



MICROBIOLOGY

TODAY

QUARTERLY MAGAZINE OF THE SOCIETY FOR GENERAL MICROBIOLOGY VOLUME 29 NOVEMBER 2002

Microbiology Today – joint winner of ALPSP award

Fish need doctoring too!

Marine microlights

The importance of marine snow

Giant algal viruses

Fossilized records of past seas

Trouble ahead in UK bathing waters

Red tides in the sunset

Marine biotechnology

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Content now on SW

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Above: The 'clean' waters
of the Atlantic Ocean come to
rest on the sands of a small
cove near St Ives, Cornwall.
Photo Ian Atherton.

Vol. 29, Part 4, November 2002

We are celebrating a great
achievement. *Microbiology
Today* has won an award, as
described on p.170. In this
issue of your award-winning
magazine, we take to the
water and look at aspects
of marine microbiology.

Fishy tales from Brian Austin
cover the incidence, diagnosis
and control of the ever-
increasing range of infectious
diseases that affect fish
(pp.171–173). Humans as
well as fish can be at risk from
harmful micro-organisms
if untreated sewage is
discharged into the sea. On
pp. 186–188 Keith Jones
describes the strict legislation
that protects bathing water
quality and outlines problems
that may prove hard to resolve.

What's going on under the
waves? Plankton is at the
base of the marine food
web and some of it forms
macroaggregates which sink
to the seabed. This 'marine
snow' plays an important role
in the ecological cycles of the
oceans, as Carol Turley sets
out on pp. 177–179. Some
types of phytoplankton

develop into blooms. The
effects of the harmful ones
are described by Robin Raine
(pp. 190–193), whilst on pp.
180–182 Willie Wilson
explores the range of viruses
that infect marine eukaryotic
plankton. The planktonic
foraminifera are an important
part of the zooplankton, and
their calcitic shells, preserved
in the ocean sediments, form
one of the most complete
fossil records on earth. Chris
Wade and Kate Darling (pp.
183–184) explain how they
can be used as indicators of
climate change.

Luminous marine bacteria
can cause fish to glow and
algal blooms to shine.
Peter Herring explains
the mechanism of
bioluminescence and some
of its applications (pp. 174–
176). Marine biotechnology
generally is at an exciting
phase and a new European
Centre opens shortly in
Scotland as Graham
Shimmield and David Green
describe (pp. 194–195).

The UK government has
a new policy to combat
infectious disease. Geoffrey
Schild gives it the once over
in 'Comment' on p.224.

These articles appear in
addition to all the regular
features and reports of
Society activities.

Microbiology Today – your award-winning magazine!

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Vietnam *Simon Cutting* 209

We won the cup!

'Microbiology Today shows good use of a modern design and clear, attractive graphics'

Judges comments

We are proud to announce that *Microbiology Today* is Joint Winner in the 2002 ALPSP/Charlesworth Award for House/Membership Journals. This award recognizes excellence in functionality and appearance in non-research publications which are intended primarily for a membership or similar group. The judges were impressed by the broad range of entries of very high quality, which led to them making an award to two publications. The joint winners were judged to be leaders in the field. SGM shared the award with *The Garden*, the magazine of the Royal Horticultural Society.

Janet Hurst, Managing Editor of *Microbiology Today*, was presented with a framed certificate and a silver cup at the Annual ALPSP Dinner, held at Savoy Place, London on 19 September. We keep the cup for 6 months before passing it on to the Royal Horticultural Society. Both cup and certificate are now on display at SGM Headquarters.



Readers may remember that last year *Microbiology Today* was Highly Commended in the ALPSP/Charlesworth competition, and the team who produce the magazine (see below) are thrilled to have won this year. We all strive to work to high standards and it is pleasing to see that our efforts are recognized externally. The competition was particularly strong this year.

● The *Microbiology Today* team

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- Managing Editor Janet Hurst
- Assistant Editor Janice Meekings
- Production Editor Ian Atherton

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- Editor Meriel Jones (University of Liverpool)
- 2002 Editorial Board Lynne Macaskie
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● ALPSP represents the community of not-for-profit publishers and those who work with them to disseminate academic and professional information. It has an informative website at www.alpsp.org and publishes a journal, *Learned Publishing*.



ABOVE: Janet Hurst (left) and a representative from the RHS (right) being presented with their certificates and the cup by Neil Charlesworth (centre).

TOP RIGHT: The *Microbiology Today* team. From left to right: Janice Meekings, Ian Atherton and Janet Hurst. PHOTO AIDAN PARTE

RIGHT: Our certificate.



Fish need doctoring too!

Brian Austin

When does the saga of fish disease actually begin? Arguably one of the first landmark publications was in 1718, when the disease 'red pest' of eels was discussed. This condition, which was probably an early name for vibriosis (caused by *Vibrio* spp.), affected eels held in saltwater, and there are descriptions of heavy losses in Italy throughout the 18th and 19th centuries. Thereafter, many bacteria, viruses and parasites became associated with disease, with new species being recognized all too regularly.

● The diseases

There are slowly developing 'chronic' diseases and faster 'acute' conditions. The slowly developing mycobacteriosis is a scourge of wild marine fish populations, with disease signs including emaciation (the fish look as if they are starving) and salt-like granules (granulomas) on the internal organs, especially the liver. These granulomas are virtually pure cultures of *Mycobacterium* spp. Mycobacteriosis is also a problem with some pet fish, with the disease signs taking several years to develop. Beware! The bacteria may spread through abrasions into us, causing a complaint known as fish tank granuloma. Acute diseases are more problematic to fish farming where the throughput of animals is comparatively fast – often only a year passes from hatching of the eggs to the arrival of the delicious looking fillets in the fishmongers. Disease signs may include:

- erosion of the head (exposing the brain), fins and tail (exposing the backbone)
- eye damage (bulging eyes, blood spots or eroded eyes)
- gill erosion/fusion (the fish can't breathe properly)
- surface blood spots (i.e. haemorrhaging, ulceration, abscesses, blisters/boils)
- distended abdomen full of a straw-coloured sticky fluid (ascites)

Internally, there may be haemorrhaging, a swollen digestive tract full of liquid, indicative of gastroenteritis, a swollen kidney, liver and/or spleen, liquefaction of the internal musculature and/or organs and the presence of tumours and/or granulomas. Vibriosis is a common disease of marine fish worldwide, with the signs appropriately described as that of a haemorrhagic septicaemia, i.e. there is abundant surface (particularly around the base of the fins) and internal (often in the musculature) haemorrhaging and necrosis/liquefaction of the organs (especially the kidneys). With advanced cases of disease, the pathogen is rampant throughout the infected animal.

● The pathogens

The range of fish pathogens is steadily increasing and new candidates regularly appear in the literature. Topical examples include *Piscirickettsia salmonis* (salmonid

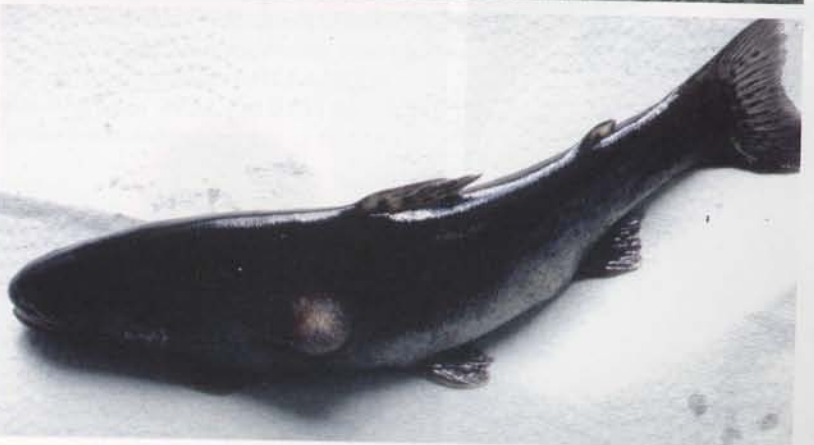
rickettsial septicaemia; a disease which was first reported in Chile), *Moritella viscosa* (winter ulcer disease; this occurred originally in farmed salmon in Iceland) and *Pasteurella skyensis* (first isolated from Atlantic salmon in Scotland). Apart from the newcomers, aquatic animals have been subjected to many bacteria (*Aeromonas*, *Chryseobacterium*, *Flexibacter*, *Photobacterium*, *Pseudomonas*, *Renibacterium*, *Serratia*, *Streptococcus*, *Vibrio*), viruses [e.g. infectious salmon anaemia (ISA), viral haemorrhagic septicaemia (VHS), infectious pancreatic necrosis (IPN), infectious haematopoietic necrosis (IHN)] and eukaryotic parasites (including sea lice and flukes).

Aeromonas salmonicida, which causes furunculosis in salmon and trout and ulcer disease in carp and marine flatfish, appears to be spreading from its traditional base in freshwater to the sea. The organism was first described in 1894 as a cause of disease in hatchery-reared brown trout in Germany. Over the next century, the organism became established as a significant killer of salmonids, particularly in Europe and North America. Many isolates were collected, and found to comprise an extremely homogeneous group, i.e. *A. salmonicida* subsp. *salmonicida*. The organism produces a brown diffusible pigment on protein-containing media (such as tryptone soya agar), does not grow readily above 30 °C,

Fish may become infected with any of a wide range of bacterial and viral pathogens and eukaryotic parasites. Brian Austin reveals the background to some of these fascinating diseases.

