"...scholarships for research and education..."

Newsletter August 2012

The Leverhulme Trust

Evolution of the Milky Way

Ancient humans of Britain

Drawn from history

Organised natural structures

All change at the RAAC

The Trust each year deals with approximately 4,000 applications for grants. Not surprisingly, given this volume of interest, the Board delegates responsibility for some award-schemes to other expert panels.

Principal amongst these is the Research Awards Advisory Committee (RAAC), which looks after three Fellowship schemes (Early Career, Research and Emeritus) and both of the Study Abroad opportunities (Studentships and Fellowships). During 2011 the RAAC made decisions about 1600 or so applications – representing approximately 20 percent of the Trust's spend for the year. The Committee itself comprises nine senior, experienced academics, who collectively take responsibility for grant-making across the spectrum of scholarly specialisms and disciplines. You don't have to be a genius at arithmetic to work out that the colleagues who are on the RAAC are hard-worked by the Director and the Board.

Fortunately, good-will abounds, and all nine colleagues never fail to impress by their diligence, efficiency, and (most important of all) their insight and exercise of great scholarship in reaching decisions about the many requests for funding that must be considered and resolved by the Committee. An important additional factor that has contributed to the success of the Committee during the past decade has been the outstanding leadership provided by its departing Chairman, Professor Keith Gull.

Keith is a distinguished researcher. Professor of Molecular Biology at the University of Oxford, Principal of St Edmund Hall, his contributions to science have been recognised by (amongst other things) his election to the Royal Society (in 2003) and his appointment as a CBE (in 2004). No less relevant, however, are those personal attributes that have enabled him to maintain good order and good humour amongst fellow committee members whose disparate backgrounds range from Mathematical Physics to the History of Art. With Keith's guidance, demanding decisions have been debated and agreed without demur, and with good grace. It has been a pleasure to observe the Committee at work.

On behalf of everyone at the Trust therefore, I want to take the opportunity offered by this Newsletter to say a very public and huge 'thank you' to Keith, for all that he has contributed over the past 15 years as a member of the RAAC, 10 as Chairman. I know that I speak for all of Keith's colleagues on the Committee in wishing him well for the future.

At the same time I am delighted to be able to announce the appointment of Professor Martin Daunton as Chairman of the RAAC. Martin is also an outstanding researcher, Professor of Economic History at the University of Cambridge and Master of Trinity Hall, elected to the British Academy in 1997 in recognition of his scholarly achievements. I expect his tenure to be no less successful than that of his distinguished predecessor and I look forward to working with him in the years to come.

Gordon Marshall

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More articles on current research can be found in the Awards in Focus section of our website: www.leverhulme.ac.uk/news

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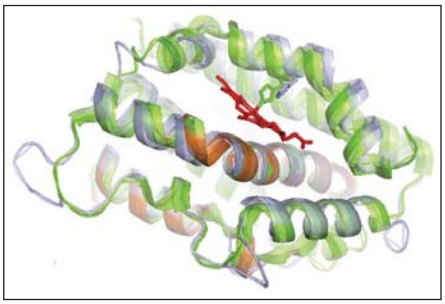
How do mosquitoes survive a blood-meal?

A female mosquito engorged with blood (courtesy of John Morgan).

Mosquitoes need to feed on blood to reproduce and, as a consequence, transmit many of the world's most devastating diseases including malaria, dengue and filariasis. Insecticides are still the most effective means to block the spread of disease and widely used to reduce mosquito populations, either coated on bednets or sprayed on walls. However, resistance to insecticides is on the increase, and new targets for the design of reagents to prevent transmission are urgently sought.

Given that blood digestion releases high concentrations of highly toxic free heme following haemoglobin degradation, how mosquitoes survive a blood meal over three times their body weight is an intriguing question fundamental to our understanding of disease transmission. Indeed, remarkably little is known about heme degradation in mosquitoes or other insects, yet it must be vital for the blood-suckers to survive.



The Anophele gambiae *(mosquito) HO (blue ribbon) structure is predicted to be similar to human (green ribbon) HO-1.*

Most higher organisms cope with free heme by breaking it down with two enzymes, namely heme oxygenase (HO) and cytochrome P450 reductase (CPR). Although HO-like genes are present in mosquitoes, and we predict they may be structurally similar to human HO-1, we have, as yet, no evidence of their function. However, having studied HO's partner, mosquito CPR, we have discovered significant functional differences between the mosquito and human enzymes that suggests very different mechanisms of heme breakdown. This finding has exposed an Achilles heel which we aim to exploit for the development of selective inhibitors of mosquito detoxification.

Insecticide being sprayed in Vanuatu to kill mosquitoes transmitting malaria.

A key obstacle to the development of new insecticides is the lack of information on the basic biology which could identify new targets for intervention. The challenge here is to understand how heme detoxification works and how it can be exploited for malaria control. This will provide fundamental new insight into heme metabolism, how blood-feeding insects survive toxic doses of heme, and a potential target for insecticide development.

Dr Mark Paine, Dr Gareth Lycett and Professor Lu-Yun Lian
Liverpool School of Tropical Medicine

Generative capacity of norms: a theory of inference from 'is' to 'ought'

Humans have a unique ability to generate novel norms. Given that there *is* famine in Somalia, it seems easy and natural to infer that we *ought* to donate to the Disasters Emergency Committee (DEC). Such inference from *is* to *ought* lies at the foundation of human normative thinking: without it, no new practical or moral norms would exist. Under the heading of the 'is-ought problem', the validity of such inference has been a longstanding conundrum in philosophy. Little is known, however, of the circumstances under which people draw such inference, or the psychological mechanisms underlying it. This is the focus of our project.

Reasoning from observation to norm (is-ought inference) appears to be logically invalid and is described by some philosophers as a major fallacy. In real life, however, people often reason with implicit premises which are conveyed by context and supposition and which may support is-ought inference. The DEC example supposes we are decent people with more money than we need and who believe in supporting worthy causes. It is not applicable to someone without money, because, as philosophers advise, 'ought' implies 'can': an example of a principle which bridges the gap between the descriptive and the normative.

Given that there ARE hungry children in Somalia, we naturally and easily infer that we OUGHT to donate to famine relief charities (image reproduced under the Creative Commons License from flickr user: Trocaire).

