Biology at Oxford

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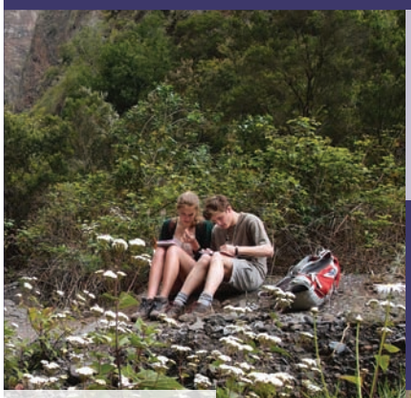
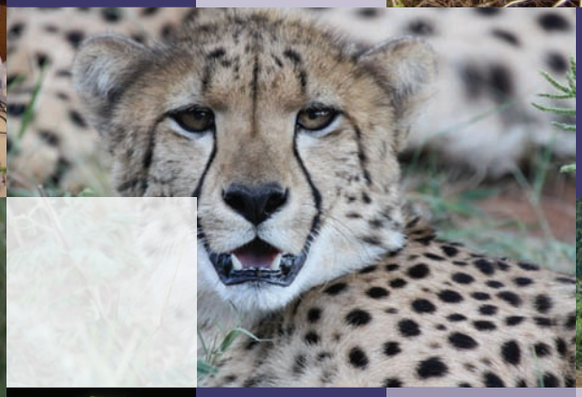
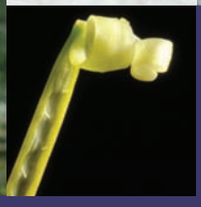
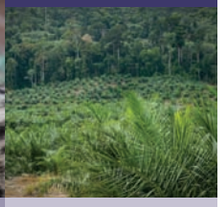








Welcome to the first issue of *Biology at Oxford*: a newsletter to keep you informed about biology at the University of Oxford – past, present and future. We hope the newsletter will be of interest to alumni, friends and colleagues, including everyone who read for a degree in Biological Sciences, Agricultural & Forest Sciences, Pure & Applied Biology, Botany or Zoology, or did a Masters or Doctoral degree with us, as well as anyone with an interest in our teaching and research.

Department of Plant Sciences • Department of Zoology

Head of Department News - Plants

As you pick up this newsletter many of you are no doubt thinking 'about time they gave us some news'. Botany Alumni have been self-organizing for a number of years and we welcome them into the Department each year over the University Alumnus weekend in September. But of course that does nothing for those of you who studied Agriculture or Forestry, or indeed for those more recent graduates who studied the Biological Sciences degree that we co-teach with Zoology. Hopefully this newsletter will help redress the balance and along with our colleagues in Zoology, we encourage you to visit us in September.

Having read this far, the more cynical among you will almost certainly be thinking that we need money – and there is no doubt that we do. However, money is not the main motive here. As higher education becomes squeezed from all angles, we need a community of friends that will help us convince politicians and society at large that teaching and research in biological sciences is more important now than ever. Some of the most significant challenges of the 21st century depend on biology, and in particular plant biology, for a solution.

Photo: John Baker

Jane Langdale

At the time of writing, the 20th cohort of Biological Sciences finalists are gearing up for exams. The pressure is not quite the same as it was when 100% of your degree rested on your performance in one week of May, but the current undergraduates face different challenges. 60% of the degree is now assessed on the basis of 2nd year exams and 3rd year course assignments and a research project, and as we examine the 'new' degree for the first time, students will sit a general paper. And when all of that is over, the student loans need to paid off.

Despite the current challenges to students and academic staff alike, Plant Sciences at Oxford is thriving. Over the last few years the University has invested significantly in our infrastructure and we have world-class facilities for research. We are currently in the process of hiring four new University Lecturers and through a generous donation from the Wood family we are seeking to elect a Chair in Forest Science.

There have been many important achievements this year. For example, Penny Sarchet, a DPhil. student, has won the Wellcome Trust Science Writing Award and Professor Sarah Gurr was appointed to the Council of the Biotechnology and Biological Sciences Research Council by the Minister for Universities and Science David Willets.

As I enter my last few months as Head of Department, I am optimistic that the Department is well-positioned to tackle the important scientific challenges that face us in the future. I hope that you will help us spread the message.

Jane Langdale

Photo: Steve Monk

Kirsty Monk on Lundy Island

Kirsty Monk (Linacre College): Role of fungi in forest communities

Woodlands are maintained by fungal pipelines, termed cords. Cords are tubes, formed by the grouping together of hyphae, which transport water and nutrients across the soil, increasing its capacity to support growth. Without cords, forest decomposition, nutrient dynamics and water cycles would be disrupted. My work investigates the diversity of cords at scales from 1 m to nation-wide and aims to understand the factors controlling the composition of forest communities. I also model changes in fungal distributions in response to environmental change. This has resulted in some very interesting preliminary results, suggesting a reduction in the land area at risk from certain fungal diseases.

Photo: Pedro Bota

Costas Garagounis in the lab

Constantine Garagounis (Magdalen College): Is molecular organization important for cell function?

It is clear that the spatial organization of cellular components over a range of scales – from proteins to organelles - is important for the coordination of chemical reactions within the cell. Using techniques of molecular biology, biochemistry and microscopy my project is defining the interactions of a glycolytic enzyme, fructose bisphosphate aldolase, with mitochondria and the microfilament actin cytoskeletal network affects metabolism in *Arabidopsis thaliana*. This work is providing insights into the important role of cellular structure on the regulation of cellular metabolism.