BELOW TOP:
An ulcer, caused by atypical *Aeromonas salmonicida*, on the flank of a goldfish.
REPRODUCED WITH PERMISSION FROM BACTERIAL FISH PATHOGENS (PRAXIS PUBLISHING)

BELOW BOTTOM:
A boil (furuncle), caused by *A. salmonicida* subsp. *salmonicida*, on the flank of a rainbow trout.
COURTESY B. AUSTIN



Who won the fight?

UPPER RIGHT: Pinprick (petechial) haemorrhages on the surface of an eel. The disease, known by its Japanese name of *Sekiten-byo*, is caused by *Pseudomonas anguilliseptica*. COURTESY G. DEAR

LOWER RIGHT: Surface haemorrhaging on an adult turbot. The disease, known as vibriosis, is caused by *Vibrio anguillarum*. COURTESY B. AUSTIN

BELOW LEFT: *A. salmonicida* subsp. *salmonicida* growing on tryptone soya agar, revealing the characteristic brown diffusible pigment. COURTESY B. AUSTIN

BELOW RIGHT: A brown-pigmented colony of the L-form stage of *A. salmonicida* growing in agar medium. COURTESY B. AUSTIN

and is notoriously difficult to isolate from samples other than clinically diseased fish. Indeed, for many years on the basis of negative data (i.e. the inability to find the pathogen away from sick fish), the formal description was of an organism, which did not occur in the aquatic environment, and was recoverable only from specimens displaying overt signs of disease. It is a moot point as to how scientists thought the organism was transferred between discrete fish populations if water was not the transport medium. Nevertheless, it was soon realized that there were isolates which did not fit into subspecies *salmonicida*. Thus, four other subspecies, namely *achromogenes*, *masoucida*, *smithia* and *pectinolytica*, were proposed to accommodate them. The taxonomic problem intensified with the recovery of an increasing number of isolates with supposedly unusual traits, including the inability to produce the brown diffusible pigment (or weak pigment production), nutritional fastidiousness, particularly for blood products, and the inability to produce oxidase (other isolates are oxidase-positive). Such isolates became regarded as 'atypical', and are associated with ulcer formation. Over the last two decades, atypical *A. salmonicida* has appeared increasingly as a pathogen (causing ulcers) in marine flatfish in European coastal waters. For the first time, isolates with an obligate requirement for sodium chloride (marine?) are appearing. What will happen next?

● Disease diagnosis

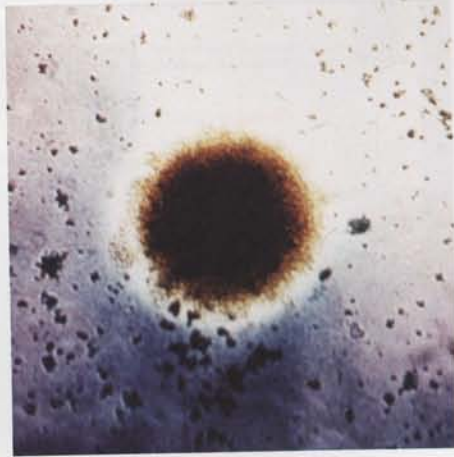
Fish disease diagnosticians seem reluctant to make judgements unless the sick animal is sacrificed, dissected and tissues taken for histology and microbiology. The procedure is not noted for its speed. Traditionally, for bacterial diseases, cultures would be obtained and characterized by a comparatively narrow range of morphological and biochemical tests. Then, identification would rely heavily on personal judgement. Rapid diagnostic systems, such as API 20E, API 20NE and BIOLOG-GN are now used widely, and the use of



the manufacturer's identification matrices has reduced the subjectivity of making meaningful diagnoses. Developments in serology have speeded up diagnoses considerably. With comparatively limited developmental work, the diagnostic laboratory may be equipped for whole-cell agglutination, indirect or latex agglutination, the direct or indirect fluorescent antibody test, Western blotting and the enzyme-linked immunosorbant assay (ELISA). Some of these systems, e.g. ELISA, are quick (within an hour), enabling diagnoses to be made directly from a pathological specimen without the need for culturing, and may be used remotely from the diagnostic laboratory. Of course, modern molecular techniques (including PCR, DNA probes and DNA sequencing) have been developed for and find regular use in the diagnosis of fish diseases. Unfortunately, these methods are often beyond the budget of laboratories in developing nations where much fish farming actually occurs. It is an interesting point that the owner of the diseased stock likes to know the names of the species (and, where relevant, subspecies) of the pathogen causing the disease. The relevance of this information to disease control is not always easy to see.

● Disease control

Very little can be done to alleviate disease in wild stock. In contrast, a wealth of methods have been devised to eliminate or reduce the impact of diseases in farmed animals. Methods involve use of vaccines, non-specific immunostimulants (such as β -1,3 glucan), dietary supplements (e.g. vitamin C), probiotics, antimicrobial compounds (e.g. the antibiotic oxytetracycline), the development of genetically disease-resistant stock and movement restrictions for infected animals. Not so many years ago, antibiotics were the principle means of disease control. However, there has been a groundswell of opinion against the use of such medically important compounds in the aquatic environment, with concerns reflecting the





intraperitoneally) or orally (historically, this was least successful but the recent development of oily oralizers which enable the antigens to survive passage through the stomach have improved the approach tremendously). Booster doses may be needed, but then protection develops often lasting for the life of the fish. The spread of serious diseases, such as ISA and VHS, may be controlled by movement restriction coupled with a slaughter and disposal policy. However, this requires governmental action and a lot of goodwill on the part of the owners of the diseased stock.

What about the future? There are programmes underway to develop disease-resistant strains, with procedures involving selective breeding and genetic manipulation. Enough said!

UPPER LEFT:
The upper rainbow trout displays a badly swollen kidney, typical of bacterial kidney disease as caused by *Renibacterium salmoninarum*. The bottom fish is a healthy control. REPRODUCED WITH PERMISSION FROM BACTERIAL FISH PATHOGENS (PRAXIS PUBLISHING)

LOWER LEFT:
Dissection through a furuncle on a rainbow trout revealing the liquefying muscle. REPRODUCED WITH PERMISSION FROM BACTERIAL FISH PATHOGENS (PRAXIS PUBLISHING)



fate of compounds (could they enter potable water supplies or remain in the fish tissues destined for human consumption?) and the build-up and possible transfer of antibiotic resistance to pathogens of human significance. Alternative approaches are needed, and to some extent probiotics (live organisms which function as beneficial feed additives) are starting to fill the void. Regularly, there have been reports of a wide range of Gram-positive (notably lactobacilli) and Gram-negative bacteria (including *Aeromonas* spp.), which boost appetite and reduce the incidence of disease. Anecdotal evidence from Ecuador suggests that since the first use of probiotics (often *Vibrio alginolyticus*) 20 years ago in shrimp farming, the need for antibiotics has decreased by 90%. In addition, vaccines have become well established as a primary means of disease prevention. Commercial products are available, principally for the control of some bacterial diseases, including vibriosis and furunculosis. Most commonly, the vaccines are formalin-inactivated suspensions of bacterial pathogens, which are applied by immersion (the fish are dipped for 30–120 seconds in the diluted vaccine), injection (small volumes, often 0.1 ml, of the formulations in adjuvant are injected

● Conclusions

Aquatic animals may become infected with an ever increasing range of pathogens and parasites. Details of new developments, especially in disease diagnosis and control, regularly grace the pages of scientific publications. Yet, the pathogens manage to keep one stage ahead. New challenges emerge, and so the saga continues.

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Further reading

Austin, B. & Austin, D.A. (1999). *Bacterial Fish Pathogens, Disease of Farmed and Wild Fish*, 3rd (Revised) edn. Godalming: Springer-Praxis.

Marine microlights: the luminous marine bacteria

Peter Herring

Luminous marine bacteria can cause fish to glow and seas to shine. How do they do it? How can we use this amazing phenomenon in biomedical science?

Luminous bacteria have had a long and distinguished career, albeit much of it cloaked in mystery. Glowing meat, fish and shrimp were well known to our less-illuminated ancestors and in 1667 Robert Boyle discovered that their light was reversibly extinguished in a vacuum. A practical, if unwitting, demonstration of the role of microorganisms was described in 1825 in a macabre experiment on the eerie light emitted by two dissected bodies in a London anatomy school. The luminous material was scraped off and was then used to induce other corpses to glow.

Luminous bacteria were grown in culture in the 1870s and 27 species had been described by 1900. The present tally of culturable marine species is about 10, three of them assigned to the genus *Photobacterium*, five to *Vibrio* and two to *Shewanella*. The taxonomy has been frequently revised and some of the *Vibrio* species previously appeared as *Photobacterium*, *Achromobacter*, *Lucibacterium*, *Neisseria* or *Beneckea*. There are also two non-marine luminous bacteria, *Photobacterium* (*Xenorhabdus*) *luminescens* and a strain of *Vibrio cholerae*.