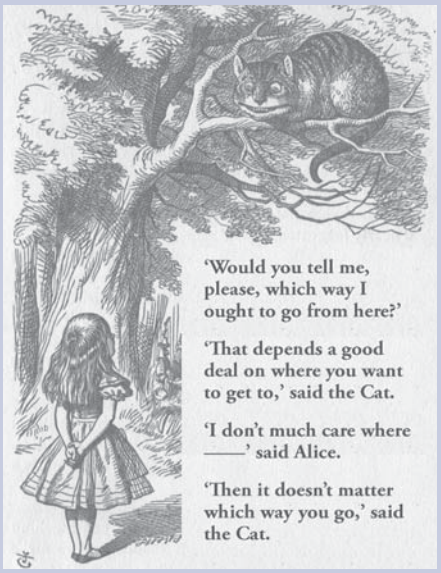
We propose that rich and sophisticated chains of inference are involved in drawing normative conclusions. Such inference typically starts with conditional sentences such as 'If you pull the dog's tail again, then he'll bite you.' Such sentences 'invite' people to infer a normative conclusion: in this case, that you *should not* pull the dog's tail. This inference is *pragmatic*: it depends on beliefs, it is sensitive to social context, it directs action, and it is probabilistic. We distinguish the following steps:

- **Goal inference:** A valued goal is implicitly inferred; e.g., *being bitten is bad.*
- **Causal inference:** A causal link between the action and the outcome is implicitly inferred; e.g., *pulling dog's tail makes dog bite.*
- **Valence transference:** Psychological value transfers through the causal link from the goal to the action; e.g., *pulling dog's tail is bad.*
- **Deontic bridging:** The transferred value bridges into a novel norm; e.g., *should not pull dog's tail.*

Because norms direct behaviour, there will often be an additional step:

- **Behavioural directive:** The deontic conclusion is translated into action; e.g., *you will not pull dog's tail.*

The project will test and refine this theory. We will present participants with descriptive conditional sentences such as 'If Lisa uses the revision booklet, she will pass the exam', and ask them to evaluate normative ('deontic') conclusions such as 'Lisa should use the booklet', on a scale from 1 (Definitely does not follow) to 7 (Definitely follows). We will test: the chain of inference leading to normative conclusions; the hypothesis that normative inference directs behaviour and the relative contribution of psychological value and causality; and the hypothesis that normative inference underlies much of the way we think about norms, both in deontic and moral thinking.



People tend to infer norms in the presence of goals and values (illustration by John Tenniel of the Cheshire Cat from the original edition of Alice in Wonderland, 1865).

Dr Shira Elqayam
De Montfort University

Ancient Egyptian demonology

Demons abound in the media today – from TV shows, to tales of possession, to the labelling of political policies as 'demonic', to the channelling of spirits for healing. Some of the most prevalent rituals in the ancient and modern worlds are those designed to target demons and those that make use of their power for benefit. The amorphous residues of these beliefs are still tangible in the surviving archaeology of Ancient Egypt.

Defining this category of 'demons' is not easy as there is no obvious uniformity to their natures or intent. Some harm, some help. Some inhabit the afterlife, others walk the paths of the living. Some assault in gangs while a few have individual names. Although they played a crucial role in the Egyptian understanding of the cosmos – some were blamed for a host of physical and psychological afflictions, others were petitioned for aid – demons have remained peripheral to most scholarship focussing on Egyptian religion or ancient ritual practice. While gods such as *Osiris, Isis,* and *Ra* are familiar, the darker side of religion and ominous entities such as *Sehaqeq,* or *Fiery-breath* have remained in the shadows. This project aims to illuminate this darker and more private side of Ancient Egyptian religion that impacted on daily lives, driving individuals to access the supernatural realm through rituals.

Since there is no universal definition of demon (any more than there is one for god), one of the goals of this project is to help develop the criteria for defining these entities so they can be brought together to construct a modern demonology of Ancient Egypt. The time period (2nd millennium BCE) and data for this project have been restricted to make completion feasible.

Clay cobra figurine representing fiery power of the sun placed in a room to protect inhabitants from demons (image courtesy of the author, based on the original ÄM 21961 now at the Ägyptisches Museum und Papyrussammlung, Berlin).

An ivory 'wand' used to draw a protective circle around vulnerable individuals past which demons cannot cross (BM 38192 now at the Egypt Centre, Swansea, © Trustees of the British Museum).

We will combine science with traditional humanistic study and digital technology to create an open-ended interdisciplinary collaborative project. The database will be available to other scholars working on demons from other time periods to input their own data and tap into our formulae for their analysis. In sum, we seek to establish a shared tool that unifies research and puts Ancient Egyptian demonology on the map.

Dr Kasia Szpakowska
Swansea University

The rhetoric of empire: managing imperial conflict between Britain and France

The word 'crisis' is much overworked in empire histories. To judge from the historiography of modern imperialism, 'crises' became endemic over the final century of European colonial rule. Indeed, one might readily conclude that the largest such Empires, those of Britain and France, constantly teetered on the brink of collapse. Conversely, imperial rivalry between Britain and France, Europe's two pre-eminent colonial powers, is typically seen as perennial, yet curiously benign, a quaint facet of the imperial past rather than a source of global instability. This is a curious misperception. Focusing on the material impact of the cross- Channel clashes between the two imperial giants, this project engages with the extensive public debates that surrounded the imperial claims made by both countries at moments of tension. Rather than 'laying bare' existing assumptions, the need to arrive at a position on Anglo-French issues forced imperialists (and their opponents) to define their own views of empire in relation to each other's arguments.

By using rhetorical analysis the project will explore the ways in which imperial actions were publicly defended in Britain and France, often at the direct expense of the imperial rival. A key aim is to analyse the rhetorical armoury of leading imperialist figures by examining flashpoints in the relationship between the two countries from the 1898 Fashoda crisis (when Britain and France came to the brink of war in the aftermath of the British reconquest of Sudan) to the Suez crisis in 1956 (when, far from defusing another imperial crisis, Britain colluded with France and Israel to invade Egypt). The focus will be on the phraseology employed, the imagery evoked, the historical precedents cited, and the appeals for support made, as well as on the exploitation of political space and symbols.

Using a combination of archival sources, newspapers and periodicals and published parliamentary debates, we will chart the forms and content of British and French political debates occasioned by some of the most serious colonial issues that arose between them.

