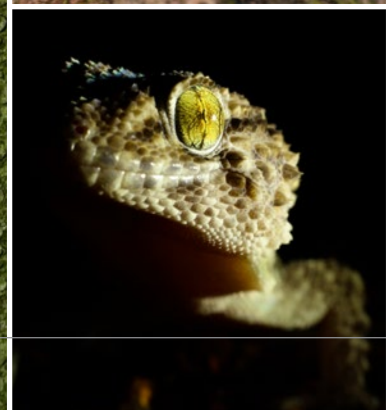

Biology News

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Newsletter for Biology Alumni and Friends

If you are not already registered with us and would like to receive future copies of this Newsletter, please email us at **newsletter@biology.ox.ac.uk**

Front and back cover photos: © Leejiah Dorward

Leejiah Dorward is a DPhil student in the Department of Zoology, and is a multiple winner of the British Ecological Society photography competition

Front cover: *Shivering sylph*, a long tailed sylph shakes off rain drops after a tropical shower in Colombia

Back cover: A portrait of a young grumpy leopard tortoise in Tanzania