University of BRISTOL

re:search

University of Bristol • Research Review • Issue 24 • Winter 2010

Saxon tooth-sampling

Ruckus on the reefs

State-of-the-art robotics

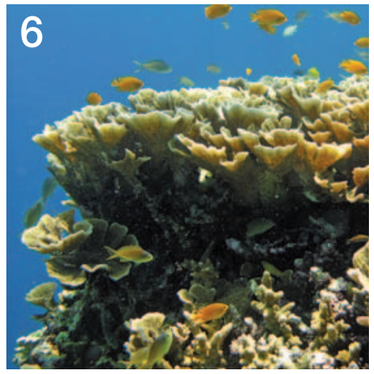
re: search editorial

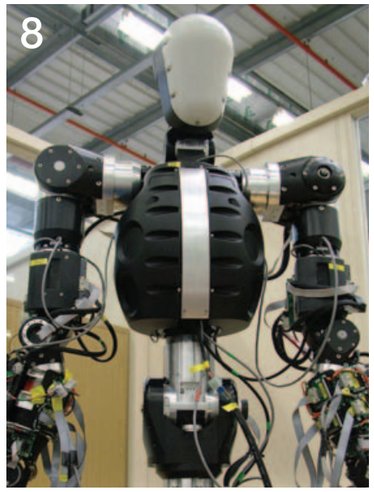
New horizons

Welcome to the 24th – and final – issue of re:*search*. Over the past eight years, the magazine has aimed to bring to life some of the many groundbreaking and exciting areas of research carried out at Bristol. This issue is no exception, covering topics as varied as isotope analysis of Saxon tooth enamel, new methods for tackling poverty in 21st-century Britain and cutting-edge, interdisciplinary robotics research.

We are keen to build on this legacy, as we believe that research can, and should, be accessible to as wide an audience as possible. With this in mind, we will be launching a new publication next year that will continue to cover topical and compelling research stories, as well as highlight some of the other aspects of the University's work and the people behind them.
We hope you enjoy the last issue of re:*search* and the new publication that follows.

David Alder





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Printed on Revive Pure Silk (100% recycled), using vegetable oil-based inks.

Cover image
Noisy damselfish on a reef in Hoga, Sulawesi. Photo by Steve Simpson.

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*re:*search No 24, Winter 2010

DAVE PRATT

Where are all the flowers from?

Amborella trichopoda, the world's most ancient flowering plant, bloomed at the University's Botanic Garden this autumn. The Garden's Director, Professor Simon Hiscock, believes this unusual specimen may hold the key to unravelling Darwin's 'abominable mystery' – the evolutionary origin of flowering plants.

The first flowering plants, or angiosperms, suddenly appeared over 130 million years ago, an event that perplexed Charles Darwin and remains a puzzle even now. Today the closest living relative of these flowers, *Amborella trichopoda*, is confined in the wild to the remote south Pacific island of New Caledonia. In 1999, new DNA evidence revealed that this strange specimen, with its tiny male or female flowers on separate plants, was the most primitive angiosperm alive, rather than the showier Magnolias as previously thought.

Since this revelation, many attempts have been made to collect and grow *Amborella* seeds. Most of these have failed, however, and because the unimpressive flowers have no commercial appeal the horticulture industry has shown no interest in them. Bristol is the only Botanic Garden in the UK, and one of just a handful of gardens worldwide, where *Amborella* has been successfully grown, from seeds collected by Professor Hiscock during a trip to New Caledonia in 2007 with botanists from the University of Lyon, France.

One of the reasons that *Amborella* is so fascinating is that, unlike most angiosperms, the male and female reproductive organs occur on different plants. More than 95% of angiosperms are co-sexual, with both male and female reproductive organs in the same flower. This optmises reproductive efficiency and can allow self-fertilisation in the absence of pollinators. The flowers on co-sexual plants comprise both stamens, the male reproductive organs that produce pollen, and pistils, the female reproductive parts made up of one or more seed-bearing carpels. By contrast, male *Amborella* flowers comprise only stamens, while the females consist of a cluster of carpels, even though the fossil record suggests that *Amborella*'s ancestors were originally co-sexual.

One of Professor Hiscock's collaborators at the University of Lyon, Dr Charlie Scutt, has demonstrated that certain genes involved in carpel development in *Arabidopsis thaliana* – a more recently evolved angiosperm widely used as a model organism in plant biology – play a similar role in *Amborella* flower development. Scutt and others have also shown that during the evolution of the flower these genes were co-opted from leaf development into carpel development, which must have been a critical step in the evolution of the angiosperm flower and its unique female reproductive structure, the carpel.

Using a similar approach, Professor Hiscock intends to use *Amborella* in his own research on reproduction in flowering plants to determine whether genes found in *Amborella* pollen and pistil are similar to those identified in *Arabidopsis*. This will provide important new insights into the evolution of the pollen–pistil interaction – a reproductive mechanism unique to angiosperms. ■

www.bristol.ac.uk/Depts/BotanicGardens

JAMIE CARSTAIRS

Male Amborella flowers.

JAMIE CARSTAIRS

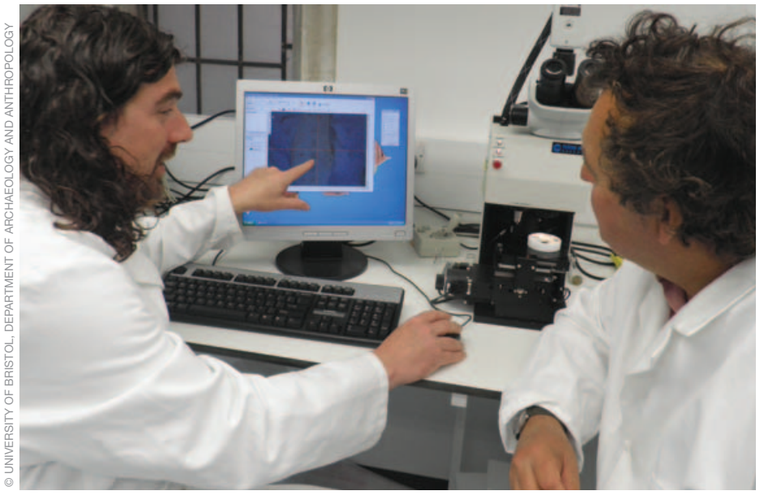
Female Amborella flowers.