Photo: Penny Sarchet

Cardamine hirsuta after explosive dehiscence

Penny Sarchet (Lincoln College): Exploding fruit

If offspring do not leave their parents and reproduce, a species will go extinct. The hairy bittercress *(Cardamine hirsuta)* solves this important evolutionary problem with a sudden and dramatic explosion, forcefully propelling its seeds at high speed. I am interested in how *C. hirsuta* coordinates this mechanism. Using histology, I have identified the cellular morphologies involved and compared these across the crucifer family. I am using *Arabidopsis thaliana*, a close relative and genetic model, to identify the *C. hirsuta* genes that pattern these morphologies, with a view to uncovering the genetic network that has evolved to control this remarkable adaptation.

Head of Department News - Zoology

Welcome to the first edition of the new *Biology at Oxford* magazine. The Department of Zoology is pleased to collaborate with the Department of Plant Sciences in producing this newsletter, showcasing research and teaching in biology in the University of Oxford. The two Departments have long had a close relationship, and we jointly deliver the successful undergraduate degree course in Biological Sciences. The Department of Zoology recently celebrated its 150th anniversary, tracing our origins to the founding of the University Museum of Natural History in 1860. But much has changed in Zoology in the past century and a half. The research interests of the Department have expanded vastly and now range from ecology and evolution, through animal behaviour, disease biology, conservation and animal welfare, to genomes and developmental biology. Our study subjects are not restricted to animals, but include bacteria, viruses, protists and ecosystems, and our researchers tackle some of the major issues of the world today, ranging from climate change and habitat destruction to the fight against transmissible diseases such as dengue and malaria. Zoology has also grown into a large Department, with around 70 academic staff or senior research fellows, 100 postdoctoral researchers, 100 DPhil students and 50 support staff, plus the 320 undergraduates taught jointly with Plant Sciences. Of course, in the current financial climate it is a challenge to maintain the funding necessary to support a large volume of internationally excellent research and teaching, and thereby maintain our position as one of the world's premier organismal biology departments. Funding for graduate students in particular is a significant challenge. Currently, the Department obtains research funding from most UK Research Councils and major funding agencies, dozens of smaller foundations and trusts, and the European Union. Our success with obtaining grant funding from the EU's flagship research program, the European Research Council or ERC, is nothing short of phenomenal. At the time of writing, the Department of Zoology holds 10 ERC grants, each worth over a million Euros – more than any other Department in Oxford and more than some European countries. Equally important have been some remarkably generous endowments and donations that have strengthened key research areas for the long term. In particular, I must mention two recently endowed Chairs – the Luc Hoffmann Professorship of Field Ornithology and the Tasso Leventis Professorship of Biodiversity – and also the support of the Tubney Charitable Trust and the Panthera Foundation in the area of wildlife conservation. The Department and its members continue to receive accolades of many kinds, ranging from prestigious scientific awards (such as the Royal Society Gabor Medal to Angela McLean and the Zoological Society Frink Medal to Paul Harvey) to the frankly unusual (the Science journal 'Dance your PhD' biology award to Cedric Tan). We were particularly delighted to become the first Department in the University of Oxford to be awarded an Athena SWAN Silver Award recognising our commitment to the careers of women in science.

Photo: David White

Peter Holland

Peter Holland

Photo: Matthew Boardman

Eleanor Watkins in Kenya

Eleanor Watkins (Merton College): Evolution of bacterial strain diversity

I was delighted to be awarded the competitive Jackson Scholarship in Natural Sciences from Merton College. This scholarship enables me to pursue DPhil research on bacterial pathogens in the Department of Zoology. I am interested in the evolutionary processes that shape the population structures of bacteria, particularly the selective pressures conferred by the host immune response. I am currently using mathematical models to investigate the effects of the immune system and competition on the maintenance of strain diversity. I plan to modify this theoretical framework to investigate the evolution of virulence in bacterial pathogens and to investigate meningococcal disease in sub-Saharan Africa.

Photo: Anon

JC Gonzalez with hornbill

Juan-Carlos Gonzalez (St. Anne's College): Ecology and evolution of hornbills

I am a DPhil student in Zoology from the Philippines. Support from the Ford Foundation International Fellowship Program has allowed me to pursue research on the evolution, ecology and conservation of Afro-Asian hornbills, a group of large, endangered tropical birds. As part of my research I have analysed DNA from historical samples taken from museum skins worldwide, including some collected by Alfred Russel Wallace, to test ideas about the evolution of hornbill diversity. I have also conducted field studies on hornbills in the Philippines, and evaluated impacts of habitat degradation. After my DPhil, I will return to a post at the University of the Philippines Los Baños, where I aspire to influence conservation priorities in the region.

Photo: Gabriele Cozzi

Femke Broekhuis with leopard

Femke Broekhuis (Pembroke College): Conservation of large carnivores

I am one of several WildCRU researchers working on large felids in Africa. With the generous support of the Tom Kaplan Prize Scholarship, my DPhil research is focused on cheetahs in the pristine Okavango Delta in Northern Botswana. As a result of habitat fragmentation cheetahs are being forced into ever-smaller areas, along with lions and spotted hyaenas. These other large predators may affect cheetah survival by both predation and kleptoparasitism (stealing of kills). Using GPS (Global Positioning System) collars, I am investigating how cheetah behaviour and distribution is affected by the presence of lions and hyaenas. With this research, cheetah conservation is being moved towards a multi-species, rather than the conventional single-species, approach.