● Mechanism

How is the light produced? Bioluminescence involves the oxidation of a substrate (generically known as luciferin) in the presence of an enzyme (luciferase). Bacterial luciferase oxidizes FMNH₂, in the presence of a long chain aldehyde (tetradecanal). All luminous bacteria share this reaction, but their control systems differ. *In vitro* the reaction emits blue-green light with a maximum at 485–495 nm, yet the light from live *Vibrio fischeri* is bluer (max. at 475 nm) because a blue-fluorescent protein (or lumazine protein) accepts energy from the reaction and emits light at its own characteristic wavelength. A strain of *V. fischeri* (Y-1) also has a yellow fluorescent protein (YFP) and emits yellow light (max. at 540 nm) (Fig. 1). Weakening the bonds between YFP and the reaction system (e. g. by dilution or by raising the temperature) reduces

the yellow component of the luminescence. Up to 18 °C the light is yellow; at higher temperatures it is blue.

Single isolated bacteria do not glow, but colonies do. Individual cells produce an 'autoinducer', which accumulates in the medium and at a critical concentration triggers the production of luciferase, thereby switching on the luminescence. Different species have different inducers, but similar systems. Autoinduction of luminescence is an example of quorum sensing, in which population density (signalled chemically) induces metabolic processes, including virulence, in many non-luminous bacteria.

● Genetics of luminescence

Light emission from marine bacteria is easy to detect. Species such as *V. fischeri* are easy to culture and dim or dark mutants frequently appear. These factors have helped to dissect the genetic basis of luminescence. Bacterial luciferase is composed of two subunits, a and b, encoded by the *luxA* and *luxB* genes. Three other genes (*luxC*, *D* and *E*) control the biosynthesis of tetradecanal. Other genes are essential in particular species. *luxF*, *G*, *H*, *L* and *Y* are involved with flavin metabolism, lumazine proteins and the colour of the light. Of the regulatory genes in *V. fischeri*, *luxI* controls production of autoinducer and *luxR* encodes the autoinducer receptor protein. The interaction of autoinducer and protein stimulates transcription of the *luxICDABEG* operon, producing light (and more inducer). *Vibrio harveyi* has a different regulatory system involving two autoinducers and its genetic alphabet includes *luxL**, *M*, *N*, *Q*, *R**, *S* and *T* (where *luxL** and *luxR** are different in sequence and in function to *luxL* and *luxR* in *V. fischeri*).

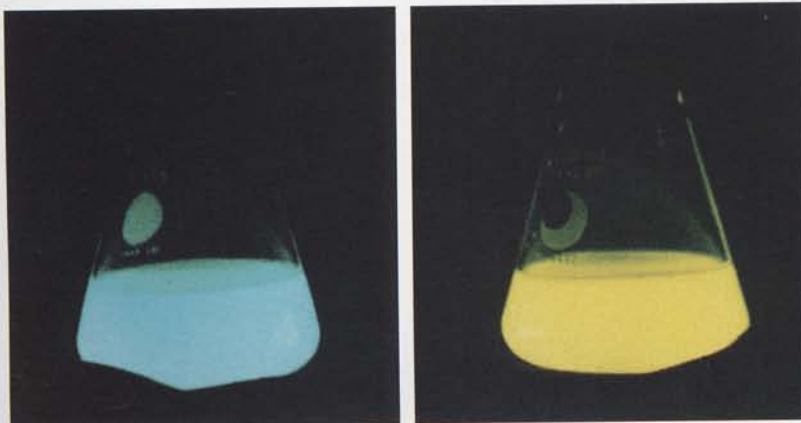
● Applications

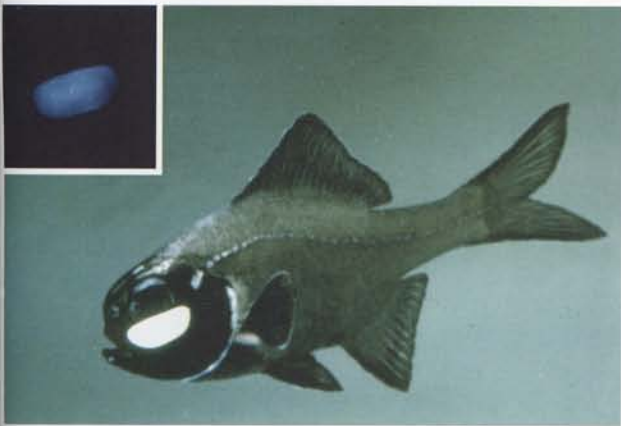
Luciferase genes were cloned in the 1980s and the ease with which these and other genes can be transferred into a wide variety of organisms has provided an almost unparalleled range of tools for studying the regulation of intracellular processes and for following the fate of different bacteria under a wide variety of conditions. The use of these tools is continuously expanding and their applications as reporters of, for example, gene expression, quorum sensing, bacterial detection and cell viability are of huge commercial and research value.

● Distribution

Culturable luminous marine bacteria occur in free-living, saprophytic, commensal, symbiotic and parasitic environments. Most species can be found in more than one habitat, though the species composition in seawater varies widely in different seasons and regions and is largely related to water temperature. *Photobacterium phosphoreum* grows at lower temperatures than other species and is more abundant in northern waters, in

BELOW:
Fig. 1. Cultures (at 18 °C) of *Photobacterium phosphoreum* (left) and *Vibrio fischeri* strain Y-1 (right) by their own light.
COURTESY TOM BALDWIN





marine snow

sea surface to the horizon glowing steadily. It occurs most frequently in the Arabian Gulf during the southwest monsoon (July and August). The most likely explanation is luminous bacteria, growing on a surface scum caused by the decay of a 'bloom' of algae, common during this period. The one scientific study within a Milky Sea did indeed find both *V. harveyi* and glowing algae, but the apparent densities of the bacteria from the seawater were too low for autoinduction to occur and several orders of magnitude lower than that necessary for the luminescence to be visible, so the bacterial hypothesis remains likely but unproven.

● Symbiosis

Luminescence is an important attribute. Although light energy accounts for <0.01 % of the bacterial cell's total expenditure, >5 % of the bacterial protein may be dedicated to luminescence. The main ecological role for luminous bacteria is probably as light sources for others. Many marine organisms, from dinoflagellates to fishes, are bioluminescent. Most species have their own luciferin/luciferase systems, but some fishes and squids contract out the job of light production to luminous bacteria, culturing them as extracellular symbionts in special light organs. This splendid arrangement nevertheless does have its potential drawbacks. The host needs (1) to maintain the bacteria in good condition (or the light goes out) and to get rid of dead or surplus ones, (2) to restrict the bacteria to the desired site and not let them spread throughout the body, (3) to be able to switch the light on and off at will (induced bacteria glow continuously) and (4) to ensure that the right symbionts are passed to the next generation.

winter and in deep water. Thus in Californian waters *V. fischeri* is found throughout the year while *V. harveyi* predominates in summer and *P. phosphoreum* is occasionally present in winter. The first two species account for 99 % of the isolates and occur at densities of 1–5 per ml. In samples from the Puerto Rico Trench *P. phosphoreum* is dominant from 200 to 1,000 m (at 1–4 cells per ml) but samples from 4,000 to 7,000 m had <1 luminous cell per litre.

Are there truly free-living luminous marine bacteria? Possibly not. At best the notionally free-living ones may simply be en route between substrates. The oceans contain flocculent organic aggregates, known as marine snow (see article by Carol Turley on pp. 177–179), on which luminous bacteria abound (in Californian waters 63 % of the aggregates present at night at 60 m were luminous). Saprophytic colonies occur on the surface of fishes and in shell lesions on crustaceans. Lethal (parasitic) infections cause sandhoppers to glow. Commensal populations of *V. fischeri*, *V. harveyi* and *P. phosphoreum* are particularly abundant in the guts of shrimps and fishes, whose faeces contain viable luminous bacteria and often glow visibly, both while sinking and when collected in sediment traps. The deeper (and colder) the water the more likely *P. phosphoreum* will be the only species present. As the commonest habitat for many luminous bacteria appears to be among the gut flora of fishes, the value of bioluminescence to the bacterium may be to attract a fish to ingest a luminous particle. A single bacterium emits only some 10^3 – 10^4 photons per second and would be invisible to a fish or shrimp, but a population dense enough to trigger autoinduction will be bright enough to see. Glowing colonies on faeces or marine snow are the bacterium's way of getting from one nutritious gut to another.

