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Editorial Group

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But you can write right?!

A recent SfAM survey found 80% of respondents within the applied microbiology community feeling the negative impacts of lockdown and the subsequent protective measures on their ability to work.

Unable to collect data and maintain/monitor experiments, with opportunities to discuss ideas and results with colleagues and supervisors diminished, most researchers are feeling the sting of social distancing. Even Super Cyborg PhD researcher Jake Bell has struggled (page 9). Expectations put on individuals to use the presumed downtime they now have to increase data analysis, up their writing output, publish papers and work on grant applications is brutal. This pressure is not only coming from supervisors and managers, but from society in general. Sometimes it feels like every minute that we do not put towards working harder or improving ourselves in some way is a minute wasted.

For most of us, we are struggling with these new challenges. Trying to function and find motivation under this amount of stress and anxiety is abnormal and a situation for which we were not prepared. Last week I was informed by a *Microbiologist* magazine contributor that she had lost four colleagues so far to COVID-19. Is this really an environment in which we should be putting any expectations on people other than to simply get through this with our health intact?

This decreased ability to work also has substantial implications for gender equality and threatens to roll back the gains in women's opportunities in STEM, as Marcela Hernández García discusses on page 34.

A potential way out of this stress and anxiety is to reconsider our responsibilities as participants in a wider society. These should extend beyond our individual economic value and the wearing of a mask. We need to use this opportunity to erode social norms around housework and childcare, to ensure inclusion and progression is based on merit and not race (page 7) or gender and to create opportunities for people struggling to find work and for the young who feel their future is in jeopardy.

Microbiologist magazine is read by 10,000 people (well, one issue was in 2018) and is a great vehicle to amplify a contribution to applied microbiology. But many of you lack the confidence in writing to submit an article. We are here to help with that. We have an incredible proofreader, an exceptional regular content editor and a bank of features editors who will help you sound SfAMazing and a designer who will bring your work to life. So email **paul@sfam.org.uk** your ideas and I will give you all the guidance you need.

And for anybody facing uncertainty, I urge you to visit the SfAM website. A number of the grants may assist in bringing newly generated research and outreach ideas to life, provide access to software or funding for resources or a small piece of equipment. There are also communities, networks, working groups, task forces and committees to join for those of you who wish to reconnect with the world and help shape the future of applied microbiology.

Paul Sainsbury
Editor

It is a privilege and an honour to take up the role of President of the Society for Applied Microbiology, which has been central to my own personal and professional development

Professor Brendan Gilmore

SfAM Virtual AGM
16 July 2020

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A year of unprecedented challenges

I have always been inspired by the work that the Society for Applied Microbiology does, so it is an immense honour to be given the opportunity to serve you as President.

I take on the role with great excitement, but also a little trepidation, acknowledging especially the work of our outgoing president, Professor Mark Fielder. Mark provided leadership to the Society through the most challenging times, from the move of the SfAM office from Charles Darwin House to steering us through the uncharted waters of the first global pandemic in the Society's history. All of this he did with characteristic warmth, humour and kindness. I would also like to take this opportunity to welcome two new members to the Executive Committee, Dr Emmanuel Adukwu and Dr Suzy Moody.

This is a year of unprecedented challenges and, since the WHO declaration that COVID-19 represented a public health emergency of international concern, we have had to radically adapt our lifestyles. Many have experienced illness, loss and the impact of lockdown on mental health and well-being. Unsurprisingly our members have risen to the challenge, using the breadth of their skills to address the needs of wider society in the COVID-19 response. At SfAM we recognise the challenges you have faced and seek to recognise your efforts and support your return to a new normal, living with and beyond COVID-19. The office team have already reacted and sought the views of members on how we can best do this, a conversation which we will widen in the weeks ahead.

Global events, including the killing of George Floyd, have also challenged us in other fundamental ways. We are committed to listening, to learning and to acting to ensure that racism, prejudice and bias, of any kind which may be structurally embedded, be challenged and addressed. We have started the process and are committed to taking the correct actions, but to do that we need your input, experience and insights.

In the coming months we will embark on our strategic review, discussing and defining our strategic priorities for the coming years, reflecting upon the role of learned societies, especially in light of COVID-19. I believe that the Society should represent, support and celebrate our members throughout their career, by listening and responding to their specific needs, celebrating achievements at every stage of their journey. We should also seek to do this in a manner which embraces equality, inclusivity and diversity.

Finally, I look forward to meeting you soon at our meetings and events, as life begins to return to normal. I would urge you to consider getting involved in the life of the Society; your input is critical, and there are countless opportunities for you to contribute and be heard. The events of the past year have demonstrated that the clear, effective voice of applied microbiology has never been more critical.

Brendan Gilmore
Queen's University Belfast

We need your help

I don't know anybody who wasn't touched by the killing of George Floyd and the stark reminder it gave us all of the persistence of ingrained racism in society. I have always abhorred racism and racist behaviour in all forms and have sought to widen participation since my appointment as Chief Executive in 2014.

Equality, **diversity** and **inclusion** are integral to creating the fabric, culture and values of SfAM. We are working through the implementation of our equality, diversity and inclusion action plan to ensure we are truly able to widen participation and now we need your help.

We are creating a working group to identify any forms of systemic racism that touch the lives of our team, committees and members.

To be truly inclusive, we must ensure all members can be part of this journey. We will need to work without ego and to listen with humility. We can then reflect and take meaningful action.

The working group will need to:

- examine how historic practices may have blocked equal participation in our work
- learn and improve by facing difficult issues and being self-critical
- have difficult conversations and face the realities of the changes needed to make our work better.

This group will focus on the processes the Society uses to provide good governance and to widen participation in our work. Our equality, diversity and inclusion action plan will be scrutinised, as will all recruitment processes to our team, committees, trustees and membership, to ensure we are genuinely encouraging participation without discrimination.

If you would like to share this journey with us, and help us become the best that we can be, please email **communications@sfam.org.uk**.

Lucy Harper
Chief Executive of the Society for Applied Microbiology

Work and research under lockdown

SARS-CoV-2 and its associated disease, COVID-19, has had a marked effect on the way we work. Here, Georgia, a recent MSc graduate on the job hunt, and Jake, a PhD student, share their experience of job-hunting and research under lockdown.

Georgia Jones

Kingston University alumna, UK currently on the job hunt

Have you ever tried to organise a birthday party at the beginning of January? As a Capricorn I can tell you, it's the worst time of the year. Everyone is mopey as Christmas is over and most are still nursing 2-day-long hangovers from New Year's Eve. Job-hunting during a pandemic is a little bit like that; no-one answers their phones, everyone is financially destitute and most people are sitting at home not really sure what to do with themselves (with the exception of our key workers).

COVID-19 certainly is one of the most powerful equalisers we've seen in a long while. It will knock you down whether you are young or old, it does not care whether you are an English teacher or head of marketing, dinner lady or bus driver. One thing is for certain: with Britain's lockdown costing an estimated 6.5 million jobs, a large portion of the population will soon find themselves on the couch in their pyjamas, Weetabix bowl resting on one knee whilst on the hunt for a new role. Despite this scary new reality that has been imposed upon us, we still have bills to pay, so on we trudge, through the relentless jobsite searches, cover-letter writing and CV formatting.

With a world full of temporarily closed businesses and a considerable part of the workforce working from home, it's hard to reach humans at all. It's also a strange and sobering thought to contemplate what that hiring person you are trying to reach may be going through right now – you can be sure they face severe disruption in their life at the very least.

Putting compassion aside, it is still frustrating and disappointing when you don't hear back. Tumbleweeds cross your bedroom floor and you become desperate for any response – even a promise to call you when 'things calm down'. If you do manage to get a response, then an awkward telephone interview may await you.

Telephone interviews sound great in practice as they remove the unpleasantness of in person interviews, such as wearing a suit in 30°C, travelling and having to find the place, nervous sweating etc. However, as the sole method of interviewing, they can be a bit of a disadvantage due to the lack of interpersonal connection you have with your interviewer. Non-verbal communication is a huge part of a 'normal' interview and helps you form a positive lasting impression through body language that projects confidence such as eye contact, a firm handshake and sitting up straight. Video conferencing software (when it works) goes someway to making the process better as you can see as well as hear each other. The 'Zoom interview' is still an odd experience though. Sat at your kitchen table with a smart shirt and blazer on top and then sweatpants on the bottom trying to take yourself seriously whilst making sure you don't need to get up.

Oh and don't forget to check your background before you go live. You don't want them to make snap judgements as they glare at photos of you and your friends on a night out in sombreros stuck to your wall under a prominent handmade sign in colourful calligraphy that reads 'kiss my arse' (*never* happened to me). It is hard enough to sell yourself as it is without your interviewer being distracted by such a *faux pas*.

On a more serious note though, if you are reading this having recently lost your job then it is likely to add distress upon distress for you. Try to be kind to yourself and remember this is not your fault, you are much more than your job. Remember that these are extraordinary times and keep sending those emails, answering those endless repetitive online application questions and fire off that CV. It is going to get easier and you are not alone.

Jake Bell

Royal Holloway, University of London, UK

Whilst I appreciate that the response to the lockdown by PhD students will vary massively, as everyone has different projects, personal situations, concerns and responsibilities, my story about research under lockdown is as I have experienced it.

I first heard of the disease now known as COVID-19 in January. News reports talked of the locked down city of Wuhan, a stretched healthcare system and immense pressure on healthcare workers. Back then the distance of the outbreak and its pre-pandemic status provided a false sense of security. Whilst there was a definite level of concern amongst friends and colleagues, it was difficult to know the extent to which this was justified.

As a PhD student, the majority of my mental bandwidth is used thinking about experiments, data and deadlines. The prospect of not being able to access the lab for months should the UK go into lockdown troubled me (in addition to the obvious health threat). By early March, this seemed a likely scenario and preparations were being made to try and limit disruption to projects.

Firstly, all non-essential activities and experiments were paused and biological material was moved to proper long-term storage. This was easy for the microbiological side of my project as I had (annoyingly) only just started it. The plants I work with were another matter – they require almost constant attention. Luckily, our brilliant technical team made sure they were watered and fed, so I could harvest material when the lockdown was over instead of forfeiting months of work. This was followed by frantically transferring all available data onto a portable hard drive and collecting computers, monitors and the lab books I needed to set up a home office.

When lockdown was officially announced, I was ready to bunker down, only leaving the house for food or to walk the dog. The next couple of months were spent analysing data, learning some new R techniques and writing. Maintaining the workday structure and having something to focus on made dealing with the lockdown a lot easier for me personally. Diving into data analysis stopped me constantly worrying about the virus as my code returned yet another error message. Sitting at the kitchen table for hours on end took some getting used to, both for us and our cat, Sid, who appeared regularly with a look of puzzlement as to why I was constantly in his favourite nap chair.

Before long it was 'safe' to return to work, and having missed the lab over the lockdown, I was eager to return and restart experiments. So, bandanna clad, looking like I had just rolled out of a cheap Western re-enactment, I went back for the first time to check on my plants and start running the LC-MS.

It has been strange so far.

Instead of the usual fun, loud and friendly place, the lab is now quieter and (comparatively) dull. A rota system has been put in place to ensure only a few people are present at one time and social distancing measures keep us apart while we work. The campus is unrecognisable compared with the hustle and bustle of a normal summer term and morning tea at the campus cafe is a distant memory. Whilst it is great to be back generating data and seeing friends, shift work and maximum occupancy rules inevitably cause delays and frustration as we adapt to the 'new normal'.

I was told before starting my project that a PhD is a lesson in resilience and patience. With social distancing measures set to stay for a while yet, that seems truer now than ever.

microtalks:

a webinar series by the SfAM ECS Committee

In March this year, when lockdown was just beginning in the UK, the ECS Committee made the decision to cancel their annual research symposium. Poster presenters were invited to join an online poster conference – the first SfAM has done – but the question was left hanging: 'what about the oral presentations?'

Research • Network • Grow

The Micro-Talks webinar series was devised as an alternative available to early career scientists who missed out on presenting among the COVID-19 pandemic. A series of 10 short talks was devised, held online via the Zoom webinar platform and chaired by members of the ECS Committee. Each 15-minute talk was followed by an extended Q&A session with the presenter to give the audience a chance to engage with the research.

Between June and August, talks were held every Tuesday at midday, with over 500 registrations from across the globe for the 10 talks. We heard from a wide variety of speakers from the fields of biotechnology, agricultural microbiology, the microbiome, environmental microbiology, antimicrobial resistance and public outreach. Many of the speakers also took to Twitter after their Micro-Talk, letting the discussion continue for longer – you can look up the **#MicroTalks** hashtag to catch up on the conversation.

The Micro-Talks webinar series mark another in a series of firsts that we've had to adapt to a changing world in 2020, but it's no exaggeration to call this event a great success for both SfAM and the early career scientists who took part.

Over 500 registrations from across the globe for the 10 talks

NEW MEMBERS OF THE SOCIETY SEPTEMBER 2020

Bangladesh
AKMSK Shawon

China
J Xu

France
M Soree
P Juarez
S Biddulph
E Wachnicka

Hong Kong
P Neelakantan

Indonesia
E Damayanti
J Widada

Ireland
A Rodgers
D Hurley

Israel
M Shemsh

Malaysia
S Bakon

Nepal
B Dhital
G Gurung
S Pandey

Nigeria
N Udemang
U Umar
C Ejikeugwu
C Okosun
NP Okolie
O Adeniran
B Odetoyin

Peru
LM Jara

Poland
Ł Wajda

Romania
AR Palade

Thailand
O Olatunde

United Kingdom
A Rafiq
A Titman
A Bavetsia
B Szomolay
C Houston
E Slade
J Giard
L Beck
L Mason
M Papadatou
P Aimua
P Littleton
P Carrillo-Barragan
D Hughes
A McCarthy
P Moynihan
E Green
A Cunliffe
M Boutflower
H Leather
DJ Williams-James
T Hassel
Y Li
M Davey
H Black
N Khumalo
T Stanton

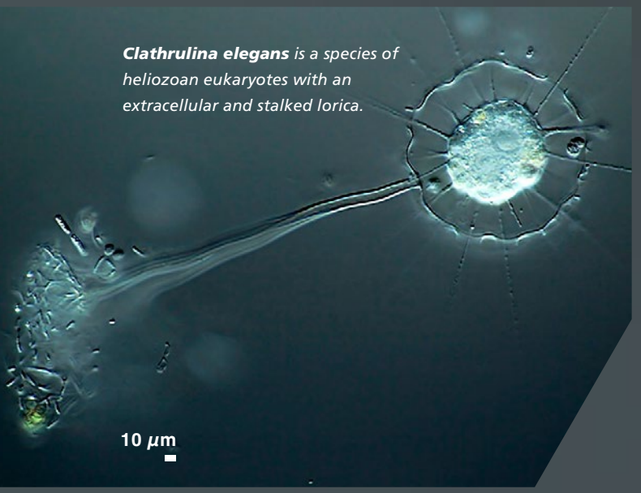
United States
M Haruna

What is special about protists?