Teaching

Photo: Martin Speight

Zoology teaching lab

The new degree course

Many of you will remember the days when biology at Oxford was offered through a range of degree courses, including separate degrees in Botany, Zoology, Agricultural & Forest Science, and Pure & Applied Biology.

In the 1990s, we amalgamated all these degrees into one, Biological Sciences, which has run successfully for 20 years. In 2009, after a careful internal review of the course, we decided to re-structure the course, creating more choice for students. The first cohort of undergraduates on the new course sat Finals this year.

We have also been discussing whether Biological Sciences at Oxford should become a 4-year degree course, or a 3-year degree with an optional 4th year, in line with most other sciences at Oxford.

Photo: Martin Speight

Plant Sciences lecture theatre

Such radical changes may have educational benefits, but would also generate some significant difficulties (including funding and facilities both in colleges and departments) and so these proposals have not yet been taken forward. We would welcome your views.

The new revised (3-year) course structure is designed to allow students as much flexibility as possible when choosing options and topics, whilst providing enhanced skills training via practical courses. The first year will still be familiar to many Oxford graduates. The three main courses are Organisms, Cells & Genes, and Ecology (which includes a field course in Orielton, Pembrokeshire). There is also a first year course in Quantitative Methods that provides a taster of statistics and experimental design for the second year. As always, there are first year exams at the end of Trinity Term of the first year.

The big changes come in the second and third year. Second year courses cover Michaelmas and Hilary Terms, and consist of two compulsory and six optional themes. In addition, we offer six practical courses, designed to provide skills expected of modern biologists. Second year exams, which count towards 30% of Finals, are after Easter in the 2nd year.

Trinity Term of the second year is primarily set aside for the Honours project, worth a very significant 15% of the degree, before (or alongside) a wide range of Specialist Option courses that continue through much of the 3rd year. Most of these are based in Oxford, but they include two optional field courses: the Mediterranean Plant Biodiversity field course in Tenerife, and the Tropical Forest Ecology field course in Sabah, Malaysian Borneo.

Martin Speight

Updated facilities

We are very pleased and proud of our teaching facilities, having invested a great deal over the last few years on the lecture theatres in Plant Sciences and Zoology, and the shared teaching labs based in Zoology.

We have been able to completely re-equip the labs with state-of-the-art technology including computer monitors on all benches, PCR machines, gel visualisation systems and so on.

New compound and stereo-zoom microscopes have also been bought, aided by a significant donation from the Edward Penley Abraham Cephalosporin Trust Fund. For field work, hi-tech equipment has been purchased such as suction samplers, bat detectors, camera traps and video equipment.

The seawater aquaria on C-level in Zoology have been overhauled, and the water-purification plant completely rebuilt to run the displays and to provide cold-seawater for research projects.

Field Courses

First year ecology field course to Orielton

At the end of their first year, all biologists go on a one-week residential Field Course at the Field Studies Council centre at Orielton, near Pembroke in Wales. This is an area of outstanding natural beauty, with a range of natural habitats, including deciduous and mixed woodlands, natural grasslands, arable land, sand dunes and both rocky and sandy shores. Students stay in the Georgian Manor house at the Field Studies Centre site, with laboratory and teaching rooms in the old Stable Block. Working in groups of about twenty, each with two or more staff members from Oxford, the students are exposed to the delights of field work on a variety of topics, including marine life, sand dune ecology, woodland and plant ecology, ornithology, and entomology.

The aim of each day's activity is to introduce students practically to some of the concepts they will have heard about during their lecture courses, and to show them how to gather and analyse field data in useful and insightful ways. Students are encouraged to discover their own ways of gathering data, to answer precise questions which they themselves have identified, and to write up their daily activities in field notebooks. Apart from the formal teaching sessions each day, the students are also shown a variety of other techniques, including small mammal trapping, moth trapping and mist netting of birds, and have the chance to see some of the local natural history wonders, including a colony of guillemots and the lily ponds at Bosherston, where they may even catch a glimpse of the resident otters.

Photo: Martin Speight

First year field course in Pembrokeshire

David Rogers & Alex Rogers

Photo: Timothy Walker

Third year field course in Tenerife

Specialist Option field course to Tenerife

After two decades of exploring the Mediterranean-type vegetation of the Algarve, the third year Plant Diversity course moved to Tenerife in 2012. The value of field work is very clear to those who teach and attend such courses, even though to the outsider it may look like a bit of a holiday. The feedback that we have received over the years has been nothing short of excellent. Connecting students with living biology reminds them why they applied to read biology in the first place. While in the field they are immersed in the subject with no distractions such as essay writing and sports. Tenerife is spectacular floristically in the spring with both native and non-native species. It also boasts at least five distinct ecological regions such as alpine, temperate woodland, schlerophyllous scrub, arid and the rare temperate laurel mist forest. In addition to teaching field skills, the students can learn about an ecological region that is quite distinct from our own. The skills, however, can be transferred to any region.

Timothy Walker

Specialist Option field course to Sabah, Borneo

A 10-day Tropical Forest Ecology field course ran for the first time in September 2011, based at the Danum Valley Field Centre in Sabah (Malaysian Borneo). The new course gives Biological Sciences undergraduates the opportunity to learn about and experience these spectacular habitats and their extraordinary biodiversity at first hand.

The new course is taught entirely at the field site and involves training in practical fieldwork techniques, site visits and small-group research projects, as well as lectures and tutorials. Danum has excellent facilities and is located within one of Borneo's few remaining blocks of undisturbed primary rainforest. Nearby oil palm plantations and logged forest blocks give students the opportunity to learn about some of the threats facing tropical forests and the feasibility of exploiting them sustainably. Students saw some spectacular wildlife, including elephants, Bornean gibbons and orang-utans. For many, the night drives and night walks were a particular highlight, with one lucky group even spotting a rare Clouded Leopard.