While each of the crises is historically familiar, the imperialist rhetoric of the leading political figures involved has not been examined in its own right. Political rhetoric was central to all of them – whether in justifying the scramble for territory, supporting imperial business, attacking French collaborationism on the one hand, the perfidiousness of Albion on the other, or, finally, in arguing that either Britain or France knew how to protect its colonised peoples and ensure regional stability where the other did not.

French imperial propaganda from the newspaper, Le Petit Journal, *showing Marianne, symbol of the French Republic distributing riches in Morocco, 1911. Image reproduced courtesy of University Nebraska Press.*

Professor Martin Thomas and **Professor Richard Toye**
University of Exeter

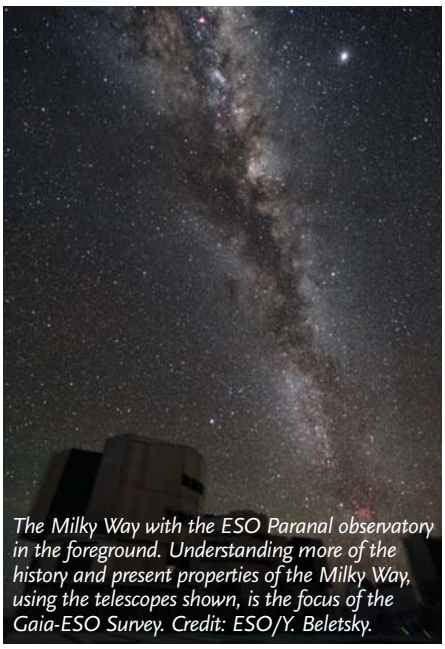
Quantifying the formation and evolution of the Milky Way

Astronomers are rather good at asking big questions: what is the Universe actually made of, since Dark Matter is not stuff like we see? Given that we live inside the Milky Way, how do we know what it really looks like? Where and when were the chemical elements we are made from created? How did they get from there to here? How much does the Milky Way weigh?

These are big questions to which we – so far – lack the answers. But we progress, with the aid of new technology, new ideas and new approaches. All three of these advances are encapsulated in Europe's most ambitious experiment in ground-based astronomy, the Gaia-ESO Survey. This project will use 300 nights on one of the four European Southern Observatory 8.2m Very Large Telescopes to make the next big step in delivering the first fair census of our Milky Way. Access to these telescopes is usually measured in hours, not hundreds of nights. Managing the data involves a consortium of over 300 people from 90 institutions, and so is itself a major sociological and organisational challenge and learning-curve; while the goal is to determine the ordinary.

Most projects in astronomy which win access to the biggest and best facilities justify themselves by studying the exceptional – the biggest, oldest, most primitive, special and newsworthy... hence we know too little about the typical. But understanding big questions, such as "How did our Milky Way grow from a ripple in the primordial Universe to what it is today?" require that we know what the Milky Way really is today. Defining that, for all the identifiable sub-parts of the Milky Way, is the goal of the Gaia-ESO Survey, which itself is the first step towards readiness for fully understanding the results from the European Space Agency satellite Gaia, due for launch in 2013.

The left-hand panel (and cover image) shows the Orion Nebula in visible light, illuminated by the central hot young stars. On the right the VISTA infrared view shows large numbers of young stars close to the centre and many curious red objects, associated with young stars and their outflows, in the region above the centre. Probably all stars, including our Sun, were formed in clusters like this, which rapidly dissolved. Credit: ESO/J. Emerson/ VISTA & R. Gendler. Acknowledgment: Cambridge Astronomical Survey Unit



The Milky Way with the ESO Paranal observatory in the foreground. Understanding more of the history and present properties of the Milky Way, using the telescopes shown, is the focus of the Gaia-ESO Survey. Credit: ESO/Y. Beletsky.

Gaia's mission is to provide the first fair census of the Milky Way. It will tell us what is there, where it is, and how it moves. But we need spectroscopy from large ground-based telescopes to tell us what things are made of: which chemical elements are found in what abundance in which types of star. Those chemical elements, and their changes over time, encode the history of the formation, lives, and chemical-element creating violent deaths of the stars in the Milky Way. They therefore allow us to measure our Galaxy's formation and evolution, in much the same way that rocks hold the story of the evolution of life on Earth. What will we learn? Watch this space!

Professor Gerard Gilmore
University of Cambridge

Drawn from history: image, place and value

The Artist in Residence scheme is funding a partnership between local artist, Sarah Kirby, and the Centre for Urban History (CUH), University of Leicester, on a series of prints depicting Leicester's architectural heritage.

Sarah's inspiration as an artist lies in the buildings that are a part of the fabric of everyday life for the urban community. Her most recent series of prints in Leicester has focussed on both iconic public buildings (such as the Market Place) and buildings that are a familiar part of everyday life, but nevertheless architecturally notable. Her work explores how buildings are imbued with meaning as a consequence of repeated use across different generations; how the buildings acquire emotional significance for local inhabitants; and how they become repositories of memory. Her art is highly evocative and prompts a rich range of responses from viewers, for whom it acts as a stimulus to reflect on what buildings mean to them and their own sense of place.

Market Place, Leicester, Linocut 2010.

At the CUH we are particularly interested in the value that societies place upon the historic urban environment; how such values inform policy decisions and their implementation; how the built environment is represented in different media; and how the historic built environment creates a sense of place and contributes to a sense of individual, civic or community identity. For the CUH the residency presents an exciting opportunity to develop new methodologies in our research: to use the responses to Sarah's work to investigate questions of value and place attachment. As urban historians we have long since recognised the importance of visual resources for historical research, but we have not done enough to engage with the artists who produce such work: this partnership will give us an exciting opportunity to explore the relationship between the image, the artist and the audience and to establish an entirely new dimension to our initiatives in outreach and public engagement.

For Sarah this residency will allow her to develop her art in a new direction using the expertise of colleagues and our library resources to deepen her understanding of the historical context in which buildings have been constructed and the different purposes they have served and the meanings they have acquired across the generations. She is also particularly interested in using the Centre's expertise at the East Midlands Oral History Archive to work with people attending her exhibitions and to record their responses, which will in turn inform her own work.

We are looking forward to a stimulating and mutually informative collaboration that will result in a new series of prints, a public lecture given by Sarah, a major public exhibition in the autumn and a radio programme on buildings and memories prompted by Sarah's prints.