Stefan Geisen
Wageningen University, The Netherlands

Background

Before this question can be addressed, I probably need to clarify one question first as many of you may wonder *What are protists?* Protists are microbes. Basically, all eukaryotic organisms that aren't fungi, plants or animals fall under the umbrella 'protist'. If we dig into the phylogenetic tree of eukaryotes, this means that most of the eukaryotic diversity by far is composed of protists! While the term protist was coined by Ernst Haeckel (the guy who drew incredible pictures of microbes and other organisms) more than 150 years ago, it was largely replaced by protozoa (for heterotrophic protists) and algae (for eukaryotic protists). The last decade has shown that protozoa and eukaryotic algae are phylogenetically intermingled with some mixotrophic taxa and those changing between heterotrophic and autotrophic forms, screwing up the protozoa-algae system. This has led to the revival and rather set implementation of the term protist. Several examples of groups of protists will be known to everyone. All amoebae, all ciliates such as the model organism *Paramecium*, oomycetes including *Phytophthora infestans* the causative agent of the Irish Famine and even human diseases, including malaria-causing *Plasmodium* species are protists!



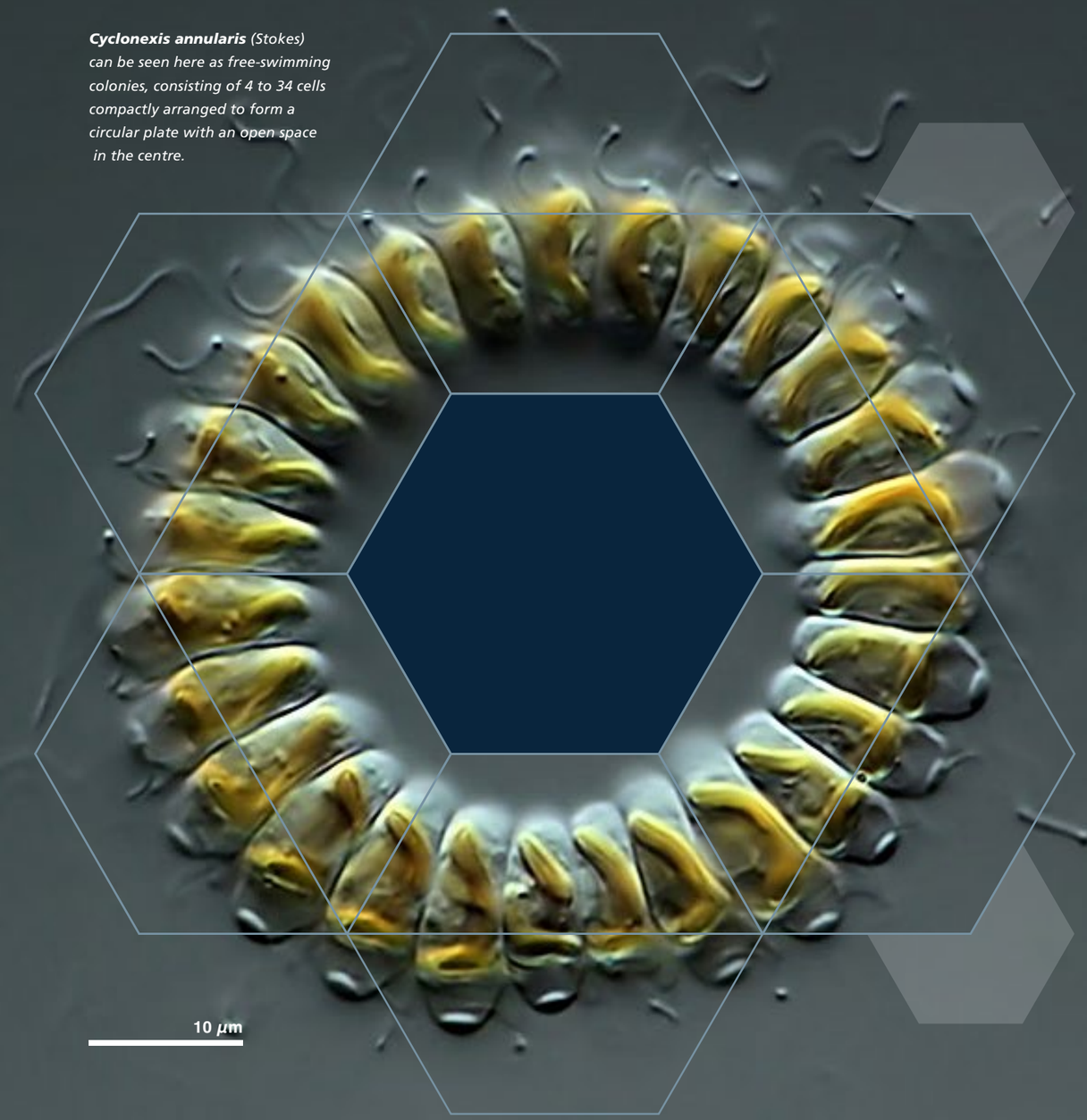
Clathrulina elegans *is a species of heliozoan eukaryotes with an extracellular and stalked lorica.*

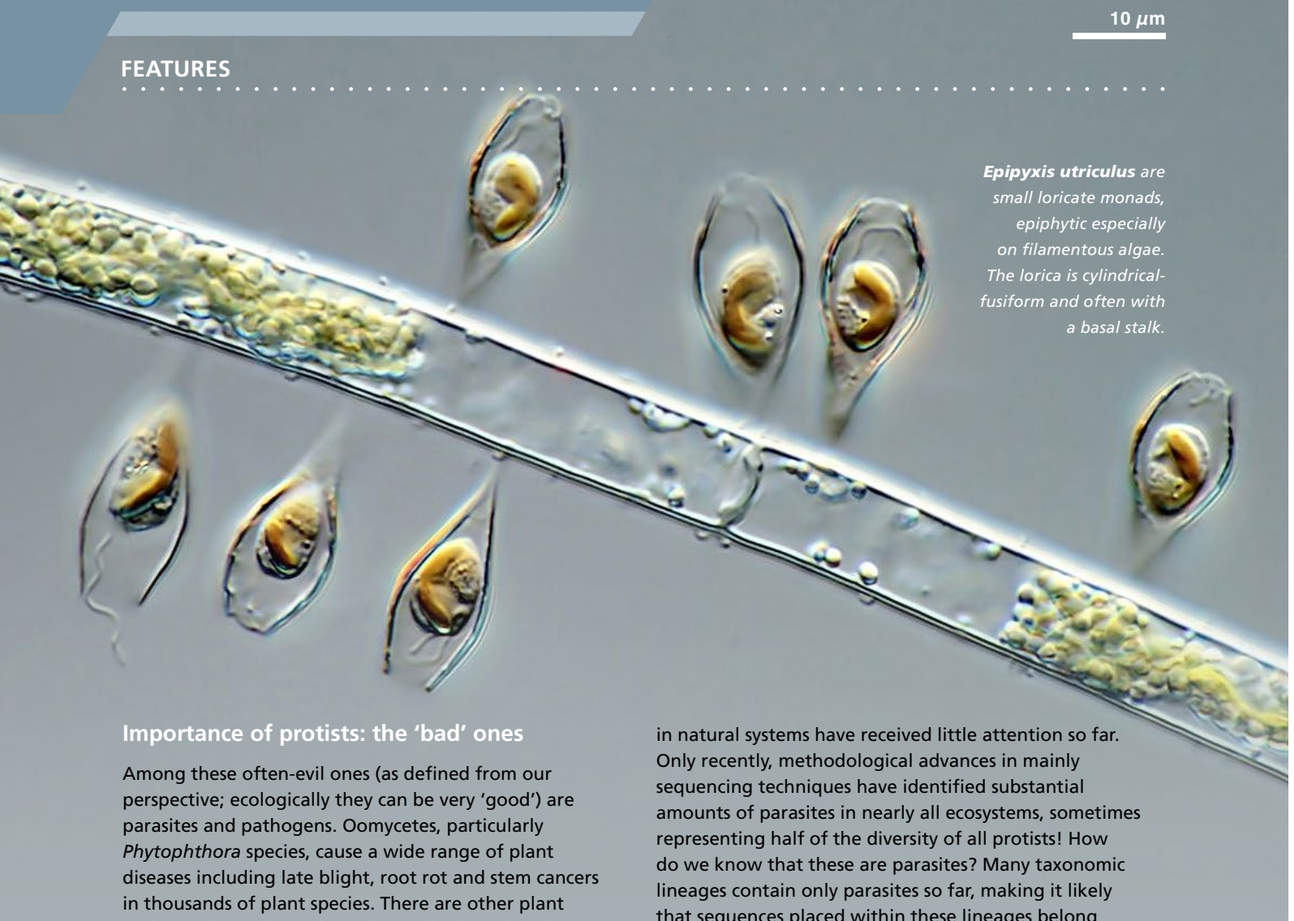
Many facts have already been mentioned above that illustrate what is special about protists? The sheer phylogenetic and functional diversity is likely only surpassed by that in bacteria. Potentially millions of protist species – we have no clue how many there might really be – have conquered all environments and hosts, as they have had more than two billion years to evolve. Consequently, many research lines study protists in the sense of finding the origin of eukaryotes. Here, I will focus a bit more on why I think protists are super important: they are key for life on Earth!

Importance of protists: the 'good' ones

Ecologically, about half of all carbon is fixed by algae that mainly include cyanobacteria and eukaryotic protists. This is likely their key role in aquatic systems but recent research has shown that even in the plankton, heterotrophic protists are likely equally abundant as their phototrophic counterparts. *What do these heterotrophic protists do?* They prey on smaller microbes including bacteria, fungi and other protists, while a substantial abundance of parasitic protists, which often infect only a limited set of hosts, ensure a stable diversity of hosts. In soils, heterotrophs obviously dominate the functional diversity of protists. As in aquatic systems, free-living protists feed mainly on other microbes. The small sizes, high abundances and fast reproduction rates of protists make this process a key element in nutrient cycling and is termed the microbial loop. In soils, plants benefit from this predator–prey interaction as they compete with free-living microbes for nutrients; protists shift the balance towards plants. But there is more to the interaction between protists and plants: as mentioned before, protists are diverse, meaning that not all protists do the same thing and like the same food. Selective feeding together results in shifts in bacterial communities with often secondary metabolite-producing bacteria and fungi benefiting from protist predation. Many of the secondary metabolites have likely evolved through these billion year-long evolutionary arms races (and not to benefit us in the form of antibiotics or other products). The secondary metabolites include plant growth-promoting substances such as auxin and antibiotics, many of which stimulate plants directly or help fighting off plant pathogens. Mutualistic protists exist within or are associated with many animal species. Among these are ciliates and amoebae that accelerate nutrient turnover in the guts of ruminants and other animals. Some protists are even essential to degrade complex organic compounds inside termite guts.

Cyclonexis annularis *(Stokes) can be seen here as free-swimming colonies, consisting of 4 to 34 cells compactly arranged to form a circular plate with an open space in the centre.*





Epipyxis utriculus *are small loricate monads, epiphytic especially on filamentous algae. The lorica is cylindrical-fusiform and often with a basal stalk.*

Importance of protists: the 'bad' ones

Among these often-evil ones (as defined from our perspective; ecologically they can be very 'good') are parasites and pathogens. Oomycetes, particularly *Phytophthora* species, cause a wide range of plant diseases including late blight, root rot and stem cancers in thousands of plant species. There are other plant pathogenic protists such as *Plasmodiophora brassicae* that causes cabbage clubroot. Together, plant pathogenic protists cause substantial losses of crop yield and can threaten many natural plant species and therefore entire ecosystems. In addition to plant pests, oomycetes and diverse taxa within Apicomplexa parasitise and can ultimately kill a range of animal species, including us. Indeed, the protist *Plasmodium falciparum* is by far the major biological agent of death in humans. The importance of these plant and animal pathogens and parasites is mainly restricted to those organisms we are directly interested in such as for commercial purposes, crop species, cattle, pets and us. Pathogens and parasites in natural systems have received little attention so far. Only recently, methodological advances in mainly sequencing techniques have identified substantial amounts of parasites in nearly all ecosystems, sometimes representing half of the diversity of all protists! How do we know that these are parasites? Many taxonomic lineages contain only parasites so far, making it likely that sequences placed within these lineages belong to parasitic species. Indeed, sequence-based techniques have increased our understanding of particularly parasitic groups showing that formerly used classical techniques to study protists have only captured a tiny fraction of the biodiversity of protists in all systems. Many studies now show that for many multicellular organisms you might have species-specific parasitic protist species. What their importance is in controlling food web structures and organism abundances remains to be studied. Protists can also help other pathogenic microbes to enter hosts such as our body to cause disease; some pathogenic bacteria were shown to bypass the human immune system inside amoebae, a process with an analogy to the Trojan Horse.

Plant pathogenic protists cause substantial losses of crop yield

State of the art, missing gaps and applied use of protists

This all sounds like we know a lot, but research on protists is just gaining momentum and is still far behind the existing knowledge on other microbes. New methods have allowed us to finally implement protists in microbiome analyses that before were nearly impossible. We have started to decipher the diversity and community structures of protists at the local and even at the global scale. We expanded the knowledge on their functional importance from direct pathogens of plants and humans to indirect, mostly positive, effects on plant performance such as via increased nutrient cycling. But we have at most scratched the tip of the iceberg on our knowledge on protists. We understand little how diverse protists interact within the entire complexity of microbiomes. Overall, we can conclude that the majority of protists in the environment likely have positive effects on microbial activity that lead to benefits for plant growth. Indeed, we could just show that communities of protists differ at plant establishment and across plant growth between plants that later became diseased and those that remained healthy – irrespective of the abundance of pathogens that was similar in both categories (**https://vimeo.com/392563706**). This might enable targeted investigations of soils before a crop is planted to enable tailor-made planting schedules. Our study also shows negative links between microbivorous protists and the bacterial pathogen in the tomato system, suggesting direct predator–prey interactions. These findings might be relevant for targeted searches for protists as biocontrol agents. Their role in catalysing microbial community turnover that facilitates nutrient release has already led to some marketed products, in which protists act as biofertilisers. As such, protists might be important elements in ongoing efforts to reduce pesticide use that will make land management more sustainable. Another possible application potential of protists is as bioindicators for soil health: we could show that communities of protists are changing rapidly with land management (here fertilisation), but also other external conditions, while bacterial and fungal communities did not differ much. Protists might thus be implementable as high-resolution indicators for diverse conditions in soils.