Our intention is to run the course annually, with (optional) participation limited to 24 final year students. Currently, students meet the costs of attending the course themselves, but we are currently exploring fundraising options with the University's Development Office, with the ultimate goal of providing bursaries. Please do contact us if you wish to find out more.

Photo: Owen Lewis

Third year field course in Sabah

Owen Lewis

Biodiversity Research

The Biodiversity Institute

In 2009, the Department of Zoology was awarded a generous donation from the Tasso Leventis Foundation for the establishment of a Chair in Biodiversity. In conjunction with this award, the Oxford Martin School provided £1.2 million to establish a Biodiversity Institute.

The University of Oxford has excellence and expertise in biodiversity spread across several life and social science departments and dedicated research centres. Creation of the Tasso Leventis Chair in tandem with the Biodiversity Institute provided an catalyst to link and build on these existing research strengths. There are now 10 postdoctoral fellows and 46 faculty members associated with the Biodiversity Institute spanning 9 University departments; the majority based in the Department of Zoology and the Department of Plant Sciences.

Major emerging research themes within the Biodiversity Institute include: ecological and evolutionary processes responsible for biodiversity; biodiversity beyond protected areas; and novel tools and technologies for measuring, mapping and assessing biodiversity. The aim is to provide excellent biodiversity science in tandem with the structures and frameworks for implementation of this science into policy and management in order to find pragmatic solutions to one of the greatest global threats, biodiversity loss.

Photo: Jake Snaddon

Oil palm and rainforest, Malaysia

Land-use change is one of the key drivers responsible for global biodiversity loss. An example of our research to address this issue can be found in the development of two automated tools. These remotely determine which landscapes outside protected areas are important for ecological processes and ecosystem services (e.g. pollination services, soil erosion protection, clean water, carbon storage). These tools can provide a report and series of maps outlining important ecological features across landscapes globally and at a 250m spatial resolution within a few minutes. The models, algorithms and datasets required to provide such assessments rely upon expertise in many aspects of biological and computer sciences. However, to provide a tool that is fit-for-purpose for the end-user also requires a large element of applied science. This includes expertise in web-technologies, smart phone apps and an understanding of the requirements of the end-user. Traditionally such subjects would not have come under the remit of biological sciences – yet are now essential if we are to move forwards in tackling global biodiversity loss.

Kathy Willis, Tasso Leventis Professor of Biodiversity

Cerrado ecology in Brazil

***Cerrado* covers some 2,000,000 km² of South America; it is the world's most diverse savanna. *Cerrado*, with its more than 10,000 plant species, is primarily found in central Brazil and is a globally recognised diversity hotspot. Currently, *cerrado* is attracting international attention because of its agricultural potential and associated biodiversity conflicts. Within global biodiversity hotspots it is unlikely the entire area has global biodiversity significance. In collaboration with the University of Brasília and BP Biofuels we are starting to use methods, developed in Oxford and applied in other tropical regions, to the problem of dissecting biodiversity in the *cerrado* hotspot.**

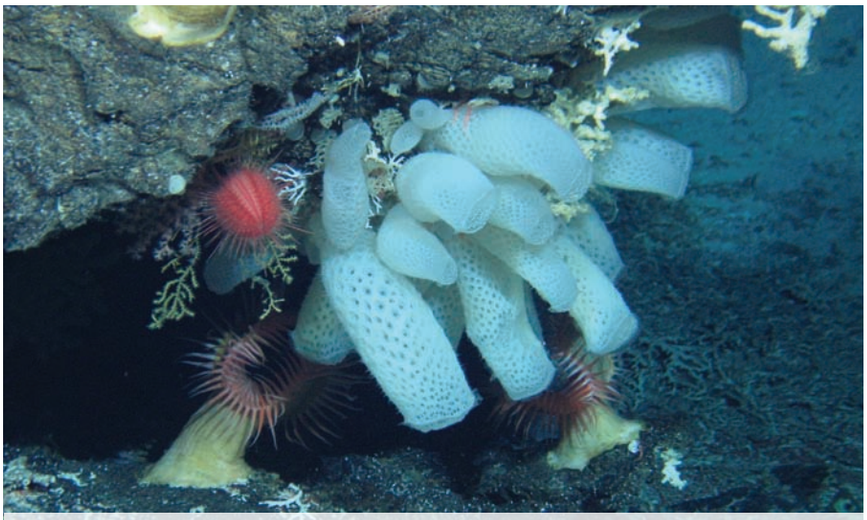
Stephen Harris, Druce Curator of the Oxford University Herbaria

Photo: Stephen Harris

Panorama of *cerrado* biome, Brazil

Biodiversity Research

Photo: Alex Rogers



Anemones and glass sponges at 800m, SW Indian Ocean

Exploring the fractal diversity of marine ecosystems

As a deep-sea ecologist the question many people ask me is '*have you found any new species?*'. It always makes me smile.

A recent study on the number of species living on Earth estimated that less than 1 in 10 marine species have been described by scientists. Our knowledge declines dramatically between the surface and 1000m deep and beyond this much of the 1 billion cubic kilometers of ocean are unexplored.