One of the reasons that Amborella is so fascinating is that, unlike most angio-sperms, the male and female reproductive organs occur on different plants

Identifying Eadgyth

Below: One of Eadgyth's teeth surrounded by synthetic material for preparation of a thin section for age determination (Professor Alt's team, Histological Laboratory, Institute of Anthropology, University of Mainz)

Right: Dr Alistair Pike (left) and Professor Mark Horton during the isotope analysis in the laboratories at Bristol University



© UNIVERSITY OF BRISTOL, DEPARTMENT OF ARCHAEOLOGY AND ANTHROPOLOGY

When German archaeologists discovered bones in the tomb of Queen Eadgyth in Magdeburg Cathedral, they looked to Bristol to provide the crucial scientific evidence that the remains were indeed those of the English royal. Dr Alistair Pike in the Department of Archaeology and Anthropology tells Hannah Johnson how tiny samples of tooth enamel proved the identity of a Saxon queen.

Teeth provide remarkable evidence about the early years of an individual's life. The region where a person grew up can be traced in the tooth enamel laid down in their first 14 years because strontium and oxygen isotope ratios in the teeth reflect the food a person ate and the water they drank.

When rocks form, they contain minute traces of radioactive rubidium 87, which decays to strontium 87. Over millions of years, the ratio of strontium 87 to the stable isotope strontium 86 changes, so, in very young rocks, the ratio will be smaller than in very old rocks.

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These rocks weather and become the soils where animals are grazed and crops grown. Some of the strontium in the soil gets into the meat and cereals produced from it and then into the teeth of the people who eat them. The strontium ratio in a person's teeth thus mirrors the strontium ratio of the geology of the area in which they spent their childhood. For example, someone who grew up in southern England would have a much lower ratio than someone from the Highlands of Scotland where the rocks are much older.

The Magdeburg remains

Archaeologists at the University of Mainz took a few average values of the strontium isotopes in teeth found in Eadgyth's tomb and compared them with those of other Magdeburg burials. The isotope ratios were completely different, thus indicating that the 'Eadgyth' teeth did not belong to someone who grew up in the area. To discover where exactly the individual came from, however, the German team needed to call on the expertise of Dr Alistair Pike and his colleagues at Bristol.

To be able to tell in such detail what people were doing from year to year isn't just remarkable, it's a revolution

The rainfall of the area is also echoed in tooth enamel. Water contains oxygen isotopes with different masses and the lighter (oxygen 16) isotopes evaporate before the heavier (oxygen 18) ones. This means that when the sun shines on the ocean and creates clouds, those clouds have more oxygen 16 than the ocean does. However, when the clouds fall as rain, the heavier, oxygen 18 isotopes fall first.

Thus, in the case of Northern Europe where most of the rainwater is evaporated from the Atlantic and blown across the continent in a westerly direction, the rain with more of the heavier oxygen 18 isotopes falls in Ireland. The amount of oxygen 18 in the rain gradually decreases as the weather system moves across Europe, so the drinking water of someone who spent their early life on, say, the west coast of Spain has a different ratio of oxygen 16 and 18 than that of someone who was a child in Central Europe. These different ratios are also preserved in their tooth enamel.

Over the past three years, Dr Pike has been perfecting a new micro-sampling technique which involves using a laser to take tiny samples from along the growth axis of a tooth. As tooth enamel is formed incrementally from the crown, a series of isotopes representing every year, every month – and possibly even every week – of a person's life is laid down layer by layer in the enamel. Using the laser allows for up to 2,000 measurements to be taken from a single tooth (earlier techniques allowed only four or five), thus creating a highly detailed picture of an individual's movements throughout the first 14 years of life.

The isotope values taken from the 'Eadgyth' teeth were compared with those on the Natural Environment Research Council's geological map of strontium ratios across Great Britain and the British Geological Survey's map of oxygen isotope values for European drinking water. Combining the results pinpointed the chalk regions of southern England as the place where the individual grew up, thus indicating that she was indeed the Wessex-born Eadgyth.

The truly remarkable discovery, however, was that these isotope results closely mirrored the facts of Eadgyth's childhood and adolescence known from historical records. Variable strontium ratios in the tooth enamel laid down in Eadgyth's early years indicated that, during this period, she lived in a number of different locations. This reflected the fact that, in the first eight years of her life, Eadgyth probably changed her domicile frequently as she moved around the kingdom in the entourage of her father, King Edward the Elder.

The isotope values then became constant, suggesting that, from the age of nine, she stayed in the same place. History records that her parents divorced in 919 when Eadgyth was between nine and ten. She and her mother were banished to a monastery, possibly Winchester or Wilton in Salisbury, where she remained for a number of years.

The isotope revolution

Dr Pike and his team have also used the technique that identified Eadgyth on teeth, both human and animal, from a number of archaeological sites around the world. The remains of cattle from a Neolithic village in the Swiss Alps, fossil orangutans in Borneo, and the 13 victims of a 4,500-year-old, Stone Age massacre buried at Eulau, Germany, have all been analysed – often with unexpected results. For example, the fairly constant isotope values of the orangutans' teeth suggested the animals didn't move from place to place as much as the researchers had assumed.

Isotope analysis allows these remains to 'speak' in ways previously unimagined. In the case of the Eulau burials, it has shown that not only did the women originate in a different region from the men (suggesting either inter-marriage or the forced abduction of women for wives) but also that the closest possible origin was the Harz Mountains more than 50 km away. The variation of the isotopes in the women's teeth also suggests they were from a more mobile society, perhaps one practising pastoralism in the mountains. Combined with other evidence, the isotope values mean archaeologists are coming closer and closer to pinpointing the exact region from which the women came.

