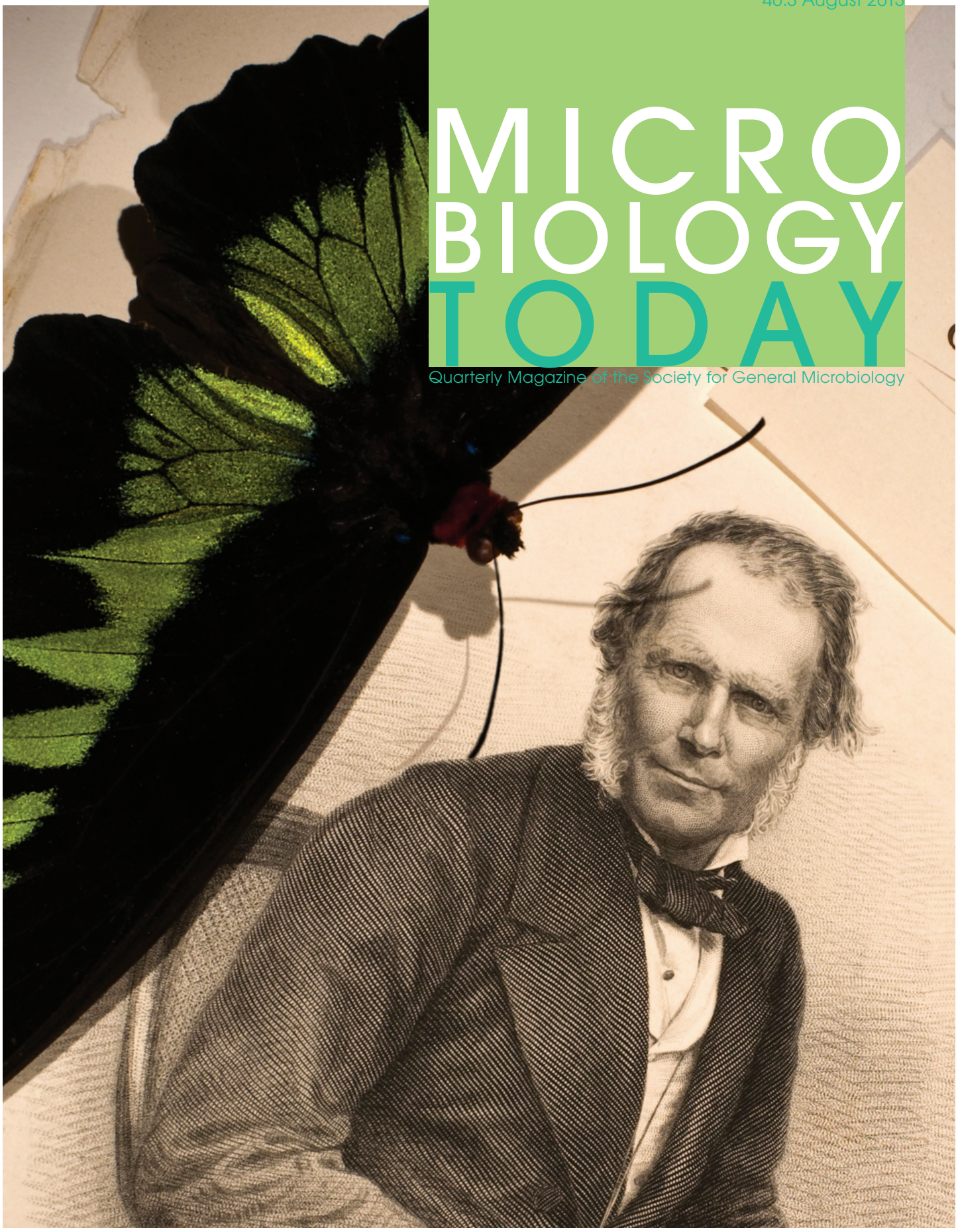
40:3 August 2013

MICRO BIOLOGY TODAY

Quarterly Magazine of the Society for General Microbiology



Biogeography

- Alfred Russel Wallace's legacy
- What Baas Becking should have said
- Biogeography of marine actinomycetes

SGM Council 12/13

Executive Officers

President – Professor Nigel L. Brown
c/o Society for General Microbiology, Marlborough House, Basingstoke Road, Spencers Wood, Reading RG7 1AG
Tel. 0118 988 1801; Email president@sgm.ac.uk

General Secretary – Professor David J. Blackbourn
Department of Microbial and Cellular Sciences, Faculty of Health & Medical Sciences, School of Biosciences & Medicine, University of Surrey, Guildford, Surrey GU2 7XH
Tel. 01483 68 6499; Email d.blackbourn@surrey.ac.uk

Treasurer – Professor Colin R. Harwood
Centre for Bacterial Cell Biology, Institute for Cell and Molecular Biosciences, Baddiley Building, University of Newcastle, Newcastle upon Tyne NE2 4AX
Tel. 0191 208 3221; Email colin.harwood@ncl.ac.uk

Chairs of Committees

Communications Committee – Dr Paul A. Hoskisson (Acting Chair)
Strathclyde Institute of Pharmacy & Biomedical Sciences, University of Strathclyde, 161 Cathedral Street, Glasgow G4 0RE
Tel. 0141 548 2819; Email paul.hoskisson@strath.ac.uk

Finance Committee – Professor Colin R. Harwood (see 'Treasurer' above)

Professional Development Committee – Dr Sara Burton
Geoffrey Pope Building, University of Exeter, Stocker Road, Exeter EX4 4QD
Tel. 01392 263437; Email s.k.burton@exeter.ac.uk

Policy Committee – Professor Nigel L. Brown (see 'President' above)

Publications Committee – Professor Colin R. Harwood
(Acting Chair – see 'Treasurer' above)

Scientific Conferences Committee – Dr Evelyn M. Doyle
School of Biology & Environmental Science, University College, Ardmore House, Dublin 4, Republic of Ireland
Tel. +353 1 716 1300; Email evelyn.doyle@ucd.ie

Elected Members

Professor Andrew Davison MRC-University of Glasgow Centre for Virus Research, Church Street, Glasgow G11 5JR
Tel. 0141 330 6263; Email andrew.davison@glasgow.ac.uk

Professor Ian R. Henderson Division of Immunity & Infection, University of Birmingham Medical School, Edgbaston, Birmingham B15 2TT
Tel. 0121 414 4368; Email i.r.henderson@bham.ac.uk

Dr Paul A. Hoskisson Strathclyde Institute of Pharmacy & Biomedical Sciences, University of Strathclyde, 161 Cathedral Street, Glasgow G4 0RE
Tel. 0141 548 2819; Email paul.hoskisson@strath.ac.uk

Dr Karen Robinson Centre for Biomolecular Sciences, University of Nottingham, University Park, Nottingham NG7 2RD
Tel. 0115 823 1094; Email karen.robinson@nottingham.ac.uk

Professor John H. Sinclair Department of Medicine, Level 5, Laboratory Block, Addenbrooke's Hospital, Hills Road, Cambridge CB2 0QQ
Tel. 01223 336850; Email js@mole.bio.cam.ac.uk

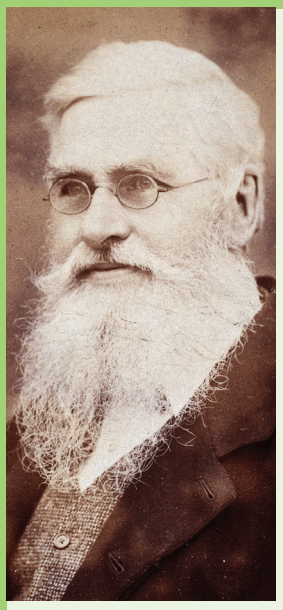
Professor Maggie Smith Department of Biology, University of York, Wentworth Way, York YO10 5DD
Tel. 01904 328500; Email maggie.smith@york.ac.uk

FEATURES

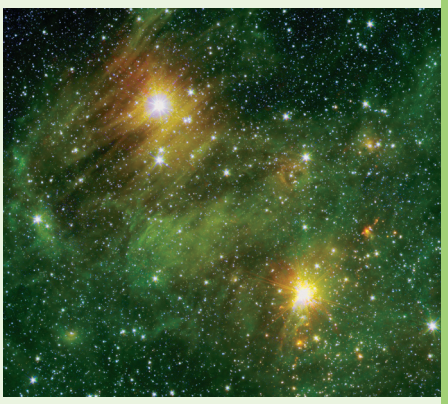
REGULARS

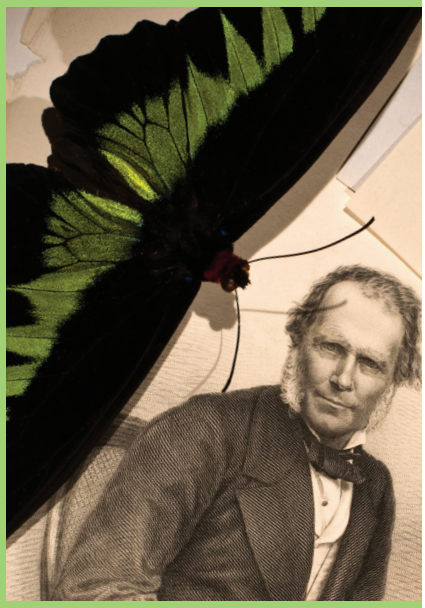
CONTENTS

MICROBIOLOGY TODAY 40:3 Aug 2013



ARTICLES





Cover Rajah Brooke's Birdwing male (Trogonoptera brookiana) shown with a steel engraving of Sir James Brooke who Alfred Russel Wallace named the butterfly for. Paul D. Stewart / Science Photo Library

Editor
Dr Paul A. Hoskisson

Content Editor
Ruth Paget

Editorial Assistant
Yvonne Taylor

Address
SGM, Marlborough House, Basingstoke Road, Spencers Wood, Reading RG7 1AG
Tel. 0118 988 1842 Email mtoday@sgm.ac.uk

Design
Ian Atherton, Corbicula Design (www.corbiculadesign.co.uk)

ISSN 1464-0570

Printed by Charlesworth Press, Wakefield

RECYCLED
Paper made from recycled material
FSC® C013436

EDITORIAL

Welcome to what is my last issue of *Microbiology Today* as Editor. I'm excited that Laura Bowater is taking over and I know that she will do great things in taking the magazine forward. Good luck Laura – I'll look forward to receiving my copy as a reader in the future.

Also, its great to welcome Benjamin Thompson and Ruth Paget to the SGM team who will be contributing to *Microbiology Today* in the future.

I was able to indulge myself in my last issue as Editor with a few articles in recognising one of my scientific heroes – Alfred Russel Wallace. This year marks the 100th anniversary of the death of Alfred R. Wallace, well known amongst biologists and perhaps the wider public for being the co-discoverer of natural selection as the mechanism for evolution of new species. Yet Wallace had great influence more widely in biology and that is often overlooked by people seeking to portray him as

a marginalised figure in the discovery of the mechanisms that underpin evolution. It is well documented that the letter Wallace sent to Darwin from the Malay Archipelago, resulted in Darwin precipitating his thoughts on evolution into what became *On the Origin of Species.* Wallace worked for many years following the publication of Darwin's *On the Origin of Species* to expand the implications of this work leading to greater insights into evolutionary biology and was a staunch supporter of Darwin. Wallace worked extensively on the geographical distribution of animals and plants, drawing on different fields of science to develop theories regarding the constraints of where different species live and why – he is therefore viewed as the father of biogeography. He also extensively studied the adaptation of various species in terms of their interaction with other organisms and their environment, mainly through trying to understand the colouration of animals. Both of these areas are currently receiving a great deal of attention in microbiology (biogeography and microbe–microbe, microbe–host interactions) and it is clear that they have their foundations in the thoughts of Alfred R. Wallace. So, in this issue I have written about some of the developments in the application of biogeography to microbiology, Christopher van der Gast has written about how microbial biogeography fits within the wider framework of microbial ecology. Last, but by no means least, Paul R. Jensen tells us about how the distribution of different *Salinispora* species in ocean samples may be the result of horizontal transfer of secondary metabolite biosynthetic clusters, and how the study of these organisms is leading to the discovery of novel and very useful compounds.

We also have a great selection of additional articles. Alan McCarthy and Paul Broda tell us about the achievements of CARA on its 80th anniversary and, in Comment, Ian Jones looks at the emergence of the novel coronavirus that is currently gaining a great deal of interest in the media. Simon Park tells us about the emergence of DIY biology and how this is attracting attention from legislative bodies, and Joanne Needham tells us about some exciting news from the Society of Biology regarding SGM members.

Finally, I'd like to thank all of the SGM staff, Editorial Board members and contributing authors during my time as Editor of *Microbiology Today*, and also the membership for their kind comments during my tenure – its been a lot of hard work, but mainly, a great deal of fun!

PAUL A. HOSKISSON, Editor
Email paul.hoskisson@strath.ac.uk

FROM THE PRESIDENT


Photo I. Atherton

This issue of *Microbiology Today* discusses biogeography and microbiology. Simplistic statements such as '*micro-organisms do not respect international borders*' are fine for ensuring that people know that diseases can travel with people, insects or wind (e.g. MERS-Coronavirus, Schmallenberg virus or foot-and-mouth disease virus, respectively). Nevertheless, there are differences in geographic, as opposed to political, boundaries as articles in this issue make clear.

Political boundaries can affect microbiologists. This year marks the 80th anniversary of CARA, the Council for Assisting Refugee Academics (**www.academic-refugees.org**). The SGM supports CARA, which is still very active in helping academics from trouble spots around the world. Alan McCarthy and Paul Broda, members of the CARA Council, have written about the work of CARA in this issue.

Another 80th anniversary is that of the birth of Professor Sir David Hopwood, a former President of SGM and a hugely influential figure in UK genetics and microbiology. I am sure that all SGM members will join with me in wishing David a very happy 80th birthday.

Our Autumn Conference takes place at the University of Sussex this September. In addition to an exciting programme of scientific talks, Professor Neil Gow will give the Fred Griffith Prize Lecture on medical mycology and Professor Sarah Gurr will give the Hot Topic Lecture on fungal plant disease. We will also award the prizes in the *Sir Howard Dalton Young Microbiologist of the Year Competition*.

Don't forget to attend the Annual General Meeting on Monday 2 September. This, usually short, meeting is the time we approve the selection of our new Officers and Committee Members and deal with issues raised by members. As I have indicated before, I am keen that we engage the whole membership in the Society's activities. I am pleased to say that we have had a reasonable number of people wishing to serve on Council and on the Committees of Council. However, it could be better, and Council has recently discussed how we can get more early-career researchers involved in the work of the SGM. We will raise this and other issues at the AGM.

We have a number of changes to members of Council and Committees. With the AGM's agreement, Professor Chris Thomas will take over from Colin Harwood as Treasurer, and Evelyn Doyle will succeed David Blackbourn as General Secretary. I would like to pay particular tribute to Colin and David, who have overseen many of the changes to modernise the Society in recent years and have been a strong support to Hilary Lappin-Scott and me as President. However, neither is lost to us – Colin will chair the Publications Committee for a year as we manage the next stages in the transition of our publishing business, and David has been appointed to the Council of the Society of Biology, our chartered body. I wish all new post-holders well in their new roles.

As always, if you have suggestions for how the Society could better serve you, I am pleased to receive these by email at **president@sgm.ac.uk**.