Next steps in protistology/microbiology

We will never understand complex ecological systems while we keep focusing on individual groups of (microbial) organisms. In several studies, we could recently highlight that protists are tightly connected within microbiomes. Microbiome studies will benefit from incorporation of diverse taxonomic groups including bacteria, archaea, fungi and protists to better understand the importance of biotic interactions as these might determine a system's functioning. Ideally, this is most efficient and fun in collaborations with experts from different taxonomic groups. We also should consider a more functional approach in which we link individual taxa and communities to what they do. Omics approaches represent a promising start but method combinations (culturing, biochemical and molecular techniques) are eventually inevitable to fully grasp microbiome functioning. We can all be excited to work in the field of microbiology and can look forward to a bright future with many novel findings awaiting discovery!

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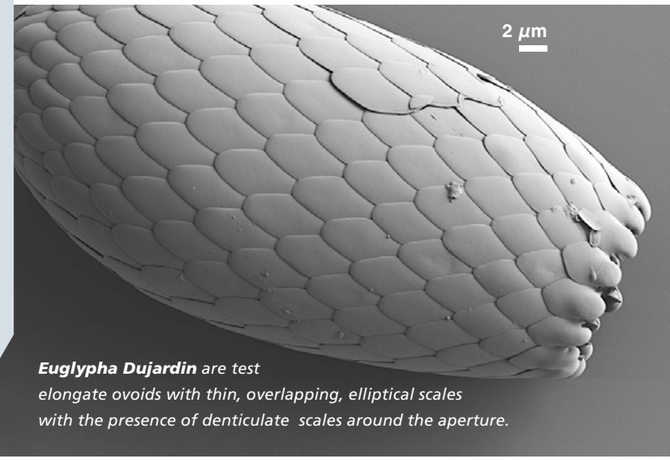


Euglypha Dujardin *are test elongate ovoids with thin, overlapping, elliptical scales with the presence of denticulate scales around the aperture.*

All images courtesy of Eckhard Völcker.

Crocodile blood: ferociously antimicrobial

Jiraporn Lueangsakulthai [1] and **Sarah E. Maddocks** [2]
[1] *Oregon State University, USA*
[2] *Cardiff Metropolitan University, UK*

Life in the wild is dangerous, with many animals competing to survive in the same habitat. Strategies for survival that provide a competitive advantage are therefore essential. Alongside the Komodo dragon, black caiman and king cobra, crocodiles are regarded as one of the most dangerous reptiles. They are semiaquatic, tending to congregate in freshwater habitats such as rivers, lakes, wetlands and sometimes in brackish water and saltwater. There are 16 known species of crocodile worldwide, which are grouped into the genus *Crocodylus*, for example, *Crocodylus acutus* (American crocodile), *Crocodylus johnstoni* (freshwater crocodile), *Crocodylus niloticus* (Nile crocodile), *Crocodylus porosus* (saltwater crocodile) and *Crocodylus siamensis* (Siamese crocodile). Crocodiles are carnivorous animals with a diet consisting of fish, amphibians, crustaceans, molluscs, birds, reptiles, mammals and occasionally cannibalisation of smaller crocodiles.

Crocodiles are fiercely territorial and frequently receive traumatic bite injuries from intraspecies and interspecies fighting. Based on what we understand about wounds in humans and other animals, it might be assumed that such injuries are rife with life-threatening bacterial infection. But this is not the case and most crocodile wounds appear to heal without infection. There must therefore be something extraordinary about crocodiles that provides them with protection from bacterial infection that could otherwise result in death. In light of the burgeoning antibiotic resistance crisis, understanding what this is could help with the development of novel antimicrobial treatments.

C. siamensis is a small freshwater crocodilian populating parts of Southeast Asia. Recently, several components of *C. siamensis* blood, including plasma, serum, white blood cells and haemoglobin have been reported to possess a broad spectrum of biological properties, mainly attributed to an abundance of active peptides. Of these, haemoglobin has shown exceptional antimicrobial and anti-inflammatory activity. Haemoglobin constitutes the most numerous blood component, primarily functioning as an oxygen transport protein. It is a heterotetramer metalloprotein consisting of two identical α-globin and two identical β-globin polypeptides, each associated with a haem group. The antibacterial activity of crocodile haemoglobin has been attributed to short peptides known to be degradation products of the heterotetramer that target the bacterial cell envelope.

Many short peptides aggregate in bacterial membranes, disrupting cellular homeostasis and stability sufficiently to cause death. Hydrolysis of haemoglobin from *C. siamensis* using the enzyme pepsin revealed that a short peptide with the sequence QAIIHNEKVQAHGKKVL (QL17) had excellent antimicrobial activity, effectively killing both Gram-positive and Gram-negative pathogens. QL17 has a hydrophobicity of 41% and a positive net charge of +2 and is therefore likely to function in a similar manner to cationic antimicrobial peptides. Amino acid sequence alignments indicate that QL17 originates from the

Crocodiles are regarded as one of the most dangerous reptiles

Veterinarian using a syringe to obtain a sample of blood from a young crocodile.

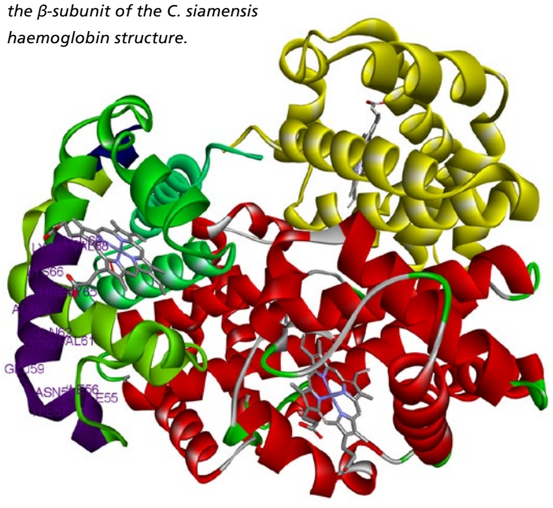
β-subunit of *C. siamensis* haemoglobin. The QL17 sequence appears to be highly conserved in *C. niloticus* (100%), *C. acutus* (100%), *C. novaeguineae* (94.12%), *Paleosuchus palpebrosus* (Cuvier's dwarf caiman; 70.59%), *Paleosuchus trigonatus* (smooth-fronted caiman; 70.59%) and *Caiman latirostris* (70.59%). Interestingly, QL17 is also conserved in some turtles (*Pelomedusa subrufa* and *Pelusios castaneus*) and birds (*Turdus leucops* and *Pheugopedius eisenmanni*).

Recent studies into synthetic derivatives of QL17 have substituted specific amino acids to increase antimicrobial activity and bacterial targeting. Lysine (K) and arginine (R) were incorporated into the peptide to increase hydrophilicity, along with hydrophobic residues such as leucine (L), isoleucine (I) or tryptophan (W) to increase hydrophobicity. Consequently, two novel antimicrobial peptides have been synthesised. Designated IL-K (IKHWKKVWKHWKKKL) and IL-R (IRHWRRVWRHWRRRL), they exhibit 40% hydrophobicity and net charge of +7. Analysis of antimicrobial activity confirmed that IL-K and IL-R had a two-fold higher activity than the QL17 parental peptide against *Klebsiella pneumoniae* and *Staphylococcus aureus*. In addition to improved antimicrobial activity, the small size of the modified peptides means they can be affordably synthesised.

Other components of reptile blood also have antibacterial activity; for example, haemocidins, leucrocin and crocosin, which have been predominantly isolated from *C. siamensis*. Haemocidins are derived from the α-helical haemoglobin fragment and can inhibit the growth of *Bacillus subtilis* by inducing membrane damage. Leucrocin, found in white blood cell extracts, similarly exhibits antibacterial activity against *Staphylococcus epidermidis*, *Salmonella enterica* serovar Typhi and *Vibrio cholerae*. Scanning electron microscopy of *S. aureus* and *S.* Typhi exposed to crocosin showed it progressively penetrated into the cytoplasmic space by perturbing the bacterial membrane. The parallel between the mechanism of these novel peptides and cationic antimicrobial peptides suggests they function in a similar way, providing reptiles with an additional arsenal against bacterial infection.

Cationic antimicrobial peptides are found in most living organisms including reptiles, mammals, insects, crustaceans, amphibians and plants. Conversely, QL17-like peptides, haemocidins, leucrocin and crocosin appear to be exclusive to reptiles and might be why the battle wounds these animals receive do not become infected. The broad-spectrum activity of cationic antimicrobial peptides has seen them exploited as a template to design and manufacture peptide antibiotics, some of which have entered clinical trials, with varying success. Scarcity in the antibiotic pipeline means there remains an urgency to find and develop new antibiotics. Growing knowledge of unique reptile-derived antimicrobial peptides could therefore contribute to the design and synthesis of high-efficacy peptide antibiotics to treat bacterial infection.

The antibacterial peptide QL17 aligned within the β-subunit of the C. siamensis haemoglobin structure.



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Other components of reptile blood also have antibacterial activity

The forensic microbiome

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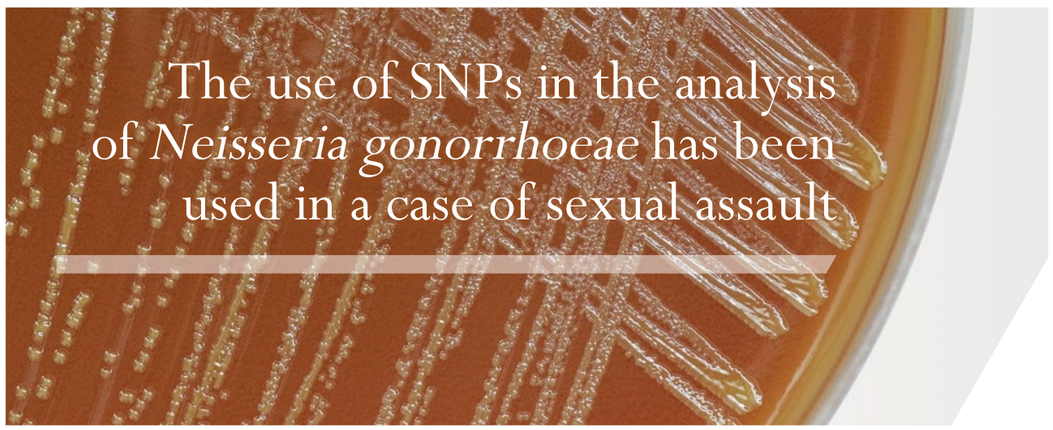
The use of microbiology in forensic science is not new, although the technology available for the microbial analysis of forensic samples has undergone a revolution in recent years. Whether this is a good thing or not remains to be seen. In this short article I hope to give you a sense of the use of microbiology in forensic science and how this may develop in the future.

The general public perception of forensic science these days is largely coloured by the TV portrayal of forensic science in programmes such as *CSI Miami*, where crimes are solved by the application of high-tech science. This has led to the so-called 'CSI effect' where juries now expect DNA evidence to be presented as a matter of course. Although DNA may be left at most crime scenes, its usability, due to the low levels present, is a problem and this has led to speculation that the microbiome deposited by a suspect at a crime scene could be used for identification purposes. I suppose we could consider the establishment of the identity of Mary Mallon (Typhoid Mary) in 1907 as an asymptomatic carrier of typhoid fever by George Soper, an American sanitation engineer, as one of the first cases of a microorganism helping to identify an individual and associating them with a particular event.

Since the beginning of the century, the use of microorganisms in forensic science has steadily advanced with the development of culture techniques, microscopy and now molecular genetics. This has allowed the use of microbiology in a variety of forensic applications, for example, the use of diatom species content of water in drowning cases, to differentiate between fresh- and saltwater drowning, and the use of bacterial community progression to estimate the age of cadavers and time since death. The use of bacteria to assess the time since death and the time a body may have been buried highlight the need for extensive experimental validation of conclusions since, as would be expected, the rate of bacterial growth is highly dependent on environmental factors with regard to exposure to air moisture and ambient temperature.



Advances in molecular genetics in particular has given an impetus to forensic microbiology. In the past, identification of bacterial species would have relied on culturing the organism, looking at colony morphology and the required culture conditions, staining and the organism's microscopic morphology and, in some cases, serology. With the advent of PCR, which is capable of massively amplifying the presence of any DNA, the necessity of culturing organisms from forensic samples is mostly unnecessary and the specificity of PCR primers can identify the organisms present in a sample. While this is a great advance, the presence of an organism must be suspected before the appropriate PCR test can be conducted since it is impractical to test every sample for every organism for which a PCR test exists. This is also impractical as the forensic material may have a very limited availability. This limitation has almost been removed by the latest advances in massively parallel sequencing (MPS), which enables the identification of almost every organism present by whole-genome sequencing. The advances in this technology have allowed the development of the concept of the microbiome, which simply put, could be considered as the population of microorganisms that inhabit a particular habitat, be that human skin, a dog's nose or the bark of a tree.

There have been suggestions that an individual's microbiome may be unique to that individual and used to identify them. Since persons at a crime scene will leave many more bacterial cells than epithelial cells on surfaces they come into contact with, detection is much easier. Experiments have been conducted in which individuals can be discriminated between on the basis of the microbiome detected by directly sequencing the hypervariable regions of the 16S ribosomal RNA genes, common to all bacteria, which can be specifically amplified by PCR. The numbers of individuals studied in these experiments is very low and it is not known how representative of the variation in the general population the results are. The use of whole-genome sequencing to detect single nucleotide polymorphisms (SNPs) within a species has been shown to be more reliable in differentiating between the microbiomes of individuals than the composition of the microbiome as a whole. In other studies, the microbiomes of regions of the body such as hands, feet, groin and face have been characterised in an effort to imply contact between specific body parts and surfaces or other individuals with varying success. In one example, the microbiome of saliva was used to differentiate between two individuals on the basis of relative abundance of species. The authors do acknowledge that there is a paucity of information regarding the effect of lifestyle on the short-term variability of the salivary microbiome but that it is known that antibiotic use can have a significant effect on the composition. The proof of concept of being able to differentiate two individuals is interesting; however, information would be required as to how common or unique these particular profiles are in the general population before that would be of evidential use. If the microbiome is going to be used as forensic evidence we need to know how easily it can be changed by interaction with others, lifestyle changes, changes in the environment and, if they occur, how quickly they can happen. There is some evidence that an individual's skin microbiome can remain relatively stable for up to three years but even this is subject to experimental design, which can influence the apparent composition of the microbiome.

The use of SNPs in the analysis of a particular organism has already been used in a case of sexual assault to show the relatedness of *Neisseria gonorrhoeae* isolates from the victim and the suspect, compared with 29 unrelated controls collected in the same geographical area. The sequence data showed that the victim and suspect isolates had identical sequences in both the bacterial chromosome and plasmid. Only one of the local controls was similar, having only two SNPs compared with the case sequences. Amongst the controls, additional cases of high similarity were observed, potentially indicating recent transmission events. This type of analysis is only possible with whole-genome sequencing. Due to the relatively low rates of mutation in the prokaryotic genome, the whole genome must be sequenced to obtain enough SNPs to make reliable comparisons.