To be able to tell in such detail what people and animals were doing from year to year isn't just remarkable, it's a revolution. The science of skeletons is allowing archaeologists to gain information about what happened to people throughout their lives, not just at the time of their deaths. It's like someone discovering a new type of artefact,

Isotopes can speak about our past as eloquently as any axe-head

Dr Pike believes, new objects never seen before. These 'objects' happen to be isotopes but, thanks to cutting-edge science, they can speak about our past as eloquently as any axe-head or bowl or pottery shard. ■

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ENGLISH PRINCESS, GERMAN QUEEN

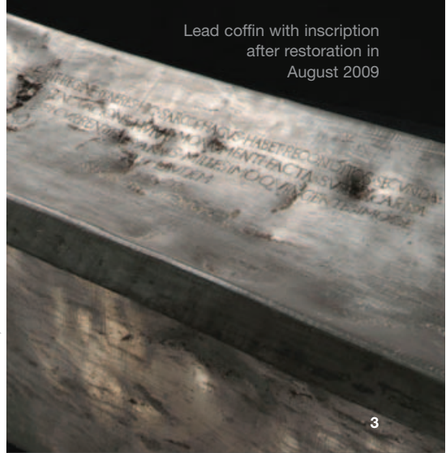
Eadgyth was the granddaughter of Alfred the Great and the half-sister of Athelstan, the first acknowledged King of England. She was sent to marry Otto, King of Saxony, in AD 929, and bore him at least two children, before her death, at around the age of 36, in AD 946. Buried in the monastery of St Maurice in Magdeburg, historical records state that her bones were moved on at least three occasions before being interred in an elaborate tomb in Magdeburg Cathedral in 1510.
It was long assumed that this tomb was empty, so, when German archaeologists opened it in 2008 as part of a wider research project, they were surprised to discover a lead box bearing the inscription 'EDIT REGINE CINERES HIC SARCOPHAGVS HABET…' (The remains of Queen Eadgyth are in this sarcophagus…).

The box contained partial skeletal remains along with textile material and organic residues. However, as medieval bones were moved frequently and often mixed up, the archaeologists needed to conduct a number of scientific tests to determine whether the remains were, indeed, those of Eadgyth.

Anthropological study carried out at the University of Mainz confirmed that they belonged to a single female individual who was between 30 and 40 years old when she died. One of the femur heads showed evidence that the individual was a frequent horse rider, thus hinting at nobility, and isotope analysis suggested that she enjoyed a high-protein diet, including a large quantity of fish, which would also indicate a high-status aristocratic lady.

Dating of the associated textiles in the lead box produced the correct range of dates for Eadgyth, but it remained for Dr Pike and his team to provide the key evidence to show that the bones were indeed those of Eadgyth and thus the oldest surviving remains of an English royal burial.

Lead coffin with inscription after restoration in August 2009



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May 2010 saw the launch of the largest-ever research project on Poverty and Social Exclusion in the UK. Professor David Gordon, Director of the Townsend Centre for International Poverty Research, describes the scope and background of this new study, which it is hoped will make a major contribution to tackling the problems of poverty and deprivation in 21st-century Britain.

Getting the measure of poverty

Many of the world's most important issues – for example, climate change, immigration and the best way to raise children – are rife with controversy and disagreement. However, there is virtual unanimity among politicians and the public about poverty and its effects. All politicians, from the far left to the far right, argue that poverty and exclusion are 'bad' and something should be done about them. In this sense, poverty is not a political issue: I have never heard any politician argue that poverty is 'good' and what we need are more poor people! The disagreement is not about the aim of reducing poverty and social exclusion, but about the best way to achieve it.

Where aims are not shared, science is of little use for policy-making. For example, scientific evidence is not very important in the debate on fox hunting because that is dominated by differences in values and beliefs. But when political parties and the public all share the same aims, then social scientists can play an important role by providing high-quality evidence about what works, in order to assist policy-makers in creating evidence-based legislation.

Just before the General Election, the Child Poverty Act (2010) was passed by Parliament with all-party support. This Act writes into law the policy commitment to eradicate child poverty in the UK by 2020. High-quality research that accurately measures poverty and social exclusion is crucial in order to evaluate whether policies are working effectively and targeted correctly so that resources are not wasted. The new survey can thus help the UK Government, and the governments of the devolved national assemblies, to achieve this ambitious goal.

For our new research, two-stage quantitative methodology will be used in both Britain and Northern Ireland: a smaller 'attitudes' survey followed by a larger main stage survey of Poverty and Social Exclusion. The main survey will over-sample the 'poor' (ie those whose circumstances feature a low income and material deprivation), ethnic minority groups, and respondents in Scotland and Northern Ireland.

This quantitative approach will be complemented by a smaller, qualitative survey involving 72 people. This will explore the 'life stories' of people experiencing poverty, in order to understand poverty persistence and the significance of key 'life events' in shaping circumstances and prospects. In Northern Ireland, a qualitative survey of around 100 people will focus on the role of family in coping with poverty. This difference in emphasis reflects the social divisions in Northern Ireland, which has led to a greater degree of reliance on family there than elsewhere. Northern Ireland therefore presents a unique opportunity to explore the continuing role of family in the transmission of poverty and in coping with it.

THE NEW POVERTY AND SOCIAL EXCLUSION SURVEY

Funder: The Economic and Social Research Council.

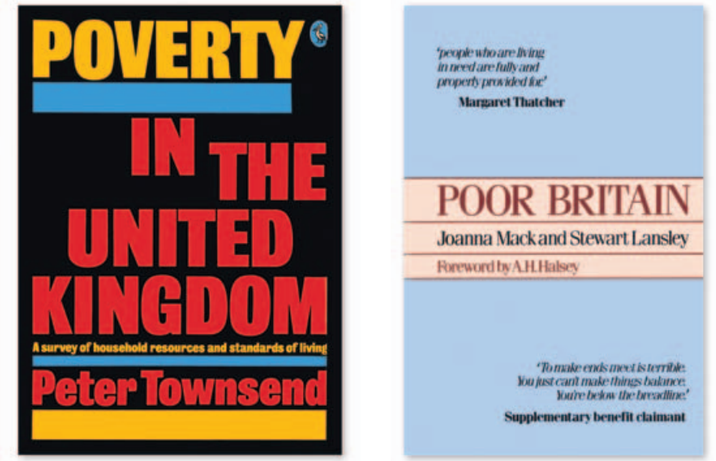
Principal investigator: Professor David Gordon.

Collaborating institutions: University of Bristol, Heriot-Watt University, the National Centre for Social Research, Northern Ireland Statistics and Research Agency, The Open University, Queen's University Belfast, University of Glasgow and the University of York.

Duration: Three-and-a-half years.

Main aims:
- Improve the measurement of poverty, deprivation, social exclusion and standard of living.
- Measure the change in the nature and extent of poverty and social exclusion over the past ten years.
- Produce policy-relevant results about the causes and outcomes of poverty and social exclusion and consider how best to address these problems.