The point of intersection between the artist, Sarah Kirby, and colleagues at the CUH lies in our common interest in the meanings that are invested in buildings and spaces, the emotional attachments that develop, and how these inform the sense of identity for individuals and communities. The residency will enable us to establish a new direction in our research which will add value to our methodologies. In short, it will exploit the synergy between Sarah's images of Leicester and the sense of place that they evoke, and the research interests of colleagues in representations of the city, place attachment and the value of heritage.

Fenwicks, Leicester, Linocut 2010.

Professor Roey Sweet hosting Ms Sarah Kirby
University of Leicester

Cover thumbnail: *Wygstons House, Leicester, Linocut 2011.*

Getting to know the ancient Britons

Carolyn Allen, *of the Trust, reports*

A Leverhulme Trust-funded project, investigating the history of the human community in the British Isles, has pieced together clues left over the last 800,000 years, to reveal who the ancient Britons were and how they lived.

The Ancient Human Occupation of Britain (AHOB) project set out to reconstruct the past lives of ancient humans, not only by carrying out new excavations but also by reanalysing old finds in existing collections using state-of-the-art technologies. The AHOB team, led by Professor Chris Stringer of the Natural History Museum, includes archaeologists, palaeontologists, stratigraphers, sedimentologists and isotope analysts. Their broad multidisciplinary approach has proved immensely successful, producing a number of ground-breaking discoveries and giving us a much clearer history of our past.

When the AHOB project commenced the earliest evidence of human occupation in Britain came from Boxgrove in Sussex where dating revealed that humans had been living in Britain around 500,000 years ago. But the occupation of Britain was far from continuous because the early Britons often failed to cope with the extreme changes of climate they had to face. As the environment became too harsh, with ice sheets covering the land, the inhabitants either moved south across land bridges that connected Britain to mainland Europe or died out, to be replaced by new populations when conditions improved.

In 2005, the AHOB team and collaborators uncovered evidence at an archaeological site in Pakefield, Suffolk, suggesting that humans reached Britain 700,000 years ago during a brief period when the climate was similar to the Mediterranean today.

"Leverhulme funding for a total of 12 years has allowed the AHOB team to highlight the quality of Britain's prehistoric record, now making it one of the fullest-studied and best understood in the World. As well as funding extensive fieldwork and collections studies, a number of experts were employed full-time on the project, allowing them to concentrate on their work and achieve much more than they could have done otherwise."

Professor Chris Stringer

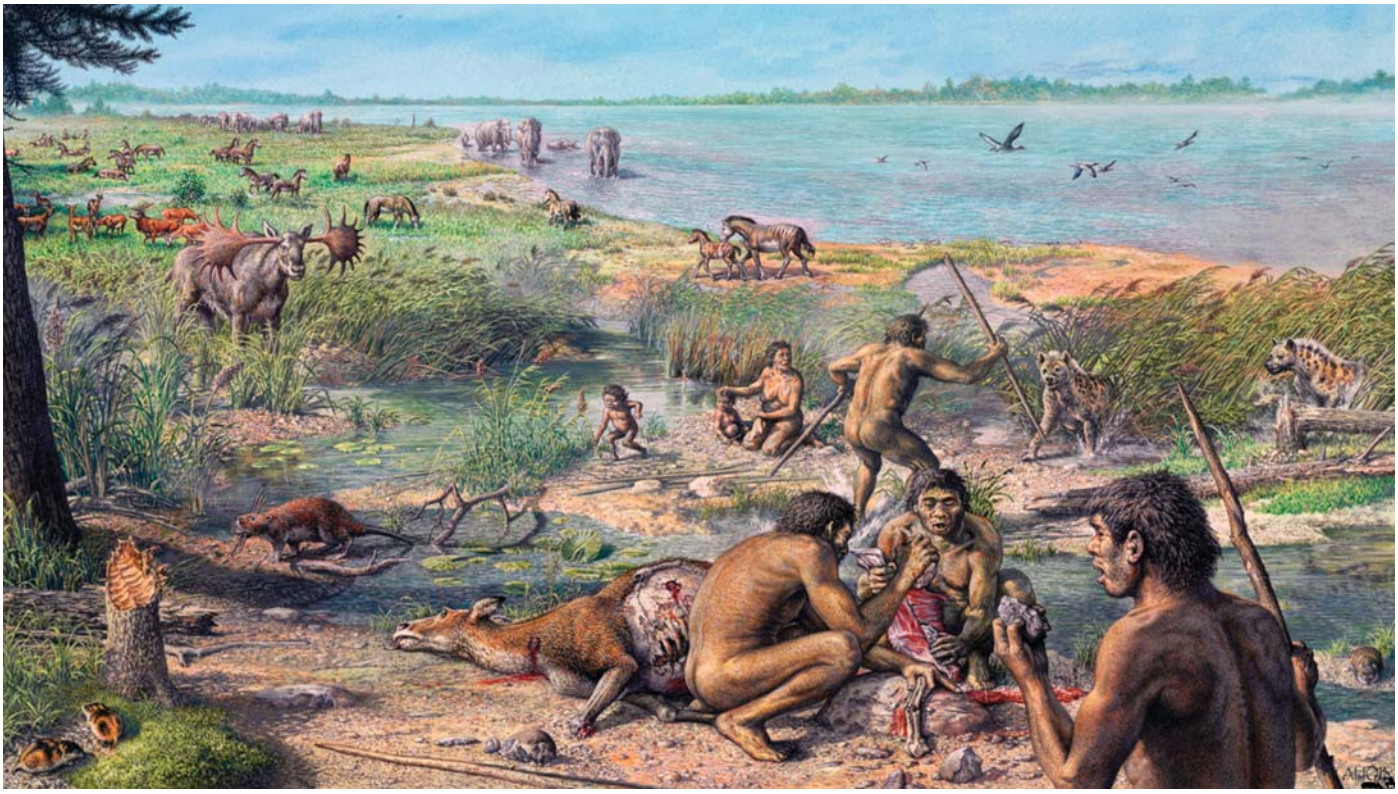
Then, in 2011, excavations by the AHOB team on the foreshore of Happisburgh, Norfolk uncovered more than 70 flint tools and flakes, pushing back the date that humans first occupied Britain by at least another 100,000 years and making this the first known settlement in Northern Europe.