The dilution effect of seawater should prevent autoinduction occurring in 'free-living' bacteria. Nevertheless, one rare phenomenon, 'Milky Sea', has been attributed to them. Seafarers describe it as like sailing over a sea of milk, with the sky dark and the entire

None of this is easy – nor is finding out how they do it. There are about a dozen groups of fishes that employ luminous symbionts, both in the deep sea (e.g. spookfishes, anglerfishes and rattails) and in shallow water (ponyfishes and flashlight fishes). Shallow water fishes and squid use *V. fischeri* or *Photobacterium leiognathi* as their symbionts while deep-sea fishes, not surprisingly, use *P. phosphoreum*. Anglerfishes and flashlight fishes contain bacteria that have not yet been cultured *in vitro* (Figs 2 and 3). The association is very specific – for each host species only one kind of bacterium will do – and populations in the light organs seem to be clonal. The light organs of most of the fishes using *V. fischeri*, *P. leiognathi* or *P. phosphoreum* develop as pouches from different parts of the gut. The symbiont simply has to be 'selected' by the light organ from the normal gut flora. Animals whose light organs do not open into the gut (anglerfishes, flashlight fishes, pinecone fishes and squids) have a more difficult task, but these light organs do have openings to the exterior through which colonization presumably takes place. As we cannot culture the anglerfish and flashlight fish

TOP LEFT:

Fig. 2. The lure of the deep-sea anglerfish *Melanocetus johnsoni* contains unculturable luminous symbionts.

PHOTO P. J. HERRING

BOTTOM LEFT:

Fig. 3. The large light organ under the eye of the flashlight fish *Photoblepharon palpebratus* (inset: by its own light) contains luminous symbionts.

PHOTO P. J. HERRING

Marine microorganisms marine bacteria

Peter Herring

Further reading

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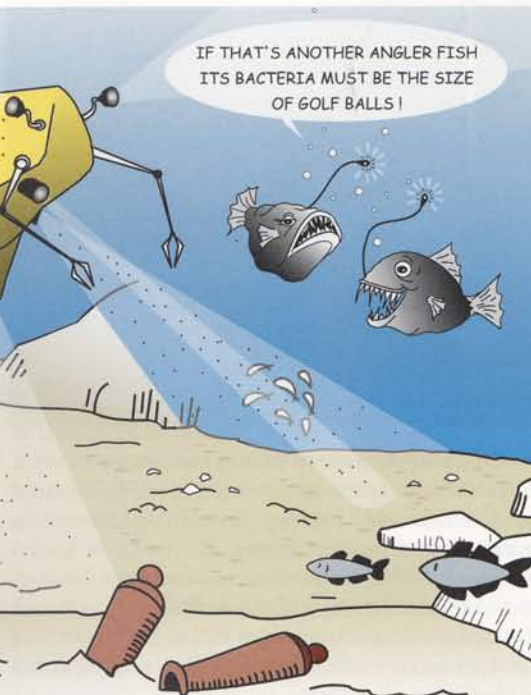
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symbionts, we do not know how abundant they are in seawater. Genetic data suggest that they are related to *Vibrio* species and, remarkably, that each anglerfish species has a different symbiont. (Fig. 4)

The light organs of fishes and squids leak bacteria into the surrounding seawater, in a steady dribble in the case of the fishes (10^7 – 10^8 cells per hour from organs containing 10^8 – 5×10^9 bacteria at local densities of about 10^{11} cells per ml) and as a daily expulsion of 95% of the bacteria in the squid. The doubling time of the bacteria in the light organ is much lower (8 hours to >5 days) than when cultured *in vitro*, but it is not certain how the host controls the growth rate. The leakage of symbionts both provides an environmental reservoir for reinfection of juveniles and offers scope for wider genetic exchange.

The larval light organs of squid and ponyfishes acquire their bacteria only when exposed to water recently occupied by leaking adults. Both the squid *Euprymna scolopes* and its symbiont *V. fischeri* can be cultured separately and manipulations of the infection process have clarified how the right bacterium is recognized and acquired (Fig. 5). At the time of hatching the larval light organ contains no bacteria, but the local seawater contains about 500 *V. fischeri* cells per ml. Ciliated lobes on the light organ harvest these bacteria, which then swim into crypts within the organ. Here they grow very rapidly (doubling time 20 minutes) until the crypts are filled (totalling about 10^9 cells). *V. fischeri* is specifically recognized by the cells in the crypt, initiating local morphological changes and sending a signal to the ciliated lobes, which then wither irreversibly in a process of programmed cell death. The specificity of



TOP RIGHT:
Fig. 4.

CARTOON KATE DAVIS, SOUTHAMPTON OCEANOGRAPHY CENTRE

BELOW:

Fig. 5. The little squid *Euprymna scolopes* cultures *Vibrio fischeri* in its two ventral light organs.

PHOTO M. MCFALL-NGAI



the association is enhanced by the role of *V. fischeri* luciferase in countering the oxidative stress in the crypt environment. Mutants that are deficient in the expression of luminescence are also defective colonizers.

Insight into the very complex association between squid and bacterium has huge potential for interpreting the factors involved in the colonization of host tissues by pathogenic vibrios or other bacteria. Luminous marine bacteria are no longer just objects of curiosity but resources for a multitude of biomedical applications – as well as for their hosts.

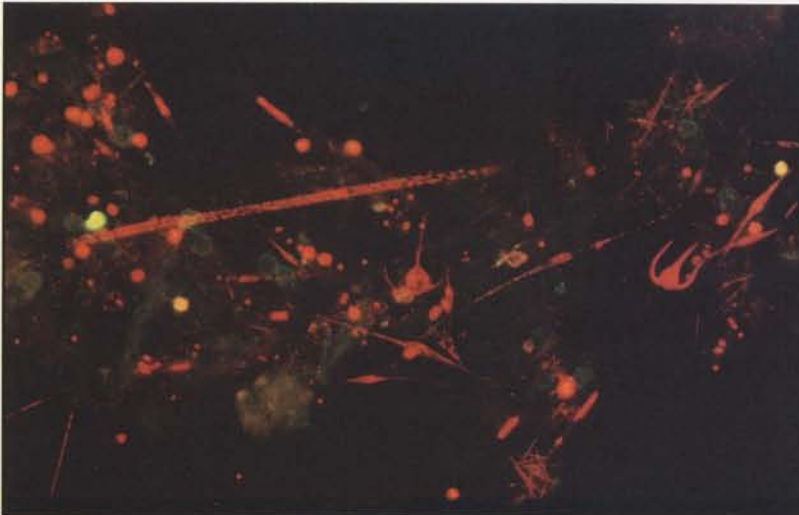
● Peter Herring is an Honorary Professor at the Southampton Oceanography Centre, Waterfront Campus, European Way, Southampton SO14 3ZH, UK. email p.j.herring@soc.soton.ac.uk

Acknowledgements

I am most grateful to Tom Baldwin, Kate Davis, Ken Nealson, Margaret McFall-Ngai and Miriam Ziegler for their help with the text and figures.

The importance of 'marine snow'

Carol Turley



What is 'marine snow'? Marine snow is made up of macroaggregates containing a wide range of species and sizes of living and dead microscopic plants (phytoplankton) and animals (zooplankton) and their faecal pellets. It was given its name by divers because the aggregates, which are usually greater than 0.5 mm across, really do look like snow flakes when seen in the water. They are held together by a sticky matrix of mucopolysaccharides produced by dying, nutrient-depleted phytoplankton cells or mucus feeding webs of zooplankton. These sinking particles also contain an enriched and active population of bacteria, relative to free-living bacteria, which are grazed by bacterivorous flagellates. Marine snow is the major component of the flux of organic material to the deep sea and is generally produced in the productive upper 100 m of the water column. Its production in the ocean cycles also exhibits strong seasonal variation with peaks shortly after the spring and autumn phytoplankton blooms in temperate waters such as those in the North Atlantic.

deep waters, or even for millions of years when it is laid down in sediments.

● Supply of food to the deep-sea bed

The arrival of marine snow on the sea bed is the major determinant of abundance and activity of large and small deep-sea animals, many of which are deposit feeders. Many taxa respond to this seasonal influx of material. For example, populations of opportunist species may increase and its arrival may regulate the reproduction and growth cycles of some animals.

Perhaps the greatest opportunists are bacteria that respond rapidly by increased enzyme production, DNA and protein synthesis and respiration; on occasions an increase in sediment bacterial biomass can be seen after this seasonal arrival of organic matter. Bacteria produce hydrolytic enzymes which cleave particulate organic matter into smaller molecules to support their metabolism. There is evidence that deep-sea-adapted bacteria are more effective at degrading the less labile

● Long-term removal of carbon

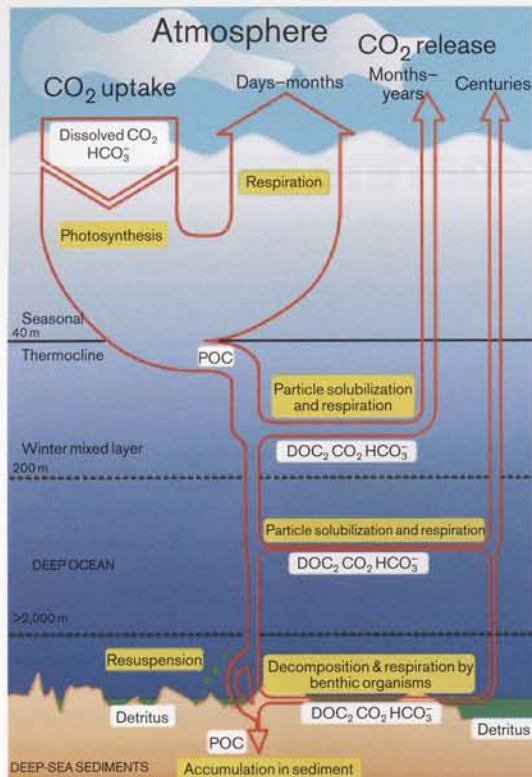
The deep sea is an important sink in the global carbon budget. About 40% of global primary production is carried out by marine micro-organisms <math><10\ \mu\text{m}</math> in size. While 10–40% of primary production may sink out of the upper 100 m of the north east Atlantic, most gets remineralized during its descent so that only a small proportion arrives on the deep-sea bed. Much of the carbon fixed by the microscopic photosynthetic cells in the upper ocean is recycled to the atmosphere within weeks through a dynamic food web. These single cells are just too small and light to sink from the surface of the ocean and have a significant effect on long-term carbon removal. However, some of the cells aggregated into the larger sinking particles, known as marine snow, remove the carbon for centuries by transporting it to mid- and

Macroaggregates containing a wide range of phyto- and zooplankton held together in a sticky matrix are known as 'marine snow'. Carol Turley describes the importance of these sinking particles to the ecology of the oceans.