Every decade or so since the late 1960s, when the late Professor Peter Townsend developed and led the groundbreaking 1968-69 Poverty in the UK survey, members of the Poverty and Social Exclusion in the UK team have carried out an independent poverty survey to test new ideas and incorporate current methods into poverty research. These surveys introduced new ideas and methods of poverty measurement by combining indicators of low income with those of material and social deprivation, and helped to keep UK academic research at the forefront of poverty measurement methodology.



Above: The original 1969 report, *Poverty in the UK* (Peter Townsend and colleagues), and one of its successors, the 1983 *Poor Britain* report (Joanna Mack, Stewart Lansley and colleagues).

High-quality research that accurately measures poverty and social exclusion is crucial in order to evaluate whether policies are working effectively and targeted correctly so that resources are not wasted

Definitions of poverty change over time, as do public attitudes to it and government strategies for tackling it. These regular surveys provide a detailed snapshot of the stages of evolution they capture. The new Poverty and Social Exclusion survey should provide the most comprehensive picture so far. Information gleaned from the project will be used to address basic issues of methodology – such as how poverty and deprivation are currently 'officially' measured in the UK and the EU, and how these criteria could be broadened – as well as the dynamics of deprivation and the effects of poverty and social exclusion on all areas of UK society.

This will have enormous relevance for policy-makers, since the impact areas covered include health, housing, employment, crime and education. In Scotland, the study will provide policy-makers with greater understanding of the extent of poverty and social exclusion amongst those people included in the new 'Solidarity' target measure (ie the 30 per cent of the Scottish population with the lowest household income).

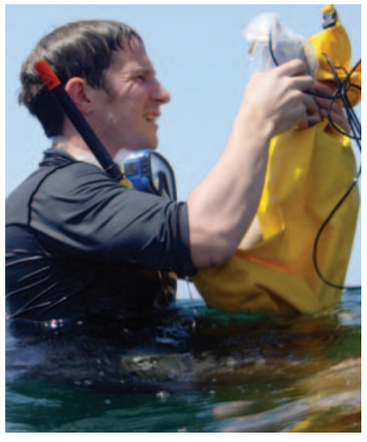
The scale of government debt that resulted from the global recession has only become more apparent since this survey was launched. Large cuts in government spending have already been announced, and more will follow over the next few years, making increases in unemployment, poverty and social exclusion almost inevitable. It is therefore more crucial than ever that high-quality scientific evidence is made widely available to inform the public and the policy-makers about the effectiveness of policies intended to reduce poverty and exclusion. ■

www.bristol.ac.uk/sps

For further details see the project's website: www.poverty.ac.uk

ADVENTURES IN A SEA OF NOISE

STEVE SIMPSON



JEN MCILWAIN

In 1953, Captain Jacques-Yves Cousteau published his groundbreaking book *The Silent World*, which has since sold five million copies and captured the imagination of generations of armchair adventurers. While breathtaking in its pioneering approach and imagery, it fell short on one minor detail: the underwater world is anything but silent.

Dr Steve Simpson in the School of Biological Sciences, currently working on the effects of climate change on fish and fisheries, has spent much of the past decade studying the natural sounds produced by fish, shrimps and urchins on coral reefs.

'Coral reefs produce truly amazing soundscapes,' he says. 'Snapping shrimps generate a constant crackling sound – which mariners often liken to that of frying bacon – that vibrates through the hull of a boat when anchored near to reefs. On top of this, fish talk to each other with a whole array of pops, grunts and chirps, and urchins scrape away at the reef to feed. Taken together, this sound is immense, and can be detected using a hydrophone (underwater microphone) from kilometres away.'

Fish talk to each other with a whole array of pops, grunts and chirps, and urchins scrape away at the reef to feed

During his PhD, Simpson realised that the models of dispersal of coral reef fish used to test fisheries management strategies lacked some basic biology. Coral reef fish undergo an early phase of their life in the open ocean, away from the predators on the reef, where they develop from eggs to fully functioning larvae. During this period, which can last from weeks to months, fish may be dispersed up to thousands of kilometres, although amazingly, many return to the reef on which they were originally spawned. The models of the time failed to capture any of this.

Through a series of experiments, Simpson has found that reef fish larvae are highly attracted to the reef noises at the time they are ready to seek adult habitat. 'We started by making recordings of reefs and playing them back around traps,' he explains. 'We caught more than twice as many larvae in the noisy traps as we did in traps where we played no recordings. Then we built artificial reefs and used recordings to attract larvae to recruit to these new sites.' This work was published in *Science* in 2005, and is now being used in the Philippines and French Polynesia as part of trials for managing fish populations.

More recently, Simpson and his students have turned their focus to variations in reef noise in different locations. He explains: 'Since reef noise is produced by the animals that reside there, it offers fish, and marine biologists, an opportunity to eavesdrop on the community. The fish can use it to select the best habitat to live in; for biologists and fisheries managers it provides a totally new tool for monitoring the health of the community.' In a study published this year in the *Journal of Experimental Marine Biology and Ecology*, Simpson and his team found that 'noisier' reefs in Panama had more fish and greater proportions of live coral than 'quieter' ones in the same region. This autumn, a recent Bristol Masters graduate, Sophie Holles, is building on this research by cruising around French Polynesia recording reefs and surveying fish communities and habitat.

Fish have a highly specialised auditory system, so perhaps it's not so surprising that larval coral reef fish use these sensitive hearing capabilities to exploit a reef's rich acoustic cues and steer towards habitat from the open ocean. In contrast, the larvae of corals appear to be little more than a bag of cells, developing for a few days in open water before hoping to land on a hard spot to start building their skeleton and, ultimately, a colony. But recent work by Simpson and his collaborators in Curaçao (published in the interactive open-access journal *PLoS ONE*) shows that coral larvae are also attracted by reef noise.

'At first I thought that playing sounds to coral larvae was crazy,' says Simpson, 'but it soon became clear that these simple animals were moving towards the noise.' Simpson is now developing methods with a bioacoustician (Dr Marc Holderied), an animal behaviourist (Dr Andy Radford) and a nanoscientist (Professor Daniel Robert), all in the School of Biological Sciences, to use lasers to measure the vibrations of tiny hair cells on the surface of the coral larva in response to sound. As Simpson explains: 'We have hair cells inside our ears; coral larvae have them on their outer surface. It is possible that coral larvae are actually inside-out ears, swimming around looking for a good spot to land.'