The associated environmental data collected by the AHOB team reveals that the Happisburgh people were somehow able to survive in quite harsh conditions on the bank of the ancient river Thames (whose outfall was then in East Anglia). Their predators would have included hyaenas and sabre-toothed cats, and maybe even other humans. From the fossil remains of pollen, pine cones, beetles and other animals such as voles, the researchers concluded that these early humans lived close to the edge of northern pine forests with few edible plants and animals and severe winters with short daylight hours.

No fossil human remains were uncovered at the site to help identify who the tools had belonged to, but the Happisburgh people would not have been modern humans, as they are thought to have evolved in Africa only 200,000 years ago.

According to Professor Stringer, the humans who made the Happisburgh tools over 800,000 years ago may well have been related to people of similar antiquity from

A human skull-cup made by ice age Britons 14,700 years ago from Gough's Cave. The process required great skill and knowledge of anatomy (image copyright Natural History Museum, London).



An artist's reconstruction of Happisburgh by John Sibbick (copyright 2010, John Sibbick/AHOB).

Atapuerca in Spain, assigned to the species *Homo antecessor* ('Pioneer Man').

Another AHOB study, this time on a piece of jawbone from Kent's Cavern in Devon, provided evidence that modern humans, *Homo sapiens*, were living in north-western Europe between 41,000 and 44,000 years ago. This suggests that the early modern humans who migrated out of Africa around 60,000 years ago, dispersed across Europe a few thousand years earlier than had previously been thought and this confirms that there was a significant overlap with the Neanderthals.

The Kent's Cavern jawbone was found back in 1927 and had previously been dated to around 35,000 years old, but traces of glue used to conserve the bone were found on its surface, meaning it was probably contaminated and so the reliability of the dating was in question. The only uncontaminated sample of the jawbone was too small to analyse so the AHOB team radiocarbon-dated animal remains that had been excavated from the same site, above and below where the jawbone was found, to pinpoint the real age of this important specimen.

Some of the most exciting discoveries from the AHOB team resulted from their detailed reanalysis of a cache of human and animal bones and artefacts found in earlier excavations at Gough's Cave in Somerset. This research revealed that the Gough's Cave dwellers were among the first humans to return to Britain from mainland Europe at the end of the last ice age and that their diet included human flesh.

Previous radiocarbon dating had given a wide range of ages for the Gough's Cave bones, suggesting that humans had used the cave for more than 2000 years, but the new findings told a very different story. The AHOB team pinpointed the age of all the bones to around 14,700 years, indicating that humans had headed west into Britain very rapidly as the ice sheets retreated, arriving at Gough's Cave within a few years, but only remaining there for a few generations.

The three human skull-cups from Gough's Cave were found with other fragments of human skull and mandibles (image copyright Natural History Museum, London).

Many of the human bones were butchered and crushed to extract the marrow in the same way as other animal bones found at the site, but the heads seemed to have been treated with special care and shaped into functional cups or bowls. The practice of making containers out of human skulls is well known worldwide but these are the oldest skull-cups to be found in the UK, and the AHOB findings are the first to reveal the intricate process of skull-cup manufacture.

Dr Silvia Bello, a palaeontologist at the Natural History Museum and lead researcher on this aspect of the AHOB project, explained:

"The cut-marks and dents show how the heads were scrupulously cleaned of any soft tissues shortly after death. The skulls were then modified by removing the bones of the face and the base of the skull.

Finally, these cranial vaults were meticulously shaped into cups by retouching the broken edges, possibly to make them more regular. All in all it was a very painstaking process given the tools available."

Professor Stringer, who helped unearth one of the skull-cups during the 1987 excavation, said the amount of work that went in to making the skull-cups suggests they had a special purpose, possibly to hold blood, water or food during rituals.

For more information about the AHOB project visit their website www.ahobproject.org or take a look at Professor Stringer's book *Homo britannicus: the incredible story of human life in Britain* (2006), Penguin Group.

Human, non-human and environmental value systems: an impossible frontier?

Every day people make calculations about how to value something, whether that something is to be sold and consumed, or protected and conserved. Normally in economics this is done by giving it a price. But as economic systems become ever more complex, and the limits of the finite resources of the planet more apparent the way that we value things, humans, the environment and other animals has also become more extensive and more complex. We have financialised and 'valued' the atmosphere through carbon trading, and parts of the environment in conservation parks and protected areas. Now, separate components of the natural and species world are becoming separately valued in new financialised systems such as species banking, eco-systems services, biodiversity banking and carbon offsetting. It is widely believed that without something having a 'price' it will not be noticed or valued by policy makers, and that processes of financialisation which give something a price are therefore to be encouraged as a way to secure a sustainable future.

However, the evidence that assigning value in this way, that is through money and prices, can actually lead to the social and environmental outcomes that we need is not very strong. Also, the way that these types of calculations are made are little understood, but very different from in the past, where a certain degree of arms-length competition in markets leads to the establishment of a relatively competitive price. Now it is often the job of experts and professionals to assign value using computational techniques, spreadsheets, formula and accreditation devices. This research will study the different instruments and calculative devices in use to see how they work, whether they work and for whom. It will explore how social policy makers decide on the price for someone's welfare (and not someone else's), on the value of an elephant or a turtle, the value of a forest or a wetland, and the 'value-for-money' of a particular development in the private sector. This research will explore a number of separate experiments in value making in the humanitarian, development, environmental and agricultural fields which value people and the non-human world.

With all this evidence of contemporary value-making processes we will then reflect on what this means for the way academics and others have understood value in the past and how we should change this to be more accurate and useful for policy makers and others in the present. It is already clear that there are many different ways that the notion of value is used, priced, unpriced, notional and framed by an expert. To value a better future we need to know how to do it better, defined in terms of securing social and environmental justice, and this research seeks to find that out.

Dr Sarah Bracking
University of Manchester

Organised natural structures using synthetic biology

The rainforests of the tropics and the vast forests of the northern latitudes are the largest structures built by biology. They are often called the lungs of the Earth, exchanging the carbon dioxide and oxygen in the atmosphere in a process of respiration similar to that which occurs within us. Both the trees that populate these forests and our lungs share a common structural feature that makes them perfectly suited for respiration; they are built in a repetitive way that makes them densely branched. The branching of trees and lungs, as well as similar features seen in broccoli and coral, represents a type of pattern we know as a fractal. Fractals are detailed repetitive patterns that are defined by relatively simple mathematical rules. In nature, the branching fractal pattern that is seen in trees and lungs offers a simple route to maximising surface area. This is a key property for biology, and defines how well tissues and cells exchange gas and chemicals with their environment. The branched fractal structure of two human lungs, for example, gives each of us a surface for respiration that is approximately half the size of a tennis court.