NIGEL L. BROWN
President

NEWS

DIGITALLY SPEAKING

We are very excited to announce that both *Microbe Post* (blog) and *Microbe Talk* (podcast) have returned – it's true, they have been away a while longer than we had anticipated – but our newly rejuvenated blog and podcast are back online (**http://microbepost.org**). We hope you like the slightly rejigged format! See *Media Update* on p. 100 for how you can get involved.

We are also celebrating the birth of a brand new blog (**http://sgmpublishing.wordpress.com/2013/07/04/welcome-to-sgm-publishing-2/**) from the SGM's publishing team. This blog is where you can stay connected with what's happening at SGM Publishing – you can also follow them on Twitter **@PublishingSGM**. Also, the wider issues affecting publishers and researchers will be discussed such as open access, best practice for submitting a manuscript and hot research topics.

NEWS OF MEMBERS

Congratulations to the following SGM members.

PROFESSORS JUDITH ARMITAGE and **MERVYN BIBB** who were recently elected to the Fellowship of the Royal Society. Fellows are elected for their contribution to science, both in fundamental research resulting in greater understanding and also in leading and directing scientific and technological progress in industry and research establishments.

PROFESSOR GURDYAL BESRA who has been elected to the Fellowship of the Academy of Medical Sciences. Fellowship of the Academy is based on exceptional contributions to the medical sciences either in the form of original discovery or of sustained contributions to scholarship.

Former SGM President **PROFESSOR ROBIN WEISS** has been elected a Foreign Associate of the US National Academy of Sciences. Members are elected to the National Academy of Sciences in recognition of their distinguished and continuing achievements in original research. Membership is a widely accepted mark of excellence in science.

Former SGM President **PROFESSOR HUGH PENNINGTON** who was awarded a CBE for his services to microbiology and food hygiene in the Queen's Birthday Honours this year.

DEATHS

We regret to announce the death of **DR J.W. LIGHTBOWN**, member since 1949, who passed away on 11 April 2013. We are also sad to announce the death of **PROFESSOR SIR KENNETH MURRAY**. His obituary is on p. 131.

ANNUAL GENERAL MEETING

The Annual General Meeting of the Society for General Microbiology will be held on **MONDAY 2 SEPTEMBER 2013** at 12:50 in the Chichester Lecture Theatre, University of Sussex.

AGENDA

1. Introduction by the President
2. Minutes of the 2012 Annual General Meeting
3. Matters arising from the Minutes
4. Announcement of the new Treasurer
5. Report of the Treasurer
   (a) Receiving of the Annual Accounts
   (b) Appointment of Auditor
   (c) Approval of membership subscription rates
6. New Members of Council, Committees and Divisions 2013
7. Any other business

Supporting papers can be downloaded from **www.sgm.ac.uk/en/utilities/about-sgm/council-governance.cfm**

DR SIMON FESTING, Company Secretary

2014 SGM JOURNALS PRICING NOW AVAILABLE

2014 subscription prices for *Microbiology*, *Journal of General Virology*, *Journal of Medical Microbiology* and *International Journal of Systematic and Evolutionary Microbiology* are now available at **www.sgmjournals.org/site/subscriptions/pricing/future_pricing_2014.xhtml**

Please encourage your librarian to subscribe, ensuring that you have online access to the high-quality research published by the Society.

NIHR THEMED CALL: PREVENTING THE DEVELOPMENT AND SPREAD OF ANTIMICROBIAL RESISTANCE

The NIHR Antimicrobial Resistance Themed Call **www.themedcalls.nihr.ac.uk/amr/home** is now open and receiving applications for research funding.

This call is for research into the evaluation of public health measures, health care interventions and health services to reduce the development and spread of antimicrobial resistance and consequent morbidity.

SYNTHBIO

The July issue of the SGM journal *Microbiology* (**http://mic.sgmjournals.org/content/current**) contains a special section dedicated to synthetic biology – a field that applies engineering principles, such as mathematical modelling or modularisation, to biological research. Although in its infancy, synthetic biology offers researchers the opportunity to understand how biological systems work by piecing them together from their constituent parts, and may allow scientists to design organisms that perform a bespoke function. For more information on the safety mechanisms that can prevent synthetic organisms from escaping or sharing their DNA, listen to July's *Microbe Talk* (**http://microbepost.org/2013/07/10/microbe-talk-july-2013/**) where Benjamin Thompson, SGM's Senior Public Relations Officer, talks to researchers from Imperial College London who are interested in this field.

CHELTENHAM LITERATURE FESTIVAL 4–13 OCTOBER 2013

The SGM is pleased to be sponsoring Cheltenham Literature Festival – where three members – **PROFESSOR LAURA PIDDOCK**, **PROFESSOR JOANNA VERRAN** and **DR THORUNN HELGASON** are taking part in three panel discussions with a distinctively microbiological flavour. See programme below:

WOUNDED – Mon 7 October. In this fascinating event battlefront medical care available to soldiers in WWI is compared to that offered today. The panel – medical historian Emily Mayhew, author of *Wounded*, Laura Piddock and Colonel Alan Kay, a serving military surgeon at Camp Bastion, discuss the challenges faced by surgeons in WWI, explore how treatment in war zones has developed over the last 100 years and give a rare insight into the working of operational theatres today.

DIRT: THE FILTHY REALITY OF EVERYDAY LIFE – Tue 8 October. From Dickens' Victorian workhouses to the 'clean spa air' of Jane Austen's Regency Bath, dirt and cleanliness play a fascinating role in 19th Century fiction. Joanna Verran, author Catharine Arnold (*Underworld London*) and historian Virginia Smith discuss how dirt and hygiene feature in writing of this period and explore how the dirty and the clean shape our view of 19th Century history in cities and spa towns alike.

BEES: FROM HONEY TO HIVE – Wed 9 October. Beekeeper Steve Benbow, author of *The Urban Beekeeper*, microbial ecologist Dr Thorunn Helgason and broadcaster and bee enthusiast Bill Turnbull, author of *The Bad Beekeepers Club* explore our enduring fascination with bees. They will be looking at how the bee has shaped culture and folklore, discussing the environmental and scientific challenges faced by contemporary beekeepers and examining the medicinal properties of honey, as well as celebrating the art of beekeeping itself.

PRIZE LECTURESHIPS

FRED GRIFFITH PRIZE LECTURE

Awarded biennially in recognition of long and distinguished service in any area of microbiology.

2013 Prize awarded to NEIL A.R. GOW The University of Aberdeen

BREAKING THE MOULD IN MEDICAL MYCOLOGY

Professor Gow graduated with a BSc from Edinburgh University in 1979 and a PhD from Aberdeen University. He was a research fellow in Denver, before returning to Aberdeen as a faculty member in 1984. He is a founding member of the Aberdeen Fungal Group and contributed to building this group to its current status as one of the largest centres of excellence for medical mycology. Professor Gow currently holds the post of Director of Research and Commercialisation for the College of Life Sciences and Medicine. Under his direction this group has recently been awarded a Wellcome Trust Strategic Award to coordinate research and training activity and build capacity in the field of medical mycology and fungal immunology across the UK and in developing countries. He is a fellow of the Society of Biology, the Royal Society of Edinburgh and the American Association of Microbiologists, and is a former President of the British Mycological Society and current President-Elect of the international Society for Human and Animal Mycology (ISHAM). He has, in recent years, helped to coordinate the SGM Eukaryotic Division and was a past member of Council and Editor of the SGM's journal *Microbiology*. He recently stepped down as Editor-in-Chief of *Fungal Genetics and Biology*.

Professor Gow's primary research has focused on: (i) the molecular genetics of cell wall biosynthesis in pathogenic fungi, in particular the genetics of glycosylation and the fungus–host interaction in relation to immune recognition and function; (ii) the genetics of chitin synthesis and the response to antifungal agents; (iii) directional growth responses of fungal cells; (iv) the virulence properties of medically important fungal species; (v) the evolution, genome biology and genotyping of *Candida* species. He has published over 300 research papers and reviews in these areas.

MEDIA UPDATE

Wellcome Images, London

Hello all, it's a great pleasure to be introducing myself to you. I'm Benjamin, the Society's new Senior Public Relations Officer; it's my job to make sure the word gets out about microbiology, the Society, its members and the amazing things that we do. I moved to the SGM from the Wellcome Trust, where I worked as a science writer. As many of you are aware, it's a very exciting time for the Society: we're moving offices, and we've got a shiny new website. This has been a good opportunity for us to relaunch *Microbe Post*, our blog, and *Microbe Talk*, our podcast.

I want to use them to highlight some of the great stuff that's happening in our field. But I need your help – there's so much going on in labs across the country/world that I don't know about. If you hear of something that would make a good story, please let me know! The more that people hear about what we do, the better it is for the Society and for microbiology as a whole.

BENJAMIN THOMPSON *Email* b.thompson@sgm.ac.uk

OUTREACH PRIZE LECTURE (SPONSORED BY YAKULT)

Awarded annually to a microbiologist who has engaged in high-quality outreach activities during the last 2–5 years.

2013 Prize awarded jointly to:

HELEN L. BROWN Institute of Food Research, Norwich

A ROUGH GUIDE TO OUTREACH

Following the completion of her BSc in Bioarchaeology at Bradford University in 2003, Helen began working at Covance Laboratories Ltd. During the 6 years she spent with the company she worked in both the Immunoassay and Biosafety departments. While working she also completed a part-time MSc in the Biological Basis of Disease at Sheffield Hallam University. In early 2011, she began a PhD project at the Institute of Food Research, Norwich, funded by the Biotechnology and Biological Services Research Council (BBSRC), with additional Council for Advancement and Support of Education (CASE) funding from Campden BRI. Her research focuses on biofilm formation in the food-borne pathogen *Campylobacter jejuni* and how this assists its food chain transmission. Alongside her PhD studies she enjoys taking part in various outreach activities. She is a member of STEMnet and Norfolk's Teacher Scientist Network. Most of her outreach work takes place in local schools, although she has spoken about her research at several events for both general public and teacher audiences.

JAMES REDFERN Manchester Metropolitan University

THE GOOD, THE BAD AND THE ALGAE: A PUBLIC ENGAGEMENT EVENT

James graduated from Manchester Metropolitan University (MMU) in 2010 with a degree in Biology. For his second year, he chose to study in the USA at South Dakota State University where his passion for microbiology began. On his return to the UK, he became a member of SGM and took his first steps into the world of science communication, helping the Science Council at the Big Bang Science Fair. Shortly after graduating, he began his PhD at MMU in practical microbiology education resource development. Three years on, he has successfully developed, written, trialled, evaluated and published a series of practical activities in order to promote the use of microbiology in the secondary school classroom. Over this time, he has been involved in a series of science communication events and activities, ranging from drop-in sessions at national science festivals, to workshops at university family fun days.

UPCOMING GRANT DEADLINES

PRESIDENT'S FUND FOR RESEARCH VISIT GRANTS

Grants of up to £3,000 to support early-career microbiologists to carry out a short visit to another laboratory to carry out a defined piece of work.

ELECTIVE GRANTS

To enable medical, dental and veterinary science undergraduates to work on microbiological research projects during their elective/extra mural studies.

INFECTION TRAINING SUPPORT GRANTS

To support small lab-based microbiology projects carried out during either foundation or speciality postgraduate medical training.

INTERNATIONAL DEVELOPMENT FUND

To support knowledge transfer and capacity building in countries with economies defined by the World Bank as low- or lower-middle-income.

WATANABE BOOK FUND

Funds to acquire books, or journals relating to microbiology for members who are permanently resident in a country with an economy defined by the World Bank as low- or lower-middle-income.

CONFERENCES

Brighton Royal Pavilion.
iStockphoto / Thinkstock

SGM Autumn Conference
2–4 Sept 2013 | University of Sussex

NOT REGISTERED YET? There's still time. Simply visit the Society's website (**www.sgm.ac.uk**), download and complete the registration form, bring it with you to the SGM Registration Desk (located in the Arts Marquee at the University of Sussex) and register on-site for an exciting programme of microbiological science.

CONFERENCE SNAPSHOT

The Autumn Conference will cover many different areas of microbiology research. ***Impact of bacteriophage in the environment*** will focus on the increasing awareness and impact of bacteriophage on the ecology of the biosphere, while ***Microbial modulation of cellular responses*** will highlight the way different bacterial toxins and effectors subvert, inhibit or activate host cell pathways to the benefit of pathogens. ***Pathogen genomics – current clinical applications*** will show how clinical practice is changing based on the data generated by next-generation sequencing technology, and ***Regulatory phosphate-based molecules*** will outline progress in understanding the actions of phosphate-based regulatory molecules, with a focus on (p)ppGpp, polyphosphates and cyclic di-nucleotides.

SGM and the British Society for Medical Mycology are hosting a joint symposium, ***Fungal diseases, diagnosis and drug discovery***. The programme spans contributions from world-leading scientists on the major human fungal pathogens such as *Aspergillus*, *Candida*, *Cryptococcus*, dermatophytes and plant pathogens, as well the latest diagnostic techniques and advances in drug discovery. ***Microbial survival in the host*** will showcase the diverse strategies mounted by fungal and parasitic pathogens to survive within the human host.

EXCITING CHANGES TO THE SOCIETY'S CONFERENCE PROGRAMME 2014–2015

The Society will be testing a new conference programme over the next 2 years to offer a wider range of conference styles to our delegates. From 2014, the SGM **ANNUAL CONFERENCE**. It will feature four packed days of microbiological sessions, workshops and forums, along with evening poster sessions and an exhibition throughout the conference.

In addition, the Society will also be trialling a new meeting format in the form of 1- or 2-day **FOCUSED MEETINGS** that will concentrate on specific areas of microbiology. Details of the three Focused Meetings planned for 2014 will be announced shortly.

FOCUSED MEETING PROPOSALS INVITED FOR 2015

To widen the scope for members to further contribute to the scientific content of the Society's conferences, there will be the opportunity to submit proposals for Focused Meeting topics for 2015. Focused Meetings can be on any area of microbiology and full secretariat support will be provided by the Society. Details on how to submit your proposal will be announced this Autumn.

The 'Three Graces' of the world-famous Liverpool waterfront (*from back to front*): the Royal Liver Building, the Cunard Building and the former offices of the Mersey Docks and Harbour Board.
iStockphoto / Thinkstock

SGM Annual Conference 2014
14–17 April
BT Convention Centre Liverpool

THE 2014 ANNUAL CONFERENCE will feature a range of scientific sessions including; *Pseudomonas* signalling, secretion and sensing, Sexually transmitted and reproductive diseases, Cell cycle, Metabolic engineering for biotechnology, Mind-altering microbes, RNA and riboswitches in bacterial regulation, Viral respiratory infections, Grand challenges in virology and Evolution of microbial populations within the host.

NEW PROKARYOTIC FORUMS

The Society recognises a need to provide opportunities for early-stage researchers to present their work and to provide a recurring forum to ensure that broad areas of microbiology are always represented at the annual conference. On the Wednesday of the conference both Virology Workshops and new Prokaryotic Forums will feature. The Prokaryotic Forums will cover four broad areas of prokaryote biology, including infection, genetics, cell biology and environmental microbiology. The remit of such forums will be broad, with scope to extend the format to other subject areas in the future. Further details on the nature of the forums and how you can contribute will be included in the November issue of *Microbiology Today*.

A call for abstracts will be made in the Autumn. The closing date for abstract submissions will be MONDAY 20 JANUARY 2014. See the Society's website (**www.sgm.ac.uk**) for full conference details.