Unfortunately the underwater acoustic world is now a very different place to that of a century ago. Man-made (or anthropogenic) noise pollution is currently doubling every decade, and a low-frequency hum from shipping can be detected in every ocean. Additionally, the noise of pile-driving and operational turbines from offshore windfarms has caught the attention of policy-makers and conservationists, and the pulses from seismic airguns – used in the search for oil – and naval sonar activities have been implicated in mass strandings of whales and dolphins. In a further study published this year in *Behavioral Ecology*, Simpson showed that the larvae of coral reef fish, when exposed to man-made noise for a few hours, can later become attracted to it. 'This would be bad news for fish,' he points out, 'if they follow ships out of harbours or try to set up home in industrial areas rich in noise but poor in natural resources.'

In collaboration with Drs Radford and Holderied in the School of Biological Sciences, and with funding from Defra, Simpson is now investigating the chronic effects of anthropogenic noise on UK marine animals. He explains: 'By combining hearing studies and behavioural experiments with measurements and models of soundscapes, we hope to estimate the distances over which animals are affected. This will help policy-makers determine how best to mitigate the effects of noisy activities in UK waters, and hopefully ensure a productive, healthy, and very naturally noisy future for the marine environment.' ■

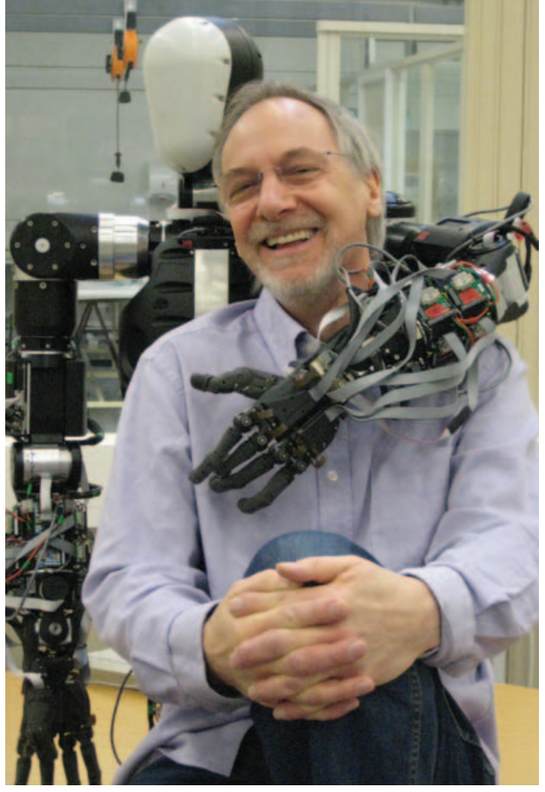
www.bristol.ac.uk/biology

The underwater acoustic world is now a very different place to that of a century ago. Man-made noise pollution is currently doubling every decade, and a low-frequency hum from shipping can be detected in every ocean

Above left: Tropical reefscapes in Hoga, Sulawesi.
Left: Steve Simpson taking a recording of a reef in Southern Oman.
Below left: Clownfish in Oman.
Below: Underwater acoustic recorder.

STEVE SIMPSON

STEVE SIMPSON



Professor Chris Melhuish, director of BRL, with robot Bert.

Welcome to the future

Imagine a robot in your home doing the dishes, while safely interacting with you and reacting naturally to your mood. Imagine a gardener robot that can charge itself by converting compost or waste water into electricity. Imagine touching and feeling a simulated liver for medical diagnosis. Sounds like science fiction? Well, according to scientists at the Bristol Robotics Laboratory (BRL), this is where we are heading.

BRL – a research partnership between the University of Bristol and the University of the West of England – is the biggest robotics laboratory in the UK. 'Robotics today is all about interdisciplinary solutions requiring multidisciplinary expertise,' explains Professor Chris Melhuish, director of BRL. According to BRL philosophy, state-of-the art robotics must exploit new materials such as artificial muscles and figure out how to best control them. This can only be done with various disciplines working together.

To this end, Melhuish brought together a number of experts from various fields – cognitive behaviour, microbiology, computer science, physics, biology, neuroscience and electrical, mechanical and aerospace engineering – and put them all under one roof. As a consequence, BRL, which opened in 2006, has fast become a 'one-stop research shop for robotics, where everything you need for an application is available in one place. This is the only way outstanding robotics research can be done. You need to have all these experts available – and Bristol is fortunate to have such broad expertise,' says Melhuish.

This open-minded and interdisciplinary attitude is also reflected in the architecture of the lab, which is divided into open workspaces, separated by glass walls. In one corner a robot arm is moving up and down, not far away a robot rat is being put through its paces, and in another corner the robot Bert is practising speech. For Adam Spiers, one of Melhuish's PhD students, the lab is a great place to work because 'through its openness you can always get inspiration, in case you run out of ideas'.

One successful example of this interdisciplinary approach is the SCRATCHbot – a robot rat. Working with neuroscientists, BRL researchers have created a neural architecture in silicon based on a rat's brain, in order to control this robot. Just like a rat, it seeks out and identifies objects using its whiskers. In the next step researchers will develop a new sensor, which will then be used in an autonomous, shrew-like, whiskered robot that will enable it to track fast-moving objects, the idea behind this being to gain more insight into the brain. Researchers hope that by designing such innovative artificial touch technologies for robots they will be able to understand how the brain controls the movement of the sensory systems.

State-of-the art robotics must exploit new materials such as artificial muscles and figure out how to best control them

Without having to think about it, humans naturally use the most effective and energy-saving way of carrying out an action; thus a research team at BRL developed control mechanisms for human-like movements of a robot's arm. 'In industry, robots are programmed to go to a certain point. Our robot also has to do the same, but it will do so in a human-like way and without programming. It is able to think through the position of its hand,' explains Adam Spiers.

The link between humans and robots is another important aspect of BRL's research. How can humans and robots work together in an easy, comfortable and, importantly, safe way? Here the emphasis is on cognitive models providing 'behavioural safety'. This means that if a robot is aware of its environment and can learn from it, the interaction can take part at a safer level because the robot platform is capable of controlled intelligent movements and its actions are largely predictable and understandable by humans.

Safe human–robot interaction is also the starting-point of the project CHRIS (Cooperative Human Robot Interactive Systems), which is funded by the European Commission. If a human and a robot perform co-operative tasks in a co-located space, such as in the kitchen, how can this be made more secure in terms of verbal and non-verbal communication, perception and understanding of intention? In other words, how can a common goal such as robots and humans cooking something together be reached?