Synthetic biology is a new area of bioscience research that seeks to re-engineer biological systems with new, programmable behaviours that have a mathematical basis. Examples of synthetic biology projects include *E. coli* bacteria modified to produce colour in response to light and yeast cells engineered to produce valuable complex chemicals usually found in rare plants. While most synthetic biology research has so far been performed using unicellular microbes like bacteria, recent projects have begun looking at coordinated behaviour of many cells together. For example, by intentionally rewiring the genetics that control how bacteria swim, one research team has recently shown that bacteria can be made to grow in bullseye patterns similar to those mathematically described as Turing Patterns.

The project we will be embarking on here will use synthetic biology to rewire a microbe to grow into branched fractal patterns similar to those of trees and coral. We will use *Saccharomyces Cerevisiae*, a non-toxic, unicellular microbe that you and I know as yeast. This species of yeast is humankind's most valuable microbe and is used extensively in biotech research, biofuel production and importantly has been key to the production of foods and drinks we have all taken for granted for thousands of years. Yeast normally grows as single cells in liquids, or as crowded colonies on solids, but it also has a dormant capability to coordinate growth in multicellular ways, forming structures known as flocs, filaments and films in response to stresses or genetic mutations. To reprogram yeast to grow in fractal patterns, our approach will be to re-awaken the dormant genes that control the formation of these yeast structures and control these genes using synthetic regulators that we can easily wire into novel networks. We will use mathematical modelling to aid our design and understanding of cells growing in fractals and ideally this will allow us to fine-tune the patterns that emerge.

In response to certain stresses or mutations, yeasts can grow in a variety of intricate structures and patterns. Image © Felice Frankel (www.felicefrankel.com).

Why do this? Well for a start, it's interesting. Controlling multicellular behaviour of unicellular microbes will give us insights into how multicellularity arises to produce tissues, organs and organisms. It will also allow us to produce fascinating microstructures of human-designed fractals that will challenge where science ends and art and design begins. Finally, it offers a unique way to control the surface area of yeast cells, an important property for their metabolism. Inspired by trees, lungs, coral and broccoli we hope to make yeast fractal patterns that allow us to tune respiration for many future biotechnology applications.

Dr Thomas Ellis
Imperial College London

Fern leaves are a natural example of a fractal containing a self-repeating pattern working on multiple scales.

Saccharomyces Cerevisiae *yeast that are grown on a solid food source typically grow as densely crowded 'colonies' of individual cells.*

Fashionable diseases

'I look pale. I should like to die of a consumption.' 'Why?' asked his [Byron's] guest. 'Because the ladies would all say, Look at that poor Byron, how interesting he looks in dying.'

Fashionable Diseases: Medicine, Literature and Culture, c. 1660-1832 promises to deliver a new, more comprehensive understanding of how diseases came to be regarded as fashionable in the 18th century and how those in our own time compare with that period. Conditions such as melancholy, consumption (tuberculosis, famously associated with the poet John Keats), indigestion, dyspepsia and gout, were paradoxically invested with a positive cultural cachet, yet often these same diseases might be regarded as fashionable in a negative manner, eliciting charges of fakery and attracting stigma rather than admiration.

The period of the long 18th century, which affords the research project its distinctive frame, was a critical one both in the development of British culture and in the history of medicine. Witnessing an emerging culture of medical consumption (including tourism) and a medical market notable for its similarities with today's medical and pharmaceutical consumerism, the period was one in which the phenomenon of fashionable diseases was to take root principally in society's upper orders.

Yet, the relevance and appeal, as well as the more ambiguous and negative meanings of fashionable diseases, also appear to have been significantly transmitted to a widening middling class, and even to the lower middling orders. The diffusion of fashionable diseases was enabled by the shifting social, economic and scientific conditions of the period, and a rich diversity of literary traditions and myths which provided a set of cultural 'templates' according to which people could understand and even experience their disease. Alongside religion, politics, and changing gender and class roles, creative literature was an important factor in the apparent rise of fashionable diseases.

This project addresses a cultural and medical phenomenon that is still little understood, particularly in its historical dimensions. No major project has yet answered the question of how fashionable diseases come to be formed, maintained and removed from history. Part of the originality of this investigation lies in its interdisciplinarity, its use of literary as well as medical sources in order to reveal the workings of fashionable disease. As well as examining the critical period of the long 18th century, we will break new ground in actively seeking to extend analysis to a comparison with fashionable diseases of our own times. 'Thinspiration' websites, for example, praise anorexia and glorify celebrities who conform to a body image where dieting has become a disease.

Portrait of romantic poet John Keats (1795-1821), August 1819.

The project also asks the related questions: do we create diseases suitable for our particular historical period and particular social groups? Do fashionable diseases have certain symptoms that make them more relevant to some times than others? How do fashionable diseases interact with each other? By better understanding how fashionable diseases work in history, we might be able to manage their definition, treatment and diagnosis better in our own period.

Dr Clark Lawlor
Northumbria University

Investigating biogeochemical evidence for chemosymbiosis at fossil cold seeps

Cold seeps are sites in the ocean where fluids rich in methane or other hydrocarbons seep onto the seafloor and fuel a series of biogeochemical reactions. One of the most intriguing features of the cold seep environment is the occurrence of dense animal communities in areas of the deep sea where animals are normally rare because of scarce food resources. However, unlike most marine life, which is part of an ecosystem based on photosynthesis, many cold seep animals depend on the highly unusual nutritional strategy of chemosymbiosis. This means that they live in symbiosis with bacteria that obtain energy for carbon fixation by oxidising compounds derived from the seep fluid (chemosynthesis).

Modern cold seep communities are populated mainly by chemosymbiotic tubeworms, mussels, clams and other bivalves, together with some non-chemosymbiotic species that consume organic detritus. Cold seep mussels can live in symbiosis with methane-oxidising (methanotrophic) or sulphide-oxidising (thiotrophic) bacteria, or both, whereas clams and other bivalves contain thiotrophic symbionts only. This difference in symbiont-type has been shown to correspond to differences in the carbon and sulphur stable isotope composition of the animals' body tissues. In modern animals, carbon and sulphur stable isotope values can be used to distinguish between chemosymbiotic and non-chemosymbiotic animals, and between methanotrophic and thiotrophic chemosymbiosis.