The potential of microbiological analysis combined with the power of MPS has great potential to contribute to forensic science; however, this needs considered and careful application to prevent overinterpretation of results and the establishment of legal precedents, which history has shown can be very difficult to reverse. This is amply demonstrated by the use of bite marks to identify an individual, which became admissible in US courts largely through the use of precedent. This has now been shown to be totally unreliable, only after many individuals were wrongly convicted by bite mark evidence and the demonstration that self-accredited, so-called experts were in some cases unable to differentiate between human and animal bites in blind trials. Many of these wrongly convicted people have been exonerated by the subsequent use of DNA profiling evidence. In spite of this, some states in the USA still allow bite mark evidence to be presented solely based on legal precedent regardless of the overwhelming evidence that now discredits bite mark evidence. It would be unfortunate if the new powerful MPS, as applied to microbial forensic analysis, was to be used in evidence without rigorous validation of any evidential claims resulting in a repeat of this unfortunate situation.

> People have been exonerated by the subsequent use of DNA profiling

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Pseudomonas syringae: a pandemic kiwi fruit pathogen

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A recently emerged plant disease, bacterial canker of kiwi fruit, is caused by *Pseudomonas syringae* pv. *actinidiae* (Psa). First reported in China and Japan in the 1980s, it was not until 2008 that a severe outbreak of Psa began to spread from Italy to other countries. The movement of Psa-contaminated propagative material, tissue cultures and pollen contributed to the detonation of this global outbreak. Since then, this disease has been the major threat to the worldwide kiwi fruit industry, leading to cumulative losses of hundreds of millions of pounds since the outbreak began.

Pseudomonas is a bacterial genus that comprises over 190 species. They are Gram-negative, obligate aerobes and non-sporulating rod-shaped bacteria. The *P. syringae* complex currently comprises over 60 different pathovars, including Psa. At present, six different Psa biovars are known (1–6), named in chronological order of detection. All six are closely related but genetically distinct. Some are systemic and others are not. Moreover, distinct kiwi fruit species and cultivars show different degrees of susceptibility to Psa. Psa biovar 3, the pandemic strain, is the most aggressive biovar and has caused devastating plant disease in countries such as New Zealand. In this country, Psa biovar 3 was first detected in Te Puke in 2010 and has gone on to infect about 3,000 kiwi fruit orchards, the equivalent of more than 90% of the kiwi fruit production area. The pathogen is thus far restricted to New Zealand's North Island, although comparatively little kiwi fruit cultivation occurs on New Zealand's South Island.

The economic consequences of Psa infection have been devastating for the whole industry. Since the 1950s, New Zealand has been the biggest kiwi fruit exporter in the world. Kiwi fruit is their major horticultural export earner and thousands of full-time jobs depend on this industry, thanks to Zespri, a cooperative of kiwi fruit growers and the largest kiwi fruit marketer with £1,400 million in sales worldwide (2018/2019 season). Since the pathogen was identified in New Zealand, Zespri has invested several million dollars into research to fight against this devastating disease.

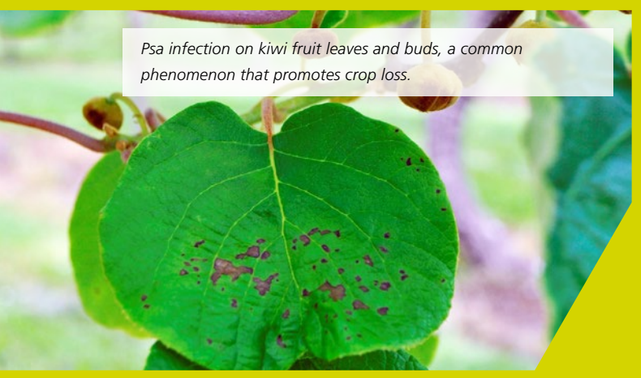
Commercial kiwi fruit orchard at the Kaimai Range, New Zealand.

Under favourable conditions, Psa can drastically reduce crop yields and even cause the death of kiwi fruit vines, but how does Psa manage to cause such devastating crop losses? To cause disease, the pathogen must first enter the plant, and does so via natural openings such as stomata or wounds on leaf surfaces. Here, flagella play a key role by helping bacteria swim into stomata (motility) and towards high concentrations of nutrients (chemotaxis). Once inside, the pathogen uses its extensive virulence arsenal to attack the plant. Psa cells, like many Gram-negative pathogenic bacteria, have a needle-like protein complex called the type III secretion system to sense the presence of eukaryotic cells and to directly secrete effector proteins (toxins and immunosuppressive factors) into the host; a near-perfect weapon to escape from the plant immune response. Another virulence feature of the *P. syringae*

Spraying with copper compounds, and in exceptional situations bactericides, is a short-term solution

complex is that they can produce phytotoxins such as coronatine (stomata re-opening), phaseolotoxin (chlorotic lesions), exopolysaccharides (biofilm formation) and degrading enzymes (to degrade the host's cell walls) that supplement the attack on their plant host.

As of 2020, 99% of kiwi fruit production already comes from countries where Psa is present. Therefore, it is essential that kiwi fruit growers have effective, sustainable and environmentally friendly crop protection agents available to control Psa, thereby guaranteeing the world kiwi fruit supply and protecting this billion-pound industry. Current Psa agrochemicals available for New Zealand kiwi fruit growers are copper compounds (e.g. tribasic copper sulphate), bactericides (streptomycin and kasugamycin), elicitors (immune response) and forchlorfenuron (cytokinin activity). However, agrochemical overuse can promote resistance emergence and the risk of horizontal transfer of resistance genes between bacteria warns us that other alternatives need to be identified. This resistance is commonly conferred due to mobile elements such as insertion sequences, transposons and integrative conjugative elements (ICEs). ICEs are self-transmissible modular mobile genetic elements integrated into a host genome. They encode the machinery to transfer genetic elements into a new host by conjugation and can participate in horizontal gene transfer (HGT). HGT often contributes to providing resistance or an adaptation to some environmental factor for their host. It has been shown that HGT played an important role in New Zealand, conferring copper and streptomycin resistance to Psa. Additionally, agrochemicals can also accumulate in the soil, affecting the health of the ecosystem and fruit quality. Spraying with copper compounds, and in exceptional situations bactericides, is a short-term solution for New Zealand kiwi fruit growers. Especially as only two years after the outbreak began, a copper- and streptomycin-resistant Psa strain was identified in the country and, thus far, no completely effective and environmentally friendly agrochemicals have been released to control Psa on kiwi fruit.



Psa infection on kiwi fruit leaves and buds, a common phenomenon that promotes crop loss.

A solution to this pandemic kiwi fruit pathogen may be Biological Control Agents (BCAs). BCAs are natural parasites, predators or pathogens of a pest. In recent years, they have been promoted due to the increased public awareness of sustainable agriculture and the hazards of agrochemicals. They are of great interest for agriculture as BCAs only target the pest they are intended for, require low maintenance after the first introduction, reduce agrochemical use, lower the risk of causing agrochemical resistance and are effective. In the case of bacteria, among their additional benefits, they may induce systemic resistance (activation of natural plant defences from prior pathogen attack) and growth promotion (e.g. phosphate-solubilising bacteria). Also, if BCAs are isolated from the same environment where the disease is present, these organisms are endemic to the ecosystem and adapted to the climate conditions and the host plant and avoids introducing non-endemic organisms into a different ecosystem. Furthermore, BCAs reduce agrochemical use and the risk of microbes such as bacteria transferring genetic material to other species and causing agrochemical resistance. Additionally, BCAs may have the arsenal we need to fight against Psa in an environmentally friendly manner, helped by the recent advances in microbiological and molecular techniques such as whole-genome sequencing and automated cluster-searching of natural products (NPs).

Plant bacteria such as *Pseudomonas putida*, *Pseudomonas fluorescens* and *Pseudomonas protegens* are widely known for their potential as BCAs against plant pathogens. In microbial interactions, to compete for nutrients and suppress other organisms, bacteria biosynthesise competitive weapons such as NPs, conferring a competitive advantage on those organisms that produce them. These include siderophores, phenols, antibiotics, bacteriocins and even toxins. On one hand, bacteria compete for territory and nutrient resources. Biocontrol bacteria tend to be good colonisers by quickly colonising as much of the plant surface as possible and advantageously taking any nutrients available. For example, this is possible with the help of molecules such as siderophores. These high-affinity iron-chelating compounds solubilise and transport iron across cell membranes. On the other hand, *Pseudomonas* species may secrete NPs to kill any competitor organism. Bacteriocins, for example pyocins, are proteins or peptides produced by bacteria to inhibit or kill closely related bacteria. They are a diverse group of toxins. For example, they can kill bacteria by depolarising cytoplasmic membranes or by degrading their DNA, be small or large plasmids or even be ribosomally or non-ribosomally synthesised. Therefore, understanding and screening bacteria isolated from underexplored ecosystems has huge potential in finding bacteria that may biosynthesise undiscovered and effective new antimicrobial agents.

Following this idea, *Pseudomonas* isolated from kiwi fruit orchards in New Zealand may help control Psa, but understanding how the plant pathogen shapes the kiwi fruit microbiome is still essential. *Pseudomonas* is one of the most abundant and best-characterised bacterial genera in the kiwi fruit phyllosphere and in many plants its abundance is correlated with the plant's health. However, naturally occurring kiwi fruit *Pseudomonas* species are currently underexplored, as are their metabolic profile and their biosynthetic potential for new NPs.

The use of bacteria in agriculture opens a whole range of potential benefits, including the biocontrol of plant pathogens by antagonistic bacteria and the enhancement of symbiotic or associative rhizosphere microbiomes, inducing systemic resistance and growth promotion. Following this idea, at the John Innes Centre, in collaboration with Plant and Food Research and Zespri International, we are actively investigating the creation of synthetic bacterial communities based on well-understood endemic bacteria to control Psa. The days of this kiwi fruit pandemic may be numbered.

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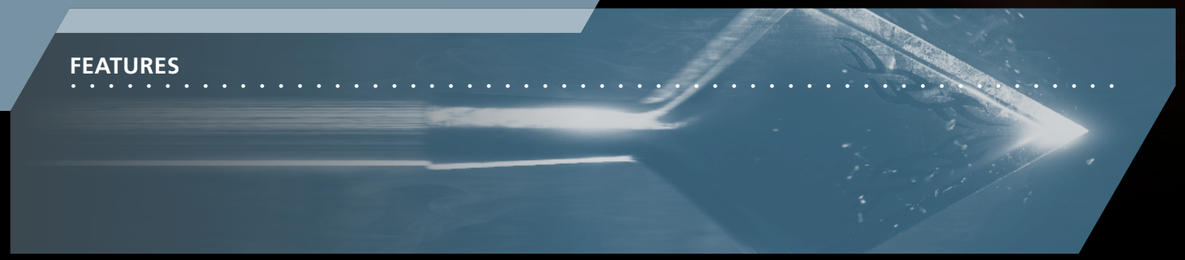
Commercial kiwi fruit orchard at the Kaimai Range, New Zealand.



The many facets of the type VI secretion system spike

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The type VI secretion system (T6SS) is a bacterial nanoweapon that injects effector proteins into a range of target cells. Such function renders the T6SS a potentially powerful medical tool to inject any protein of interest into target cells using bacteria as vehicles. However, for such application we need to better understand how the T6SS nanoweapon delivers its effectors before modifying it. New data on what the T6SS spike complex looks like and how effectors attach to it show how puzzling and multifaceted this nanomachine is and that a therapeutic application is more challenging than previously assumed.

The T6SS is a protein secretion system that works like a crossbow. Anchored to the bacterial inner membrane, a cytosolic sheath propels a T6SS arrow into neighbouring target cells. Types of target cells that have been identified include competing bacteria, fungi but also eukaryotic predators or human cell lines. The arrow of the T6SS is also referred to as the T6SS spike, having a pointed shape and penetrating the prey cell membrane.

The T6SS spike consists of four proteins: a conical PAAR protein, responsible for membrane puncturing, which sits on top of a long needle-like trimer of VgrG proteins. Besides perforating the prey membrane, the T6SS arrow is also decorated with substrates, or effectors, that have toxic effects on the prey cell. These range from killing bacterial competitors to modulating the host cell metabolism for the attacker's own benefit. To deliver T6SS effectors, the arrow provides different patches for effectors to recognise and bind to, rendering this arrow highly versatile and modular. Because of this versatility and efficiency to puncture a diverse set of cell types, the T6SS has been proposed as a tool to deliver therapeutic proteins in medical contexts. However, to design an artificial T6SS nanoweapon, we need to better understand how effectors are attached to the T6SS spike. Many studies have shown us what the T6SS spike looks like in different organisms and how effector proteins recognise their specific patches on the arrow.

One such patch is an extension domain containing a transthyretin-like (TTR) motif, generally known to mediate protein–protein interactions. Several PAAR and VgrG proteins were identified that contain C-terminal TTR domains required for effector loading onto the T6SS spike. For example, both *Vibrio cholerae* and *Pseudomonas aeruginosa* produce PAAR proteins with TTR domains, which are required for binding their cognate effectors TseH and TseT, respectively.

Other players decorating the T6SS spike can be effectors from the Rhs toxin family and a new study shed light on how the massive Rhs proteins might be attached to the T6SS spike. Pei *et al*. discovered that TseI, a modular Rhs effector in the waterborne pathogen *Aeromonas dhakensis*, is subject to two self-cleavage steps before its secretion. All three domains seem to be secreted with the help of a cognate chaperone.

The T6SS arrow in *Francisella tularensis* appears to be even more intriguing. Here, Yang *et al*. discovered that the spike is made of a PAAR-like protein, a VgrG trimer and another component, PdpA. Interestingly, at the bottom of PdpA an empty cavity is located, which the authors suggest could be filled with effector proteins. This novel way of attaching effectors to the T6SS spike highlights the diversity of mechanisms bacteria developed to deliver T6SS effectors into target cells.

Many T6SS arrows have recently been described that deliver effectors in various ways. Effectors can attach to the very top of the spike, to its needle-like structure and – as a novel way – to a cave at the bottom. The presence of all these different patches on the T6SS arrow for effectors to bind to makes the T6SS a promising tool for medical appliances. By adjusting which effectors can attach to a designed T6SS arrow, we might be able to synthesise medical bacteria that deliver chosen therapeutic proteins into biologically relevant target cells.