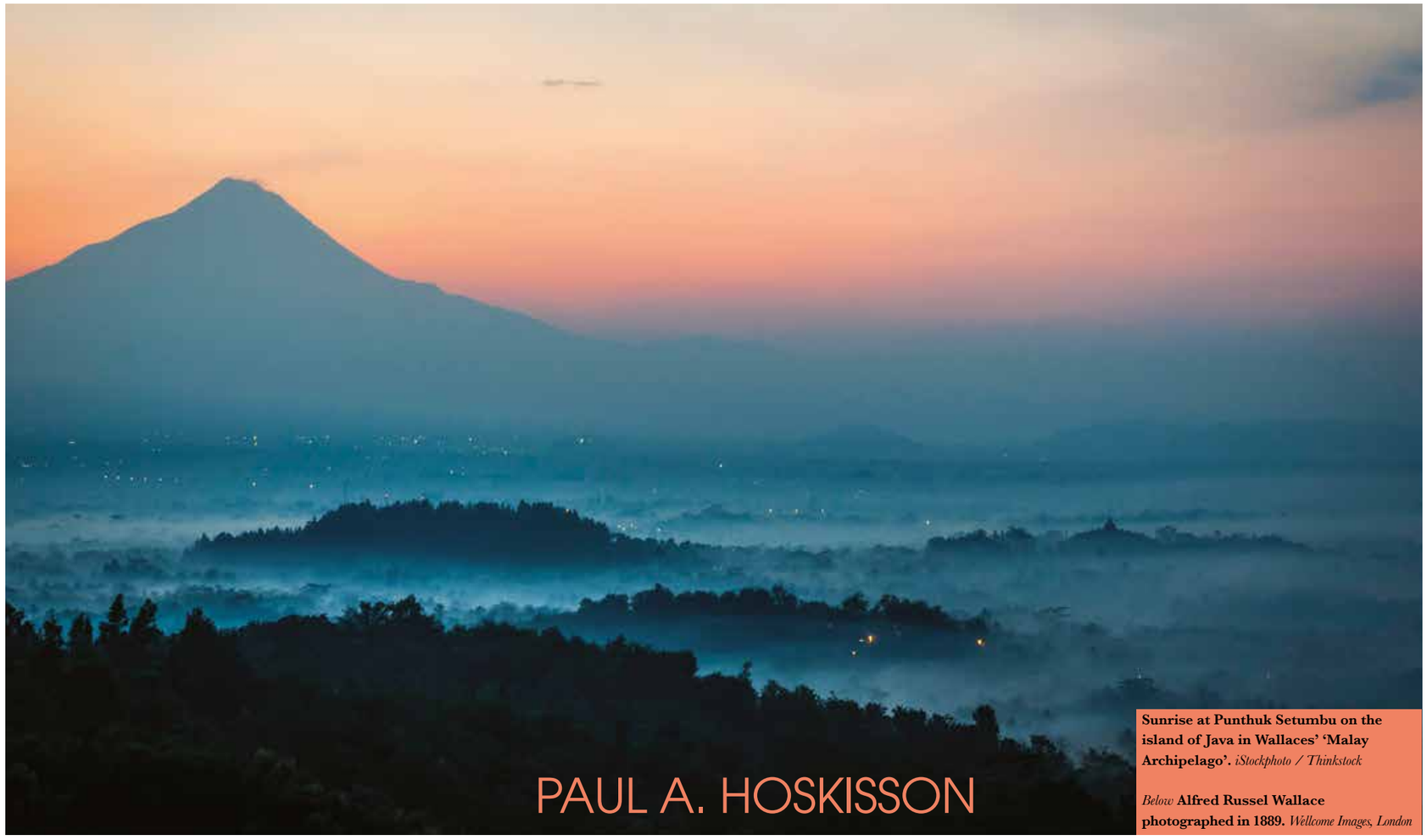
OTHER SGM SPONSORED SCIENTIFIC MEETINGS

***Staphylococcus* Great Britain & Ireland [Staph-GBI] 2013**
5–6 September 2013
Trinity College Dublin, Ireland
www.staphgbi.org

14th International Conference on *Pseudomonas* 2013
7–11 September 2013
Lausanne, Switzerland
www3.unil.ch/wpmu/pseudomonas2013

CHRO 2013: 17th International Workshop on *Campylobacter*, *Helicobacter* and Related Organisms
15–19 September 2013
Aberdeen, UK
www.chro-2013.org

Alfred Russel Wallace's legacy and the impact of biogeography on microbiology



Sunrise at Punthuk Setumbu on the island of Java in Wallaces' 'Malay Archipelago'. *iStockphoto / Thinkstock*

Below **Alfred Russel Wallace photographed in 1889.** *Wellcome Images, London*

PAUL A. HOSKISSON

Alfred Russel Wallace was one of the 19th Century's greatest field biologists, yet his scientific legacy is much farther reaching than it would first appear to the casual observer. A great supporter of Darwin throughout his life, following the co-discovery of natural selection, he studied biology in a much wider context, making seminal contributions to evolutionary biology, ecology and biogeography.

DURING HIS TIME in the Malay Archipelago, Alfred Russel Wallace observed many things regarding the distribution of macro-organisms, and how certain species were confined to specific regions – what he referred to as '*the faunal discontinuity with geology*'. Wallace had written as early as 1852 on the effects of geographical barriers on the distribution of primates in the Amazon Basin (*Proc Zool Soc Lond* **20**, 107). Darwin himself mentions these works in Chapter 11 of *On the Origin of Species* in relation to his own words, '*barriers of any kind or obstacles to free migration, are related in a close and important manner to the differences between the productions of various regions*', later in the chapter directly quoting Wallace's 1855 paper from *Annals & Magazine of Natural History* (September, 1855) – '*every species has come in to existence coincident both in space and time with a pre-existing closely allied species*'. These works clearly show that Wallace was considering evolutionary theory in a biogeographical framework from an early stage in his studies.

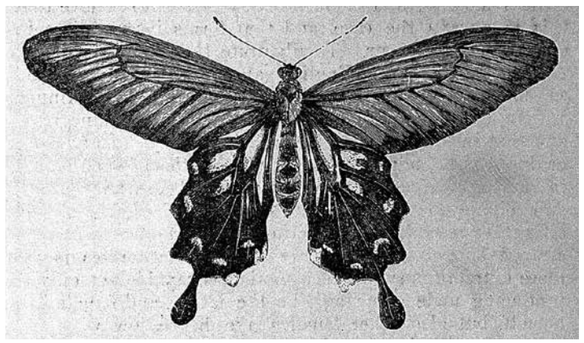
The extensive fieldwork and other observations of Wallace during his time in the Amazon Basin and the Malay Archipelago on the distribution of species culminated in the publication of *The Geographical Distribution of Animals* (2 vols, London: Macmillan) in 1876. It is this and his other works that laid the foundations for the emergence of the branch of science we now refer to as biogeography – the study of the spatial (geographical) and temporal (geological) distribution of species. Wallace was also immortalised by Huxley, who coined the phrase '*Wallace Line*' to describe the line dividing the islands that represent the change from Indian to Australian fauna within the Malay Archipelago, underlining the importance of Wallace as the father of biogeography.

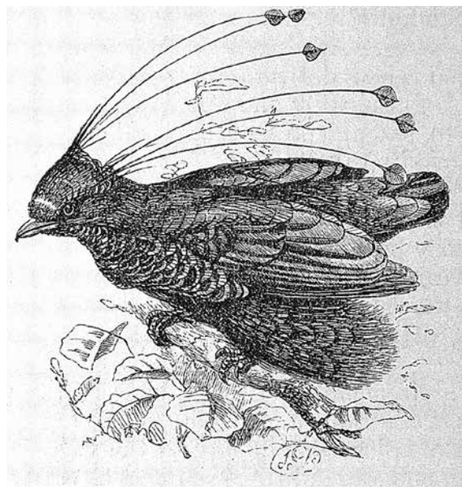
Of course, in the mid-19th Century the existence of micro-organisms was known, but their fundamental importance was yet to be fully realised. The prevailing view was then, and until recently, that micro-organisms are distributed globally and can proliferate in any suitable habitat, with even Darwin stating in *On the Origin of Species* that '*the lower any group of organisms is, the more widely it is apt to range*'. This view was, of course, reinforced

by the famous quote of Lourens Baas Becking of '*everything is everywhere, but the environment selects*'.

These views are now beginning to change and there is an increasing body of evidence that points to micro-organisms having a biogeography of their own. As we continue to further our understanding of the influence micro-organisms play within ecosystems, the importance of microbial biogeography will increase, such that we will gain a greater understanding of global localisation within global nutrient cycling, decomposition and recycling, autotrophic production and the search for novel biotechnology. Key to this is the defining of the microbial species, which has also attracted a lot of attention (see Staley, 2009, in *Further reading*). These concepts are well established in higher organisms or at least, less controversial, yet they operate at a different taxonomic resolution to those applied to micro-organisms such that, when viewed at the biogeographical level, details of distribution and the factors affecting microbial species may be masked.

It is, however, clear that technological advances in biology, such as affordable genome sequencing and molecular detection methods, are driving the study of microbial biogeography forward. Work carried out in Rachel Whitaker's laboratory at the University of Illinois has built on the conventional evolutionary biologist's viewpoint which states that new species arise when genetic exchange between populations is blocked, resulting in reproductive isolation, adaptation and emergence of a new species (allopatric speciation in technical terms). Using whole-genome sequences of the extremophile *Sulfolobus islandicus*, from widely separated populations in the USA and Russia, Whitaker has been able to study population divergence in isolation. In keeping with how island evolution crystallised Wallace's thoughts, the isolation of *S. islandicus* in the hot springs it inhabits may also be thought of as analogous to island isolation, separating the strains from wider populations. Whitaker was able to show that in the case of *S. islandicus*, the physical and chemical processes within the hot springs it inhabits had relatively little effect on divergence. Interestingly, the variation observed in the genomes of *S. islandicus* is mainly due to viruses that act as parasites and agents of genetic transfer and the viral resistance mechanisms encoded within the *S. islandicus* genome that help protect them from viral attack (such as CRISPR-*cas* and restriction-modification systems). This is a trend we see in our own work on the human pathogen *Corynebacterium diphtheriae*; however, the biogeographical trends are obscured due to emigration and immigration amongst human populations, resulting in transfer of strains between this most mobile of ecosystems – the human body. This transfer of microbial species is an increasingly interesting concept in the world of microbial biogeography in terms of pathogen co-evolution with hosts. It has also been explored in the context of ectomycorrhizal fungi and how humans, moving plants with intact root systems, have transported these around the world, mainly for economic purposes. Anne Pringle's laboratory have shown that over 200 ectomycorrhizal fungi have been transported around the world, with various outcomes in terms of their survival, such as inability to colonise, succession by local fungal species in the host plant, persistence in the host plant but strains not spreading to local plant species, persistence in the host plant and strains spreading to local plant species, and finally failure to persist in the original host plant yet spreading to local plant species. This work clearly emphasises how little we understand about the microhabitats and the fundamental constraints micro-organisms experience to successfully colonise a niche.





'Butterfly (*Papilio coon*)' (*above*) and 'The sixth-shafted bird of paradise (*Parotia sexpennis*)' (*left*). Illustrations taken from *The Malay archipelago: the land of the orang-utan, and the bird of paradise* by Alfred Russel Wallace. *Wellcome Images, London*

> "Work on global diversity of bacteriophages, evolution of viruses, co-evolution of viruses and parasites with their hosts, and emergence of novel pathogens all draw heavily on biogeography and the interaction of organisms with each other. These are exciting times to be a microbiologist…"

On a macrobial scale, we think of biogeography as islands and continents, and barriers to gene flow being rivers and mountain ranges, but on a microbial scale the barriers are much smaller. Again, these frameworks are intrinsically linked to speciation and understanding the species concept. We have already met allopatric speciation above, but a more controversial theory (at least in macrobial terms) is sympatric speciation, where species evolve from a common ancestor whilst inhabiting the same geographical region. The influence of horizontal gene transfer in microbial systems is clearly a potential driver of such processes, but perhaps the concept of microallopatric speciation is worth considering in a microbial setting. Many micro-organisms inhabit environments with complex spatial structures resulting in discrete microhabitats within a specific ecological niche, soil being a good example of this. Bulk sampling would suggest that species are sympatric (inhabiting the same niche), yet they may be constrained in a strict ecological microniche within that sample. It is this kind of situation where microallopatric speciation may explain evolution of microbial species, where limited gene flow can still occur, yet the organisms are largely partitioned within these microniches. Whilst microallopatric speciation was first considered in terms of macrobial species, where species inhabit discrete habitats in broadly overlapping ranges, it is a concept that fits nicely in a microbial setting and is similar to the concept of parapatric speciation, where adjacent populations diverge with limited gene flow.

Many groups have advanced our understanding of speciation and niche partitioning in terms of microbial biogeography, a particularly elegant story is that of *Salinispora* (see Paul R. Jensen's article in this issue of *Microbiology Today* on p. 112), yet we still have a long way to go. Work on global diversity of bacteriophages, evolution of viruses, co-evolution of viruses and parasites with their hosts, emergence of novel pathogens all draw heavily on biogeography and the interaction of organisms with each other. These are exciting times to be a microbiologist – I wonder what Wallace and Darwin would make of the diversity of micro-organisms we now know about, considering each was astounded by the diversity of animals and plants.

What is clear is that to explore the biogeography of microbial populations we need to clarify our microbial species concept and then start to place the spatial patterns of microbial evolution and diversity into a clear ecological and evolutionary framework with which we can gain insight in to all living things.

PAUL A. HOSKISSON

Strathclyde Institute of Pharmacy & Biomedical Sciences, University of Strathclyde, 161 Cathedral Street, Glasgow G4 0RE, UK. *Tel.* +44 (0)141 5482819; *Email* paul.hoskisson@strath.ac.uk

FURTHER READING

Martiny, J.B.H. & others (2006). Microbial biogeography: putting microorganisms on the map. *Nature Rev Microbiol* **4**, 102–112.

Reno, M.L. & others (2009). Biogeography of the *Sulfolobus islandicus* pan-genome. *Proc Natl Acad Sci U S A* **106**, 8605–8610.

Smith, C.H. & Beccaloni G. (editors) (2010). *Natural Selection & Beyond; The Intellectual Legacy of Alfred Russel Wallace.* Oxford: Oxford University Press.