It is hard to describe the excitement of finding and exploring completely new ecosystems in the deep sea but this is exactly what the Ocean Research and Conservation group do. In 2010 we explored hydrothermal vents on the East Scotia Ridge south of South Georgia. This research was aimed at understanding the evolution of the fauna that inhabit these hot springs which are now under threat of mining for metals such as copper, gold and silver. We were astonished as the cameras of our deep-sea robot (remotely operated vehicle or ROV) revealed chimneys belching black smoky fluid up to 383˚C and millions of hairy pale crabs (yeti crabs), stalked barnacles, black snails and seven-armed sea stars. Every species we saw was new and the discovery has changed ideas about the distribution and connectivity of these strange ecosystems.

In 2011 we found ourselves exploring the seamounts of the South West Indian Ocean Ridge. This range of incredibly rugged undersea mountains lies more than a 1000 nautical miles from land, between South Africa and the Antarctic, with summits lying a few hundred meters from the surface and cliffs and slopes diving to more than 5000m depth. We were greeted by astonishing sites, deep-sea coral reefs (the first found in the Indian Ocean), coral gardens, some with bright pink bubblegum corals and bamboo corals more than 2m in height as well as great vase-like glass sponges. However, our surveys also revealed devastating damage from deep-sea fishing with whole areas of the seamounts laid to waste by trawling or strewn with lost fishing gear. The samples we brought back to the ship with the ROV revealed something remarkable. Almost every species of coral and even some of the sponges appeared to have their own suite of associated animals. Worms, shrimps, small squat lobsters, amphipods (like the sand hoppers on a beach) and woodlice-like isopods all lived amongst the branches of corals.

Not all our work is focused on the deep sea. Tropical coral reefs are amongst the most threatened ecosystems on Earth and here we are also exploring the diversity of smaller animals associated with reef-forming corals. The abundance and number of species we find in these corals is startling and we hope that our work will give some idea of the threat posed to these smaller members of the reef community by human impacts such as blast fishing, pollution and climate change.

Alex Rogers

Zoology Research

One hundred thousand great tit eggs and counting…

The Edward Grey Institute – part of the Department of Zoology – conducts research on the ecology, behaviour and evolution of animals in natural environments.

While we're best known for research on birds, we also study reptiles, insects, plants and mammals – whichever organism is best suited to a research question. Research ranges in scope from molecular analyses of gene expression to macro-ecological analyses of diversity across continents.

Despite this diversity, a core part of our research work remains the long-term study of great tits in Wytham Woods. Started by David Lack in 1947, this study is now well into its seventh decade of data collection, and thus predates the birth of anyone currently working on it by more than a decade! Setting up standardised methods of data collection early in the study was a far-sighted decision and now allows us to study how populations and individuals change in concert with the environment.

The words 'environmental change' are often synonymous with climate change these days, and indeed, we have been able to use the data to understand how great tits adjust the timing of their annual cycles to the advancing timing of spring. The secret lies in their ability to respond to environmental cues – such as day-to-day variation in temperature – and by doing so maintain close synchrony with the food supply for their offspring.

Photo: Simon Evans

Newly hatched great tit chicks

The real strengths of this study for understanding the effects of environmental change are its scale and duration. With more than 100,000 eggs laid and monitored from hatching to old age (9 years is the record lifespan, but 1 to 2 years more usual), we can track the fate of a very large number of individuals. And, because we can identify parents and offspring, we have been able to trace back great tit pedigrees for more than 35 generations (the equivalent of tracing human genealogy to pre-Norman conquest).

Taking these two aspects together we can understand how natural selection works in natural populations, and how this varies over time and space. Populations are made up of individuals, but it is how these interact with each other that holds the key to understanding how populations behave. Until recently, this has been hard to study in the wild, because direct observations can only sample a minute fraction of the interactions between individuals. New methods developed here in Oxford, involving miniature tags, automated feeding stations, and statistical approaches from network theory, are now allowing us to study the interactions between individual great tits in unprecedented detail. We can now use this framework to understand why some individuals are social, why relationships change over time, and how information and disease spread through populations. Long-term studies, which allow such detailed investigations to be grounded in a comprehensive understanding of the ecology of a population, are increasingly under threat in a short-term, immediate-results focused world. Oxford University's long-term stewardship of Wytham Woods for research has been a vital element in enabling this sort of research to take place.

Ben Sheldon, Luc Hoffmann Professor of Field Ornithology

The Wildlife Conservation Research Unit (WildCRU)

WildCRU was established in 1986 as part of the Department of Zoology, and is a pioneering, inter-disciplinary research unit. WildCRU's mission is to achieve practical solutions to conservation problems through original scientific research, and advises environmental managers and policy-makers worldwide. Originally based within the main Department building in Oxford, the entire WildCRU team of ~50 researchers moved to the impressive Recanati-Kaplan Centre, Tubney House, in 2004 – thanks to generous endowments from the Tubney Charitable Trust and from Tom and Daphne Kaplan. Current projects undertaken by WildCRU range from studies on the ecological effects of invasive species and agricultural practices in the UK, through to human-wildlife conflicts in Africa and South America. WildCRU is particularly renowned for its work on carnivores and, with significant support and impetus from the Recanati-Kaplan Foundation and the Robertson Foundation, aspires to be the world's foremost academic centre for felid conservation research. With projects on 21 of the 36 wild cat species around the world – including puma in Chile, cheetah in Botswana, the Scottish wildcat, rare forest cats of Borneo such as clouded leopard, and one of the smallest cats in the world, the güiña or kodkod endemic to the temperate rainforests of southern Chile and Argentina – we are on the way to achieving this goal.

