UNIVERSITY OF CAMBRIDGE
Department of Zoology

Zoology Graduate Symposium

14th February 2014

Timetable

8.45AM	**BREAKFAST AND REGISTRATION**	
9.15AM	**Jack Green**	Evolution of the pair rule gene network: Insights from a centipede
9.35AM	**Maja Goschorska**	Exploring cell competition as a tool for regenerative medicine
9.55AM	**Dareen Almojil**	Population and individual fitness of two reef sharks from the Arabian Gulf, Sea of Oman, Red Sea and the Indian Ocean: implications for conservation
10.15AM	**Hope Usieta**	Biodiversity on African farmland depends on the sex of the farmer
10.35AM	**David Labonte**	Slippery when wet: functional morphology of the pitch plant trapping zone
11.00AM	**TEA AND COFFEE**	
11.30AM	**Eyemen Kheir**	Studying the intracellular localisation and dynamics of Y RNAs
11.50AM	**Anthony Lamb**	Can land sparing mitigate climate change?
12.10PM	**Samuel Wilks**	Antibody landscapes: visualising changes in immunity following vaccination and infection
12.30PM	**Marjorie Sorensen**	Why do birds sing in winter?
12.50PM	**LUNCH**	
1.45PM	**Erik van Bergen**	Nature's ecological recorders: stable isotopes reveal patterns of ecological diversification in Mycalesine butterflies
2.05PM	**Tim Bayley**	Calcium imaging in insect neurons
2.25PM	**Simon Martin**	Three million generations of hybridisation between *Heliconius* butterflies
2.45PM	**Sarah Luke**	The impacts of logging and oil palm agriculture on stream invertebrates in Malaysian Borneo: can riparian margins mitigate the loss of biodiversity
3.05PM	**Thomas Clay**	The spatial ecology of non-breeding albatrosses
3.30PM	**TEA AND COFFEE**	
4.00PM	**Dr. Nick Hopwood**	Haeckel's embryos: images, evolution, and fraud
5.00PM	**WINE RECEPTION**	

Jack Green

Laboratory for Development and Evolution

Prof. Michael Akam

Evolution of the pair rule gene network: Insights from a centipede

Comparative studies have examined the expression and function of homologues of the *Drosophila melanogaster* pair rule and segment polarity genes in a range of arthropods. The segment polarity gene homologues have a conserved role in the specification of the parasegment boundary, but the degree of conservation of the upstream patterning genes has proved more variable. We identify a complete set of pair rule gene homologues from the centipede *Strigamia maritima*, and document their relative expression with respect to each other and to the key segment polarity genes. There are three major results. First, 15 of 17 of the *Strigamia* pair rule genes are expressed in periodic patterns before the appearance of morphological segments, and before the first expression of the segment polarity genes. Second, we find evidence for a conserved hierarchical organisation of the pair rule genes, with a division into early- and late-activated genes that parallels the functional division into primary and secondary pair rule genes described in insects. Third, the relative expression of sloppy-paired and paired with respect to wingless and engrailed at the parasegment boundary is conserved between myriapods and insects; suggesting that the functional interactions between these genes might be an ancient feature of arthropod segment patterning

Maja Goschorska

Piddini Group

Dr. Eugenia Piddini

Exploring cell competition as a tool for regenerative medicine

Gene therapies against single-gene disorders, such as cystic fibrosis (CF), struggle to correct enough cells to restore organ function. We propose to employ cell competition to overcome this problem. Cell competition is a process whereby neighbouring cells contend for their place in tissues. As a result less fit or malfunctioning "losers" are eliminated, while more robust "winner" propagate, thereby increasing overall organ fitness and functionality. Our initial aim is to investigate whether in the lung, the main tissue affected by CF, we can induce cell competition. To do so we use cells mutant in ribosomal genes (which in *Drosophila* are effectively outcompeted by wild-type cells), and confront them with normal or rescued cells. All experiments will be carried in vivo in the mouse respiratory system, or in vitro using air-liquid interference cultures of trachea cells, suitable for live imaging. If the above is successful, our ultimate goal is to combine strategies to induce cell competition with gene therapy against CF. We hope to increase the ability of CF corrected cells to colonise tissues and therefore improve treatment outcome. If this were successful it would provide a proof of principle that this approach could be used for therapeutic purposes.