How can a common goal such as robots and humans cooking something together be reached?

'When humans interact with others a lot of non-verbal as well as verbal communication is constantly happening: facial expression, body position, gestures, tone of voice and goal-sharing, as well as understanding and following instructions. We interpret these constantly, but unless they are missing, you never even think about them,' explains Melhuish. Future robots will thus need a higher level of sophistication to meet these demands. This can be achieved through engineering the robot and its 'thinking' (cognition) so that it can perform physical tasks which involve real-world interactions.

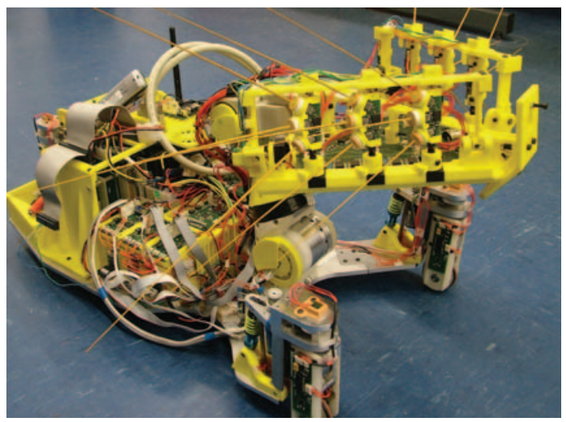
'Although humans find these interactions very simple to achieve, getting a machine to do it is proving very difficult. But if we can accomplish this one day, service robots could become a part of our society,' says Melhuish. To help achieve this, researchers at BRL also use robot heads, Jules and Eve, to explore facial expressions. These robots can copy human facial expressions. The overall goal is to build a new robot that will include many elements: gesturing, facial expression, non-language utterances like gaze, body language and, of course, speech.

Biologically inspired projects (taking models from natural systems – not necessarily humans – and from those developing artificial intelligent systems as well as inventing new materials for robots) are yet another example of research at BRL where microbial fuel cells were first developed. These cells are able to turn biomass into electricity. When these cells were built into a robot called EcoBot II, it was able to prove its self-sustainability by running continuously for 12 days in a row on dead flies. Ecobot II was the first robot in the world to carry out sensing, processing, communication and movement by converting biomass to electricity. The robot will feature in the Bristol Museum at the end of the year.

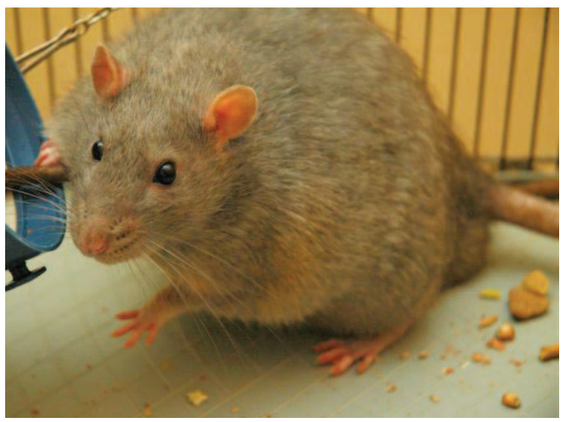
'Swarm robotics' is a new approach to co-ordinating the behaviours of a large number of relatively simple robots in a decentralised manner. As the robots in the swarm have only local perception and very limited local communication abilities, one of the challenges in designing swarm robotic systems with desired collective behaviour is to understand the effect of individual behaviour on group performance. BRL researchers are exploring techniques to design and optimise the interaction rules for a group of foraging robots that try to achieve energy efficiency collectively.

Research at BRL is forging into a new, exciting and also unknown future. How long it will take to develop a robot to do the dishes is hard to say, but the team around Professor Melhuish has made enormous progress. This impressed a recent visitor, Iain Gray, CEO of the Technology Strategy Board, a government-funded organisation to promote innovation: 'This is "real" science fiction happening on our doorstep in Bristol,' he said, 'for here we have world-leading research with world-leading researchers.' ■

For more information on the BRL, please visit www.brl.ac.uk or contact Professor Chris Melhuish on +44 (0)117 328 6334.



The robot rat SCRATCHbot identifies objects through its whiskers.



The real thing.

PLAN BEE

A toxin found in bee venom could hold the key to a new treatment for diseases including a form of muscular dystrophy. Neil Marrion, Professor of Neuroscience in the School of Physiology and Pharmacology, describes his laboratory's work on finding new approaches to old problems. He begins by explaining the crucial role played by electricity in the human body.

We are electric: almost everything we do depends on the flow of electrical current. Whether you're moving your big toe or deciding whether to buy oranges or lemons, not to mention the beating of your heart, electricity is essential. But in our bodies, this electricity doesn't flow as electrons down a copper wire; it flows as charged ions (of potassium, sodium, calcium and chloride) that move across a cell membrane. These ions cannot freely move across cell membranes, but must enter or exit a cell through holes formed by ion channels.

Ion channels are proteins embedded in the cell membrane at irregular intervals. Each has a hole (or pore) that provides a water-filled connection between the outside and inside of a cell. Ion channels comprise about 1.5% of our genome, with over 400 genes encoding these proteins. This means that we have at least 400 different types of ion channel throughout our body – many more, in fact, because alternative splicing of genes produces varieties of the parent ion channel.

You'd think that if ion channels are so important to how our bodies function, drug companies would be selling a large number of drugs that target them. This is partly true: there are drug therapies for conditions such as epilepsy and angina that block specific ion channels. The trouble is that many cell types that need a particular ion channel to function are distributed throughout the body. For example, a specific type of ion channel that lets potassium out of a cell might be in the heart and the brain, so that if you target that channel in the brain you will create side effects in the heart. Nature has provided a few ways round this by providing subtypes of channels whose distribution within the body is more limited. But these subtypes are very similar to each other, making it hard to find a unique place on the channel to target a drug.

In the past, drug development was often a matter of laborious experimental progress, and some discoveries were even accidental. For example, the first anti-depressant drug (called iproniazid) was originally used to treat tuberculosis, but was found to make patients feel 'inappropriately happy'! Alas, we have probably come to the end of this serendipitous approach – but the increase in computing power at our disposal has enabled us to run experiments *in silico*, ie via computer simulation. Using these techniques, my laboratory has collaborated with two others – one here at Bristol, the other at the University of Liège – on a combination of approaches towards designing a drug that will target subtypes of a particular ion channel.