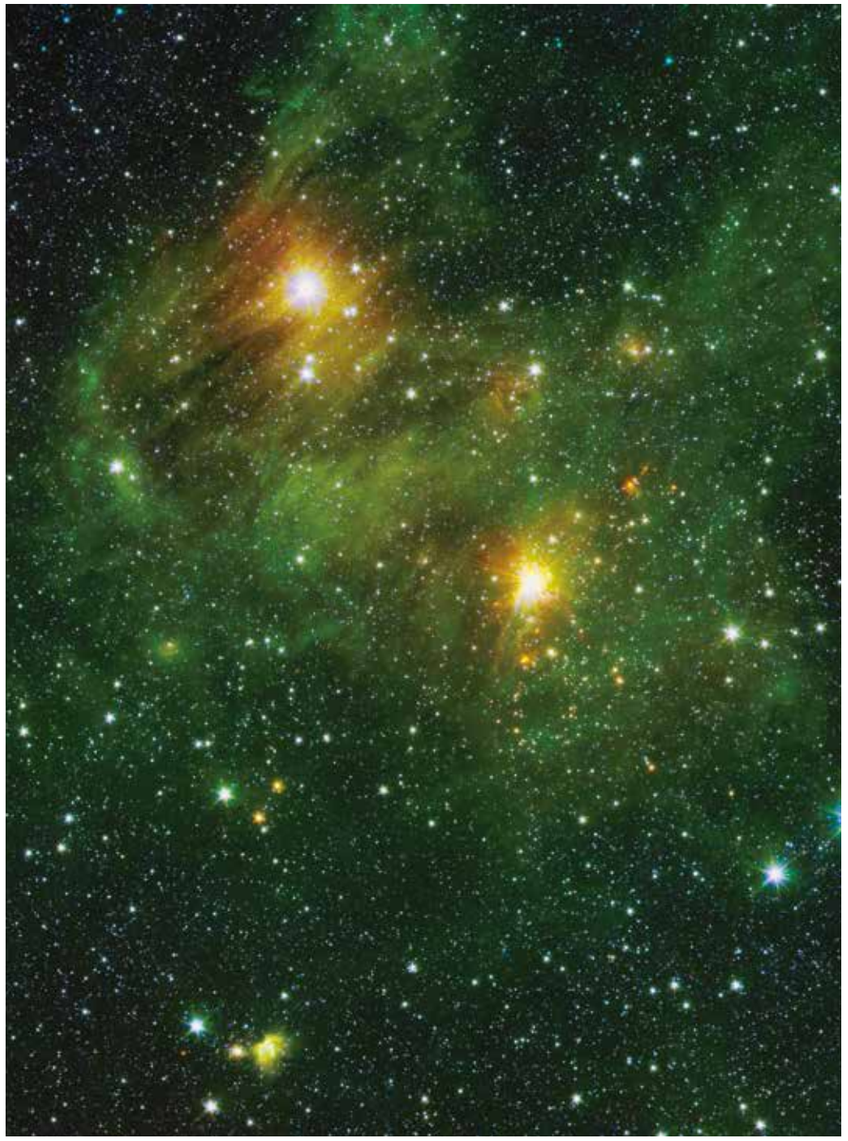
Staley, J. (2009). The phylogenomic species concept. *Microbiology Today* **36**, 80–83.

Vellinga, E.C., Wolfe, B.E. & Pringle, A. (2009). Global patterns of ectomycorrhizal introductions. *New Phytologist* **181**, 960–973.

Microbial biogeography and what Baas Becking should have said

CHRISTOPHER VAN DER GAST

Compared to the discipline of ecology, the science of microbial ecology is in its infancy. But can the models and principles of general ecology be used in combination with modern molecular methodologies to provide insights into how microbial communities organise and change in space and time?



Microbes on earth outnumber the stars in the universe by a factor of 9! *Stocktrek Images / Thinkstock*

EARLIER THIS YEAR I received an invitation from the SGM to write a short article on my work on microbial biogeography – being recognised as a pioneer and driver of this new field of microbial ecology ('*how nice*', I thought, '*of course I would be delighted to help serve the Society…*') – with this article and others to create an issue of *Microbiology Today* focused around 'biogeography' and to tie in with the 100 year anniversary of the death of Alfred Russel Wallace. Wallace was one of the early pioneers of what would become the scientific fields of ecology and evolution, along with others such as von Humboldt, de Candolle, Darwin, and many, many others.

What I know of Wallace and indeed his contemporaries like Darwin is vague at best – this is either a reflection on me personally (fair play – I admit I'm not perfect) or has wider reflections on incorporating the history of science into scientific teaching at say the undergraduate level. A third, and probably heretical viewpoint to some, is although such pioneers provided fundamental conceptual beginnings for ecology, evolution and biogeography, over a century later, it is difficult for me to relate their immediate influence and importance on the work I do now – although there are those who will no doubt strongly argue otherwise. To clarify my own viewpoint, we should be aware of what has gone before us – and I applaud people like the comedian and natural history enthusiast Bill Bailey's efforts to bring Wallace out of the shadow of Darwin – but ultimately for me science should be about moving forward and ever pushing those boundaries for societal and economic benefit.

WHAT IS BIOGEOGRAPHY?
Getting back on topic with regards to this piece on microbial biogeography – one of my overarching aims has been to bridge the gap between the disciplines of general ecology and microbial ecology. A key conceptual framework in ecology that I, and others, have since adopted is that of biogeography – the study of the distributions of biodiversity over space and time to reveal where organisms live, in what abundance, and why. But first, it is important to appreciate certain facts about the field of microbial ecology in general and then more specifically the diversity and abundance of micro-organisms.

MICROBIAL ECOLOGY
Ecology as a science is over 150 years old and over that time ecologists, such as Alfred Russel Wallace, Charles Darwin, Frank Preston, Robert May, Robert MacArthur and Edward Wilson (to name a few from the many), have developed principles and theories on the distribution and abundances of animal and plant species, and the interaction among species, and between species and their environments. In contrast, microbial ecology is in its relative infancy (~30–40 years). A main challenge for microbial ecologists over that shorter time frame has been to develop better (read 'molecular-based') techniques to survey microbial communities in their natural habitats. It could be argued that little robust microbial ecological theory exists – Koch's postulates and Baas Becking's '*everything is everywhere, but, the environment selects*' aside – I'll come back to the latter later on. As such, my fundamental work has and continues to be focused on better understanding and predicting how microbial communities assemble and develop, and how micro-organisms are distributed across different spatial and temporal scales; in essence, unravelling the complexity of microbial communities in their natural environments. I have achieved this by exploiting and (importantly) adapting models, theories, and principles from general ecology, coupled with ever improving developments in genomics and bioinformatics. I emphasise 'adapting' because it is important not to lose sight of the fact that the biology of animals and plants is different to that of microbes – and even the biology of different microbes can be staggeringly different. Therefore, a simple mapping of ecological theory on to microbial populations and communities is extremely naïve in that respect.

IMMENSE AMOUNTS OF MICRO-ORGANISMS WITH A HUGE DIVERSITY
It is well known that microbial ecology has been both driven and limited by the increasing plethora of techniques used to assess micro-organisms and their communities. In many cases this has led to an almost unhealthy obsession for using the latest methodologies, typically at the expense of the research questions being asked. However, these methodological developments are needed to assess the vast diversity and abundance of micro-organisms. Based on current best estimates – there are 10^{30} microbial individuals on Earth, when compared with 10^{21} stars in the universe, making the microbial world immense. It is now believed that microbes in our bodies add up to 100 trillion cells, 10 times the number of human cells (good news for those watching their weight – you can take 90% off straight away!). Further, with approximately 10^{9} bacterial individuals in 1 g of soil, you would only need to sample a handful of soil to surpass the current global human population of ~7 billion people. With regards to diversity estimates, it is reported that healthy people can share their bodies with up to ~10,000 species of microbes. In the environment it is estimated that there are 70 species per ml in sewage works, 160 per ml in oceans, and up to 38,000 per g of soil. These current best estimates of microbial abundance and diversity make those for larger organisms pale into comparison. Just the sheer extent of diversity and abundance should be enough of a driver for many to study micro-organisms and their ecology.

> "A simple mapping of ecological theory on to microbial populations and communities is extremely naïve."

Confocal micrograph of *Bacillus subtilis*, a Gram-positive bacterium, commonly found in soil. There are more bacterial individuals in a handful of soil than there are people on earth. *Wellcome Images, London*

BAAS BECKING SAID WHAT?
The adoption and adaption of ecological theory in microbial ecology began to really gain momentum from the middle of the last decade – centred largely on the question of microbial biogeography. Some researchers used the Baas Becking 'tenet' of microbiology '*everything is everywhere, but, the environment selects*' as a battle ground for whether microbial biogeography could exist or not. The increasing amount of papers published since then provides strong evidence for microbial biogeography (whether bacteria, archaea, fungi or protists) and indeed there is evidence for certain scenarios where no biogeographical patterns are found to exist. In retrospect, the Baas Becking tenet now seems a ridiculous statement to base debate on microbial biogeography. It is probably the case that '*some things are everywhere and some things are not. Sometimes the environment selects and sometimes it doesn't.*' – admittedly this is not as snappy as the original but it is based on factual truth. Clearly, the question should be what factors are driving patterns of spatial or temporal distribution, as we need to unravel and understand the underlying mechanisms for such patterns of diversity and distribution.

Finally, the potential of exploiting theories, models and principles from general ecology, coupled with ever-improving molecular methodologies, could well provide invaluable insights into how microbial communities organise and change in space and time. This increased knowledge of microbial community ecology will help us better understand and predict changes in the natural environment, allow improved manipulation of agricultural and industrial processes and give improved protection of human health.

CHRISTOPHER VAN DER GAST
NERC Centre for Ecology & Hydrology, Maclean Building, Benson Lane, Crowmarsh Gifford, Wallingford, Oxfordshire OX10 8BB, UK. *Email* cjvdg@ceh.ac.uk. He is currently learning more about Alfred Russel Wallace.

Biogeography of marine actinomycetes and the secondary metabolites they produce

PAUL R. JENSEN

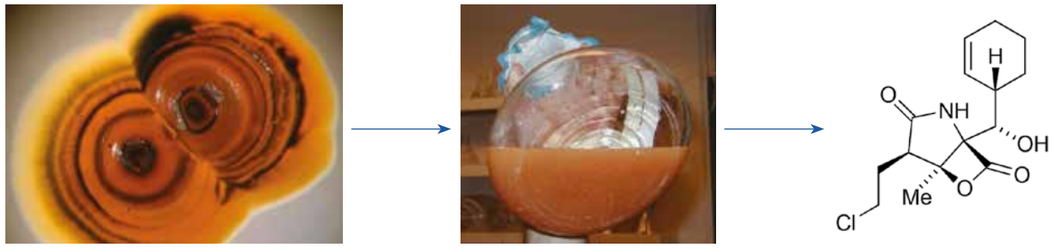
The discovery of new antimicrobials has failed to keep up with the rise of drug-resistant bacterial infections. But might the answer come from the marine environment? And what opportunities does this provide for finding correlations between taxonomy, biogeography and secondary metabolite production?

The marine environment.
iStockphoto / Thinkstock

SINCE THE DISCOVERY OF STREPTOMYCIN by Selman Waksman in 1943, microbially derived antibiotics have dramatically improved human health and well-being. But not all bacteria produce antibiotics. In fact, the vast majority of microbially derived antibiotics have been discovered from the genus *Streptomyces*, which single-handedly played a major role in shaping the pharmaceutical industry in the mid-20th Century. Despite the importance of microbially derived natural products as a source of antibiotics and other medicines, diminishing returns on actinomycete-based drug discovery efforts have led the pharmaceutical industry away from soil microbes as a resource for new drug leads in favour of alternative discovery platforms, such as combinatorial chemistry. Unfortunately, these new approaches have not kept pace with the demands to treat drug-resistant bacterial infections and other chronic diseases. In response, there has been a resurgence of interest in natural product research that includes the exploration of new microbial resources such as those that occur in the world's oceans.

THE GENUS *SALINISPORA*

While many of the actinomycetes that can be cultured from marine samples appear no different from those that occur on land, there are exceptions. One example is the genus *Salinispora*. This taxon displays clear evidence of adaptation to life in the sea, including a failure to grow when seawater is replaced with deionised water in the growth medium. Most reports of this taxon come from marine sediments, where they have been estimated to occur in abundances of approximately 10^3 per ml. When compared to total bacterial counts of 10^9 per ml, they can be considered a part of the 'rare biosphere'. *Salinispora* species are a rich source of secondary metabolites, including salinosporamide A, which has entered clinical trials for the treatment of cancer (Fig. 1). This finding has prompted extensive surveys of the diversity and distributions of *Salinispora* species in the hopes of finding additional drug candidates and other structurally unique secondary metabolites. The results have provided opportunities to test for correlations between *Salinispora* taxonomy (who they are), biogeography (where



S. tropica growing on an agar plate

S. tropica growing in liquid culture

Salinosporamide A

Fig. 1. **Compounds derived from marine micro-organisms that are in clinical development for the treatment of cancer include salinosporamide A, which was discovered from *S. tropica*. This compound is a potent and highly selective inhibitor of the 20S proteosome and is being evaluated for the treatment of multiple myeloma in addition to other types of cancer.**

they live), and secondary metabolite production (selective traits that provide survival advantages).

While there are clear barriers to surviving dispersal in the case of bacteria that inhabit extreme environments such as hot springs, barriers are less apparent for actinomycetes such as the genus *Salinispora*, which produce resistant spores that have the capacity to remain dormant until suitable growth conditions are encountered. Thus it is not surprising that *Salinispora* species have been cultured from near-shore tropical and sub-tropical sites around the globe (Fig. 2). What is more surprising is that they have yet to be cultured from deeper or more temperate locations despite having been detected with culture-independent methods from these locations, including ocean sediments as deep as 3,000 m in the South Pacific Gyre and greater than 5,000 m in the Canary Basin. While the conditions required for the cultivation of these deep-sea strains remain unknown, their detection provides intriguing evidence for global oceanic dispersal.

At the species level, biogeographic patterns begin to emerge with *S. tropica* having only been reported from the Caribbean, and *S. pacifica* from most sites except the Caribbean. This could represent an example of speciation due to geographic isolation. However, there are other potential explanations, including environmental factors that prevent the growth of one species at a particular site or relative abundances (i.e. one species may be below the detection limits of the methods applied). While it's relatively straightforward to demonstrate the presence of an organism at a specific site, it's much more difficult to demonstrate its absence, as made clear by the adage '*absence of evidence is not evidence of absence*'. Deep-sequencing techniques will provide new opportunities to further test for the presence of the three *Salinispora* species among global collection sites and better address the Baas Becking hypothesis '*everything is everywhere, but the environment selects*'.

The biogeography of *S. arenicola* suggests a different evolutionary paradigm. This species has the broadest distribution, having been recovered from all sites from which the genus has been reported. Its consistent co-occurrence with the other two species suggests they may be ecologically distinct. While any such differences have yet to be clearly established, it is interesting to note that the major phenotypic trait (subsequently confirmed at the genomic level) that differentiates the three *Salinispora* species is secondary metabolism. This presents the intriguing possibility that secondary metabolites represent ecotype-defining traits in *Salinispora* species. This possibility is all the more surprising given that the genes responsible for secondary metabolite biosynthesis in these bacteria are known to be subject to horizontal gene transfer.

It is now well established that horizontal gene transfer is a major force in bacterial evolution. This is a remarkably effective process that provides the immediate opportunity to test the products of new genes as opposed to waiting for existing genes to evolve. In the case of secondary metabolism, it's not only a single gene that can be transferred, but also entire gene collectives that account for secondary metabolite assembly and also regulation, transport and resistance. The transfer of these pathways, which can exceed 100 kb, provides immediate opportunities to test the effects of new secondary metabolites on fitness.

The biogeography of *Salinispora* secondary metabolism is providing interesting insight into the ecology and evolution of the three species. One of the more interesting observations is that all *S. arenicola* strains examined to date, including those derived from global collection sites, produce compounds in the rifamycin class. There is clear evidence that the biosynthetic pathway responsible for the production of this compound was acquired by horizontal gene transfer, yet it has become a diagnostic phenotype of the species. The notion of a chemotaxonomy associated with secondary metabolism is at odds with horizontal gene transfer, and implies the existence of strong selective pressures to maintain the production of this compound after the pathway was acquired. Given that *S. arenicola* is essentially a clonal species at the 16S rRNA level, the population that acquired this pathway has spread via ocean currents at a pace that far exceeds the rates at which changes are accumulated in this gene.

> "We are entering a new age of natural product discovery that is being guided by genomic blueprints and bioinformatic assessments of secondary metabolite biosynthetic potential."