David Macdonald, Director of WildCRU

Zoology Research

Photo: Graham Taylor

Caroline Brighton with goshawk

Raptor flight research

Our research into animal flight investigates aerodynamics and control in birds, bats and insects.

We are particularly interested in the movements of the wings and the airflows they generate, and study these in carefully controlled windtunnel experiments. In parallel, we investigate how flight is controlled in real time, by placing flying insects in 'virtual reality' immersion systems and then altering the visual image experienced by the insect and analysing how it compensates.

In addition to work in the laboratory, we have also begun to work extensively in the field with trained birds of prey, studying their aerodynamics and control as they fly freely in their natural habitat. Our first steps revolved around our Steppe Eagle 'Cossack', particularly his ability to tolerate gusts and turbulence while soaring and maneuvering, and his wing morphing techniques used in landing.

Working with large birds of prey opens up whole new approaches for research. The birds will fly freely for hours in their natural environment before returning to their handlers and are large enough to carry inertial measurement units generating masses of data (3-axis gyros, accelerometers and magnetometers, plus airspeed and GPS-sensors, all in a matchbox-sized package weighing less than 50 grams).

For example, one project deals with attack strategies, and for that we need to know not only the flightpath of the predator, but also the trajectory of the target. To that end, we have started training birds of prey to chase artificial targets: dummy-bunnies dragged along the ground and miniaturised robotic target-drones. An array of high-speed cameras can capture the trajectories of predator and prey with unprecedented precision.

Our work with birds of prey has two fundamental drivers. First, if we can understand how birds achieve such fluid, elegant control, and long effortless soaring, this will ultimately be of great help in the design of unmanned aerial vehicles (drones). Second, at a more fundamental level, we are interested in the evolution and adaptation of animal flight designs. Since flight performance is so closely linked to well-defined physical (biomechanical) properties, bird's wings offer an excellent opportunity to investigate the resolution and optimality of natural selection.

Adrian Thomas, Graham Taylor & Richard Bomphrey

Photo: Amy Dickman

Cheetah

Photo: Inigo Montes

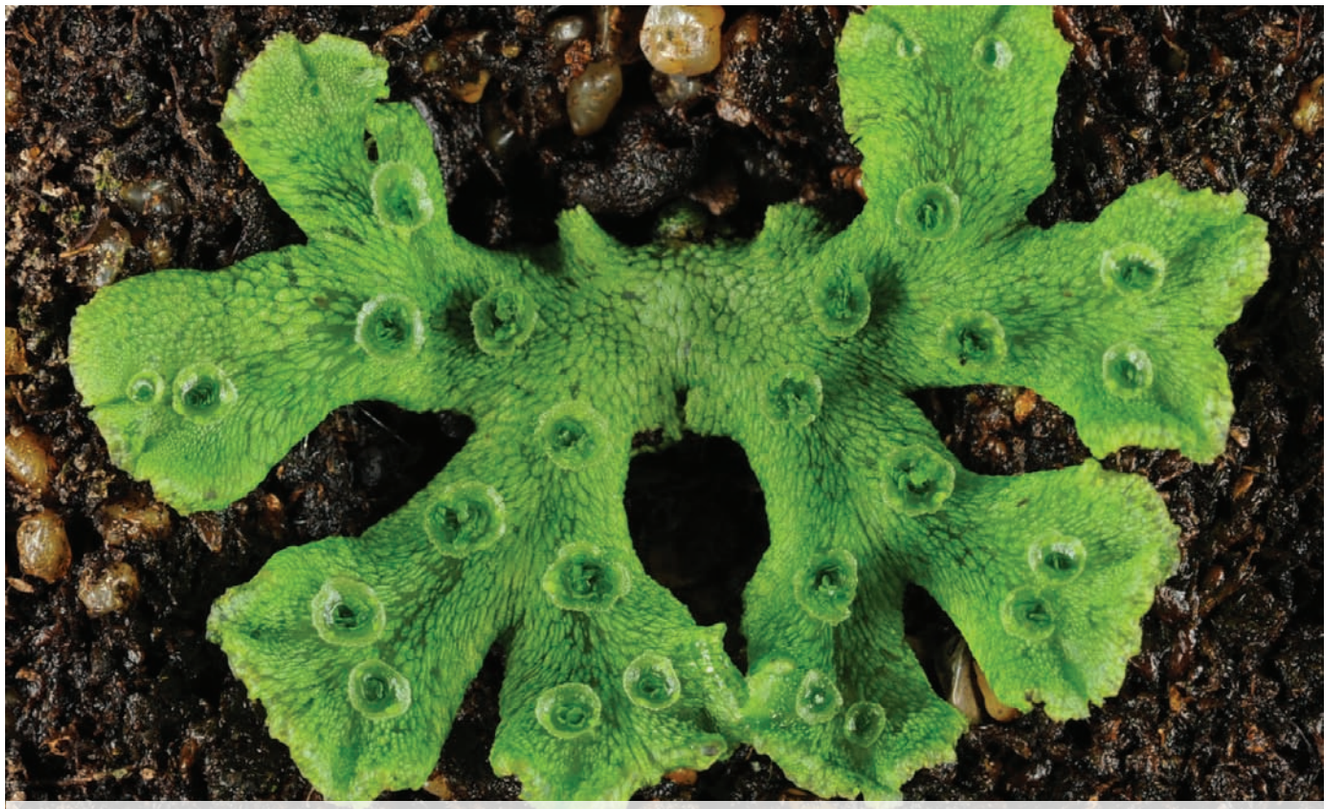
Recanati-Kaplan Centre, Tubney House

Photo: Gálvez Hernández

Güiña or kodkod

Plant Research

Photo: Helen Prescott



Marchantia polymorpha; a non-vascular plant

Evolution of the first land plants caused dramatic climate cooling

Land plants invaded the continental surfaces of the planet sometime before 470 million years ago. Recent research demonstrates that the evolution of these early land plants had a dramatic impact on the climate.