LEFT: Epifluorescent micrographs of recently formed marine snow aggregates showing the range of red autofluorescing phytoplankton cells (top) and acridine-orange-stained bacterial cells colonizing the surface (bottom).

(TOP) REPRODUCED FROM TURLEY (2000) *FEMS MICROBIOL ECOL* 33, 89–99

(BOTTOM) COURTESY C. TURLEY



RIGHT:
Schematic diagram showing the flux of carbon through the NE Atlantic water column to the deep-sea sediment.
REPRODUCED FROM TURLEY (2000) *FEMS MICROBIOL ECOL* 33, 89-99

BELOW:
A sediment core with an overlying layer of marine snow.
COURTESY KEVIN BLACK, UNIVERSITY OF ABERDEEN

FAR RIGHT TOP:
Schematic diagram of processes on a marine snow aggregate and interactions with the surrounding seawater.
COURTESY C. TURLEY

FAR RIGHT BOTTOM:
The distribution of bacteria biomass and production with depth and integrated over sunlit zone, mesopelagic and bathyal zones of the oceanic water column.
COURTESY C. TURLEY

material than their upper water column counterparts. The metabolic versatility of deep-sea bacteria may, therefore, enable the breakdown of compounds that are unavailable to other organisms. Investigations indicate that bacterial growth in the deep sea is limited by food rather than the enormously high pressures and low temperatures often found there.

● Life on marine snow

Not surprisingly, bacteria and flagellates find the marine snow to be rich in organic and inorganic nutrients, which produce active populations in an otherwise nutrient-replete environment. Bacteria that colonize the marine snow clearly play an important role in the remineralization and solubilization of particulate organic carbon, so that many aggregates will not only be formed in the sunlit waters of the upper ocean, but will also be recycled there. However, many – most likely the larger, stronger aggregates – do escape

to the twilight zone of the midwaters and the dark abyss of the deep sea where decomposition rates by the colonizing bacteria originating from surface waters may be reduced by the cooler temperatures and higher pressures. Protein and DNA synthesis in bacteria attached to the aggregates in the surface waters may be drastically influenced by the high pressures (100 atm every 1,000 m) as well as the low temperatures experienced during the sinking of large particles. The reduced microbial activity on such particles may contribute to the delivery of relatively undegraded aggregates to the deep-sea bed.



● Sustenance of free-living bacteria in the twilight zone and deep-sea

The waters of the twilight zone and deep sea are probably the most under-studied oceanic environments, but make up the largest volumes of the oceans. Studies have centred on the interfaces, such as the productive upper ocean, the sediment and coastal environments. Although the upper 100 m of the oceanic water column contains higher concentrations of bacteria, the greatest reservoirs lie below this – about 60 % of the total water column bacteria. We know that these areas are truly nutrient-replete, so how are these bacteria surviving?

There is evidence that bacteria attached to marine snow may play an important role in releasing dissolved organic carbon to the surrounding water and the free-living bacteria that live there through extracellular enzymic hydrolysis of the particulate organic carbon it contains. Presumably, this will be patchy and sporadic, and in the form of microzones around the descending aggregates. But is that sufficient to sustain them? Some scientists have proposed that these bacteria also tap the substantial reservoir of old, refractory dissolved organic carbon found in the deep sea. Others have proposed that there is a downward flux of the more labile dissolved organic carbon occurring in the upper oceans.

Not surprisingly, these sinking particles are also the main food resource for the animals that live in these watery depths and they have evolved adaptations to scavenge the particles during their descent. However, the enormous reservoir of carbon within the free-living bacteria is also a great potential food resource – if it can be captured. Little work has been done on the food web in deep waters, but there are animals that can filter large volumes of water or capture microscopic cells using their mucus webs and have the potential to extract the bacteria.

● Mechanism for genetic exchange between isolated populations?

The deep ocean covers 60 % of the earth's surface and previously scientists thought that bacteria surviving at these enormous pressures and depths, in total darkness, were very isolated from most other bacteria occurring in the surface of the oceans. However, as many as 1×10^{12} bacterial cells per m^2 per year, which is equivalent to around 3×10^{13} plasmid encoded phenotypic genes per m^2 per year, can be transferred from the surface of the ocean to the deep-sea bed, a distance of about 4–5 km, through sinking of marine snow. The big question then is does the formation and sinking of marine snow also act as a method of genetic exchange between populations previously assumed to be genetically isolated from the enormous population of bacteria found in deep-sea sediments?

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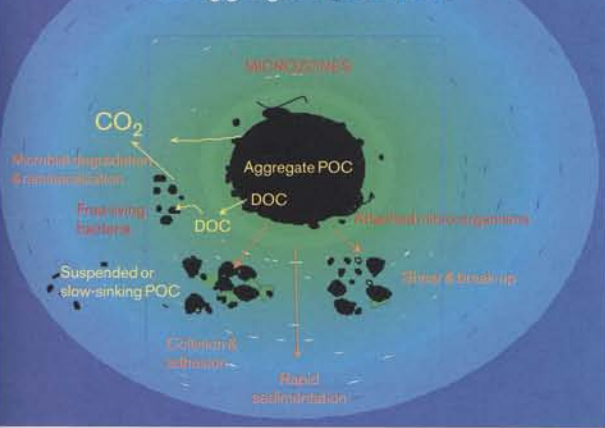
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The Aggregate Microniche



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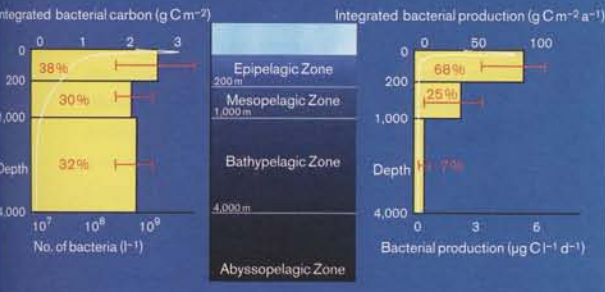
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NE Atlantic: 47–59°N 20°W – summer



Conclusions

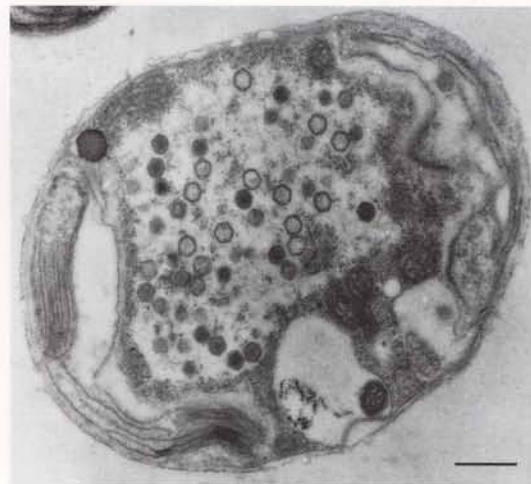
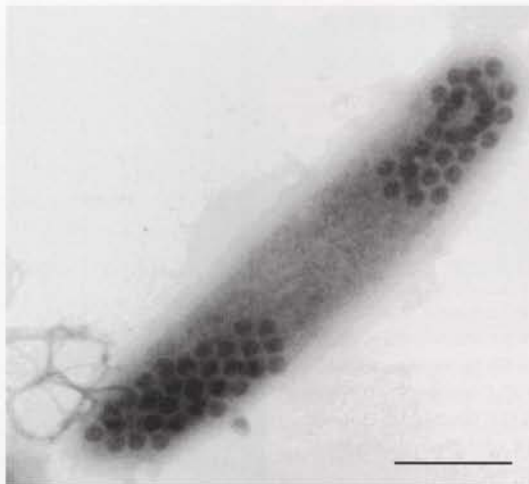
The formation and sinking of marine snow in the sunlit upper water column and its microbial degradation, during and after its descent is of key importance to the global carbon cycle as well as to the delivery of food to organisms within the inner space of the deep-sea water column and on the deep-sea bed. The deep oceans are the largest and perhaps the oldest biosphere on Earth and hold an enormous reservoir of bacteria that is a potential resource of diverse and unique micro-organisms that may have evolved around 3.5 billion years ago. Marine snow plays a role in the sustenance of these micro-organisms and in combination with the wide range of pressures and temperatures found in the deep sea may contribute to the creation of a high metabolic and phylogenetic diversity. Obviously, there are still many unresolved questions and it is this and the fascination of the unknown that drives researchers in this 'extreme', at least to us, environment.