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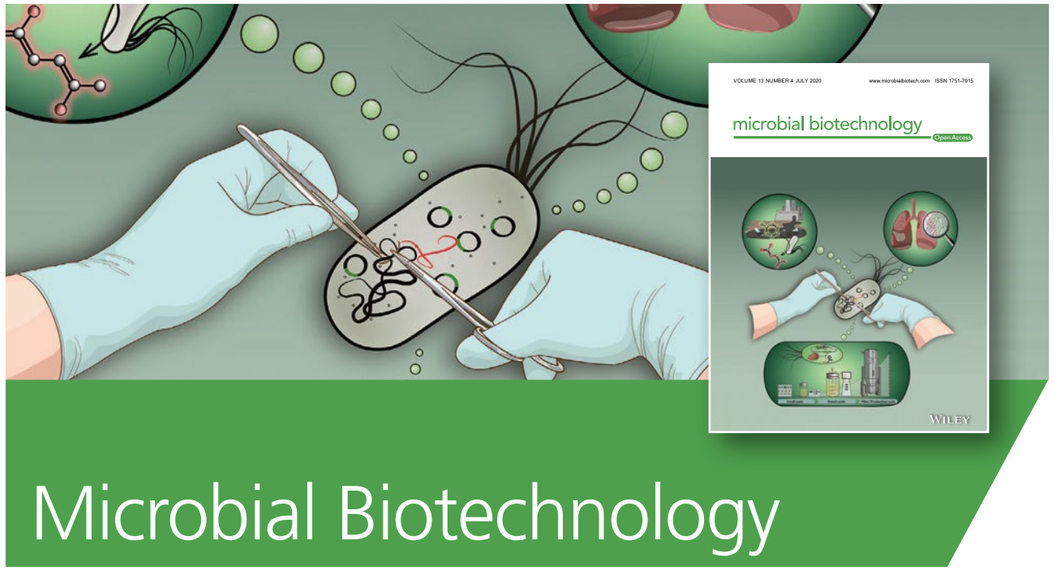

Microbial Biotechnology

Application of glycine in novel vaccine platform technology: breakthrough strategy in bacterial membrane vesicle production.

Hirayama S, Nakao R. Glycine significantly enhances bacterial membrane vesicle production: a powerful approach for isolation of LPS-reduced membrane vesicles of probiotic *Escherichia coli*. *Microbial Biotechnology* 2020; 13(4), 1162–1178.

Available from

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Hirayama and Nakao at the National Institute of Infectious Diseases (NIID), Tokyo, Japan, discovered a robust and easy method to efficiently produce bacterial membrane vesicles (BMVs), which are nanometre-scale spherical structures wrapped by a bacteria-derived membrane.

Native and bioengineered BMVs are of increasing interest in medical and healthcare settings nowadays, as they would be applicable for the development of novel drug delivery systems, especially for BMV-based vaccine development. Vaccines are the only possibility for defeating pathogens in the long term. In the new era under the global threat of not only COVID-19 but also any other emerging infectious diseases, a novel vaccine platform could therefore contribute to maintaining competent public health of human beings.

BMVs consist of various components derived from bacteria. Thanks to the structural stability and the multifaceted function (especially in the context of their potent mucosal adjuvanticity), BMVs can carry antigens, immunomodulatory molecules and other beneficial molecules without being damaged by the innate immune system or environmental factors such as pH or temperature. However, variability of BMV productivity is an important consideration to be addressed for practical applications of BMVs and no generally satisfactory method has been developed for the massive production of BMVs.

In this article, a simple and efficient method for the production of BMVs using glycine has been provided, when constructing and analysing those from a flagella-deficient clone of a probiotic *Escherichia coli* strain Nissle 1917. Furthermore, the amount of LPS in glycine-induced BMVs was surprisingly approximately 8-fold lower than that in non-induced BMVs. This method may be generally applicable for other bacterial strains of interest.

In addition, we would like to announce the first international workshop on BMVs, which will take place in Japan in autumn 2021, after the re-scheduled Tokyo Olympic and Paralympic Games in summer 2021.
https://www.embo.org/events/events-calendar
Join us!

EMBO Workshop, Bacterial membrane vesicles: Biogenesis, functions and medical applications. 24–26 November 2021, Tsukuba International Convention Center, Japan.
http://events.embo.org/coming-soon/index.php?EventID=w20-52

Ryoma Nakao
McGill Department of Bacteriology I
National Institute of Infectious Diseases, Japan

Journal of Applied Microbiology

Composition of semen and foreskin mucosa aerobic microbiota and its impact on sperm parameters of captive collared peccaries (*Pecari tajacu*).

Santos CS, Silva AM, Maia KM, Rodrigues GSO, Feijó FMC, Alves ND *et al*. Composition of semen and foreskin mucosa aerobic microbiota and its impact on sperm parameters of captive collared peccaries (*Pecari tajacu*). *Journal of Applied Microbiology* 2020.

Available from

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The recent development of assisted reproductive technologies, such as semen cryopreservation, plays an important role in ensuring the maintenance of biodiversity and supporting the conservation programmes of vulnerable species. Among the species benefited, we highlight the collared peccaries, wild pigs that inhabit North, Central and South America and have ecological importance as seed dispersers and as prey for large carnivores.

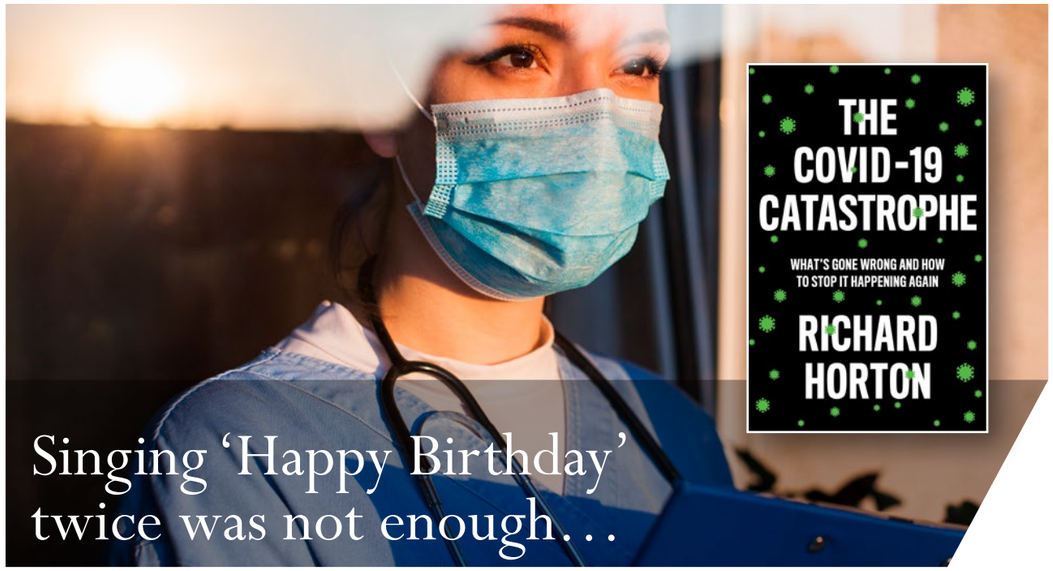
Since the animal's semen can be contaminated during collection or cryopreservation, the pathogens can not only damage sperm, but also can be easily disseminated through the exchange of contaminated samples. Therefore, the importance of the knowledge of the composition of reproductive microbiota in wild mammals is notable since these animals can act as a source of emerging diseases that can also affect humans.

This study allows us to know the semen and foreskin mucosa microbiota of the peccaries as a representative wild species, thus providing information related to the composition and role of their bacterial microbiome, as well as of microbe–host interactions. The presence of *Corynebacterium* species and *Staphylococcus* species is highlighted as the main mesophilic aerobic bacteria isolated. *Corynebacterium* species deserve special attention since they were proven to impair some peccary sperm parameters.

The authors also investigated the sensitivity and resistance profile of bacterial strains to the antibacterial agents used in semen diluents, highlighting the use of penicillin, streptomycin and gentamicin. This knowledge will help in the development of appropriate extenders containing antibacterial substances able to prevent bacterial contamination during storage and exchange of semen from peccaries.

We highlight the novelty of the data provided by the research that will serve as a basis for the conduct of ecological approaches, helping us to understand and prevent the consequences related to the perturbations in this microbiota, specifically associated with the use of antibiotics. Moreover, it will contribute immeasurably to both animal and human health and welfare.

Alexandre Rodrigues Silva
Laboratory of Animal Germplasm Conservation
Federal Rural University of the Semiarid Region, Brazil



Singing 'Happy Birthday' twice was not enough…

Review of Richard Horton's *The COVID-19 Catastrophe. What's gone wrong and how to stop it happening again.*

In the middle of January this year I was teaching in Hong Kong and my morning habit was reading the newspapers. I followed the initial stories of a mysterious respiratory infection in Wuhan and elsewhere in disbelief as it was clear there was person-to-person transference but it was not officially recognised. I shared with my students my observations and the BBC report of Professor Neil Ferguson's data given to WHO predicting the number of infections based on Wuhan's population size and the amount of air travel. It was clear there was a storm coming. Yet back in the UK it seemed to be just a game of watch and wait to see what happens next. It was therefore with great interest that I read Richard Horton's short book. As Editor-in-Chief of *The Lancet*, one should listen and reflect on his opinions, which appear haunted by the frightening messages from frontline healthcare workers over the lack of preparedness and PPE, followed by their avoidable deaths.

The book has seven chapters, and is short at 127 pages plus references, which have been kept to primarily peer-reviewed papers. It took me just over an evening to read. Most chapters start with a quote from other pandemic-related books, especially Laurie Garrett's *The Coming Plague* from 1994. Chapter 1, *From Wuhan to the World*, sets the scene with a timeline of events from 30 December 2019, including the WeChat message of Li Wenliang, through to WHO notification on 1 January, the WHO declaration of Public Health Emergency of International Concern (PHEIC) on 30 January, and the predictive epidemiology work of Gabriel Leung's group in Hong Kong. The shadows of SARS, Ebola and Zika are very evident in the decision-making by the numerous political and health groups, and the path that Tedros Ghebreyesus, WHO's Director General, has tried to take.

The book progresses with coverage of the various lockdown approaches adopted by various governments and their effect to the date of the book (May 2020). Richard defends China's approach against many of the criticisms, but not all. He is also highly critical of Donald Trump's approach within the USA and in particular his intended withdrawal of funding from WHO, Richard describes as 'a crime against humanity'. As for the UK, the PM is criticised and U-turns listed. But so too are parts of the UK scientific community criticised. Those named include the Medical Royal Colleges, the Academy of Medical Sciences, the British Medical Association, Public Health England, the Faculty of Public Health, The King's Fund and Nuffield Trust. Why? Because of their deaf ears to the WHO's declared PHEIC. The SAGE committee is also criticised for their initial anonymity, inclusion of Dominic Cummings and the lack of experts in respiratory and intensive care medicine. SAGE members are regarded as being too dependent upon government funding to rock the boat. The final chapter, *Towards the Next Pandemic*, emphasises the need for change, the recognition of inequality and lack of adequate funding for social care. Unfortunately, at a time of 'One Health', we need the recognition of 'One World' in order to prepare for the next pandemic; instead we have an unhealthy polarisation of countries.

As mentioned before, the book is short and aspects I would have liked to have been expanded upon include: (1) why WHO's advice on 'test, test, test' was not initially undertaken in the UK, (2) the accuracy of early test kits used in China, Japan and the USA and (3) the story of *Diamond Princess* (and other cruise ships) and the studies that have been done on the transfer of the virus via staff, food and air.

I can only give a taster of the book in this article, but I hope it has encouraged you to read it for yourself and reflect on what needs to change if we are to survive the next potential pandemic.

Steve Forsythe
SfAM *Executive Committee Member*

MUST-READ ARTICLES

The PM is criticised and U-turns listed

An interview with

Marcela Hernández García

School of Environmental Sciences, University of East Anglia, UK

COVID-19 and the gender gap in science: a mother's perspective

This pandemic is seriously affecting the lives of all scientists and working from home has highlighted and compounded the heavier burden borne by mothers. Environmental microbiologist and SfAM Executive Committee member Marcela Hernández García talks to *Microbiologist* about her current experiences.

Does science still have a gender inequality problem?

The gender gap in science is not closing fast enough as relatively little has been done to right the balance. For many mums who are academics, one of the first challenges is maternity leave. We panic as our male colleagues are publishing, while we are at home learning how to be mothers. Then, much of the time, mothers prioritise their partner's career, which means we are willing to have a career break while settling in another country or city. Now comes COVID-19, causing the planet to go on hold and straining our work–life balance. This is disproportionally affecting mothers, single parents and parents who share caring responsibilities.

What does the work–life balance look like for you during the pandemic?

I personally am fortunate to have a job and to be happy with the flexibility I have negotiated in order to balance work and family. Unfortunately, this is not the case for many mothers in academia. I have read several cases that contrast completely with my reality and should not be ignored. For example, principal investigators (PIs) who think their staff should be working from 9:00 to 17:00 as normal, or PIs 'looking for the cat's fifth leg' in order to get permission for their staff to go into the lab (trying to find an issue, defect or problem where there is none), or those PIs offering half-time contracts because the pandemic will cause those mums to be more focused on their children than on their projects. In that case, should those mums just pay half of the bills?

How do you feel mothers in academia are coping?

I have two daughters aged 5 and 9 and have this constant feeling of guilt that I am not doing enough with them. Even though I have a partner who helps with home schooling and chores, I still always want to be an active caregiver. Many mums who are scientists are struggling, trying to juggle projects, editorial roles, writing manuscripts and grants, making sure their students are fine, Zoom meetings and online lessons together with lockdown activities. Some of those activities include online shopping, sport, laundry, cleaning, organising meals, calling relatives, worrying about our relatives, printing out school activities, scanning them and sending them to the school on time (as if they are grant deadlines!). I am sure many mothers in science would relate with this, not finding enough time to do everything perfectly neither at home nor at work.

How should mothers be prioritising?

At this point in our lives, we need to prioritise our families rather than science. This should be fine if the scientific community understands and keeps promoting equity and inclusion for mothers in science. Having to navigate the challenges of parenting in a pandemic SHOULD NOT become damaging to our careers.