While it is clear that some pathways can be shared among all individuals within a *Salinispora* species, the distributions of most pathways are more limited. In particular, there is evidence that pathway distributions are correlated with location, suggesting that populations are sampling from local gene pools. One might imagine that *Salinispora* species are constantly acquiring new biosynthetic pathways and testing their products in an ongoing experiment in chemical ecology and natural selection (Fig. 2). In some cases, the pathways sweep through the entire population such that the trait becomes a phenotypic marker for the species. Alternatively, the acquisition of a pathway may provide new opportunities for niche exploration and thereby drive diversification. If correct, these processes imply that secondary metabolism may be far more important for the ecology and evolution of bacteria than previously appreciated.

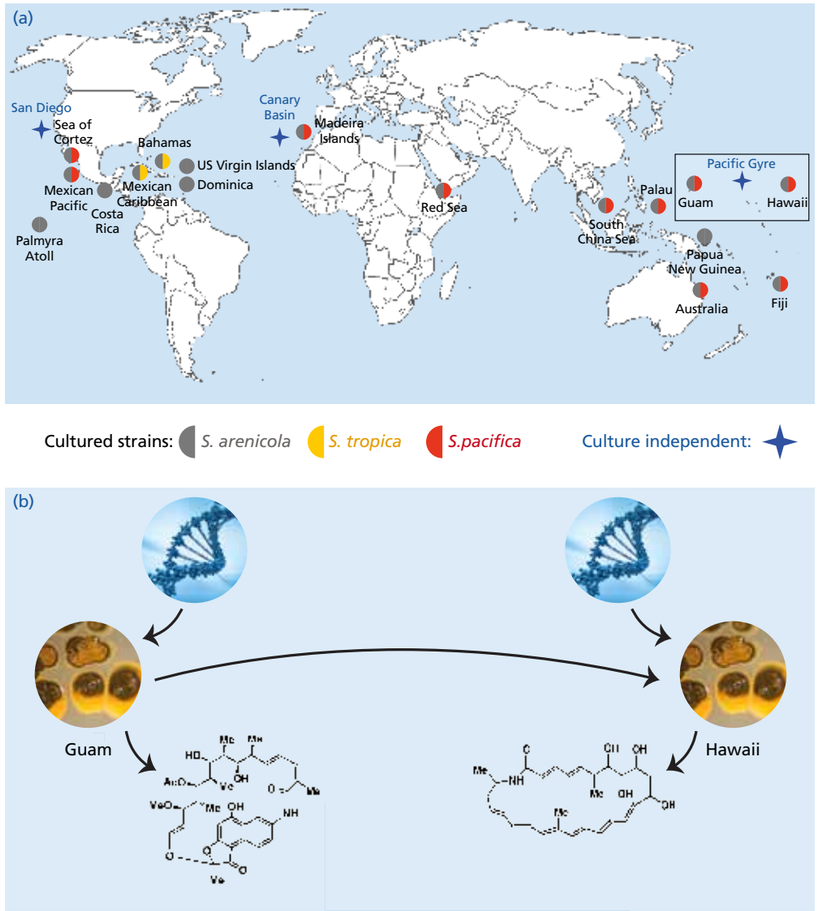


Fig. 2. **Global distribution of *Salinispora* species. (a) Reports come from multiple research groups and global collection sites and include the culture-independent detection of the genus in sediments collected as deep as 5,000 m from the Canary Basin. (b) There is evidence that *Salinispora* species (pictured here as colonies growing on agar plates) are sampling secondary metabolite biosynthetic pathways from a local gene pool. The products of these pathways include biologically active small molecules, which may provide a selective advantage in that particular environment. As strains move to a new location (direction inferred), they will have access to a new gene pool that may provide opportunities to test different secondary metabolites.** *Pauline Capote (DNA image from iStockphoto / Thinkstock)*

CONCLUSIONS

We are entering a new age of natural product discovery that is being guided by genomic blueprints and bioinformatic assessments of secondary metabolite biosynthetic potential. Yet the genetic resources that will inform future discoveries remain distributed among strains and habitats in ways that we have not yet begun to decipher. The emergence of genomics-based natural product discovery will inevitably provide exciting new insight into the biogeography of natural-product-producing bacteria and the biosynthetic genes that assemble these useful compounds.

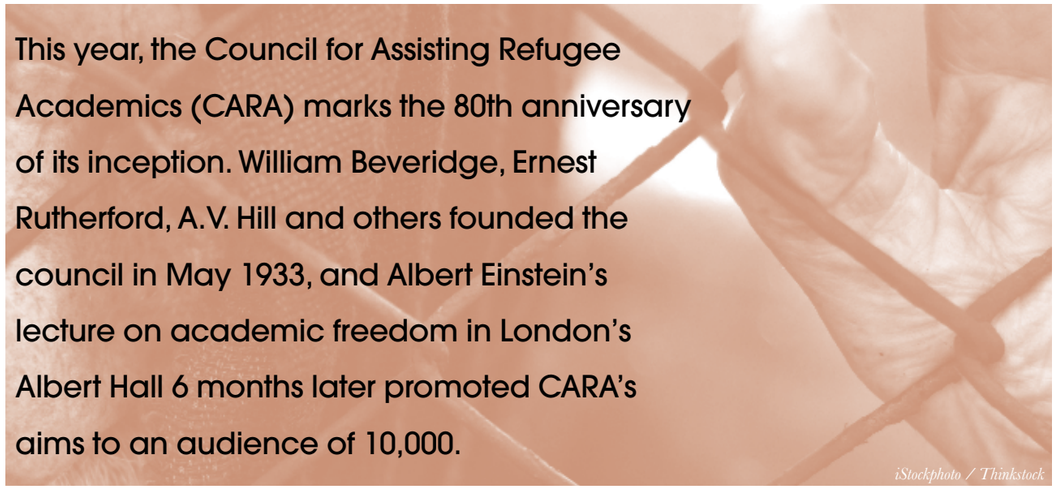
ACKNOWLEDGEMENTS

The author acknowledges financial support from the National Institutes of Health (NIH), Fogerty Center International Cooperative Biodiversity Groups program (grant U01- TW007401-01).

PAUL R. JENSEN

Scripps Institution of Oceanography, University of California San Diego, 9500 Gilman Drive, La Jolla, CA 92093-0204. *Email* pjensen@ucsd.edu

CARA microbiologists – then and now



This year, the Council for Assisting Refugee Academics (CARA) marks the 80th anniversary of its inception. William Beveridge, Ernest Rutherford, A.V. Hill and others founded the council in May 1933, and Albert Einstein's lecture on academic freedom in London's Albert Hall 6 months later promoted CARA's aims to an audience of 10,000.

iStockphoto / Thinkstock

MANY FAMOUS, and less-celebrated academics have benefited from CARA's humanitarian and financial support to rebuild their lives after fleeing from the tyranny of a diverse range of countries and regimes. The origins, of course, were in the flight of Jews from Nazi Germany in the 1930s, and from this quarter many famous careers were built on the support provided by CARA in the UK, and The Scholar Rescue Fund in the US. Through the Cold War and latterly in the Middle East and Africa, CARA has continued to provide help to all those individuals who arrived at its door. A number went on to achieve great things in science (Hans Krebs and Max Perutz, for example) and in other fields (**www.academic-refugees.org**).

The SGM joined with CARA in 2011 to set up an annual grant of £5,000 to support microbiologists who found themselves forced to shelter in the UK, and specifically to help them rescue their careers. This is a landmark because it is the first learned society in the UK to make such a commitment and it is to be hoped that others will follow this lead.

The Society's first President, Alexander Fleming, and Ernst Chain shared the Nobel Prize for identifying penicillin with Howard Florey. Chain, who was later to learn that his mother and sister had died in a concentration camp, fled Germany in 1933 and was the first of CARA's microbiologists, arriving as the charity was formed. With just £10 in his pocket, Chain joined Gowland Hopkins' laboratory at Cambridge University, then went on to Oxford as a pathology lecturer in 1935 where he met up with Florey in 1939, to revisit Fleming's original observations on penicillin.

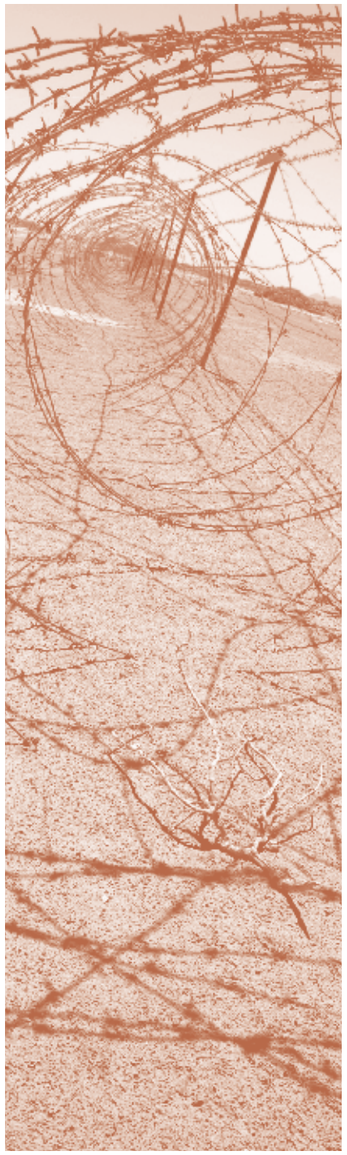
Many SGM members will also be familiar with Salvador Luria, who shared a Nobel Prize for pioneering work on the genetics of viruses, another Jew fleeing fascism in the 1930s, this time from Italy to the US.

Two major challenges that have emerged in the last 10 years are a result of the conflicts in Iraq and Zimbabwe and, in addition to working with refugee academics in exile, CARA brokers outreach programmes in both countries. Rebuilding shattered lives is the main activity, but helping to reconstruct academic and research infrastructures through supporting individuals is also now a part of the broader remit.

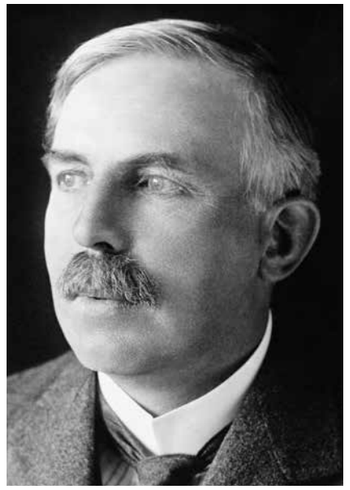
In 2011 and 2012, the SGM grants to CARA supported Banaz, an agricultural genetics lecturer who fled death threats in Iraq. SGM provided essential funds for fees and childcare while she studied for a MSc in Medical Microbiology at the London School of Tropical Medicine. In 2012, SGM funds also provided tuition fees for a biochemistry lecturer who, while in Libya, helped Sudanese refugees with medical assistance and supplies and whose life was consequently under threat when he returned to Sudan. Accordingly, he has been able to complete a MSc in Biotechnology in the UK and has just been accepted onto a PhD programme. Tuition fee support from SGM was also awarded to Hamdin, a microbiology lecturer in Khartoum who escaped to the UK after detention and torture. After periods of voluntary laboratory work, he is now reunited with his wife and on course to graduate with a PhD from the University of Bristol.

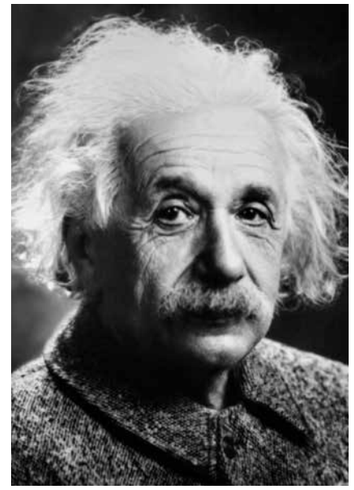
These are just tiny fragments of CARA's work with refugee academics. SGM has enabled formally, for the first time, targeted financial support to be directed to academic refugees in a specific discipline, and the membership should be proud that it is microbiologists who are the first to benefit from this approach.

ALAN McCARTHY & PAUL BRODA
CARA Council. *Emails* aj55m@liverpool.ac.uk; paulbroda@talktalk.net



iStockphoto / Thinkstock





Ernest Rutherford (1871–1937) (*left*), New Zealand physicist, and Albert Einstein (1879–1955) (*right*), who were both instrumental in the founding and promotion of CARA in its early days. *Library of Congress / Science Photo Library*

Professional recognition for microbiologists at the Society of Biology

Microbiology is an extremely diverse branch of the biological sciences, offering those working in sectors such as food, water and waste valuable careers in academia, industry, education or research. However, competition remains high and it is increasingly essential that scientists working within this field can demonstrate transferable skills. Continuing professional development is therefore vital for the microbiologists of today.

THE SOCIETY OF BIOLOGY'S

Professional Registers in Science provides support to scientists for professional recognition and development at all levels and stages of their career. Under a license from the Science Council, the Society of Biology offers three levels of professional recognition and development awards: **Registered Science Technician (RSciTech)**, **Registered Scientist (RSci)** and **Chartered Scientist (CSci)**. The registers are a UK-recognised pan-science scheme regulated by the Science Council, and the Society of Biology is one of eight professional bodies licensed to award professional recognition.

In order to become professionally registered, applicants must join the Society of Biology and demonstrate how their relevant skills and experience (gained in the work place) fit the competency requirements in five areas for professional registration: application of knowledge and understanding, personal responsibility, interpersonal skills, professional practice and professional standards.

Applicants can apply online by completing the Society of Biology application form; applications are then sent for external evaluation by Society of Biology assessors. Alternatively, the Society of Biology also runs professional registration by interview, whereby candidates are given the opportunity to discuss with our assessors how their skills fit the competency requirements.

By gaining professional registration, scientists and technicians are awarded one of the above nationally recognised post-nominal letters. Gaining this status demonstrates the skills, competencies and experience of registrants and signals their commitment and dedication to gaining external verification of their ability. Ultimately, therefore, these awards highlight the transferable skills of registrants.

Candidates need to submit evidence of Continuing Professional Development (CPD) every year to maintain their professional registration and again this signals dedication to gaining new skills, knowledge and experience. The Society of Biology has developed a simple but thorough online system for recording and submission of CPD.

Guidance for all the Society of Biology professional registers and our CPD scheme can be found at **www.societyofbiology.org/development**

Sara White, a Senior Biology Technician (City of London School) received Registered Science Technician (RSciTech) by applying through the Society of Biology online application system. She says: '***I see this as recognition of 30 years of working as a technician.***'

Stuart Phillips, a Scientist from Life Scan (Scotland), received the Registered Scientist (RSci) professional award by interview with the Society of Biology; he is excited to have received this: '***The award means that the level of work that I undertake has been externally verified as meeting an established standard. This gives me greater confidence in the value of my work***'.

For employers, professional registration clearly demonstrates external recognition of the skills, competencies and experiences of their employees. In addition, maintaining professional registration via CPD signals their dedication for professional development.

Karen Heaton, Microbiological Services Manager at Severn Trent Water, says: '*This scheme is a great way for analysts to get recognition for their development and skills which they cannot get from their job title. The analysts had a real sense of achievement when they got their new recognition.*'

Through training and development in the workplace, Registered Science Technicians and Registered Scientists may become eligible to move along a pathway of progression of work towards Chartered Scientist status. Chartered Scientist status provides a benchmark for scientists working in more senior or managerial roles in science, and is recognised as a hallmark of excellence in the UK and the European Union.