We work on a class of ion channel called SK channels, which let potassium ions exit a cell and cause its activity to be dampened. These SK channels are opened by calcium ions binding to their intracellular tail; they work to stop cells being active and letting calcium ions into the cell. By doing so, they act as a break on activity or excitability. They perform this function in a lot of cell types, including nerves in certain brain regions. For example, the activity of one subtype of this channel (SK2) is responsible for controlling the excitability of nerves in our hippocampus and cortex, where our cognitive functions are based. Blocking these channels causes nerves to become hyperexcitable, producing improved learning that has implications for the treatment of dementia and depression.

Blocking SK channels causes nerves to become hyperexcitable, producing improved learning

Recently, it has been discovered that there is another SK channel subtype (SK3) whose expression underlies the development of the symptoms of myotonic muscular dystrophy (DM-1). (Myotonia is the uncontrolled firing of action potentials in skeletal muscle, causing muscle stiffness and inability to relax and leading to the progressive muscle weakness and paralysis that characterises this disease.)

SK3 is not in normal muscle and is not found in many places outside of the brain, so developing an SK3-selective drug could give relief from myotonia in DM-1 without major side effects.

Our problem is that the extracellular portions of channels in the SK family are very similar, and all of these subtypes are located throughout the body. But they also share something else, and this is where the bees come in: all of these channels can be blocked (albeit with different levels of sensitivity) by a toxin called apamin, which is found in the venom of the honey bee (*Apis mellifera*). We have been using apamin to investigate how SK channels can be blocked with different sensitivities. Several potassium channels have been crystallised, which enables us to study their structure – and they are complicated arrangements, being composed of four subunits that weave their way through the cell membrane.

Channels can be blocked by a toxin which is found in the venom of the honey bee

Fortunately, SK channels are a very close relation to one of these crystallised potassium channels. With my in-house collaborator, Professor David Jane, we have mapped the amino acid sequence of our SK channel on to the structure of this potassium channel to give us a structure that we can dock molecules on to using a computer simulation. We have found that apamin makes contact with the rim of the pore, with its tail sticking out towards an extracellular loop (see diagram below). With our collaborators at the University of Liège, headed by Professor Vincent Seutin, we have mutated the amino acids in the channel that, according to the modelling, make contact with the apamin.

This approach has allowed us to identify not only where the toxin binds to the channel, but also how the channel is blocked (see diagram below): instead of simply plugging the pore to prevent the flow of potassium ions, apamin binds to the rim of the pore and forces it to change shape, resulting in block (a mechanism known as allosteric modulation). We have been able to identify specific amino acids in the channel pore that are responsible for the ability of apamin to block some SK channels more potently than others. This is a highly unusual mechanism for a toxin, but it makes sense when you realise that apamin can discriminate between channel subtypes – a rare ability among toxins.

Our goal is to use this approach to design, manufacture and test novel blockers that will act selectively on either SK2 or SK3 channels. Our design will consider the location of the target: an SK2 blocker will be designed to cross the blood-brain barrier to act as a cognitive enhancer, while the design of an SK3 channel blocker will ensure that it remains outside of the brain and target muscle in patients suffering from DM-1.

It is not at all uncommon to find a medicinal use for something that occurs as a poison in nature. The key is to develop new approaches to utilise what nature can offer, and we hope that new treatments and therapies for diseases like muscular dystrophy will eventually result. ■

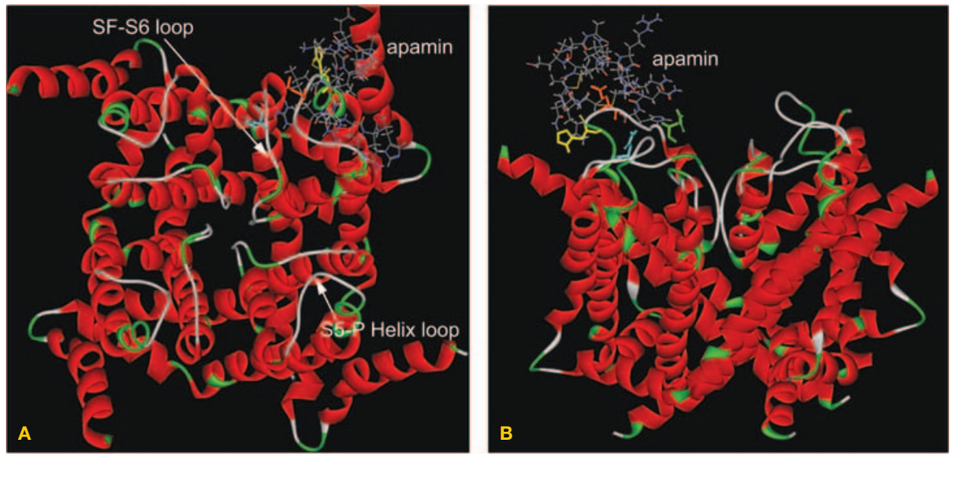
www.bristol.ac.uk/phys-pharm

NO BEES WERE HARMED…

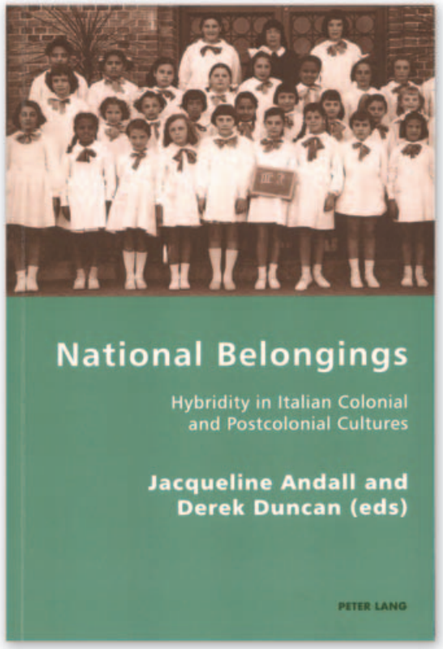
So how do researchers get hold of the apamin in the first place?

The venom from the gland of the honey bee contains two enzymes and four peptides; one of the peptides is the toxin apamin. Collecting this used to be a rather brutal process: venom glands from worker bees were removed and minced in a food blender. The resulting mush was poured over a column filled with a resin that apamin adheres to. The apamin was then washed off the resin and purified by a process called chromatography.