The fossil record indicates that the first land plants were simple in structure and closely related to extant liverworts. These plants were small and didn't have specialised water-conducting cells.

It is known that large plants with specialised water transporting cells enhance the weathering of silicate minerals in soils. During silicate weathering, carbon dioxide is removed from the atmosphere and moves to the ocean as bicarbonate where it precipitates as calcium carbonate (limestone). This removal of carbon dioxide results in global cooling all other things being equal.

Vegetation dominated with vascular plants increases chemical weathering by between 5 and 10 fold. It is now generally accepted that this enhancement of chemical weathering by large plants with complex water transporting tissues, explains the cooling of the global climate between 360 and 400 million years ago.

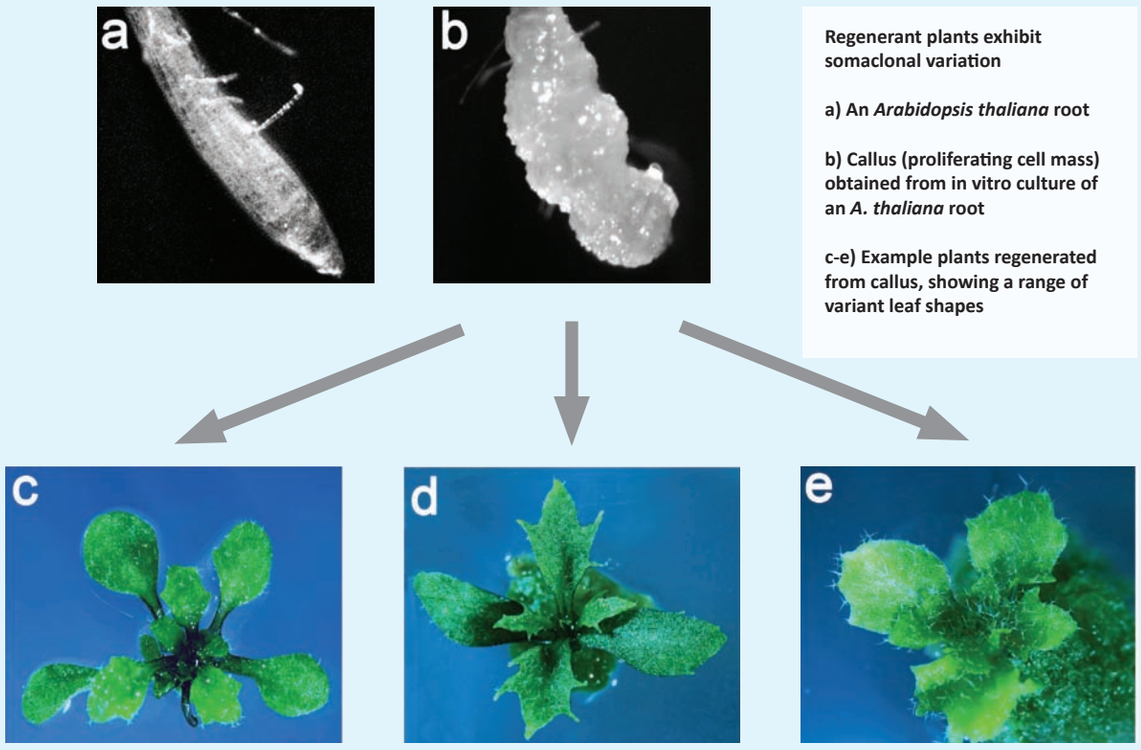
To determine if the appearance of the first land plants could have had a similar effect 100 million years earlier, we asked if non-vascular plants (like liverworts and mosses) could enhance silicate weathering. Using simple microcosm experiments, we demonstrated that non-vascular plants enhanced silicate weathering by between 1.6 and 5-fold over background levels. Incorporating these data into globally climate models demonstrated that the appearance of these small, non-vascular plants would have reduced global mean temperature by approximately 6 degrees. This would have contributed significantly to the onset of a previously unexplained ice age around 443 million years ago.

This demonstrates that the invasion of the land by plants would have had dramatic effects on the global Carbon Cycle and climate. Future research will identify the precise mechanisms used by these early colonisers to enhance silicate weathering and provide insights into how rooting systems impact on today's climate.

Liam Dolan, Sherardian Professor of Botany

Plant Research

Photos: Nick Harberd



Regenerant plants exhibit somaclonal variation

a) An *Arabidopsis thaliana* root

b) Callus (proliferating cell mass) obtained from in vitro culture of an *A. thaliana* root

c-e) Example plants regenerated from callus, showing a range of variant leaf shapes

Why clonal organisms are not identical

The multicellular bodies of both plants and animals can be regenerated from single cells or cell nuclei, by a process popularly known as 'cloning'. It has long been known that the clones derived from single individual plants can look very different. This phenomenon is called 'somaclonal' variation. The genetic basis of this variation has not been understood until now.

In recent research, my group describe the discovery of the molecular causes of plant somaclonal variation. Because somaclonal variation is inherited from one generation to the next, it was considered likely that genetic differences could explain the plethora of forms that are seen. However, the nature of these genetic differences was poorly understood.