For more information on professional recognition for microbiologists, contact Joanne Needham at the Society of Biology: **joanneneedham@societyofbiology.org**

Members of the Society for General Microbiology can enjoy a 50% discount on Society of Biology membership for the first 2 years. For further details please contact Mark Leach: **markleach@societyofbiology.org**

The Society of Biology's Professional Registers in Science is supported by the Gatsby Charitable Foundation.

JOANNE NEEDHAM
Professional Registers Officer,
Society of Biology

The first Registered Scientists and Registered Science Technicians received their awards at the Biology Week Parliamentary Launch (October 2012). *Society of Biology*

DIY biology: bio-inspired or biohazard?

Do-it-yourself (DIY) biology is a rapidly growing global movement in which individuals, or small informal groups, seek to experiment with and also promote public access to biotechnology.

DEPENDING ON THEIR PARTICULAR APPROACHES and background, these amateur biologists might call themselves 'biohackers' or 'bioartists' and their activities might include building their own low-cost laboratory equipment (microscopes, centrifuges, PCR machines) and attempting to perform experiments and research that would normally be confined to academic or industrial environments.

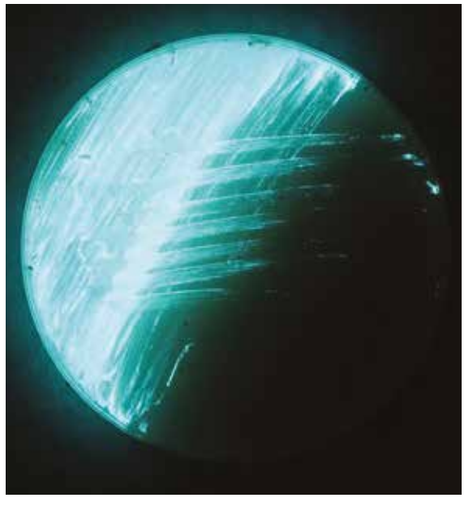
Emphasising its 'do-it-yourself' credentials, DIY biology is often carried out with little financial resource, by individuals with little or no formal training, in the absence of oversight by professionals, and mostly outside of governmental regulation and legislation. The specific aims of DIY biology's participants are manifold, ranging from simply allowing easy access to the wonder of this science, to making political statements and challenging what some see as overly prohibitive legislation. Indeed, there seems to be no limit to the ambition of these projects with one group imagining a future where '*self-aware citizens may manage their own stem cells, grow them in the garage and store them in the fridge*'.

DIY biology inevitably interfaces with microbiology and it is here that it can add great benefit to outreach and engagement, but also gives rise to significant concerns and criticisms. There are a number of excellent examples of DIY biology practice. Genspace is a non-profit laboratory in New York that is open to members of the public and promotes education in molecular biology using DIY biology. At a cost of €4,000, Cathal Garvey has converted a bedroom at his home in Cork, Ireland, into a Containment Level 1 laboratory. Manchester's Madlab host the UK's largest DIY biology group who regularly run engaging public workshops that feature many aspects of DIY microbiology. My own small contribution to this field is *Microbiology at Home: A short non-laboratory manual for enthusiasts and bioartists*, a manual of methods for making various microbiological media at home with ingredients that are readily available at supermarkets.

General Kitchen Agar (GKA), the most widely used medium for DIY microbiology. GKA is a novel modification of Plate Count Agar. It is made from ingredients available at supermarkets and can be used for the growth of a wide range of bacteria. *S. Park*

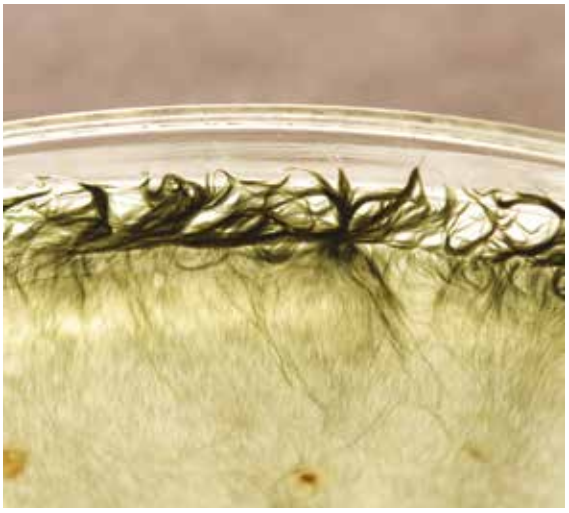
DIY biology does, however, suffer from a number of criticisms related to issues of safety, its scope and how it is reported. The dispersed and unregulated nature of the work gives rise to concerns that an individual or group might attempt to deliberately or inadvertently grow and release harmful biological agents. Additionally, where DIY genetic modification is being performed in an unregulated environment, there is a real danger that genetically modified organisms (GMOs) may be released into the environment. The examples of this type of DIY biology that I have seen for myself involve simple self-cloning and transformation with plasmids that are exempted from all of the GMO containment/use requirements. Nevertheless, persons undertaking these activities are still required to ensure that exposure of humans and the environment to the GMO is reduced to the lowest level that is reasonably practicable and to work under the general principles of good microbiological practice and occupational safety. This is clearly not the case in some of the examples that I have witnessed, with, for example, food and drink being stored and eaten in the same spaces where these experiments are being carried out. These safety concerns mean that DIY biology is now attracting the interests of governments. The prospect of 'biohackers' creating pathogens and GMOs in unmonitored garage laboratories led the Federal Bureau of Investigation (FBI) to begin sending representatives from its directorate for weapons of mass destruction to DIY biology conferences in 2009 and, in 2012, the FBI even invited and paid for the flights of around 60 of the most prominent figures within the DIY biology movement from across the world to a 3-day FBI-organised conference in California.

Bioluminescent Kitchen Agar (BKA), a medium for the isolation and growth of bioluminescent marine bacteria. It is made from ingredients available at supermarkets. *S. Park*



As a scientist, I see a great deal of hyperbole and over-enthusiastic reporting about DIY biology. At the moment, there is a vast chasm in the possibilities available to an amateur biologist, compared to someone with access to a traditional laboratory. I don't want to dismiss DIY biologists or to suggest that you need to be highly trained to be able to do this properly, but with the resources available at present, there has been little meaningful scientific impact from the widespread use of biological technology that the early pioneers promised. I'm not seeking to belittle the DIY biologists but compared to my experiences within various scientific institutions I see much of their practice as 'bio-tinkering', which is not to mean that their work is without merit. At their worst, DIY biology activities can trivialise the scientific endeavour that preceded them and can also give rise to potentially damaging misinformation in their search for sensationalism.

DIY biology and the scope of some of its claims have acquired considerable momentum through the advent of synthetic biology. The art world views some examples of DIY biology very differently to scientists, but I find some of these particularly troubling, such as '*The Cactus Project*', an artwork based on a transgenic cactus that allegedly makes use of *Agrobacterium*-mediated gene transfer to introduce hair keratin genes into its cells. As a scientist, I immediately see the resulting hairy cactus as a hoax, but I suspect that



Left **Cyanobacterial Kitchen Agar (CKA), a medium for the isolation and growth of cyanobacteria. It is made from ingredients available at supermarkets and garden centres.** *Below* **The preparation of Cyanobacterial Kitchen Agar (CKA).** *S. Park*

many artists and members of the public do not view it as such. Tuur Van Balen's '*Pigeon d'Or*' project involved the creation of a genetically modified *Lactobacillus* species that produces soap, which he proposes to introduce into feral pigeons, to enable them to defecate soap. This is a fun idea but it trivialises the promise of synthetic biology and glosses over serious ethical and safety issues that the project raises. Adam Zaretsky is a bioartist who is feted within the arts community because he constantly finds himself on the edge of legality. Ironically, the title of one of his recent works the '*Errorarium*' (a home for zebrafish embryos injected with algae) may reflect his tendency to perpetuate error and misinformation. For example, Zaretsky believes that algae can apparently '*revert just like* E. coli *to things like cholera*' – he has previously stated '*it does happen*'.

My own viewpoint is that I do not want to see the door closed on DIY biology, which, at present, can offer a valuable means of public engagement in microbiology and in the future it might make some meaningful scientific impact. However, I do believe that it is important for DIY biologists to seek at least some insight from scientists so their work is safe and may be equally valued by both artists and scientists alike. An exemplar in this movement is Genspace, which has a strict policy against working with organisms that can infect humans and it has established a safety review board of experts from the Massachusetts Institute of Technology, the United States Department of Health and Human Services and other institutions to approve proposals for new experiments.

SIMON PARK, University of Surrey
Email s.park@surrey.ac.uk

FURTHER READING

Genspace, New York City's Community Biolab. **http://genspace.org**

Indie Biotech, an open source biotechnology resource for everyone. **www.indiebiotech.com**

bioCurious, a community biology lab for amateurs, inventors, entrepreneurs. **http://biocurious.org**

Microbiology at Home: a short non-laboratory manual for enthusiasts and bioartists. **http://exploringtheinvisible.com/2012/11/05/94**

Practical microbiology in schools

The importance of practical work in science is widely accepted, and it is acknowledged that quality practical work motivates students and promotes engagement (SCORE). It enables students to acquire skills from both laboratory and field-based work, it supports the learning of scientific knowledge and promotes an understanding of the key concepts that underpins learning. *I listen – I forget, I look – I remember, I do – I understand* (Hodson).

STUDIES OVER TIME have collected teachers' views on the aims of practical work. Work by Kerr in 1964, Beatty & Woolnough published in 1982 and Swain and colleagues in 1998 all showed that four aims remained constant with teachers, regardless of the kind of practical work being done:

- to encourage accurate observation and description
- to make phenomena more real
- to arouse and maintain interest
- to promote a logical and reasoning method of thought.

These aims still apply to practical work done in schools today.

With their small size, rapid growth rate and relatively low cost, microbes are ideal for practical work in schools. Unlike many organisms, they do not necessarily have to be maintained over long periods and do not have to be fed and watered at weekends! Apart from their fundamental importance, micro-organisms can be used to demonstrate principles of biology just as well as plants and animals. For example, algae can be used to teach photosynthesis. They can also be used to model industrial processes, as well as offering opportunities for teaching across the curriculum. Practical microbiology also offers scope for quantitative project work providing data, which can be analysed using statistical techniques.

Teachers can be put off using microbiological investigations because of worries about safety, but reassurance is available from the SGM on all safety issues. The Society can provide information on where to find resources, including cultures, and offer many suggestions for suitable and safe investigations. More information is available from the Society's dedicated educational website (**www.microbiologyonline.org.uk/teachers/safety-information**).

To support the teaching of practical microbiology the Society provides two practical manuals free to schools, ***Basic Practical Microbiology*** and ***Practical Microbiology for Secondary Schools***, which give introductions on practical microbiology and provide a range of microbiological investigations to try. The two manuals are supported by short videos demonstrating basic practical microbiology techniques (**www.microbiologyonline.org.uk/what-s-new/videos**)

Photo I. Atherton

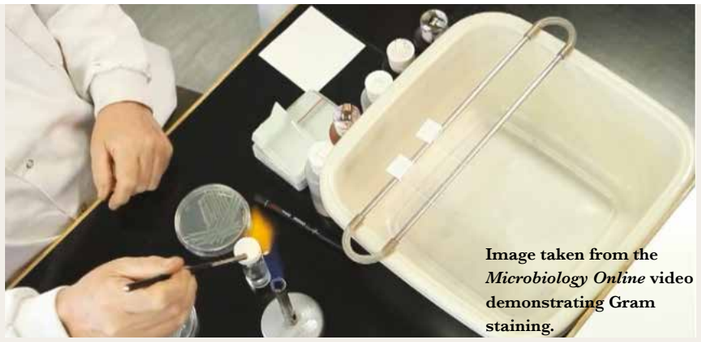
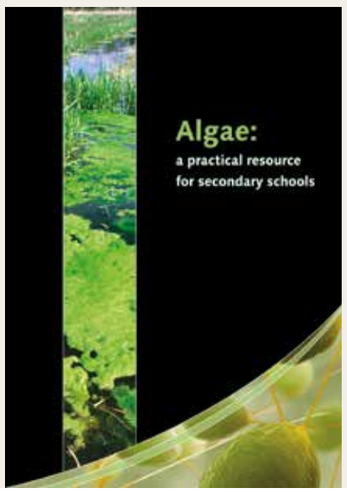


Image taken from the *Microbiology Online* video demonstrating Gram staining.



In 2012, to further support practical microbiology teaching in schools, the Society published, ***Algae: a practical resource for secondary schools***. The first copy is free to school members. The price to non-members is £15. Algae are common, easy and safe to handle, easy to source and cheap to use. They can be used to illustrate a range of topics, including:

- bioluminescence
- eutrophication
- gas cycling
- microscopy
- phototaxis

As well as practical activities, the SGM produces a wide range of microbiology teaching resources for all age groups from primary to post-16. The material is carefully targeted to meet curriculum requirements and fit with the specifications for science learning.

Visit the SGM resources page for information: **www.microbiologyonline.org.uk/teachers/resources**

If you have any ideas for future resources or have any questions about teaching practical microbiology in schools, please do not hesitate to get in touch with our Education and Outreach Officer, Theresa Hudson (**t.hudson@sgm.ac.uk**)

DARIEL BURDASS, SGM

FURTHER READING

Beatty, J.W. & Woolnough, B.E. (1982). Why do practical work in 11–13 science? *School Science Review* **63**, 758–770.

Hodson, D. (1993). Rethinking old ways: towards a more critical approach to practical work in school science. *Studies in Science Education* **22**, 85–142.

Hodson, D. (1998). *Teaching and Learning in Science: Exploring and Developing Personal Understanding Through Practical Work*. Open University Press.

Kerr, J.F. (1963). *Practical Work in School Science: an enquiry into the nature and purpose of practical work in school science in England and Wales*. Leicester: Leicester University Press.

Science Community Representing Education (SCORE) Practical Work in Science: a report and proposal for a strategic framework **http://score-education.org/downloads/practical_work/report.pdf**

Contemplating what's next after your PhD? Go to GRADschool

For more than 10 years, Vitae have run a highly regarded intensive three-day residential practical learning and development programme for PhD students called GRADschool. Here is why you should attend!

GRADschool is designed to make you think about you – your strengths, your weaknesses, your aspirations, your life outside a PhD. It is about getting to better understand your professional skills, and using that knowledge to think more deeply about how it might affect your future career choices.

In addition to the Vitae-run GRADschools (the next Vitae GRADschool takes place 22–25 October 2013 in Windermere), many universities also run in-house GRADschools. Find out if your institution (or a nearby one) runs a GRADschool that you can attend.

To support our student members to make informed choices about their next career step, the Society offers grants to contribute the full course fees of a Vitae GRADschool. Two grant recipients from 2012 describe their experience at GRADschool and what they learned about themselves.

Photo C. Tranthar

EMMA TRANTHAM

University of Bristol

Third-year clinical veterinary science PhD student studying carriage of Campylobacter in chickens

'Tip for 2013 attendees: It really will be as exhausting as they say it will be!'

I'm really grateful to the Society for General Microbiology for funding my place on the GRADschool. It was a great experience and I can barely contain my enthusiasm (or my wildly gesticulating arms!) when I speak to people about it.

Over the three days we were given a series of tasks to do – some were obviously relevant (like interview practice), but I didn't fully appreciate the purpose of some (like climbing trees and ropes at Vertical Air) until I reflected on them later. For me, the most helpful aspect of GRADschool was that it clarified the values that are important to me (I found that previously I had mostly just assumed what was important to me and not spent an awful lot of time thinking about it). It also made me feel more motivated about my PhD and better able to handle getting it finished.