Since the discovery of the first cold seeps, many fossil accumulations of previously uncertain origin have been identified as ancient cold seep communities. For the past 65 million years, cold seeps have been populated mainly by bivalves from groups with modern chemosymbiotic seep representatives. Older seep ecosystems also contained bivalves from now-extinct groups, as well as rhynchonellid brachiopods (another type of two-shelled marine animal physiologically distinct from bivalves), whose relatives are still alive today but do not live at modern seeps. Fossils with modern chemosymbiotic relatives are assumed to be chemosymbiotic, but whether older seep animals were also chemosymbiotic is currently unknown. The aim of this project is to investigate chemical evidence for chemosymbiosis in seep fossils, in order to better understand the biochemistry of extinct seep animals.

Clam from New Zealand – modern relatives have thiotrophic symbionts.

Chemosymbiosis has been extensively studied in modern seep animals but most of the methods used cannot be applied to fossil specimens. However, the shells of bivalves and rhynchonelliform brachiopods are formed of calcium carbonate minerals crystallised within and around an organic, protein-rich framework, which can form up to 5% of the shell by weight. This organic component of shells, or 'shell-bound organic matter' (SOM) is secreted by the soft tissues of the animal and therefore can be expected to have similar stable isotope values. This has been confirmed in a small number of non-seep bivalve species, and previous research has demonstrated that SOM can be preserved in fossil shells, providing a record of soft tissue isotopic composition that persists even when no soft tissues are preserved. Analysis of the carbon and sulphur stable isotope composition of SOM preserved in cold seep fossil shells therefore has the potential to reveal methanotrophic and thiotrophic chemosymbiosis in extinct animals.

Dr Fiona Gill
University of Leeds

Grants awarded by the Board at their June 2012 meeting

Research Programme Grants

Dr Sarah Bracking *University of Manchester*	Human, non-human and environmental value systems: an impossible frontier?	£587,269
Professor Sir Richard Evans *University of Cambridge*	Conspiracy and democracy: history, political theory and internet research	£1,584,611
Professor Graham Loomes *University of Warwick*	Risk, time and society: the behavioural economics of value	£902,875

Research Project Grants

Sciences

Dr Suzanne Aigrain *University of Oxford*	A robust toolbox for exoplanet data analysis	£219,278
Dr Alexandre Anesio *University of Bristol*	Are viruses major ecological and evolutionary drivers of microbial community change in low temperature habitats?	£158,083
Dr Heike Arnolds *University of Liverpool*	Ultrafast spectroscopy of molecular electronic junctions	£102,813
Professor Alison Baker *University of Leeds*	Synthetic organelles: manipulating peroxisome protein import to create designer compartments	£225,906
Professor Isabel Bermudez *Oxford Brookes University*	Characterising the functional spectrum of the mosquito GABA receptor	£153,275
Dr Jan-Willem Bos *Heriot-Watt University*	Reduced titanium and niobium oxide thermoelectrics	£145,784
Dr Will Branford *Imperial College London*	Imaging low temperature phases in artificial spin ice	£223,471
Professor Zdzislaw Brzezniak *University of York*	Quasi-geostrophic and related stochastic partial differential equations	£93,155
Dr Colin Campbell *University of Edinburgh*	Mapping local steady state redox potentials with subcellular resolution	£243,900
Dr John Carr *University of Cambridge*	Payback: do plant viruses compensate their hosts by helping attract pollinators?	£241,544
Dr Alfonso De Simone *Imperial College London*	Combining carbon-detected NMR and simulations to study intractable proteins	£176,847
Professor Jens Eggers *University of Bristol*	Geometrical description of free-surface singularities and cusp universality	£141,437
Dr Thomas Ellis *Imperial College London*	Organised natural structures using synthetic biology	£78,215
Dr Matt Friedman *University of Oxford*	Reconciling ichthyology and palaeontology with exceptionally preserved fossils	£212,663
Dr Matthew Fuchter *Imperial College London*	Asymmetric photochemical synthesis with circularly polarised light	£110,609
Dr Todor Gerdjikov *University of Leicester*	Optogenetic analysis of reward mechanisms in the brain: contributions of the PPN – VTA circuit	£82,067
Dr Fiona Gill *University of Leeds*	Investigating biogeochemical evidence for chemosymbiosis at fossil cold seeps	£85,002
Professor Gerard Gilmore *University of Cambridge*	The Gaia-ESO survey: quantifying the formation and evolution of the Milky Way	£262,680
Dr Jelena Grbic *University of Manchester*	The homotopy theory of toric spaces	£219,633
Dr Chris Greenwell *Durham University*	Archean earth peptide formation: setting geochemical constraints on the origin of proteins	£240,015
Dr Robert Harrison *Liverpool School of Tropical Medicine*	Has defence dictated the evolution of venom composition in spitting cobras?	£209,171
Dr Natalie Hempel de Ibarra *University of Exeter*	How insects learn: the fixed and variable components of bumblebee learning flights	£237,467
Dr Katharine Hendry *Cardiff University*	Southern Ocean sponges: the link between biogeography and geochemistry	£75,142
Dr Mikko Juusola *University of Sheffield*	From wiring to brain function in *Drosophila*; the role of intrinsic activity	£236,734
Dr Malcolm Kadodwala *University of Glasgow*	Ultrasensitive characterisation of biological structure with supertwisted light	£162,255