In collaboration with Richard Mott and Jiannis Ragoussis at the University of Oxford Wellcome Trust Centre for Human Genetics, we exploited recent developments in DNA sequencing technology in the model flowering plant *Arabidopsis thaliana* to reveal for the first time what happens to the genetic material of plants during regeneration.

By analysing the complete DNA sequence of many different clones derived from individual plant cells, we discovered that regeneration is mutagenic. That is, many changes in the DNA sequence occur during the regeneration of clones. Furthermore the spectrum of mutations that occur during regeneration is very different from those that normally occur in plants. Thus there is something about the regeneration process that causes the accumulation of DNA sequence mutations in regenerant plants. We also showed that a subset of these mutations cause the differences in appearance that are characteristic of somaclonal variation.

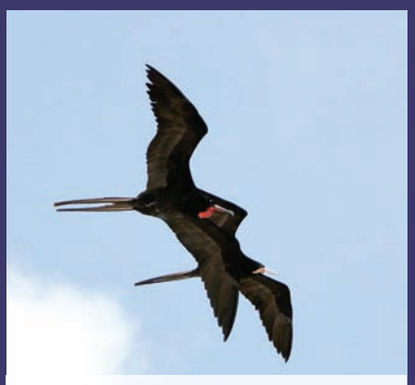
This discovery is helping to resolve a long-standing debate about the cause of somaclonal variation. It demonstrates that mutation in the DNA sequence is a major contributor to somaclonal variation. This is an important advance in understanding the fundamental biology of organisms that reproduce clonally, and also has important implications for the plant biotechnology industry. Somaclonal variation is at once a significant problem (when uniformity of clonally propagated plants is required) and a potential advantage (can generate the phenotypic variation that breeders can use in crop improvement). Our discovery allows us, for the first time, to develop strategies to enhance its benefits and minimizes its deleterious effects.

Nick Harberd, Sibthorpian Professor of Plant Sciences

Photo: Timothy Walker

***Echium wildpretii*, Canary Islands**

Photo: Martin Speight



Frigate birds, Mexico

Photo: Kerry Kilshaw

Scottish wild cat

Newsletter for Biology Alumni and Friends

Welcome to the first edition of the new *Biology at Oxford* newsletter. We want to bring you news from the Departments of Zoology and Plant Sciences and share the excitement of new discoveries from the wide range of biological science research taking place at Oxford.

Take a look inside to find out about yeti crabs, exploding fruit, kodkods and why biologists are getting involved in creating apps, along with many other articles, including a fresh look at what it's like to study Biological Sciences at the University of Oxford.

FRIENDS

You don't have to have studied at Oxford to receive this newsletter. If you are not an alumnus, we would still be delighted to send you future editions of the newsletter, either as hardcopy or electronically. If you would like to receive it, do register by emailing "newsletter@biology.ox.ac.uk", telling us a bit about yourself and in which format you would like to receive the newsletter. Please do recommend us to your friends, colleagues, teachers, in fact, anyone with a professional or personal interest in biology.

ALUMNI

If you would like to receive future copies of this newsletter, please email us at "newsletter@biology.ox.ac.uk" and tell us whether you would prefer hard copy or electronic format. Please include your postal address and/or email.

UPCOMING EVENTS FOR ALUMNI

15 September 2012: Biology Alumni Day. Each year, the University and Colleges hold an 'Alumni Weekend' with dozens of events being held. This year the dates will be 14 to 16 September 2012. Most events insist on pre-registration, so please go to the website for further details (www.alumniweekend.ox.ac.uk). Biological Sciences will be holding an Alumnus event on 15 September 2012; we hope you will be able to attend, and please bring family and friends. For further details please check either the University alumni website (www.alumniweekend.ox.ac.uk), or our Biological Sciences alumni website (www.biology.ox.ac.uk/alumni/).

ALUMNI CONTACT DETAILS

To ensure we keep you and your friends up to date with news about research and information about events, we strongly recommend that you register with the Alumni Office. You can do this through the website www.alumni.ox.ac.uk, or by contacting : The Alumni Office, University of Oxford, Wellington Square, Oxford OX1 2JD, UK; +44 (0)1865 611617; "enquiries@alumni.ox.ac.uk". Alumni are entitled to an 'Alumni Card' which provides a range of benefits in Oxford, around the UK, internationally and online.

We hope to generate a network of experts from diverse walks of life who are willing to encourage students to study biology at Oxford and to pursue many and varied careers. We would love to hear your stories about your experiences during your time at Oxford and in particular after graduating. Please contact us on "alumni@biology.oxford.ac"

OTHER WEBSITES

www.alumni.ox.ac.uk
www.biology.ox.ac.uk
www.plants.ox.ac.uk
www.zoology.ox.ac.uk

Electronic version of this newsletter available: see www.biology.ox.ac.uk

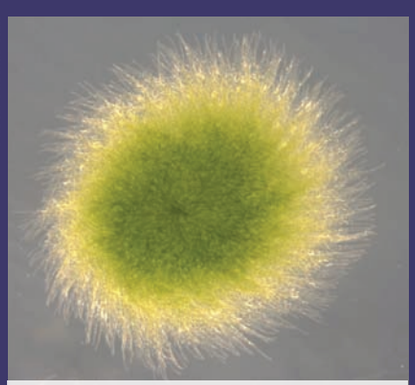
Photo: Alex Rogers

"Hoff crabs" at 2400m, Southern Ocean

Photo: Martin Speight

Coral Reef, Indonesia

Photo: Thomas Tam



Young moss, *Physcomitrella patens*