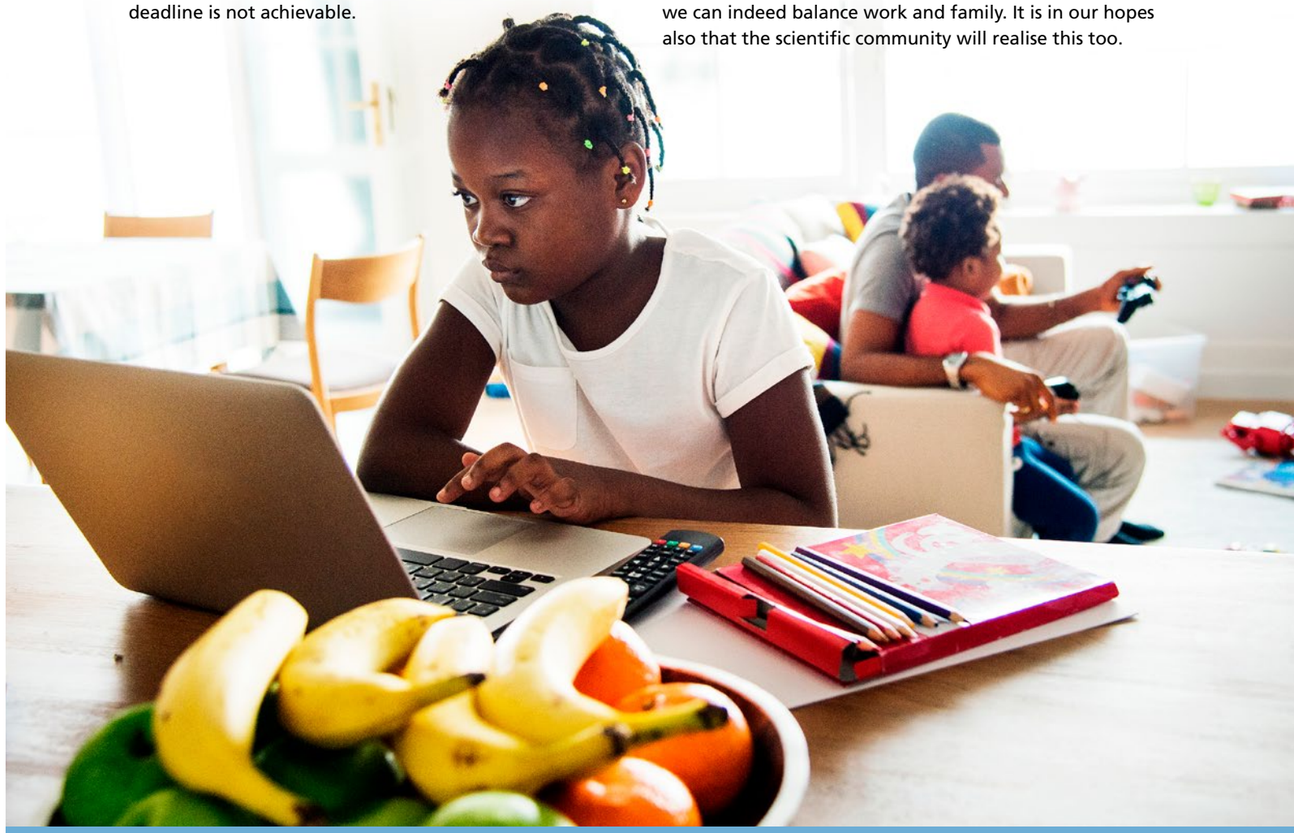
We should avoid thinking that it is because we are not good enough and we have to hope that:

- hiring committee members don't praise publication lists during 2020 while not taking caring responsibilities into consideration
- conference organisers invite female and male speakers in equal proportion
- more societies and grant bodies allocate budgets to support mothers in science affected by this pandemic*

*As an example, UK Research and Innovation has just released £180 million in funding to sustain research and fellowships affected by COVID-19 (**https://www.ukri.org/news/ukri-confirms-covid-19-grant-extension-allocation/**). Even though this budget doesn't specify how much will be allocated to mothers in science, it is a window of hope for us.

Are working mothers finding time to write papers?

Evidence is showing that the coronavirus crisis and subsequent lockdown has increased journal submissions. Comparing April to June this year to last year, the submission rate for the *Journal of Applied Microbiology* (JAM) increased by 26% and for *Letters of Applied Microbiology* (LAM) by 53%. With lockdown ending, we have seen a decrease of 10% for JAM and 6% for LAM, when you compare July and August with April and May. We do not know the gender of the authors, but based on my own experiences of lockdown I would guess a high proportion of those increased submissions come from male academics (or from academics without caring responsibilities). During this pandemic, things are not the same and cannot be the same. For example, we need to realise that editorial deadlines go to the bottom of our daily list and many times the four-day or seven-day deadline is not achievable.



What would you say are the major threats to our well-being right now?

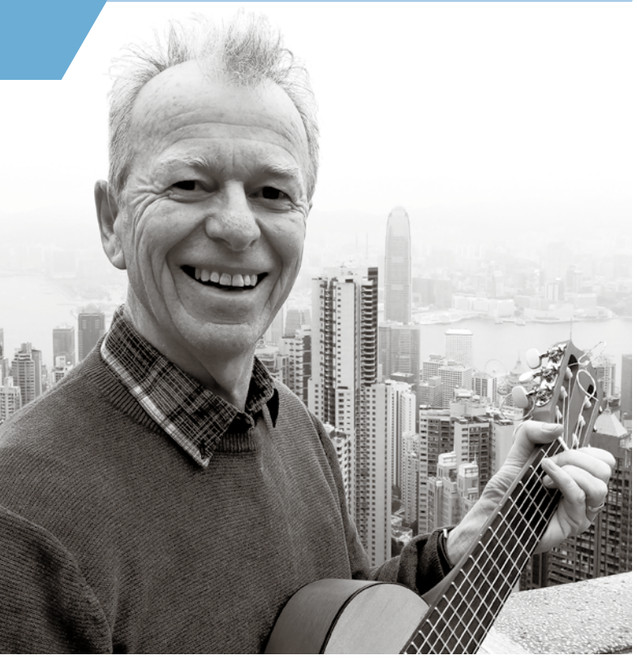
Applying for new jobs is impossible. Certainly university hiring has been frozen in several countries and looking at two international job websites during May and June, I found zero lectureships being advertised in the field of environmental microbiology. So, what is left for scientists whose contracts were about to start and now have been frozen? What about those who were about to move to a new country and are stranded somewhere else?

..and dads?

Certainly I don't intend to stereotype men and women and the careers of many men have also been affected by their caring responsibilities. It is also not just male PIs who are not supportive of mothers in science. The issue is that there is a gender and diversity gap in science that as a global community we need to address.

What next?

The COVID-19 pandemic has been a life lesson for our children, and we need to make sure they are in a safe and loving environment. It is in our hopes that our kids will realise in the future how important our jobs are and that we can indeed balance work and family. It is in our hopes also that the scientific community will realise this too.



My zig-zag life

Sometimes new researchers look at the academic world and wonder how they can make an impact and find their own identity. My story, I think, reflects that sometimes you have to work with the circumstances you're in and look for the small opportunities. In the end I have authored over 130 peer-reviewed papers, 3 books, supervised over 30 PhD students, became a Professor of Microbiology as well as external advisor to WHO, the European Food Standards Agency and UK's Food Standards Authority. My research on the safe feeding of infants was rated 4* in REF 2014. But what was my 'journey'?

I was born in Cornwall, and remember reading a book by Isaac Asimov when I was about 15 that gave me an interest in physics. I thought I would go into telecommunications as it was the era of electronics. However, one Christmas (~1970) my new Philips Electronics kit proved very problematic as the values of the resistors were colour-coded and it turned out I am colour-blind. Fortunately, when I started doing A-levels, I changed to having greater interest in biology. I was fascinated by cell structure and collected *Scientific American* articles on the chloroplast and mitochondria. I also bought the book *Microbes and Man* by John Postgate, which introduced me to the world of microbiology and it was that single book that convinced me to be microbiologist. I was expected to do well at A-levels but I crashed badly through severe exam nerves. Fortunately, Bristol Polytechnic (now University of the West of England) came to my rescue.

Steve Forsythe
SfAM *Executive Committee Member*

Their four-year thick sandwich degree had a significant amount of continuous assessment (something of a novelty at the time). During my one-year placement at Torry Research Station (Aberdeen), one of my projects was a rapid detection system based on impedance microbiology.

My PhD in agricultural biochemistry at Newcastle University required me to learn the Hungate technique for strict anaerobic microbiology. Peter Silley (former SfAM President) worked in the lab next door. My PhD analysed the diversity of microbes in the intestinal tract and modelled nitrogen flux between the intestinal flora and host bloodstream. I modified the strict anaerobic approach for my postdoc at the University of Birmingham, where I worked on oxygen-sensitive nitrate- and nitrite-reductase enzymes from bacteria, which I had isolated from patients with neutral pH stomachs. I was looking at the possible production of carcinogenic *N*-nitroso compounds as these patients had a raised incidence of gastric cancer. In fact, we were amongst the first to isolate *Helicobacter pylori* (then *Campylobacter pyloridis*) from human subjects. Unfortunately, as I could not grow it in liquid culture I did not pursue it – my biggest ever research mistake.

My first lectureship was at the University of East London. I lectured in food microbiology because no one else wanted to cover it. I developed (with Peter Silley) a rapid method for detecting potential carcinogens within six hours by combining DNA repair-deficient *E. coli* strains with the impedance microbiology. However, since I was commuting for at least six hours each day, I took the opportunity of a new lecturing post at Nottingham Trent University (NTU).

At Nottingham I gradually built up a microbiology research group on food microbiology. But I also worked on the bioremediation of textile dyes, and used impedance microbiology to demonstrate genotoxin production. One of those papers has been cited >400 times. In 2000, I wrote *Microbiology of Safe Food*, which was one of the first food microbiology books with web addresses and online support. The 3rd edition was published this year (January 2020).

My largest research output has been on the emergent bacterial pathogen *Cronobacter*, which can cause life-threatening meningitis in neonates. Our first paper has had almost 500 citations. Our research ranged from co-developing a chromogenic agar with Oxoid (Thermo Fisher) for the improved recovery of the organism from infant formula, through to DNA sequence-based identification and genotyping methods of MLST, SNP, CRISPR-Cas arrays and capsule profiling. I am curator of the open-access PubMLST *Cronobacter* database, which currently has almost 3,000 strain entries and over 500 whole genomes. We also started a longitudinal study of the neonatal microbiome. Being at an institute without any frequent research council funding meant much of the work was funded by self-funded students. The huge benefit is that together you can just investigate ideas without having to keep to a pre-agreed plan.

Currently, I am visiting professor to universities in Hong Kong and Finland. Outside of academic work, I play classical guitar and am 3rd Dan black belt in taekwondo.

This all sounds like high achievement, but it is due to my many supportive colleagues, co-workers and research students, whom I thank.

My largest research output has been on the emergent bacterial pathogen *Cronobacter*

London's microbiota: the sun-kissed docks

Martin Adams
SfAM President 2011–2014

Like other major seaports, the hinterland of London's docks was once a hive of industrial activity, crowded with processing and manufacturing. Though host to some vibrant communities, it is fair to say that the area fell some way short of being a rural idyll. You might therefore think it unlikely if I claim that one local company brought something of the sun-kissed lemon groves of Sicily to the area and, for much of that time, used microorganisms to do it.

In 1867 John Bennet Lawes, the agricultural innovator who famously pioneered the use of superphosphate fertiliser and co-founded the Rothamsted Experimental Station, took over a former cement, tile and terracotta factory near Millwall Docks to establish the Atlas Chemical Works. He was already producing superphosphate elsewhere, and used the Atlas Works to manufacture citric and tartaric acids; both used primarily for their acidulant and chelating properties in the food, beverage and pharmaceutical industries. Their production employed two, rather esoteric, raw materials: calcium citrate from Sicilian lemon juice and argol, a crusty deposit that accumulated in casks used to store wine. Argol, comprising mainly potassium hydrogen tartrate, was also famously used by Louis Pasteur as the source of crystals for his early work on chirality and optical activity, when he painstakingly separated the enantiomeric forms of tartaric acid and its salts using the asymmetry of their crystals.

In 1870, Joseph Kemball, a manager at the Atlas Works, left to set up on his own, moving into the Crown Chemical Works at Three Mills, Bow, in 1871 and going into partnership with Colonel Conway Bishop to form Kemball Bishop (KB). The company flourished, initially producing around 10 tons of citric acid and 4 tons of tartaric acid each week, and later acquired Lawes's original plant in Millwall as well as building a factory in Australia.

The Production of citric acid by filamentous fungi had been demonstrated in Germany as early as 1893 by Wehmer using what were later identified as penicillia. Wehmer's factory operating the process only lasted for 10 years, but there was considerable interest elsewhere and in 1917 Currie published work done at the US Department of Agriculture on citric acid production by *Aspergillus niger* grown in surface culture. Currie later moved to Chas Pfizer & Co. of New York where his work became the basis of a commercially successful process starting in 1919. KB had long had a cordial relationship with Emil Pfizer who agreed to supply them with calcium citrate and later, in 1935, they further agreed to licence the fermentation process itself.

The mould was cultured in shallow aluminium trays containing a medium with a high concentration of sugars, typically 12-15%, (in KB's case, supplied by beet molasses) and gave yields in excess of 55% on a weight basis. After a few days' growth, the surface mycelial mat was removed and the citrate extracted from the remaining liquor. For the organism to produce such high levels of what is normally just a Krebs cycle intermediate, vegetative growth of the mould must be restricted, blocking the cycle so that citrate accumulates. This appears to be achieved in a number of ways, primarily by restricting the concentration of metals in the medium, particularly iron. Precise details are vague because, although there is substantial published literature on the fermentation, those companies successfully producing citric acid rely largely on close-guarded secrecy to protect their methods, so venturing further here might condemn me to a future spent looking anxiously over my shoulder.

The agreement with Pfizer led KB to halt its own project to develop a fermentation process but another British company, J & E Sturge of Edgbaston, a Quaker-run concern that had been producing citric acid from Sicilian lemon juice since 1831, adopted their own process. This is believed to have been based on a 1927 patent assigned to the French industrial microbiologist Auguste Fernbach and the confectionary firm Rowntree & Co.

In March 1938, KB diversified its fermentation activities, commissioning a new plant at Bow to produce calcium gluconate, but, with the start of the Second World War, its focus turned elsewhere when it became one of several UK companies contributing to the industrial production of penicillin. ICI were first, converting a former dyeworks in Manchester in 1941 and KB followed shortly afterwards, adapting their own fermentation plant for the purpose. Despite an unrelenting bombing campaign, KB increased its penicillin production from 50 fermentation trays in 1942 to 200 in 1944 and 600 in 1945. Initially, the fermentation broth was sent to Oxford for extraction but this was later done at the Crown Works along with testing and packaging. Wartime scarcity of steel and enthusiasm for a possible chemical synthesis of penicillin, prevented the rapid adoption of the deep culture fermentation used in the USA where, by 1944, production had dwarfed that of the UK.

Penicillin was produced at Bow until 1947, by which time the deep culture process was well established elsewhere in the UK and the Ministry of Supply indicated that it would no longer purchase penicillin produced by surface culture. KB adapted by converting their penicillin plant to the production of itaconic acid by *Aspergillus terreus* and built an additional citric acid plant at Millwall. The relationship with Pfizer, which had become increasingly close over the years, culminated in the takeover of KB in 1958. Production at Bow continued until 1971 when the plant was closed and production moved to a Pfizer factory using deep culture at Ringaskiddy in Ireland.