Dareen Almojil

Molecular Ecology

Prof. William Amos

Population and individual fitness of two reef sharks from the Arabian Gulf, Sea of Oman, Red Sea and the Indian Ocean: implications for conservation

Effective conservation of wild populations requires more than knowledge of population structure and abundance trends. Understanding the selection forces that drive population structure and contribute to species local fitness is equally important; this includes understanding the dynamics of sexual selection. By looking at the genetics of mate choice to understand sexual selection and its role in population fragmentation, links to the basic units that drive evolutionary processes of population divergence could be provided. Therefore in this study I aim to investigate the relationship between mating success and some traits that are related to fitness in sharks (such as; mean individual heterozygosity, total body length, parasite burden and/or age). If any of the listed traits prove to play a role in driving sexual selection, then there are important additional traits to be considered when managing shark stocks in the future. The existing regional shark management plans are placed with out scientific basis. Regional historical shark abundance trends are hard to infer due to the lack of shark archival catch reports. Therefore I inferred the status and trends of regional shark populations by testing for the occurrence of shifting baseline syndrome between local fishermen of different age groups. My preliminary results support a significant difference in the reported scale of depletion between young fishermen (<30 years old) compared to older fishermen (>50 years old), which reflects a shift in the abundance of local shark populations towards

depletion. This finding supports the need for a conservation plan to protect regional shark stocks. A preliminary conservation plan needs to be informed about the level of gene flow between individuals of the targeted species for protection. Thus I also aim to investigate population connectivity of the black-tip shark *Carcharhinus limbatus* and the Spot-tail shark *C. sorrah* along the region using neutral microsatellites markers.

Hope Usieta

Conservation Science

Prof. William Sutherland

Biodiversity on African farmland depends on the sex of the farmer

Most farming in Africa is carried out by women, but this varies between crop types and regions. Women-managed fields are thought to be farmed much less intensively than men-managed fields while women are more likely than men to support environmental protection. We quantified the consequences of intensification and gender differences on farm management across traditional and industrial fields in southern Nigeria and determined the consequences of management differences on birds, trees and field weeds. We found that women-managed fields support much higher bird species richness and density compared to fields managed by men. We also identify mechanisms causing this gender difference: higher densities of trees and weeds in women-managed fields were the main determinant of the higher bird richness and density. This has a range of implications, including that many development policies are aimed at one sex.

David Labonte

Insect Biomechanics

Dr. Walter Federle

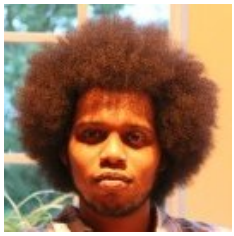
Slippery when wet: functional morphology of the pitcher plant trapping zone

Nepenthes pitcher plants capture prey with a specialised surface at the pitcher rim, the peristome, which becomes slippery only when wet. The peristome's function appears to be aided by radial ridge structures that have two different length scales: first-order ridges on the 100μm length scale, superimposed on which are several second-order ridges on the 10μm length scale. In order to clarify the function of the first- and second-order ridges, we measured single-pad friction forces of *Carausius morosus* stick insects on dry and wetted peristome replicas and artificial surfaces patterned with ridges comparable in length scale to both first- and second-order ridges. Replicas were produced in transparent epoxy using silicone moulds of *Nepenthes maxima* peristomes; artificial ridge structures were made from the same material after taking moulds of ridge substrates fabricated by photolithography. Friction forces were significantly reduced on wetted substrates in all cases, but much more strongly on the surfaces containing second-order ridges. Dynamic contact angle measurements on fresh pitcher peristomes revealed that water rapidly spread and wetted the peristome along the ridges, but fluid movement was strongly limited across the first-order ridges. Our results indicate that the second-order ridges alone are sufficient to stabilise the water films on which insects aquaplane, whereas the first-order ridges may help to confine wetting to channels running into the pitcher, thereby facilitating prey capture when only small amounts of water are present.

Eyemen Kheir

Krude Lab

Dr. Torsten Krude



Studying the intracellular localisation and dynamics of Y RNAs

Cell division is an essential process for all organisms; it enables growth, tissue repair and reproduction. The cell division cycle is highly regulated and precisely timed. In order for cell division to take place, DNA must be accurately and efficiently replicated. Non-coding Y RNAs are crucial for the initiation step of chromosomal DNA replication in vertebrates. Y RNAs levels are higher in human tumour tissues in comparison to normal tissue. Nonetheless, little is known about the intracellular cellular localization and dynamics of Y RNAs during the cell cycle. My work focuses on studying the intracellular localisation and dynamics of Y RNAs during the cell cycle.

Anthony Lamb

Conservation Science

Prof. Andrew Balmford

Can land sparing mitigate climate change?