'GRADschool isn't about showcasing every single type of career that is on offer, it's about finding out your own strengths and weaknesses and using this knowledge to help with your decision-making.'

RACHEL ROBERTS

University of Reading

Third-year soil science PhD student studying Rhizobium diversity and green manure

Not to sound corny, but everything about GRADschool was useful! There was a lot of group work where we told each other what we thought (in a constructive and helpful way!). This included a 'mock

Photo J. Roberts

Career options: research in industry


Fuse / Thinkstock

'There is a lot of opportunity for self-development, but it really is up to you how to use that!'

interview' session where I was interviewed by my group for a job I would have applied for in real life and then given some amazing feedback. I learned that I appear confident even when I don't feel it (my group thought my ideal job would be presenting Gardener's World!).

Before the course I had written a list of what I want to do when I finish my PhD, which included science policy, science communication, charity work and postdoc-ing, or some combination of the above! After GRADschool I'm not any clearer on what I want to do, but I am much more aware of what my skills are, and am much better able to look at job adverts objectively and see if I'm likely to be right for them – and them for me. I've realised that my job prospects are actually far broader than I initially thought, and that traits I've sometimes seen as weaknesses can be turned into strengths.

'GRADschool improved my confidence enormously and I am now much more likely to apply for positions that will really challenge me.'

FURTHER INFORMATION

Vitae GRADschool: www.vitae.ac.uk/researchers/15672/Vitae-GRADschools.html

SGM GRADschool Grants www.sgm.ac.uk/en/grants-prizes/careers-funds.cfm/gradschool-grants

I speak to many PhD students (and postdocs) at conferences and careers events and get asked many questions about moving from research in academia to industry. But I also get a sense that many don't really understand what 'industry' means, how it differs from academia and how the skills they are gaining in academia should be promoted on their CV for an industry job.

THIS ARTICLE COMPARES research in academia and industry to inform those considering the move and to help them assess whether the grass will be greener on the other side. A recent PhD graduate who has successfully made the move is profiled.

WHAT IS 'INDUSTRY' AND ARE THERE JOBS THERE?

A whole spectrum of companies are involved in commercial research; from global giants in pharmaceuticals, food, medical and industrial biotechnology, medical technology and diagnostics to small- and medium-sized enterprises (SMEs), to contract research organisations (CROs), to biotech and medtech start-ups. The Department for Business, Innovation & Skills reports that the UK had 4,500 life sciences companies employing over 167,000 people in 2012.

The global recession has affected sales and therefore corporate strategies and, certainly in big pharma, stories of site closures or reduction in numbers of employees seem to be commonplace. Despite the sense of doom and gloom this engenders, opportunities do exist in commercial research, but the nature and location of these opportunities is currently very fluid. Although there has

been an overall trend to shrink R&D, the sectors affected in each company may be different dependent on their corporate strategy; for example, one company may be divesting bioinformatics at the same time as another has placed an emphasis on mathematical modelling and systems approaches and is hiring people with computational skills. Also, when companies downsize it can lead to an increase in outsourcing and there have been a number of partnerships between big pharma and CROs announced.

HOW IS INDUSTRY DIFFERENT TO ACADEMIA?

In academia, research is undertaken (mostly) for non-commercial purposes in the pursuit of new knowledge and understanding (although you will have to convince a funder that there is a justifiable reason for the work being done). In this environment, there is opportunity and flexibility to follow an interesting lead or to make a change in research direction to see where it takes you; diverging from the specific aims of a grant may be a problem when the time comes to renew, but the risk is yours (or your Principal Investigator's), as is the reward.

In industry, research is undertaken for commercial purposes (to develop a product to sell). You will not be pursuing your own ideas but the ideas of the company. You may be able to make a case for a new programme of research, but the decision is management's and will be guided by business considerations. Being driven by commercial opportunities makes this a highly reactive environment and tends to mean that the pace of change (projects starting or stopping) is faster than in academia. This can also make internal re-organisations more common. In industry there is the additional factor of the work being affected by mergers or takeovers.

In industry you will probably be working on multiple projects simultaneously as directed by management. You will (at least initially) have little/no say as to which projects. This could mean you work on a project that is new and fascinating or it may mean that you have to work on a product that you don't believe is a good idea, or just don't find interesting. Each project will have defined deadlines. In academia you know well ahead of time that a grant or abstract is due, and there is some flexibility in the way deadlines can be achieved over comparatively long periods (for example, getting enough publications for the Research Excellence Framework). If you miss the deadline, the impact is mainly on yourself. In industry, deadlines are more often and can come at short notice. It is not unusual for last-minute projects to be thrown your way. This will now be your priority and you will have to make this short deadline as well as manage your other deadlines.

APPLYING FOR A JOB IN INDUSTRY

When applying for a job in industry focus on skills, achievements and goals and have a separate section listing your technical skills (especially if the job description specifically mentions certain techniques as essential/desired). In particular, make sure you cover the skills listed in the box below. Show them you are confident, personable and independent and that you have skills that could enable you to move up in the company.

SKILLS DESIRED BY INDUSTRY

- Communication
- Problem-solving
- Technical proficiency
- Ability to work in a team
- Ability to work in a hierarchical environment
- Ability to work to deadlines

Keep in mind that the first person to read your application/CV is likely to be someone in HR who may not have a science background. If you have taken the more 'academic' approach of listing each project name this will not be enough information for them to know that you fit the requirements of the job.

A tailored covering letter is very important for applying to an industry job and should specifically mention why you want to work for this company. For this (and definitely for the interview) review the website and learn about their current portfolio of products; show them you know about their company.

FURTHER INFORMATION

Pharmaceutical Industry Career information from ABPI: http://careers.abpi.org.uk/your-career/post-graduate-and-post-doctoral/Pages/default.aspx

Strength & opportunity 2012: the landscape of the medical biotechnology, industrial biotechnology and pharmaceutical sectors in the UK. Annual update – December 2012 (2012). Department for Business, Innovation & Skills: www.gov.uk/government/

Got a question about your career options?

Have a suggestion for other careers you would like to see featured in Microbiology Today?

Email careers@sgm.ac.uk

publications

UK Life Science Start-up report 2012 (2012). Mobius Life Sciences: http://mobiuslifesciences.com/report

Think 'skill' not 'D.Phil' (2012). Sarah Blackford, Bioscience Careers Blog: www.biosciencecareers.org/2012/01/think-skill-not-dphil.html

How to succeed in industry by really trying (2013). B.L. Benderley. Science Careers Magazine: http://sciencecareers.sciencemag.org/career_magazine/previous_issues/articles/2013_05_03/caredit.a1300090

KAREN McGREGOR, SGM

A JOB IN: COMMERCIAL RESEARCH

AVIKA RUPARELL
Research Microbiologist at Unilever Research and Development
Medical Genetics, BSc University of Leicester
Molecular Microbiology, PhD The University of Nottingham

Q How did you get a job at Unilever?

A I'd always wanted to experience industry research but I had no prior experience. When I finished my PhD at the end of 2011, the job market was tough so I widened my job search and applied for anything and everything that was relevant to my skills and expertise. I saw the job at Unilever on one of the popular online science job sites and applied. A PhD was not required for the role, but it definitely gave me an advantage over those applying with an undergraduate degree.

Q What's your typical working day like?

A My job involves in vitro testing of novel and existing formulations for product claim support. Every day is different and I find, compared to my PhD, there is much more variation in the nature of the laboratory work as I am involved in several projects with different aims. As well as the laboratory work, there will be meetings for delivery of the results via pre-prepared reports and presentations.

Q What are the most important skills you need to successfully do your job?

A Good communication skills! Each project is worked on by a team and these teams can be made up of people with different specialities. It is important that you can explain the work from your specialist area to the other team members so they will understand your results, ideas and opinions.

Q What are the highlights and lowlights of working in industry?

A The financial support available is on a completely different level to academic research. The money to support research and development in industry, such as for commercial products, comes from their sales. With Unilever being the third-largest consumer goods company in the world, the figures sometimes still surprise me! With finance comes the breadth of technology. Gaining experience with various robotics systems for high-throughput testing has been hugely enjoyable (and is an excellent addition to my CV). In this environment there are always more projects to do, more deadlines to meet and pressure to do more and more – but that is a part of every job. Though I'd say, compared to academia, the workload is controlled such that you are stretched but not stressed.


Photo V. Symington

Q What advice would you give to someone looking to move from academia to industry?

A Don't rule out applying for contract positions. My first appointment was a short-term contract and it has now been extended twice. From personal experience, I can understand the frustrations of not knowing whether you'll have a job in six or nine months, but the experience is invaluable. I'm gaining new knowledge and skills every day and I think that having a company like Unilever on my CV is going to boost the potential for my future career.

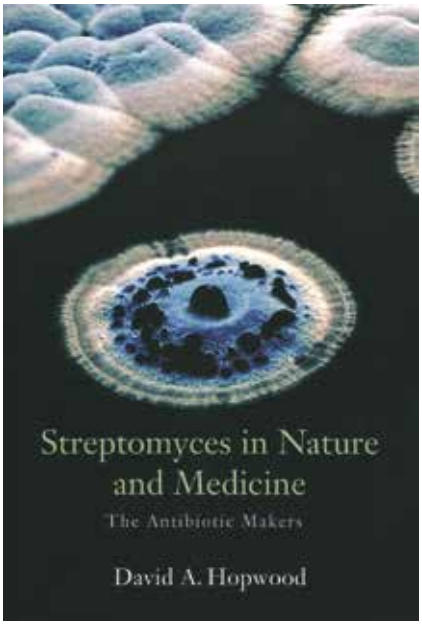
Happy 80th birthday Professor Sir David Hopwood!

IT IS RARE that you hold an 80-year-old as a role model to students in their 20s, but we are pleased to do so on the occasion of Professor Sir David Hopwood's 80th birthday. David is 80 this month after a remarkable career as a scientist, mentor and collaborator. He also served as President of the SGM, from 2000 to 2003.

David has worked for much of his career on the genus *Streptomyces*, and in particular the genetics and biology of *S. coelicolor* A3(2), undoubtedly the best-understood of the huge variety of actinomycetes. He has carved out his own niche in microbiology, and anybody doing serious work with *Streptomyces* has been to the John Innes *Streptomyces* laboratory in Norwich where David has led an eminent team working on this micro-organism. He has always been willing to share his knowledge and expertise, and techniques and strains, leading the *Streptomyces* community by example. This has led to a highly functional, interactive and innovative community that consists not only of academic researchers, but industrial researchers and companies. Streptomycetes produce the majority of the known naturally occurring antibiotics used in human and veterinary medicine, as well as antitumour, antiparasitic and other bioactive molecules, and research on the organisms has had huge impact (**www.bbsrc.ac.uk/research/impact/streptomyces-antibiotics.aspx**).

David has never been content to rest on his laurels. In 1997 he led the bid to sequence the *S. coelicolor* A3(2) genome, one of the early bacterial genome sequences and most complex at the time, due to its high GC content and large (8.7 Mb) linear chromosome. This gave even more insight into this remarkable organism and its relatives, driving the field forward.

David's scientific eminence has received many national and international honours. He was elected Fellow of the Royal Society in 1979, knighted in 1994 and awarded the SGM Prize Medal in 2011.



David and his wife, Joyce (who also has a significant birthday this month), are recognisable figures at conferences worldwide, and have always been supportive of the microbiology community. It is appropriate and pleasing that David's 80th Birthday will be celebrated with a conference at the John Innes Centre this September attended by many from across the globe who have reason to be grateful for his leadership.

On behalf of the SGM and its membership, we wish Professor Sir David and Lady Joyce Hopwood very happy birthdays.

PAUL A. HOSKISSON & NIGEL L. BROWN, SGM

Obituary: Professor Sir Kenneth Murray (1930–2013)

PROFESSOR SIR KEN MURRAY FRS, FRSE, BSc, PhD (Birmingham) (30 December 1930–7 April 2013) was an eminent scientist who developed some of the earliest methods for genetic engineering. He used these to produce the first effective vaccine against hepatitis B virus, which has saved countless lives worldwide.

Ken Murray was born in Yorkshire and brought up in the Midlands. He left school at 16 to join Boots in Nottingham as a laboratory technician, where his potential was recognised and he was persuaded to study part-time for a degree. He obtained a first-class honours degree in chemistry and then a PhD in microbiology from the University of Birmingham. It was in Birmingham that he met Noreen, who was to become a lifelong scientific colleague as well as his wife.

After working at Stanford University and the MRC Laboratory of Molecular Biology, Ken joined the University of Edinburgh in 1967. His scientific interests lay in methods for analysing and manipulating DNA. Along with Noreen and others, he helped develop recombinant DNA technology, and immediately put these methods to use – in developing a vaccine for a potentially fatal liver disease, hepatitis B. There was no reliable treatment and around 300 million people were infected with the virus. Ken found a way to identify the hepatitis B virus and then produced a recombinant vaccine.

This was done under difficult conditions, as people were apprehensive of new genetic engineering technology. By 1978, Ken and colleagues had created the vaccine and later proved that it was effective in treating hepatitis B. He was involved in the establishment of Biogen, the first European-based biotechnology company, which successfully commercialised the vaccine. Using the income from licensing the vaccine, Ken founded the Darwin Trust of Edinburgh in 1983. The Trust has supported the education of many early-career scientists, and helped to fund research and facilities at the University of Edinburgh. Ken had always taken an interest in science education, and he funded outreach activities to help inspire schoolchildren to be interested in science.

Ken received many honours for his outstanding work. He was elected to the Royal Society in 1979, received the Willem Meindart de Hoop Prize in 1983, and a Saltire Society Scientific Award in 1992. He was knighted in 1993, and awarded two Royal Medals – one by the Royal Society of Edinburgh in 2000 and one by the Royal Society in 2012.

The new science and engineering library at the University of Edinburgh has been named the Noreen and Kenneth Murray Library, in recognition of the couple's scientific success and their support for science and engineering. It was typical of Ken that he was reluctant that the library should be named after them, but, having been persuaded, he insisted that Noreen's name should be first. Despite Ken's many scientific successes and his personal wealth through the licensing of the hepatitis B vaccine, he remained a very modest and approachable person. He thought that teaching was an important activity for an academic researcher, and was himself an inspirational teacher. He was very supportive of colleagues and quick to praise success.

Although Ken suffered ill health in later years, he remained intellectually very active. Noreen predeceased him in 2011. There is a wide community of people who consider themselves privileged to have known them, and many other people who did not know Ken, but whose research has been possible through science he developed, or whose education he financed, or whose lives have been immeasurably improved because of his vaccine work.

Noreen and Ken Murray.
Jonathan Littlejohn, Edinburgh

This obituary is based on one originally written by Professor Mary Bownes OBE FRSE, Senior Vice-Principal, The University of Edinburgh.

REVIEWS

Essential Guide to Reading Biomedical Papers: Recognising and Interpreting Best Practice

Edited by P.D. Langton

Published by Wiley-Blackwell (2012)

£24.99 pp. 350 ISBN 978-1-11995-997-7

This is a new textbook aimed at presenting and analysing the results obtained from a variety of experiments relevant to biomedical science research. The book is organised into a series of short chapters each focussing on a specific technique, written by academics largely from the physiology and pharmacology branches of the biomedical sciences. Each chapter seeks to introduce the technique and explain its applicability as well as outlining the major issues and considerations that can affect any subsequent analysis and data interpretation. The book would be of most benefit to new researchers or early-career scientists, although it would be beneficial to the more experienced scientist moving into a new discipline. One of the strengths of the book is that it covers a wide variety of topics, but this is also its weakness. Each chapter provides only the most basic introduction to the techniques and can only address key issues in terms of generalities. The latter is understandable given the breadth of the biosciences and so, while the book provides a useful introduction, it may be best employed as a first reference text found in an institutional collection rather than as a comprehensive personal guide.