Thankfully, modern chemistry has given us a less messy and more humane solution: synthetic apamin is now made in the laboratory. Bees, after all, are becoming scarce enough already.



Right: Ribbon display of the SK2 channel, with the red coils of each of the four subunits folding around the water-filled pore in the middle of the structure. This is shown in a top-down view (A) and a side view (B). Docking apamin to this structure *in silico* shows that the toxin binds to the rim of the pore region of the channel with its tail pointing away from the channel.



National Belongings

Edited by Jacqueline Andall (University of Bath) and Derek Duncan (Department of Italian, University of Bristol)

National Belongings: Hybridity in Italian Colonial and Postcolonial Cultures is part of an emerging academic discourse which examines how colonialism shaped Italy's identity, challenging the pervasive view of Italy as a mono-religious and mono-cultural society. The book is an offshoot from a round of conferences initiated by co-editors Jacqueline Andall and Derek Duncan in 2001, which brought together scholars from the UK, the US and Italy. *National Belongings* picks up where Duncan and Andall's first collection of 2005, *Italian Colonialism: Legacy and Memory*, left off.

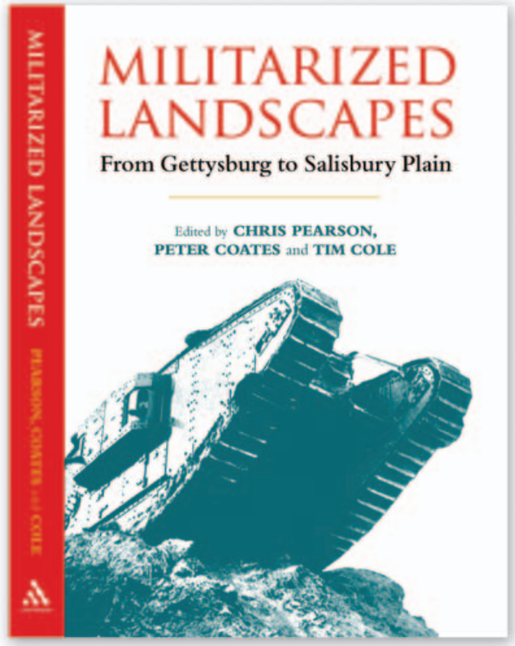
Essays exploring the present as well as the past from the perspective of history, anthropology, architecture, literature and film reveal how contact with Africa continues to affect Italian society, culture and politics, something which the editors note has been relatively underplayed by Italy's 'defenders of national purity'.

The book's contributors examine how different notions of hybridity – the social transformation facilitated by the nature and interaction between segregated social groups – help illuminate the process of historical change in a country ambivalent about its colonial past and its dual Mediterranean-European identity.

This collection represents a departure from earlier discussions in the field in that the contributors 'engage actively with the unpredictable consequences of colonialism through the analysis of different cultural sites of human interaction'.

Other contributions include essays by Bristol academics Charles Burdett, reader in Modern Italian Studies and a specialist in Italian literature and culture under Fascism; and Maurizio Marinelli, senior lecturer in East Asian Studies and a specialist in the influence of contemporary China's social, political and intellectual history on the rest of the world. ■

Peter Lang, 2010



Militarized Landscapes: From Gettysburg to Salisbury Plain

Edited by Chris Pearson, Peter Coates and Tim Cole (Department of History)

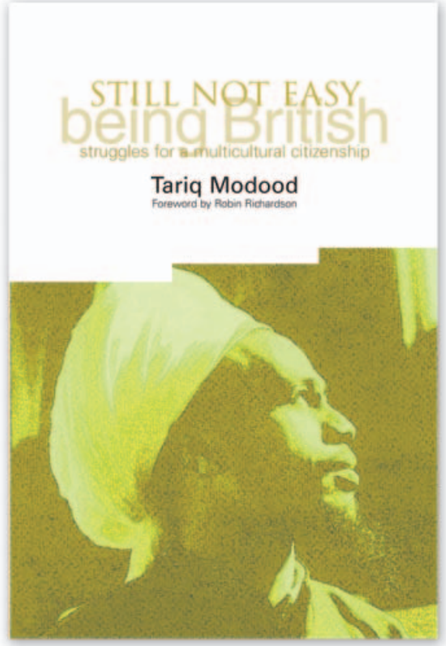
Militarized Landscapes is one of the major outputs of a three-year project that explores these often hidden, dangerous and controversial sites. Moving beyond the narrow definition of militarized landscapes as theatres of war, it focuses on the rural environments that have been reshaped by preparation for warfare.

The book includes contributions from historians, geographers, a landscape architect and a clinical psychologist. Chapters range from contemporary flashpoints such as the Korean De-militarized Zone to former nuclear testing sites in the deserts of the American West, and from the memorial landscape of the celebrated US Civil War battlefield site of Gettysburg to the UK Ministry of Defence's training grounds on Salisbury Plain, the Dorset coast and the Welsh mountains. Other places covered include Norway and the occupied Palestinian territories.

One of the book's most surprising findings is that certain militarized sites and training grounds have become unexpected and unintentional wildlife refuges, and are now managed for environmental as well as military objectives.

The book also examines how political activists, displaced civilians, and environmentalists have challenged the military mobilization of landscapes, villages, and other sites rich in local history, cultural meaning, and natural biodiversity. ■

Continuum, 2010



Still Not Easy Being British: Struggles for a Multicultural Citizenship

By Professor Tariq Modood (Centre for the Study of Ethnicity and Citizenship)

The notion that 9/11 and 7/7 signalled the end of multiculturalism is based on a false understanding of multiculturalism and a fixation on terrorism and extreme marginal issues like the burqa. Such are the reflections of Professor Tariq Modood, a renowned commentator on Muslim politics, in his latest book, *Still Not Easy Being British*.

In the book, Professor Modood shows that the issues of multiculturalism need to be addressed with increasing urgency as Britain and Europe become more multi-ethnic and multi-faith by the day. He offers a concept of multiculturalism that is compatible with and strongly based on liberal citizenship, moderate secularism and an inclusive Britishness.

'We need to review the kind of society that we think Britain is becoming and ensure that we do not, through unthinking prejudice, confine religious people and especially Muslims to the margins,' says Professor Modood. 'But we should not be over-anxious; we are making progress, especially in terms of political integration and mutual understanding. However, we must stop demonising Muslims and multiculturalism. The scare about multiculturalism is based on caricatures.' ■

Trentham Books, 2010

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