● Dr Carol Turley is a senior researcher at Plymouth Marine Laboratory, Prospect Place, The Hoe, Plymouth PL7 1TP, UK. Tel. 01752 633464; Fax 01752 633101 email ct@pml.ac.uk

Giant algal viruses: lubricating the great engines of planetary control

Willie Wilson

Many viruses have been isolated that infect marine eukaryotic phytoplankton. Some of these have the largest virus genomes known.



In a wonderful quote from *Light and Life in the Sea*, Paul Tett stated, 'the illuminated region is only a small part of the 3.7 km mean depth of the ocean yet it houses several of the great engines of planetary control'. It is well known that the absorption of heat energy by the ocean and light energy by tiny floating marine plants, known as phytoplankton, help to regulate many aspects of the global environment. Phytoplankton form the base of the marine food web and through their photosynthetic activity provide an important carbon sink which influences the global carbon cycle and even climate. If you find this difficult to believe then you only have to look at some of the compelling satellite images of massive phytoplankton blooms (<http://www.soes.soton.ac.uk/staff/tt/eh/satbloompics.html>), hundreds of square kilometres in area, that writhe spookily across the oceans. Of course, phytoplankton blooms don't last forever; they break down through a range of different processes such as simply running out of nutrients (known as 'bottom-up' control), being eaten by grazers ('top-down' control), or just sinking out as marine snow (see article by Carol Turley on pp. 177–179). Organic carbon produced in this breakdown process fuels heterotrophic bacterial production, which in turn drives nutrient flow and biogeochemical cycling through the marine microbial loop. Following the discovery of high concentrations of viruses in seawater reported in 1989 (up to 10^8 per ml), another breakdown process was added to the cogs of these great engines. Would this discovery throw a spanner in their works?

● Marine viruses

We now know that the majority of viruses in the ocean infect bacteria (Fig. 1), with numbers typically ranging from between 10-fold less and 10-fold more than bacterial concentrations, though usually dependent on trophic conditions. Over the last decade numerous reports have been made on the isolation

of different viruses that infect a range of marine eukaryotic phytoplankton. Most of these viruses belong to the family *Phycodnaviridae*, a group of viruses that infect eukaryotic algae, which have icosahedral symmetry and large dsDNA genomes ranging from 180 to 560 kb. Marine phytoplankton virus members of the *Phycodnaviridae* lie at the top end of this genome size range and represent the largest virus genomes known.

● History of algal viruses

Surprisingly, observations of phytoplankton viruses are not new. Numerous observations of 'virus-like' particles (VLPs) in eukaryotic algae were reported in the 1970s as well as many incidental reports of VLPs observed in thin-section ultrastructure studies of marine phytoplankton. For example, one ultrastructure report on natural phytoplankton, conducted in 1974 by Manton & Leadbeater, discussed that VLPs observed in *Chrysochromulina mantoniae* were apparently similar to VLPs commonly found in moribund or dead *Coccolithus huxleyi* (now referred to as *Emiliania huxleyi*) cells. Viruses were clearly openly discussed in these early papers; however, research into phytoplankton viruses never seemed to be followed up at the time. Just recently, I was shown some electron micrographs of thin sections of a marine *Pavlova* sp. that was full of hexagonal VLPs (Fig. 2). It was evident that this nutritious phytoplankton, often used as a food source for feeding zooplankton and shellfish in hatcheries, was in the latter stages of infection by a large virus. I was amazed to find that these exciting micrographs were actually prepared back in 1978! The VLP images had been 'filed' for long-term storage because there was no interest in phytoplankton viruses 25 years ago, perhaps surprising given the ecological implications of virus infection of the major oceanic primary producers.

TOP LEFT:

Fig. 1. Final stages of infection in a marine bacterium. The cell was harvested from a natural seawater sample directly onto a 400-mesh copper grid by ultra-centrifugation, then negative-stained with uranyl acetate. Bar, approx. 250 nm. COURTESY W. WILSON

TOP RIGHT:

Fig. 2. Final stages of infection in the marine phytoplankton *Pavlova vivescens*. Note the different stages of virus assembly in the cell cytoplasm. Samples prepared by thin-sectioning back in 1978! Bar, approx. 500 nm. COURTESY JOHN GREEN (NOW RETIRED, FORMERLY MBA, PLYMOUTH)

RIGHT:

Fig. 3. True colour satellite image of a high reflectance *E. huxleyi* bloom south of Plymouth, UK, on 30 July 1999. Water samples taken from this bloom contained up to 1 million *E. huxleyi*-specific viruses per ml. THE SEAWIFS IMAGE WAS PROCESSED BY THE PLYMOUTH MARINE LABORATORY REMOTE SENSING GROUP USING DATA FROM THE NERC DUNDEE SATELLITE RECEIVING STATION

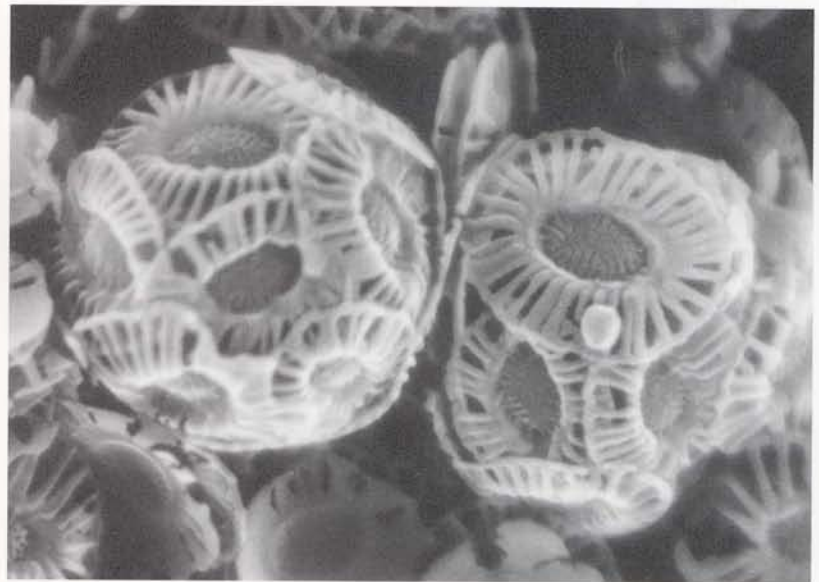
Evolutionary history of past seas and the impact of climate change on marine phytoplankton communities

Despite a few reports of virus isolations between 1978 and 1982, it was not really until the early 1990s that research into phytoplankton viruses was taken seriously and started gaining momentum. Reports of high virus concentrations in seawater caused considerable excitement amongst biological oceanographers. It soon became clear that viral action on marine phytoplankton communities would go beyond the simple infect–replicate–kill cycle; their role would have far-reaching implications in determining microbial biodiversity, nutrient and energy flow, biogas production and global climatic control.

● *E. huxleyi*-specific viruses

Take for example, *E. huxleyi*, a marine coccolithophorid, which is well known for forming vast coastal and mid-oceanic blooms that can be easily seen from space. Following the sudden virus-induced death of *E. huxleyi* blooms we have measured high concentrations of dimethylsulfide (DMS). When pulses of DMS escape to the atmosphere it is oxidized into acidic compounds that form cloud condensation nuclei; this increases cloud formation and consequently affects global radiation.

Most years we see large blooms of *E. huxleyi* right on our doorstep in the English Channel, off Devon and Cornwall (Fig. 3). During these blooms we can easily isolate viruses that infect laboratory cultures of *E. huxleyi* (Fig. 4). This isolation data, taken together with biological data collected during the blooms,



suggest that viruses are responsible for the demise of these *E. huxleyi* blooms. Cycling of the carbon output through the microbial loop, following the bloom crash, ensures the succession from an *E. huxleyi*-dominated population to a more characteristic mixed summer phytoplankton community. Continuing with the 'great engines' analogy then these *E. huxleyi*-specific viruses could be seen as lubricants that ensure phytoplankton succession by killing one group to make room and provide nutrients for different groups.

During their characterization we discovered that the *E. huxleyi*-specific viruses belong to a new genus we have termed the *Coccolithovirus* (based principally on the phylogeny of their DNA polymerase gene), which is within the virus family *Phycodnaviridae*. With the addition of *Coccolithovirus* in the family, it questions the validity of some of the genera, even just something as simple as naming one of the genera '*Prymnesiovirus*' is now wrong since *E. huxleyi* is a Prymnesiophyte, yet *E. huxleyi*-specific viruses do not fall into this genus. Clearly, the *Phycodnaviridae* will evolve into a large complex family or, more likely, split into several families as new algal viruses are isolated and characterized. Perhaps the reason for such complexity can be explained by a recent provocative paper that expanded this phylogenetic analysis and placed the *Phycodnaviridae* near the root of all eukaryotic DNA polymerases. It is believed that some of the first eukaryotic cells resembled unicellular green algae. If algal viruses appeared at around the same time and co-evolved with their hosts, then algal viruses could be dated back more than 1.2 billion years.