The UK has committed to achieving an 80% reduction in greenhouse gas emissions by 2050. Meeting the 80% target in the agriculture sector will be especially challenging in light of ongoing increases in population and food demand. 'Land sparing' is an approach to farming that seeks to free-up some farmland for habitat restoration by increasing agricultural yields elsewhere. This strategy might present an opportunity to reduce net emissions, given that spared land can be managed as a carbon sink. Anthony Lamb will outline a project seeking to quantify the potential greenhouse gas savings from such a strategy in the UK.

Samuel Wilks

Centre for Pathogen Evolution

Prof. Derek Smith

Antibody landscapes: visualising changes in immunity following vaccination and infection

We have been developing the technique of "antibody landscapes" as a tool to visualise information within serological data in an intuitive fashion in order to develop a better understanding of the immune response to antigenically variable pathogens, using influenza as the organism. Using human serum samples titrated against a panel of influenza viral strains, the technique models and describes how immunity to different strains varies in terms of the antigenic differences between them. The ultimate goal is to better understand how immunity to different strains is built up over time and how immune responses following pathogen exposure depend not only on the nature of the virus encountered, but also the nature of immunity already present against similar strains. Answers to the questions posed in this area allow powerful inferences to be made about the fundamental basis of development and maintenance of adaptive immunity in general. Further, an understanding of how the human immune response can be manipulated more effectively yields the potential for even wider impacts, for example increasing the protection afforded for vulnerable individuals through more effective vaccine strain selection.

Marjorie Sorensen

Behavioural Ecology

Dr. Claire Spottiswoode

Why do birds sing in winter?

Trans-Saharan migratory birds spend over 60% of the annual cycle in Africa thousands of kilometers away from their European breeding grounds, but little is known about their winter ecology or the factors that affect individual over-winter success. In particular, many Palearctic-breeding species sing vigorously in Africa, but the function of this behaviour is entirely unknown. Do migrants use song in territorial defence or does song serve another function such as song learning? I investigated these questions in Great Reed Warblers (*Acrocephalus arundinaceus*) overwintering in Zambia, using playback experiments, comparative analysis, physiological indices of body condition, and radio telemetry to determine space-use patterns. I asked whether the incidence of song was related to territorial vs transient movement strategies at the individual level, and whether each of these was related to condition as reflected by scaled mass indices and spring migration departure dates. Singing males were in better condition and left earlier for spring migration than their non-singing counterparts. This suggests an adaptive function of winter song; however, I found no support for the long held supposition that winter song functions for feeding territory defence. Rather, my results suggest that winter singing may function in song learning, as species that invest most in winter song are those species where sexual selection for song complexity is strongest. A better understanding of the non-breeding ecology of Palearctic-African migrants at the individual level may have significant implications for the conservation of long distance Palearctic-African migrants, which are currently in a state of precipitous decline.

Erik van Bergen

Radiating Butterflies

Prof. Paul Brakefield

Nature's ecological recorders: stable isotopes reveal patterns of ecological diversification in Mycalesine butterflies

Mycalesine butterflies have radiated dramatically in Africa, Madagascar and Asia to produce more than 300 extant species. Larval host plants are nearly always grasses. The primary driving process of these radiations could have been the ability of mycalesine butterflies to invade the empty niches that arose as a result of the evolution of the C_4 photosynthetic pathway and the world-wide expansion of C_4 grasses in open, sunlit environments. Primary forest species of mycalesines are expected to be C_3 specialists as the advantage of the C_4 pathway declines in shaded forest understories where cool conditions improve the relative photosynthetic efficiency of C_3 grass species. In more open habitats we expect mycalesines to be more opportunistic and generalist in their host plant choice or even to have become C_4 specialists.

Reliable host plant data are essential to be able to test this hypothesis but detailed host plant records for mycalesines are very limited. However, over the last three decades stable isotope analyses have become an important part of the ecologists toolbox. Here, we used daily trap captures of adult butterflies from a community of three sympatric species of *Bicyclus* in Malawi to explore whether $\delta^{13}C$ and $\delta^{18}O$ values can be used to detect micro-climate conditions during the larval development of Mycalesine butterflies. In addition, we have begun to examine the larval feeding preferences, in terms of C_3 and C_4 grasses, in a broader phylogenetic-ecological framework. By mapping the data of this

large scale isotope survey and the current habitat preferences of *Bicyclus* butterflies onto the phylogenies we are now able to reconstruct whether one or more shifts to C_4 grasses were associated with the colonization of open habitats and subsequent expansions.