The original KB site on the banks of the Lea Navigation is now a large Tesco supermarket where recently shoppers have been patiently queuing 2 m apart to buy, among other things, a wealth of products, many containing citric acid that, unfortunately, no longer comes from Bow or even Sicily.

Building capacity where it is most needed

Ali Floyd
Wellcome Centre for Anti-Infectives Research (WCAIR), UK

At the Wellcome Centre for Anti-Infectives Research (*W*CAIR) we want to drive change and tackle inequality globally.

We have three key missions: to discover new medicines, to train a new generation of researchers and to educate and inspire people through our public engagement work.

The Centre was launched in April 2017. Consisting of academics from the University of Dundee's School of Life Sciences and the world-class expertise of the Drug Discovery Unit (DDU), Wellcome's investment recognised the outstanding work already happening in Dundee. In particular, the DDU's development of novel anti-malarial and anti-leishmaniasis compounds has garnered worldwide attention. The new support has allowed us not only to continue our existing work, but more importantly to develop new ways of working, to drive change across the sector.

Our research mission is to tackle neglected tropical diseases (NTDs). In particular, we work to support the London 2012 declaration to eradicate NTDs. Ultimately, our goal is to position ourselves and our partners at the cutting edge of how drug discovery for major infectious diseases of low- and middle-income countries is carried out. Our ambition is to radically increase the rate of delivery and success of drug discovery projects. We will achieve this by creating a fundamentally redesigned approach to drug discovery for these diseases. We are working with key opinion leaders from multiple disciplines to critically assess and establish new methodologies and technologies that can be implemented by a wide range of drug discovery groups.

The gaps and issues we are currently addressing include:

- **gaining a deeper understanding of parasite biology and mode of action of successful therapeutics**
- **defining critical paths and assay cascades predictive of human efficacy**
- **applying and integrating state-of-the-art approaches to compound design and synthesis.**

By tackling these issues, we are making impacts across the whole of the drug discovery continuum. We are improving capabilities and decision-making, to accelerate the progression (or closure) of projects and thus increase the flow of candidate drugs.

Our training programme has an equally important mission. The vast majority of our industry is based in the global north. This means that the rewards of drug discovery and the ability to set priorities are also disproportionately based here. With our training programme, we seek to rebalance this situation. By bringing promising early career

wellcome centre anti-infectives research

We have also been able to run training courses in several countries, including South Africa and Malawi

LifeSpace is red when viewed through the sand fly gut.

researchers from low- and middle-income countries to Dundee to learn what we do, we will build capacity in drug discovery where it is most needed.

The programme is completely bespoke for these researchers. Our team of expert trainers works with each individual to discover what they really need. Placements have lasted from 3 months up to 1 year in Dundee, after which they return home with new skills and a new support network. We have remained in touch with our trainees as they begin their onward projects, and we're excited to see what changes they will make happen.

Three print images inspired by laboratory gloves.

We have also been able to run training courses in several countries, including South Africa and Malawi. Here we have built strong links with our Malawian friends. Not only have we worked with researchers, but we are also engaging with lab managers to help build new infrastructure. This will be vital as we seek to change the shape of drug discovery worldwide.

The third strand of *W*CAIR is public engagement. As a part of the University of Dundee's School of Life Sciences, we are in one of the UK's leading institutions for public engagement. In 2017, the School was the first UK awardee of the National Coordinating Centre for Public Engagement's Gold Watermark Award at faculty level. As with our research, the concept has always been to find synergies between the School's existing public engagement work and the new capacity from the Centre.

This has manifested in several ways. LifeSpace is an interdisciplinary science art gallery, run in collaboration with Duncan of Jordanstone College of Art and Design. We have already created two new exhibitions of work. They each celebrate scientific research, artistic creativity and public engagement. *Parasiteseeing* imagined a travel

The concept has always been to find synergies between the School's existing public engagement work and the new capacity from the Centre

blog as written by the *Leishmania* parasite, in an exhibition that has already toured to Dundee Science Centre. *Translations* paired scientists with artists from the Dundee Print Collective. Together, they made new work, taking print into 3D, and formed an entirely new collective of their own.

We have also created a piece of site-specific theatre with the Dundee Rep, and developed a strong, long-term partnership with a local community in Dundee. We firmly believe that public engagement is a two-way conversation, and we have learned a great deal from each of these publics already.

As we complete our third year of funding, it is an exciting time at *W*CAIR. We know that the culture change we are seeking to implement takes time, but we are beginning to see some really promising results. You can find out much more about our research, training and public engagement at **wcair.dundee.ac.uk**.

Translations preview, visitors view ***Me, Myself and Research*** *by John Post.*

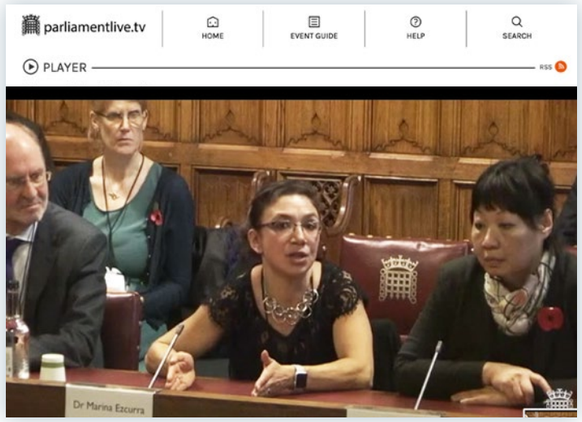
Building back better

‘Build back better’ has been declared the underlying principle for the UK’s post-COVID-19 recovery plans. As Boris Johnson’s words emphasise, the UK is not looking to resume pre-COVID-19 policies but to recover with smarter policies.

Already science and research are being incorporated into policies, such as the Chancellor’s summer statement, which includes a £3 billion investment in green initiatives, and the government’s Research and Development Roadmap, which commits £300 million to progressing the UK’s research infrastructure.

As policymakers are reviewing what UK policies should and should not change following this tumultuous year, now is a great opportunity to engage them in those areas that matter to you. Having witnessed the terrible consequences of inadequately investing in science, policymakers are keen to learn from these mistakes and use your expertise to inform future decisions. I urge SfAM members to seize this opportunity to engage with their MPs, committee clerks, etc. to promote public interest with evidence-based ideas and solutions.

To help members connect with the right stakeholders, we added new resources to our Policy webpages on engaging policymakers. These pages include ways to contact stakeholders, communication tips and anecdotes from SfAM members, like Dr Ezcurra’s following piece on presenting oral evidence to a Committee. We hope you find the information useful and, more importantly, inspiring.



Presenting evidence
Dr Ezcurra presenting evidence to the Science and Technology Committee.

Lisa Rivera
Policy and Public Affairs Manager

It’s only a number

Dr Marina Ezcurra
University of Kent, UK

I am a biogerontologist, studying the biology of ageing, to understand the molecular processes driving ageing. Ageing is a universal process affecting not only all humans but also most, if not all, animal species. It is a fascinating biological question to study. Why do we age at all? What are the biological processes underlying ageing? Can we use molecular information about the ageing process to improve the way we age, so that we can stay healthy and active for longer? These are questions that us biogerontologists are hoping to answer.

Ageing is now also a pressing social, economic and medical issue. With many countries experiencing rapidly ageing populations, global governments are now facing massive challenges in terms of how to provide care for the elderly population and how to manage the social and economic consequences. It is therefore great news that the House of Lords (HoL) Science and Technology Committee launched an Inquiry into Ageing, interacting directly with scientists to develop future strategies for the UK’s ageing population.

The UK government recognises the importance that ageing has on society by setting an ambitious target for the coming years – the aim is to increase the time we spend healthy as we get old by at least 5 years by 2035. This is a great but very ambitious goal – so *how* do we achieve it? This is what the Science and Technology Committee has set out to determine. The inquiry is looking into what treatments could be used to address ageing and ageing-related diseases and what health advice to give to the public about healthy lifestyles.

One aspect of healthy ageing that the Committee is interested in is how the gut microbiome might be affecting health during ageing and if it could be a way to improve health. The idea that the microbiome could affect how we age is not as alien as one might think. The gut microbiome sits in the boundary between diet, metabolism and immunity. Our metabolic and immune functions are important determinants in health and ageing, and intricately connected to the microbiome. The microbiome undergoes remodelling during ageing, and combined with the decline of our immune systems, this is likely to have major effects on our health.

Together with Kay-Tee Khaw, Professor of Clinical Gerontology, University of Cambridge and John Mathers, Professor of Human Nutrition, Newcastle University, I presented evidence to the Committee in November 2019. We had a great discussion about the effects of modern Western diets, with high levels of processed foods and sugars, on health and ageing and how these effects are likely to, in part, act through the microbiome. We also talked about how important it is to undertake research to understand the molecular mechanisms underlying how interactions with the microbiota affect our health and for the need for researchers from different disciplines to come together to tackle ageing.

An important aspect of improving health and ageing in our populations is the engagement of politicians. We need policies based on scientific evidence and we need funds to conduct this research. The level of engagement and genuine interest of the members of the House of Lords Science and Technology Committee combined with their ambitious inquiry makes me dare to hope that the Committee will contribute to policies that will support a healthier ageing population, improving quality of life for all of us.

Upcoming Mental Health Awareness Days

OCTOBER

World Mental Health Day

10 October 2020

The WHO recognises World Mental Health Day on 10 October every year. World Mental Health Day is an international day for mental health education, raising awareness about mental health issues and advocating against the social stigma.

SUICIDE PREVENTION ADVICE

WAIT!

- **W** **Watch out** for signs of distress and changes in behaviour
- **A** **Ask** "are you having suicidal thoughts?"
- **I** **It will pass** – assure your loved one that, with help, their suicidal feelings will pass with time
- **T** **Talk to others** – encourage your loved one to seek help from a GP or health professional

Mental Health Foundation 70 YEARS

SEPTEMBER

World Suicide Prevention Day

10 September 2020

World Suicide Prevention Day is organised by the Internation Association for Sucide Prevention and the World Health Organization. The purpose of the day is to promote a global commitment and action to prevent suicides.

NOVEMBER

International Stress Awareness Day

7 November 2020

International Stress Awareness Day aims to raise awareness to stressors that can have a negative impact on our mental health and offer proven coping strategies and other sources of help for individuals and organisations.

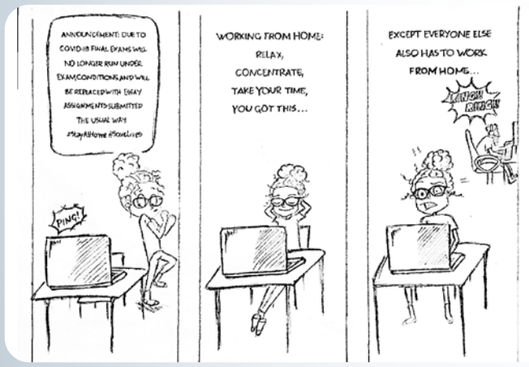
Micro Comic Comp 2020

As part of Mental Health Awareness week, SfAM hosted a comic competition to increase mental health awareness in STEM. The competition highlighted the importance of expressing oneself through various media, in this case via illustration, and provided SfAM members an opportunity to share their experiences and feelings during such extraordinary times. We want to send a big thank you to everyone who participated in our comic competition and helped to make it a huge success.

Winning Comic

Marylette Roa *Taking charge of my thoughts*

From time to time, I find myself spiralling into unhappiness. So, let me try to explain how I deal with crippling negative thoughts and show kindness to myself. Firstly, I acknowledge that the thoughts are present and do my best to pry myself away – although this sometimes takes a while and requires a lot of effort. I examine my thoughts from an 'outside' perspective looking in so that I can understand what is going on. Sometimes, this also leads me to accept that an explanation is not necessary nor possible at the moment. By allowing myself to engage with my thoughts, I feel better and more equipped to take charge of my feelings and actions afterwards.

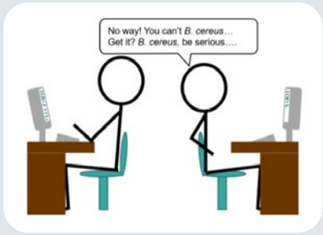


Runner-up

Elitsa Penkova *The Struggles of Lockdown*

I am a final-year undergraduate student in my very final exam session. Due to COVID-19, my university replaced all my exams with essay assignments, which I have a few weeks to write in the comfort of my own home. At first, I was quite excited I won't have to go through the devastating one-hour rush to recall everything I've ever learnt and construct it into a sensible piece of work. Except, I failed to account for the fact it won't be just me working from home…

Two PhD students working in a shared office. Character 1 leaning back in their chair looking exhausted but relieved. Character 2 working away on a computer. Character 1: 'I've done it! After years of hard work, I've finally finished my thesis!'



Character 2 turns around to talk to character 1 with a smirk, they had been waiting for this moment. Character 2: 'No way! You can't B. cereus.... Get it? B. cereus, be serious.'

Character 1 head in hands, looking tired, character 2 continues trying to explain the joke, thinking character 1 has somehow missed the joke. The speech of character 2 slowly gets smaller as if fading into the background noise. Character 1: 'I can't wait to get out of this office.' Character 2: 'B. cereus, be serious, it's funny, come on what happened to your sense of humour. I thought it was one of my best…'

Runner-up

Anna Liuzzi *Office "mates"*

BioFocus: putting the bioscience sector in the spotlight

I don't think anyone could have imagined how different life now could be to how it was only six months ago. What began as a three-week lockdown for the UK has stretched into a whole spring and summer of restrictions on life as we knew it, and it will no doubt be many more months until we return to 'normal'.

The pandemic thrust science squarely into the spotlight, with the daily briefings broadcasting scientists straight into the living rooms of millions in the UK. The COVID-19 outbreak brought much of the country to a standstill, but for scientists, healthcare workers and essential workers, it was very much the opposite.

Almost overnight, the bioscience community mobilised to face the challenge head on, with usual processes such as diagnostic developments, drug trials and vaccine testing being accelerated to breakneck speeds.

We interviewed a number of biologists about how their work has changed this year, and despite the sombre effects of the pandemic being felt worldwide, many tackled the challenges head on with a positive zeal.

Sector behemoth the Francis Crick Institute converted its whole site for COVID-19 research and diagnostics, and its director, Sir Paul Nurse Hon FRSB, commended the science sector for responding so quickly: 'This is an unprecedented situation, unplanned and chaotic. The science sector has pulled together quickly and openly, which has been impressive to see. Once the pandemic is over, it will be vital to come together to see what worked well, what went wrong and how it could be improved. But for now everyone must focus on the challenge at hand.'