Dr Heather Knight *Durham University*	Control of specificity in gene expression	£172,188
Dr Sylvain Ladame *Imperial College London*	G-quadruplexes in gene promoters and untranslated regions: myth or reality?	£174,974
Professor Peter Meyer *University of Leeds*	Dissecting an ancient, but hitherto cryptic function of DNA methyltransferases	£101,765
Professor William Motherwell *University College London*	Studies of non-covalent interactions of functional groups with π systems	£155,648
Dr Neil Oldham *University of Nottingham*	Trans-polyketide synthases and their products: making the connection	£153,221
Dr Iain Oswald *University of Strathclyde*	Pressure-induced synthesis of doped polymers – a greener route to functional polymers	£159,982
Dr Mark Paine *Liverpool School of Tropical Medicine*	Molecular characterisation of *Anopheles gambiae* heme oxygenase	£205,361
Dr Rosie Parnell *University of Sheffield*	Children transforming spatial design: creative encounters with children	£231,059
Professor Roy Quinlan *Durham University*	Development of a multiscale model of the eye lens to inform evolution and tissue morphogenesis	£251,138
Professor David Ritchie *University of Cambridge*	Developing thermodynamic probes to study two-dimensional electron systems	£243,523
Dr Jonathan Sadler *University of Birmingham*	Integrating ecology and social science in conservation: orchards, beetles, and agroecology	£256,552
Professor Ekhard Salje *University of Cambridge*	Domain boundaries as active elements in multiferroic materials and in minerals	£90,178
Dr Nadia Sidorova *University College London*	Localisation for branching Bouchaud random walks	£200,253
Dr Radostin Simitev *University of Glasgow*	Two-layer thermo-compositional dynamo models of the geomagnetic field	£147,661
Dr Junwang Tang *University College London*	Feasibility of nanomaterial fabrication by microwave-promoted microreactor	£249,930
Dr Tchavdar Todorov *Queen's University Belfast*	Dynamics of irradiation in materials and biological systems	£88,509
Dr Sophia Tsoka *King's College London*	Community structure detection in complex networks	£185,267
Dr Tobias Uller *University of Oxford*	Epigenetics in context: how ecology shapes the epigenome in wild animals	£107,740
Professor Paul Valdes *University of Bristol*	Assessing the tropical climate over the last glacial/interglacial	£177,357
Dr Darren Walsh *University of Nottingham*	Fuel cells inspired by nature: thin film catalysts from renewable materials	£70,565
Dr Jonathan Wilden *University College London*	Development of novel sulfonamide-based peptidomimetics	£78,170
Dr Gregory Wildgoose *University of East Anglia*	Calixarene-modified electrodes: enzyme mimics for heterogeneous chiral synthesis	£80,063
Dr James Wilton-Ely *Imperial College London*	Gold nanoparticles functionalised with transition metal units	£74,545
Dr Shengfu Yang *University of Leicester*	Synthesis of neutral helium compounds in superfluid helium nanodroplets	£132,980
Professor Jamie Davies *University of Edinburgh*	Building a synthetic cell patterning mechanism to test a biological model	£238,569

Humanities

Dr Tim Ayers *University of York*	The building accounts for St Stephen's Chapel, Palace of Westminster, 1292-1366	£118,832
Dr Pratik Chakrabarti *University of Kent*	An antique land; geology, philology and the making of the Indian subcontinent, 1830-1920	£221,439
Dr Cecile De Cat *University of Leeds*	Referential communication and executive function skills in bilingual children	£161,284
Dr Peter Flugel *School of Oriental and African Studies*	Johannes Klatt's Jaina-onomasticon	£245,160
Professor Edith May Hall *Royal Holloway, University of London*	Classics and class in Britain, 1789-1917	£226,533
Dr Clark Lawlor *Northumbria University*	Fashionable diseases: medicine, literature and culture, ca. 1660-1832	£259,193
Dr Jeff Oliver *University of Aberdeen*	European migrant landscapes and intercultural relations in western Canada	£159,367

Dr Kasia Szpakowska *Swansea University*	Ancient Egyptian demonology project: second millennium BCE	£158,220
Professor Martin Thomas *University of Exeter*	The rhetoric of empire: managing imperial conflict between Britain and France	£148,566
Professor Janet Watson *University of Salford*	Documentation and ethnolinguistic analysis of the modern South Arabian languages	£149,680

Social Sciencies

Dr Shira Elqayam *De Montfort University*	Generative capacity of norms: a theory of inference from 'is' to 'ought'	£75,450
Professor John Gaffney *Aston University*	The nature and process of the construction of contemporary leadership discourse and persona	£77,055
Professor Christopher Harding *Aberystwyth University*	Explaining and understanding business cartel collusion	£87,743
Dr Patricia Justino *Institute of Development Studies*	Community cooperation in post-conflict Bosnia: coping strategies and violence	£64,635
Dr Kimberly Quinn *University of Birmingham*	Witnessing virtue versus vice: comparing moral praise and moral condemnation	£78,297
Dr Susie Scott *University of Sussex*	A qualitative exploration of asexual identities and practices of intimacy	£103,782

International Networks

Sciences

Dr Michael Rogerson *University of Hull*	A new speleothem-based record of past rainfall changes in central North Africa	£43,153
Professor Luca Susmel *University of Sheffield*	Multiaxial fatigue assessment of aluminium friction stir welded joints	£125,000
Professor John Derek Woollins *University of St Andrews*	Chalcogen-nitrogen compounds for electronics and spintronics	£85,946

Humanities

Professor Hartmut Behr *Newcastle University*	Critical theory meets classical realism: crisis, modernity, and the return of humanity	£97,888
Ms Daria Martin *University of Oxford*	Mirror touch: film and mirror-touch synaesthesia: symposium, practical workshop	£59,948
Dr Sarah Turner *University of York*	Enchanted modernities: theosophy, modernism and the arts, c. 1875-1960	£124,356

Social Sciences

Professor Alistair Cole *Cardiff University*	Territorial governance in Western Europe: between capacity and convergence?	£74,285
Dr Jessica Woodhams *University of Birmingham*	Detecting serial offenders: C-LINK (Crime Linkage International NetworK)	£79,456

Artists in Residence

Dr Dorothy Buck *Mathematics, Imperial College London*	Ms Gemma Anderson Printmaking	£15,000
Dr John Lees *Physics and Astronomy, University of Leicester*	Mr Andrew Williams Multimedia	£15,000
Dr Alex Murdoch *School of History, Classics & Archaeology, University of Edinburgh*	Ms Catriona Taylor Installation	£14,500
Professor Ben Quash *Department of Theology and Religious Studies, King's College London*	Mr Michael Takeo Magruder Visual art	£15,000
Professor Roey Sweet *Centre for Urban History, University of Leicester*	Ms Sarah Kirby Printmaking	£14,966
Dr Natalya Vince *School of Languages and Area Studies, University of Portsmouth*	Mr Patrick Altes Visual art	£14,500
Professor Edward Watkins *Mood Disorders Centre, Psychology, University of Exeter*	Mr Daniel Jamieson Playwriting	£12,516

Arts Portfolio

Mr Jeremy Ward *Trinity Laban*	Mentorship Awards for Junior Fellows	£97,500