Tim Bayley

Insect Acoustic Communication

Dr. Berthold Hedwig

Calcium imaging in insect neurons

Changes in neural activity are accompanied by changes in cytosolic calcium concentrations. Calcium imaging can be used to monitor the activity of neurons in several areas at once; either on a large scale, across the entire nervous system, or a small scale, within the neurites of single neurons. For large scale imaging, I have studied fictive locomotor patterns spreading across the ventral nerve cord of the fruit fly, *Drosophila melanogaster*, and on the small scale, I have analysed Ca^{2+} changes in the dendrites and axon of a local auditory interneuron of the bush-cricket, *Mecopoda elongata*, in response to acoustic stimulation. In both cases, I have combined calcium imaging with electrophysiology.

Simon Martin

Butterfly Genetics

Dr. Chris Jiggins

Three million generations of hybridisation between *Heliconius* butterflies

There is growing interest in whether incipient species could emerge and persist without complete reproductive isolation. Documenting the extent of gene flow during speciation poses a challenge, as ranges change over time and hybridisation rates may not reflect historical trends. We used whole-genome analysis of *Heliconius* butterfly populations at different levels of genetic and geographic divergence to quantify gene flow across the genome and through evolutionary time. Closely-related species with overlapping ranges showed a signal of pervasive gene flow, affecting up to 40% of the genome. This signal was strongly reduced on the Z sex chromosome, consistent with observed female hybrid sterility. Patterns of shared variation and linkage disequilibrium were consistent with hybridisation extending deep into the past. To dissect this signal more finely, we used coalescent simulations in an approximate Bayesian computation (ABC) framework, to date the onset of hybridisation between two species. This revealed strong support for an onset of hybridisation about 0.75 million years (or 3 million generations) ago, indicating that a significant period of isolation occurred early during speciation. This period of isolation may have been necessary for the accumulation of genomic changes that have helped to maintain species integrity during a remarkably long period of ongoing hybridisation.

Sarah Luke

Insect Ecology and Aquatic

Ecology

Dr. William Foster and Dr. David Aldridge

The impacts of logging and oil palm agriculture on stream invertebrates in Malaysian Borneo: can riparian margins mitigate the loss of biodiversity?

Freshwaters provide essential ecosystem services, and comprise highly biodiverse habitats, but are heavily threatened by land use change. In Southeast Asia, tropical rainforest stream ecosystems are being impacted by rapid expansion of logging activities and growth of oil palm agriculture causing changes in inputs of sediment, nutrients and flow. These changes may substantially impact biodiversity, ecosystem function and consequent provision of services, but research has been limited, and there has been little testing of strategies for mitigating logging and oil palm agriculture effects.

Our work at the Stability of Altered Forest Ecosystems (SAFE) Project, in Sabah Malaysia, tests the effects of catchment logging and oil palm plantations on stream macroinvertebrate assemblages, and the value of riparian forest margins for protecting stream ecosystems from disturbance. Macroinvertebrates form a major part of the freshwater biota and changes in their assemblages are likely to have significant impacts on ecosystem function. We surveyed benthic insect larvae, surface skater bugs, large shredders/grazers (crabs, shrimps, snails), and adult dragonflies across streams with a range of catchment forest quality and oil palm. We found that diversity and abundance of many macroinvertebrate groups was reduced in low quality forest and oil palm catchments, however dragonflies remained abundant and species rich. However, this richness

was maintained through a shift in community composition, rather than all species surviving the disturbance many forest specialists and locally restricted species were lost from disturbed streams.

This shows that recent logging and oil palm land use change in Malaysian Borneo, and likely wider Southeast Asian tropical forests, has significant impacts on macroinvertebrate communities, and particularly on specialists. Strategies such as riparian forest margins must be developed to maintain freshwater ecosystems and unique biodiversity, in the face of expanding agriculture.

Tommy Clay

Evolutionary Ecology

Dr. Andrea Manica

The spatial ecology of non-breeding albatrosses

Recent developments in tracking technology have improved our understanding of large-scale animal movements, yet little is still known about the drivers of these movements, particularly in the dynamic marine environment where monitoring of populations is challenging and where individuals have extended periods away from their breeding colonies. My research uses albatrosses from South Georgia as a study system to answer important ecological questions regarding space and habitat usage in long-lived and far ranging species. I use archival geolocator data to create habitat preference models to explain the influences of climate and oceanography on seabird movements and distributions. Furthermore, I use these models as a platform to link spatial usage with life-history characteristics and to predict the potential impacts of anthropogenic threats such as fisheries bycatch and climate change on these globally threatened species. In this talk, I will give an introduction to the topics I aim to cover in my PhD and briefly discuss some of the results gained so far and implications for future work.