'The collaborative spirit is extraordinary and unprecedented,' says Bristol-based synthetic biologist Imre Berger FRSB, who joined forces with 40 other scientists and sector leaders to address the previously unfathomable challenges presented by the pandemic. 'More people are running towards the fire than running away from it,' as US microbiologist Michael D L Johnson puts it.

Within months we have had promising news that one group of researchers at the University of Oxford had initial trial success with a potential vaccine, whilst another Oxford team had identified dexamethasone as an effective treatment for those in hospital.

The RSB has also amassed more than 500 responses to a recent survey for biologists about the effects of the pandemic on them. We'll be releasing that information soon to properly demonstrate the seismic shift that has affected the sector, and to highlight the essential role bioscientists of disciplines have played in tackling this disease.

Working remotely has certainly had its challenges, but has provided a number of new opportunities, including taking many of our events online.

Mark Downs CSci FRSB
Chief Executive of the Royal Society of Biology

Sector behemoth the Francis Crick Institute converted its whole site for COVID-19 research and diagnostics

Our most recent Policy Lates event, supported in part by SfAM, saw leading scientists come together virtually to discuss the 'One Health' approach to AMR. Despite the change in format, it was actually the most popular Lates ever – hundreds of people were able to join the live stream from all over the world, and discuss solutions to a challenge that affects populations globally.

This year's Parliamentary Links Day, also supported by SfAM, drew registered interest from over a thousand people online, as an impressive line-up of policymakers, scientists and sector leaders came together to discuss how the pandemic has affected the public trust in science.

Sir Patrick Vallance, now a household name due to his appearances on the daily coronavirus briefing in his capacity as chief scientific advisor, said the events of the last six months had improved trust in science and the way science is understood by politicians and the public.

'I do think that there is an absolute understanding inside government now that science is important in all sorts of areas of government,' Sir Patrick said. 'Where previously, you were pushing hard to get science heard, I do not think that will be the case going forward, and I think that will be to the benefit of a lot of government and the policies that come out.'

Sadly, we were unable to enjoy our usual summer schedule of visiting science festivals and fairs to deliver our outreach and engagement activities, but not all hope was lost; Lambeth Country Show and the Isle of Wight's Hullabaloo festival took place entirely online this year, and we were able to take part and share some digital content for activities suitable to do at home.

We'll continue to work closely with SfAM and our member organisations through our Outreach and Engagement Working Group, and share best practice and further refine our digital outreach work.

RSB staff are assessing a gradual return to our London offices, although it is unlikely that we will be there in any significant numbers this side of Christmas. Staff have adapted exceptionally well to working from home, and we'll be using this change in circumstance as an opportunity to revise how we work and ensure we can be even more flexible whilst still meeting our objectives.

With our first ever virtual Biology Week around the corner (3–11 October), we hope you get involved with the festivities this year, even if they are in a slightly different format. We look forward to returning to a more diverse format of events and activities in 2021, whilst ensuring we continue to stay safe and well.

The latest news, views and microbiological developments

NCTC: New Antimicrobial Resistant Strains

A revised edition of the National Collection of Type Cultures' *Antimicrobial Resistant Reference Strains* brochure is now available for download: **www.phe-culturecollections.org.uk/AMR**

Revisions include updates to reflect the latest recommendations from the European Committee on Antimicrobial Susceptibility Testing (EUCAST), the Clinical and Laboratory Standards Institute (CLSI) and Public Health England, as well as the inclusion of strains with known intrinsic resistance determinants and the addition of recently accessioned strains.

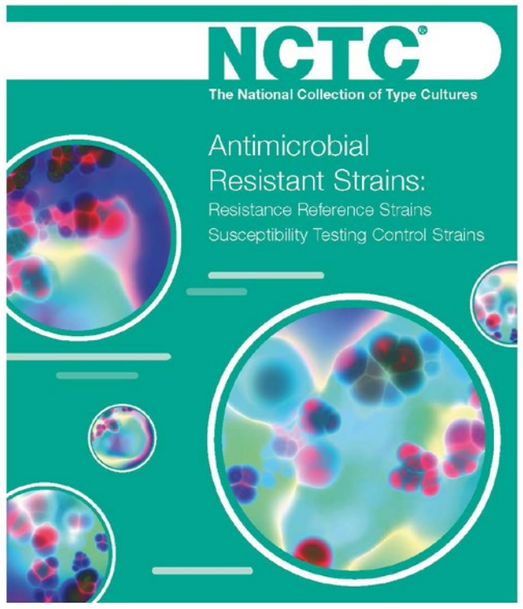
Among these new additions are strains resistant to "last-resort" antibiotics such as colistin and linezolid, a strain of *Neisseria gonorrhoeae* with combined ceftriaxone and high-level azithromycin resistance, and more "classical" antibiotic resistant bacteria such as methicillin resistant *Staphylococcus aureus* and vancomycin resistant enterococci.

The curation of antimicrobial resistant strains by NCTC is supported by the expertise of Public Health England's Antimicrobial Resistance and Healthcare Associated Infections laboratory and a range of international depositors and researchers which helps to ensure that both well-known and emerging resistant phenotypes are available from NCTC. Representative strains of contemporary lineages of bacteria, both globally disseminated (such as *Staphylococcus epidermidis*) and domestic hospital adapted (such as *Enterococcus faecalis*), are also included.

These strains are suitable for a wide range of applications, such as phenotypic testing or molecular assays.

Further information

Visit: **www.phe-culturecollections.org.uk**
Tel: **+44 (0)1980 612512**
Email: **culturecollections@phe.gov.uk**



KWIK-STIK™ from Microbiologics

Laboratories throughout the world have been praising the KWIK-STIK for decades. That's because its simple, all-inclusive design makes life easier for lab techs while reducing chances for errors.

Each KWIK-STIK contains a qualitative lyophilized microorganism pellet, ampoule of hydrating fluid and inoculating swab. Everything you need to grow reference cultures for QC testing is included in this one handy device.

Available in packs of 2 or 6, KWIK-STIKs are universally used for all types of microbiological control testing.

- Accredited reference material under ISO 17034 standard
- Over 900 strains available
- All-in-one design reduces the risk of contamination
- Strains are less than or equal to three passages from reference culture
- Ready-to-use format saves time and money

Further information

Visit: **www.bioconnections.net**
Tel: **+44 (0)1782 516010**
Email: **welcome@bioconnections.co.uk**

The Small Workstation with Big Ideas

The new Whitley A20 Workstation is our smallest anaerobic chamber, the perfect step-up from using anaerobic jars. Despite its diminutive size, the A20 has the same precise control of parameters as our larger workstations, providing excellent conditions for the processing, incubation and examination of samples without exposure to atmospheric oxygen.

Unlike with jars, the A20 allows you to check your plates as often as you like without risk to samples and is very economic to run. It can accommodate 240 x 90mm Petri dishes whilst retaining a generous working area but will actually hold up to 400 plates for emergency incubation.

The A20 is equipped with two oval, multi-functional glove ports, each capable of transferring 10 x 90mm Petri dishes at the same time as a user inserts his/her arms. A side-loading letterbox entry system enables individual items to be introduced quickly.

Whitley A20 Anaerobic Workstation

Colour, touch-screen control acts as a visual display of temperature, humidity, etc and an interface for easy control and operation of the workstation. Options include remote access, data download, and Anaerobic and Catalyst Conditions Monitoring, which guarantee optimal growth conditions.

This workstation can be used for both anaerobic and microaerobic applications simply by changing the gas supplies.

Further information

Visit: **www.dwscientific.com**
Tel: **+44 (0)1274 595728**
Email: **sales@dwscientific.co.uk**

Validation of GPS™ CoVID-19 dtec-RT-qPCR Test for detection of the SARS-CoV-2

A Real-Time qPCR assay containing all the required reagents that can be transported at room temperature.

On 27th January 2020, Genetic PCR solutions™ launched one of the first commercial kits for specific real-time PCR (qPCR) detection of the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), responsible for the COVID-19 disease. First design was based on ca. 14 genomes released on to GISAID (Global Initiative on Sharing All Influenza Data) by 19th January from 6 different laboratories.

A full review using most of genomes described to date (1,572 genomes; 25th March) has been performed and compared to primers and probes recommended by WHO, designed by CDC (Atlanta), Charite (Berlin), Institut Pasteur (París), National Institute for Viral Disease Control and Prevention (China), Hong Kong University, Ministry of Public Health (Thailand), and National Institute of Infectious Disease (Japan). This study demonstrated that the target selected by GPS™ is fully **inclusive** and showed a much higher **exclusivity** than these designs developed by all other laboratories. Database analysis was updated in July.

Internal validation following the guidelines of international norms UNE/EN ISO 17025 and ISO/IEC 15189:2012 has been achieved for the GPS™ CoVID-19 dtec-RT-qPCR Test with strict validation criteria. The assay can detect specifically the SARS-CoV-2 virus in all the phases of disease, even in asymptomatic patients. The *CoVID-19 dtec-RT-qPCR Test* received diagnostic validation from the reference laboratory *Instituto de Salud Carlos III* (ISCIII, Madrid) showing 100% of diagnostic specificity and sensitivity, recently also participated in a program

organized by Public Health England (PHE) resulting in 100% correlation with reference methods. This study is now available in the Journal of Applied Microbiology (**http://dx.doi.org/10.1111/jam.14781**).

Dr Antonio Martínez-Murcia
Director GPS™

Further information

Visit: **www.geneticpcr.com**
Tel: **+34 96 542 9901**
Email: **info@geneticpcr.com**

NCIMB marks 70 years

NCIMB recently marked a significant anniversary. Seventy years ago, the creation of a National Collection of Industrial Bacteria was announced in the journal Nature. The collection took over the non-pathogenic cultures held by the UK's National Collection of Type Cultures and, at the time, was reported to house some 350 types. The number was expected to increase considerably as the collection became more representative of the needs of industry. This collection went on to merge with the National Collections of Marine and then Food bacteria to create the culture collection that NCIMB Ltd curates today – the National Collection of Industrial, Food and Marine Bacteria.

The collection has continued to grow since 1950, and now includes thousands of strains isolated by scientists around the world, from all kinds of environments. Recent additions to the collection have even included several novel species of human gut bacteria.

So seventy years on, our name is more of a reflection of our history than the contents of our culture collection – we are proud of how the collection has developed over the years so it can continue to meet the needs of both academic researchers and industry – maintaining a genetic resource for the future as well as supplying the cultures that are needed today.

You can learn more about our culture collection at **www.ncimb.com**.

Further information

Visit: **www.ncimb.com**
Tel: **+44 (0)1224 009333**
Email: **enquiries@ncimb.com**

Minutes of the 89th Annual General Meeting of the Society for Applied Microbiology

16 JULY 2020, 16:00 | VIRTUAL AGM VIA ZOOM

1 Present:

Thirty-nine members attended the AGM. This included:

President, Mark Fielder
Vice President, Brendan Gilmore
Meeting Secretary, Ian Feavers
Trustee, Tim Aldsworth
Trustee, Elaine Cloutman-Green
Trustee, Mike Dempsey
Trustee, Stephen Forsythe
Trustee, Claire Hill
Treasurer, Oern Greif
Trustee, Linda Thomas
Trustee, Sally Cutler
Trustee, Marcela Hernández García
Trustee, Catherine Ludden

In attendance:

Lucy Harper, *Chief Executive*
Paul Sainsbury, *Head of Communications and Business Development*
Chris Bonfante, *Operations & Governance Manager*
Lisa Rivera, *Policy & Public Affairs Manager*
Laura Lincoln, *Events & Projects Manager*
Lucky Cullen, *Science Policy Officer*
Ali Morse, *VA to the Chief Executive*

2 Apologies for absence

Arthur Gilmour
Peter Wareing
Hilary Lappin-Scott
General Secretary, Clare Taylor

3 Minutes of the 88th Annual General Meeting

The minutes of the 88th Annual General Meeting held in Glasgow in 2019 were published in the September 2019 issue of *Microbiologist*. They were unanimously accepted by those present.

Proposer – Elaine Cloutman-Green
Seconder – Mike Dempsey

4 Matters arising from the previous minutes

There were no matters arising.

5 Report of the Trustees of the Society 2019

The Chief Executive noted the successes of the Society during the previous year, particularly with respect to the continued success of the Society journals.

Dr Harper summarised the three main areas of SfAM activities during 2019: Impact, Voice and Sustainability. Notable successes had included strong campaigns, wide-ranging inter-disciplinary collaboration, and influential responses to government consultations and parliamentary work. A particular success was the FEMS Congress in Glasgow: SfAM had forged a strong partnership with FEMS and had a very strong presence at the Congress. SfAM had also strengthened its commitment to Equality, Diversity and Inclusion and joined EDIS, an organisation that supports these values in science and health.

Dr Harper noted that membership of the Society through 2019 was strong, and thanked staff for their dedication and support. She also noted that she was delighted by the successful activities of the Early Career Scientists Committee, and thanked them for their energy, commitment and being pivotal to moving a lot of SfAM events online. SfAM awarded 251 grants in 2019.

Dr Harper closed her presentation sincerely thanking the work of all the Trustees and the brilliant team at the Society.

6 Adoption of the Annual Report and financial statements for 2019

Copies of the Annual Report and financial statements of the Society for 2019 had been distributed previously. Members noted receipt of the report and statements and unanimously accepted the Annual Report.

Proposer – Brendan Gilmore
Seconder – Sally Cutler

7 Election of new members (including honorary members), deaths and resignations

A list of the names of applicants for membership and a list of deaths has appeared in the *Microbiologist* throughout the previous year. The Society also holds a summary list of new members and resignations throughout the previous year.

8 Nomination and election of new Executive Committee members

1. Members voted unanimously to accept the Executive Committee's recommendation that Professor Brendan Gilmore be appointed President of SfAM.
2. Members were notified of the end of term for two Executive Committee Members of SfAM: Dr Linda Thomas and Dr Tim Aldsworth.
3. Members voted unanimously to confirm the election of two new Trustees, as indicated by the online ballot held live at the AGM.
   1. Dr Suzy Moody
   2. Dr Emmanuel Adukwu
   Proposer – Oern Greif
   Seconder – Ian Feavers

9 Special resolution to alter the Articles of Association

The President explained the background to this agenda item. Members unanimously agreed that the draft Articles of Association produced to the meeting, and for the purposes of identification, initialled by the Company Secretary, be adopted as the Articles of Association of the Charity in substitution for, and to the exclusion of, the existing Articles of Association, subject to and with effect from the approval of the Charity Commission of any changes which require its consent.

Proposer – Marcela Hernández García
Seconder – Mike Dempsey

There were no proxy votes to take into account for any of the votes at this meeting.

10 Any other business

There was no other business.

Society for Applied Microbiology

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