SUE LANG, Glasgow Caledonian University

The Human Microbiota: How Microbial Communities Affect Health and Disease

Edited by D.N. Fredricks

Published by Wiley-Blackwell (2013)

£86.95 pp. 389 ISBN 978-0-47047-989-6

The human body harbours an entire community of micro-organisms. Indeed, the numbers of micro-organisms are estimated to out-number our own cells by ten to one. Micro-organisms inhabit our skin and the mucous membranes that constitute our alimentary, respiratory and urogenital tracts. Our bodies get 'contaminated' with micro-organisms from the moment we are born and our microbiota changes with time and exposure to micro-organisms and other environmental factors. Furthermore, it is becoming clear that our microbiota changes in cases of disease, although whether this is cause or effect isn't easy to determine. This book reviews our understanding of the microbiota of different human anatomical sites and the technologies available for study, as well as the means of manipulating microbiota in an attempt to prevent and treat disease. Considering the potential effects that bacteriophages can have on their bacterial hosts, namely disrupting the balance of particular species in complex populations by cell lysis or potential effects on survival and virulence by lysogenic conversion, I am surprised that this book doesn't mention the role that phage may have on microbiota. In my opinion, the book would benefit from an introductory chapter giving a basic overview of microbiota at different sites, as well as an abstract at the beginning of each chapter. Furthermore, I believe that a final summary chapter would have been beneficial in giving an overview of what is known, and what is not yet known on the subject. The book is well presented with many of the figures in colour. This undoubtedly contributes to the very high price of the book (£87), which is very likely to restrict purchase to institutions. Having said that, I'm sure the book will be of interest to all those studying the effects of micro-organisms on the human body.

CHRISTOPHER RING, Middlesex University

Helicobacter Species: Methods and Protocols

Edited by J.M. Houghton

Published by Humana Press (2012)

£85.50 pp. 258 ISBN 978-1-62703-004-5

This book should not be mistaken for a comprehensive compendium of lab methods representing universal best practice in all aspects of the study of these sometimes 'difficult' pathogens. It is, however, a very useful guide to the often challenging work involved in the use of cellular and whole-animal models of infection and infectious processes. The book begins with a few chapters on basic lab manipulation, including culture, storage and genetic manipulation. However, a functioning gene manipulation lab needs more expert input than a few short protocols! The culture sections are moderately useful but idiosyncratic. The order of chapters seems arbitrary here – a short review of the *cag* pathogenicity island is sandwiched between culture and genetics sections of the book, for little apparent reason. So, for those working on disease models and patho/immunobiology I recommend the book highly. For those aspiring to be experts in *Helicobacter* molecular biology it will be a disappointment.

CHARLES PENN, University of Birmingham

Regulation of Bacterial Virulence

Edited by M.L. Vasil & A.J. Darwin

Published by American Society for Microbiology (2012)

US$199.95 pp. 620 ISBN 978-1-55581-676-6

Given the extraordinary breadth and pace of change within the field of bacterial virulence regulation, it would seem a challenge indeed to produce a text that adequately reflects the multitude of virulence strategies and underlying regulatory mechanisms that diverse pathogens employ to colonise and engage with their particular host niche. Yet, commendably, the editors have done just that in this compendium of authoritative and expert reviews. Arranged in six main sections which broadly define temporal stages in the host–pathogen interaction, review chapters nicely blend historical context with up-to-date contemporary detail, providing the reader with a strong appreciation of both progress in a particular area and the key outstanding research questions. Reviews are accessibly written, comprehensively referenced and adequately, but not elaborately illustrated. The extent of themes covered in this book, including regulation of quorum sensing, adherence, colonisation, virulence protein production/secretion and regulatory responses to host molecules should draw attention from anyone with an interest in bacterial pathogenesis and infectious disease, from experienced researcher to student alike. Given its scope, it's unlikely to be read from cover to cover, but will no doubt be a well-thumbed essential reference for many and a highly recommended addition to any institutional library.

ROB DELAHAY, University of Nottingham

Genomics and Bioinformatics: An Introduction to Programming Tools for Life Scientists

By T. Samuelsson

Published by Cambridge University Press (2012)

£29.99 pp. 338 ISBN 978-1-10740-124-2

As more of us discover the accessibility and power of microbial genome sequence data, there is a growing need to learn at least some basic programming for quickly mining or manipulating the data. Although the chapters of this book predominantly address eukaryotic biological problems, the tools developed in each exercise should be adaptable to settings more familiar to most microbiologists. The appendices include very useful introductions to Unix and Perl, but given the basic nature of these tutorials, more explicit instruction on setting up Perl would be useful for complete novices. Anyone with no experience of programming will probably need guidance from a friendly informatician to get started!

As this book is aimed at 'life scientists', I think that some of the early chapters are too basic, with descriptions of the structure of DNA and PCR, but they do start to focus on increasingly complex programming fairly quickly.

The book is appropriate for personal purchase, though there are other books that perhaps target the needs of microbiologists more directly.

MATHEW UPTON, University of Plymouth

Science Communication: A Practical Guide for Scientists

By L. Bowater & K. Yeoman

Published by Wiley-Blackwell (2012)

£80.00 pp. 406 ISBN 978-1-119-99312-4

If you are thinking of taking your first steps into the world of science communication (sci-com), my advice would be '*have a go!*' There is simply no substitute for experience. If you want to know more about the history of science communication, how it fits with your day job, or about other people's experiences then this book will be of value. It is written in an academic style with references to further reading throughout. The case studies give excellent insight into the thought processes and logistics behind developing an activity; however, what they lack is basic instructions of how to do key activities, which would be helpful to naïve scientists taking their first tentative steps into the field. While there are sections that will quickly date (courses, grants, prizes, etc.), that is the nature of a book of this type. The important thing is that it alerts the reader to the opportunities available. There are some issues throughout regarding font size and lack of editing. I would recommend this book as an introduction to sci-com.

VICKI SYMINGTON, Royal Society of Chemistry

Virology: Principles and Applications, 2nd edn

By J.B. Carter & V.A. Saunders

Published by John Wiley & Sons (2012)

£39.99 pp. 360

ISBN 978-1-11999-142-7

This is an excellent book of high value, even in an age of e-books. It is thoughtfully constructed, well illustrated and succinctly written. It has an excellent 'virologist vocabulary' at the end prior to a helpful index. It covers all major virus groups and deals with common themes, such as methodology, replication and virus structure before following key virus groups in detail. There are several excellent chapters on evolution, transmission and emerging viruses, including measles. If I had one criticism, it is the reliance on diagrams to illustrate concepts, when an actual photograph would have been just as informative. For example, gradient centrifugation (p. 15) or SDS-PAGE (p. 17) would have been well served by a photograph showing the real thing. This is an excellent reference for anyone who is working in the field of virology and won't cost an arm and/or a leg.

EDWARD D. BLAIR,
University of Cambridge

COMMENT

MERS-Coronavirus: occasional zoonotic or emerging pathogen?

MERS-CoV particles. *Centre For Infections / Public Health England / SPL*

IAN JONES

Following the first reports of MERS-CoV in 2012 in Saudi Arabia, and the media frenzy following the appearance of cases in Europe, what do we know about this novel virus and its potential to develop into a serious threat to public health?

A NEW CORONAVIRUS causing acute respiratory distress syndrome was first reported in Saudi Arabia by Ali Mohamed Zaki in a ProMED posting in 2012[1]. The virus was characterised at Erasmus Medical Center in Amsterdam resulting in the name new coronavirus-EMC, nCoV-EMC. More recently, the name of Middle Eastern Respiratory Syndrome coronavirus, MERS-CoV, has been suggested to reflect the predominant geographical location of cases to date (Fig. 1)[2]. Infection can give rise to severe respiratory distress and of the 91 cases documented by the World Health Organization (WHO) since September 2012, 46 have died, making the mortality rate as high as that of H5N1 influenza and higher than that of the SARS-CoV outbreak of 2003. Although mostly confined to the Middle East, interest in Europe has been sparked by people returning with the infection after visiting the region and by patients from elsewhere being flown in for expert medical care. Person-to-person transmission, first reported in a hospital in France and associated with a minor media frenzy (Fig. 2), is now confirmed in other cases[3], albeit predominantly in a hospital setting. The obvious questions are: how do individuals become infected in the first place, and what level of threat does the new virus represent? Are these unusual sporadic cases, or are we witnessing the emergence of a new virus destined to spread among humankind? To date these questions have been difficult to answer with any certainty.

The MERS-CoV virus is most closely related to HKU4 and HKU5, both coronaviruses of bats[2,4]. Aside from SARS-CoV, which no longer circulates in man, there are four extant co-circulating human coronaviruses. Serological evidence suggests that most people have been infected by all of them by their teens. For the most part they cause mild respiratory disease, although more serious clinical cases can occur, often with other underlying infections. The relationship of MERS-CoV with bat viruses echoes the findings for SARS-CoV that originated in the Chinese horseshoe bat[5]. Indeed bats have been found to harbour a large number of viruses, their dense colonies providing ideal conditions for virus circulation, and they may be the original source of many coronaviruses[6]. If bats and man interacted more extensively we would probably see a number of new zoonotic infections, but as bat roosts are generally remote, direct infection of people from bats is a rarity, which brings us back to the question of MERS-CoV and its origins. The low number of cases means a common link to a source of infection has not emerged. Animals common to the Middle East, such as goats and camels, have been suggested as intermediate hosts,

Fig. 1. **Cases of MERS-CoV to date have centred on Saudi Arabia. Cases in the countries shown are limited (1 or 2) and have been in people who have either directly returned from the Gulf or have had close contact with those already infected.** *I. Jones*

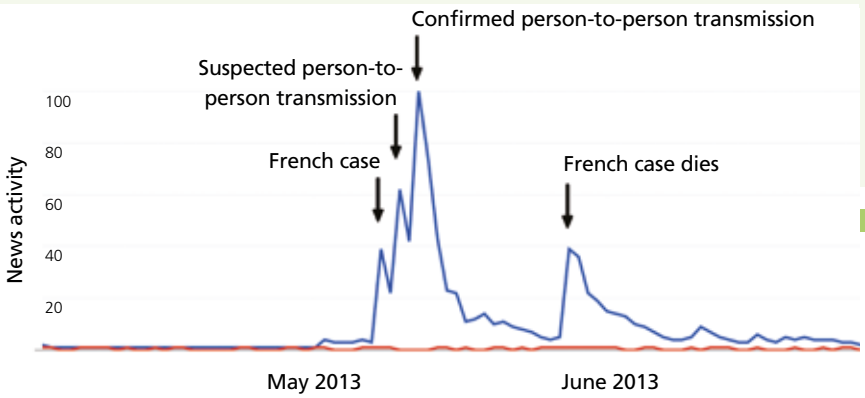


Fig 2. **Unbalanced media attention? A Google trends output of 'Coronavirus' (blue) and 'Nipah' (red) for 90 days in May and June 2013. The coverage of the MERS-CoV cases in Europe may be understandable, but it ignores similar infections elsewhere.** *I. Jones*

and antibodies to the virus have recently been detected in dromedary camels in keeping with a suggested local intermediate host[2]. A poorly transmissible but distributed source of infection might also fit the current pattern, for example, infection via a food substance, perhaps a regional food. The bat link emerges again here – just as the WHO reported human-to-human transmission of MERS-CoV, another bat virus, Nipah virus, caused 21 deaths in Bangladesh[7]. Nipah, a paramyxovirus, has been known since 1998 and causes regional small-scale outbreaks of human infection, also with a high fatality rate. The virus is transmitted by bat saliva and urine contamination of foodstuffs, date palm sap in the case of the current Bangladeshi outbreak. Something similar could be the cause of MERS-CoV outbreaks. The Nipah outbreak is less reported because it is not a new virus and, since the SARS episode, there is a spook factor associated with the name coronavirus. No one would wish to underplay the seriousness of MERS-CoV infection – it kills a large proportion of those it infects, and the opportunity for mutation in this largest of RNA virus genomes means that adaptation is certainly possible. But at the moment there is little evidence to suggest MERS-CoV is anything more than another Nipah-like occasional zoonotic that is unlikely to spread on a wider scale.

Of the infection itself, a lot remains to be learned. In SARS, virus attachment to the cellular receptor ACE2 causes receptor shedding that exacerbates the pathology[8]. The MERS-CoV receptor has been identified as CD26[9], but there is little data yet on whether receptor impairment has a role in the outcome of infection. It is curious that despite being caused by different viruses, the mortality rate for MERS-CoV or Nipah, or influenza H7N9 come to that, is similar, suggesting that the pathological mechanisms triggered are perhaps shared, plausibly the cytokine storm leading to lung damage and a rapid decline or slow recovery. There are neither effective drugs nor vaccines so patient support is the only clinical treatment option. As cases accumulate, passive immunotherapy with convalescent serum from survivors might be a possibility, but whether the logistics required to achieve this are feasible is unclear. As with any zoonotic of this type, surveillance and as rapid a diagnosis as possible, offer the best chance of a recovery outcome.

Judging the likely threat of any new pathogen with so few cases and a general lack of data is only marginally better than guesswork. But based on the facts to date, the occasional zoonotic pattern seems to me to be the most likely outcome in the case of MERS-CoV. I hope I am not wrong.

IAN JONES, University of Reading
Email i.m.jones@reading.ac.uk

REFERENCES

1. Zaki, A.M. (2012). Novel coronavirus – Saudi Arabia: human isolate. *Int Soc Infect Dis* **www.promedmail.org/direct.php?id=20120920.1302733**

2. de Groot, R.J. & others (2013). Middle East Respiratory Syndrome Coronavirus (MERS-CoV); Announcement of the Coronavirus Study Group. *J Virol* **87**, 7790–7792.

3. Assiri, A. & others (2013). Hospital Outbreak of Middle East Respiratory Syndrome Coronavirus. *N Engl J Med* **doi:10.1056/NEJMoa1306742**

4. Zaki, A.M. & others (2012). Isolation of a novel coronavirus from a man with pneumonia in Saudi Arabia. *N Engl J Med*, **367** 1814–1820.

5. Lau, S.K. & others (2005). Severe acute respiratory syndrome coronavirus-like virus in Chinese horseshoe bats. *Proc Natl Acad Sci U S A* **102**, 14040–14045.

6. Woo, P.C. & others (2009). Coronavirus diversity, phylogeny and interspecies jumping. *Exp Biol Med (Maywood)* **234**, 1117–1127.

7. Institute of Epidemiology (2013). D.C.a.R. Nipah Infection in 2013 (cited 2013 30/06/2013). **www.iedcr.org/index.php?option=com_content&view=article&id=106**

8. Glowacka, I. & others (2010). Differential downregulation of ACE2 by the spike proteins of severe acute respiratory syndrome coronavirus and human coronavirus NL63. *J Virol* **84**, 1198–1205.

9. Raj, V.S. & others (2013). Dipeptidyl peptidase 4 is a functional receptor for the emerging human coronavirus-EMC. *Nature* **495**, 251–254.