● Ancient viruses?

The genomes of two phycodnaviruses have been completely sequenced, a *Paramecium bursaria* *Chlorella*

ABOVE:
Fig. 4. Virus attached to an *E. huxleyi* cell. Infected cells were dehydrated in an acetone series, oven dried and sputter coated with gold prior to viewing in a scanning electron microscope. The virus particle is approx. 190 nm in diameter.

COURTESY K. RYAN, MBA, PLYMOUTH



Government funding of the scientific learned societies

The Government provides substantial funding each year to the Royal Society (RS) (£29m) and the Royal Academy of Engineering (RAE) (£5m). The House of Commons Science and Technology Committee, chaired by Dr Ian Gibson MP, has recently published the report of its inquiry into whether good value for money is obtained. The inquiry – to which SGM submitted evidence – also ranged over a number of other aspects of the operations of scientific learned societies. As always with this Committee, the report is outspoken and provocative.

Most of the government funds provided to the RS and RAE are passed on to the scientific community in the form of research fellowships and awards. The inquiry concluded that these are highly regarded by the scientific community, and fund valuable work, but was unable to evaluate whether they were cost-effective in comparison with other schemes.

The Committee recognized that many of the 245 other scientific learned societies did excellent work, for example in providing scientific advice to government and in educational activities, while receiving no government funding. It recommended that government should make more extensive use of the expertise of these learned societies and provide adequate financial compensation for their efforts. Overall, the committee felt that government funding of the learned societies was haphazard rather than the product of strategic thinking in the Office of Science and Technology.

In a more controversial section of the report, the Committee expressed disappointment at the number of women among the fellows of the RS and RAE, their possible bias against newer scientific disciplines and universities other than London, Oxford and Cambridge, and a perceived lack of inclusiveness and transparency. The Committee was particularly critical of the way that Copus (formerly the Committee for the Public Understanding of Science) sits within the RS and the confusion and ill will that this has generated, and recommended that it be reformed as an entirely independent umbrella body for science communication efforts, receiving its funding direct from OST.

The full Report, written evidence and records of examination of witnesses are available at www.parliament.uk/commons/selcom/s&thome.htm

● **Ron Fraser, Executive Secretary**

Giant algal viruses
great engines of pl
Willie Wilson

Further reading

Emiliania huxleyi home page: <http://www.soes.soton.ac.uk/staff/tt/>

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virus (PBCV-1) and an *Ectocarpus siliculosus* virus (EsV-1), and we are in the process of sequencing an *E. huxleyi* virus (EhV-86). Their genomes are 331 kb (PBCV-1), 336 kb (EsV-1) and 410 kb (EhV-86) with 376 (PBCV-1), 231 (EsV-1) and 493 (EhV-86) currently identified open reading frames (ORFs) that encode possible genes. In comparing the genomes of these three viruses, they only have nine genes in common, particularly surprising since they all come from the same virus family. This information alone indicates that algal viruses and their genes are ancient, which has allowed major differences in their sequence information to evolve. Consequently, studies on algal viruses should reveal interesting aspects about the evolution of genes and genomes.

● Future perspectives

As more researchers start investigating algal viruses it is inevitable that a much greater variety of viruses will be discovered. There are already reports of algal RNA viruses being isolated that have completely different characteristics and infection mechanisms to members of the *Phycodnaviridae*. We are clearly in the 'lag phase' of our understanding in algal virology and as new genomic technologies become more widely used in this field, I predict we will see an exponential rise in interest as the role of the many genes in these giant algal virus genomes become known.

● *Dr Willie Wilson is head of the the Aquatic Virology Group in a joint position between the Marine Biological Association (MBA Research Fellow) and Plymouth Marine Laboratory (Principle Scientist). He is currently based at the Marine Biological Association, Citadel Hill, Plymouth, PL1 2PB, UK. Tel. +44 1752 633356; Fax +44 1752 633102 email whw@mba.ac.uk*

Fossilized records of past seas

Chris Wade & Kate Darling

The planktonic foraminifera (Fig. 1) are globally distributed across the world's oceans, forming an important part of the zooplankton. The calcitic shells of this fascinating group of organisms are readily preserved in the ocean sediments as microfossils (Fig. 2). They form one of the most complete fossil records on earth, stretching across some 130 million years. The record is used to date sedimentary rocks and study evolutionary processes, and is one of the most important archives of past climate. The species, abundance and shape of shells are used to reconstruct sea surface temperatures. Environmental parameters can also be deduced from the chemical composition of the shells. The planktonic foraminifera are therefore used extensively as indicators of climate change.

With the advent of molecular biological techniques, it has become possible to study the evolutionary relationships between species of planktonic foraminifera living in the oceans today. These studies have led to the discovery of previously unrecognized genetic diversity, providing the potential to enhance the role of the foraminifera as indicators of past climate. Furthermore, in combination with their fossil record, planktonic foraminifera provide a unique and ideal tool for addressing important questions regarding the mechanisms of plankton speciation and evolution through time.

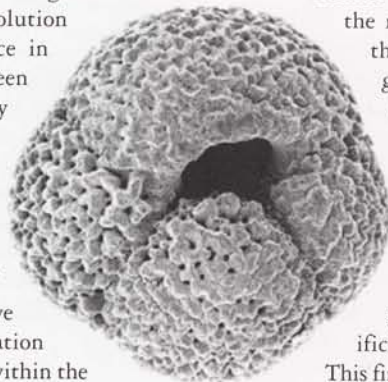
● Origins of the foraminifera

It is possible to discover the evolutionary relationships among organisms by comparing their DNA sequences. These relationships are typically shown in the form of an evolutionary tree (a phylogeny). To date, most studies of the foraminifera have focused on comparing the ribosomal (r)RNA genes. When their small subunit (SSU) rRNA genes are compared with those of other eukaryotes, they seem to form one of the earliest diverging eukaryote lineages in the 'tree of life' (Fig. 3). This placement is interesting because it means that the foraminifera could provide information about events early in eukaryote evolution. However, more work is needed because the foraminifera show an exceptionally fast rate of evolution in their rRNA genes.

Lineages with high rates of evolution are notoriously difficult to place in evolutionary trees, and it has been suggested that the foraminifera may in fact have a far less ancient origin.

● From ocean floor to planktonic life

Despite the reservations about external relationships, studies of foraminiferal SSU rRNA genes have provided a great deal of information about evolutionary relationships within the



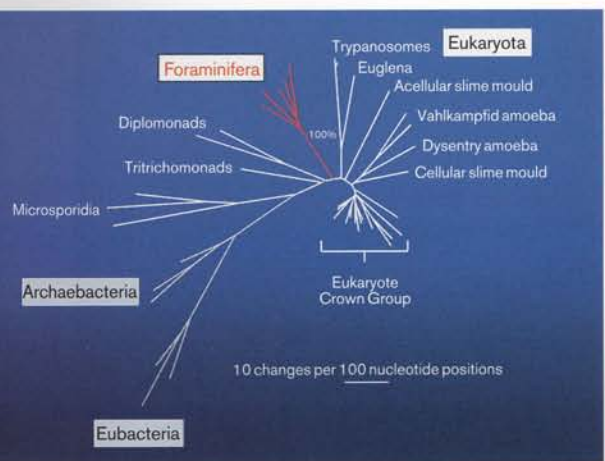
foraminifera. As well as planktonic forms, there are benthic species that live on the ocean floor. The evolutionary transition between benthic and planktonic forms is of considerable interest. Planktonic species first appear in the fossil record long after the benthic forms, and arose from the adaptation of a benthic species to life in the plankton. Since this has been considered to be a major evolutionary step, it was concluded that all planktonic species arose from a single benthic ancestor. This hypothesis is not supported by the genetic data; instead of the planktonic species clustering in a single group, they occupy three separate locations in the molecular tree (Fig. 4), suggesting that the planktonic way of life has evolved from at least three independent benthic lines. The planktonic spinose species (foraminiferans with spines) cluster separately from the planktonic non-spinose species, which are located in two separate regions of the benthic cluster.

● Hidden diversity and the implications for reconstructing past climate

The planktonic foraminifera are divided into distinct types ('morphospecies') based upon the morphology of their shells. One of the most interesting outcomes of genetic studies concerns the extent of differentiation within these morphospecies. Most of them show an exceptionally high level of genetic diversity in their SSU rRNA genes, and many include more than one genetically distinct entity (Fig. 5). Some of these genetic types may warrant classification as separate 'cryptic' species. This finding is important because of the role

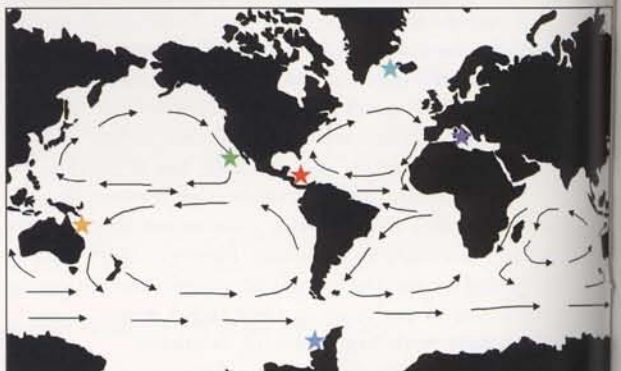
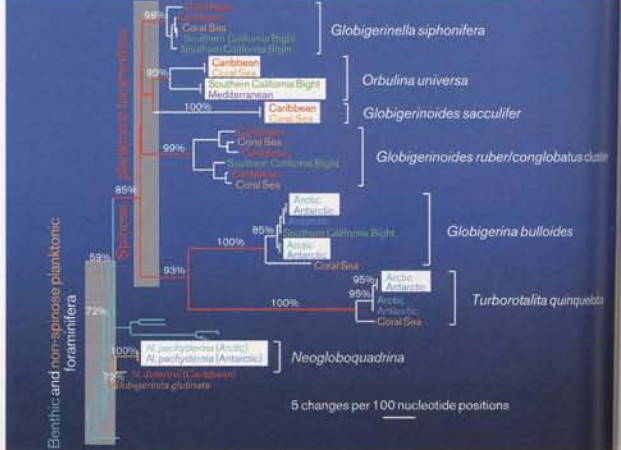
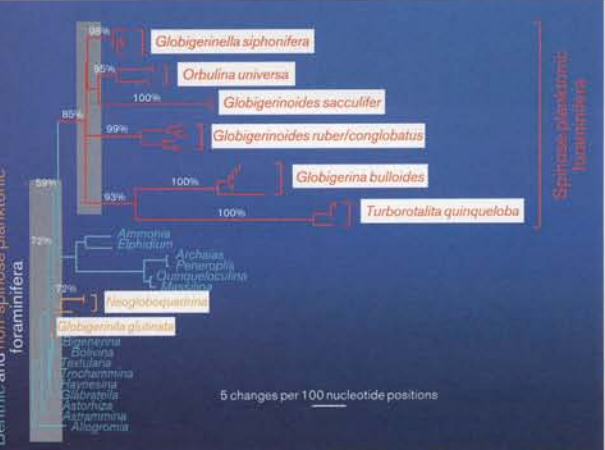
ABOVE:
Fig. 1. The planktonic foraminiferan *Globigerinoides sacculifer*. The cell is enclosed within a calcitic shell, which has a series of interconnecting chambers. This species has an array of spines that serve as a 'net' for snaring prey. Energy is also generated by photosynthesis and this species contains a large number of algal symbionts, which are distributed out along the spines to maximize light. COURTESY DR K. DARLING, DEPARTMENT OF GEOLOGY AND GEOPHYSICS/ICAPB, UNIVERSITY OF EDINBURGH

BELOW:
Fig. 2. A microfossil of the planktonic foraminiferan *Neogloboquadrina pachyderma*, obtained from marine sediments. COURTESY DR M. KUCERA, DEPARTMENT OF GEOLOGY, ROYAL HOLLOWAY, UNIVERSITY OF LONDON



of foraminiferal microfossils in reconstructing past climates. For climate reconstruction it has been assumed that each morphospecies is a single entity with a specific ecological (and thus climatic) preference. If the distinct genetic types within morphospecies are in fact adapted to different habitats, and exhibit different ecological and climate preferences, then the assumption that each morphospecies is characteristic of a particular climate would be wrong. If this is so, there may be significant errors in current models of climate reconstruction. Recent work suggests that different genetic types are indeed associated with different environments. If it does become possible to distinguish these newly recognized genetic types in the fossil record, the role of the

Seas (Fig. 5), and also in individuals from the Eastern Pacific and Mediterranean in *O. universa* (Fig. 5). These findings are important because they suggest that gene flow is occurring on a global scale, with genetic intermixing between populations as far apart as the Arctic and Antarctic, or the Pacific and Atlantic. This is at odds with the observation that many morphospecies have high levels of genetic diversity and include more than one genetically distinct entity. For diversity to arise, it is generally considered that there must be some form of barrier to gene flow. It is therefore unclear how diversity arose in the planktonic foraminifera when there are apparently no effective barriers to gene flow. The planktonic foraminifera raise intriguing questions concerning the process of speciation in the oceans.



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 ● Dr Kate Darling is an NERC Advanced Research Fellow in the Department of Geology and Geophysics/Institute of Cell, Animal & Population Biology at the University of Edinburgh, UK. email: kdarling@glg.ed.ac.uk

ABOVE TOP: Fig. 3. Evolutionary tree showing the origins of the planktonic foraminifera. The eukaryote crown group includes all multicellular eukaryotes (including plants, animals and fungi) and several other groups of unicellular protists. Percentages indicate the level of support for branches in the tree.

ABOVE BOTTOM: Fig. 4. Evolutionary tree showing the relationship between planktonic (red and orange) and benthic foraminifera (blue). The planktonic species can be further subdivided into species with spines (spinose; red) and those without spines (non-spinose; orange). Percentages indicate the level of support for branches in the tree.

foraminifera as indicators of past climate could be greatly enhanced.

● **Global gene flow and the implications for the origin of new species**

Genetic studies of the planktonic foraminifera have also begun to illuminate the processes of speciation in the oceans. Despite the high degree of genetic diversity observed in their SSU rRNA genes, identical sequence types (genotypes) have been found in individuals collected at opposite ends of the globe in several morphospecies (white boxes, Fig. 5). Perhaps most remarkable is the discovery of identical rRNA genotypes in individuals collected from the Arctic and Antarctic subpolar regions within each of the cool-water morphospecies *Globigerina bulloides*, *Turborotalita quinqueloba* and *Neogloboquadrina* (Fig. 5). This is surprising, as these morphospecies are only found in the high latitudes and are absent from the tropical regions, which are considered a formidable barrier to gene flow. Similarly, identical rRNA genotypes have been found within the warm-water morphospecies *Orbulina universa* and *Globigerinoides sacculifer* in individuals collected from the Caribbean and Coral

Archives matter!

Peter Harper

Further reading

Darling, K.F., Wade, C.M., Kroon, D., Leigh Brown, A.J. & Bijma, J. (1999). The diversity and distribution of modern planktic foraminiferal small subunit ribosomal RNA genotypes and their potential as tracers of present and past ocean circulations. *Paleoceanography* 14, 3–12.

Darling, K.F., Wade, C.M., Stewart, I.A., Kroon, D., Dingle, R. & Leigh Brown, A.J. (2000). Molecular evidence for genetic mixing of Arctic and Antarctic subpolar populations of planktonic foraminifers. *Nature* 405, 43–47.

de Vargas, C., Norris, R., Zaninetti, L., Gibb, S.W. & Pawlowski, J. (1999). Molecular evidence of cryptic speciation in planktonic foraminifers and their relation to oceanic provinces. *Proc Natl Acad Sci USA* 96, 2864–2868.

Wade, C.M., Darling, K.F., Kroon, D. & Leigh Brown, A.J. (1996). Early evolutionary origin of the planktic foraminifera inferred from SSU rDNA sequence comparisons. *J Mol Evol* 43, 672–677.

UPPER LEFT:

Fig. 5. Evolutionary tree showing hidden diversity in planktonic foraminiferal morphospecies. Sequences are coloured according to where they were collected (see Fig. 6 for details of collection sites). Identical sequences are highlighted in white. Percentages indicate the level of support for branches in the tree.

LOWER LEFT:

Fig. 6. Sites of collection. Planktonic foraminiferans have been taken from the Coral Sea (off Australia), the Caribbean, the Southern California Bight in the Eastern Pacific, the Mediterranean, the Arctic and the Antarctic.

Archives are fundamental to our understanding of the past, showing us and future generations how we as nations, communities and individuals came to be what we are. In the UK we have an unrivalled archival legacy whose potential as a rich learning resource for all is increasingly being realized. Archives of the science that has transformed our lives over the last century must be preserved as part of that legacy. In this way the contributions of leading scientists to the national life will take their place alongside those of politicians and military and literary figures in the archival record.

Science archives may not receive as much publicity as other aspects of our archival heritage, but they are not a neglected area. Since 1973 a specialized archives project, sponsored by the Royal Society and now based at the University of Bath, has made an indispensable contribution to preserving the archives of eminent British scientists. The National Cataloguing Unit for the Archives of Contemporary Scientists (NCUACS) locates the archives, brings them to Bath for cataloguing and then finds homes for them in established, usually university, repositories. In this way 225 archives of British scientists have been saved and made accessible to those wishing to explore the country's modern scientific heritage.

Although the remit of the NCUACS covers all the sciences, it has catalogued a very respectable number of archives of scientists of interest to the SGM. These include, from the list of the Society's original members: Sir Frederick Bawden, Norman Heatley, Edward Hindle, David Keilin, Sir Hans Krebs, Kenneth M. Smith, Richard L.M. Syngé and Donald D. Woods, while the archives of two further original members, Norman W. Pirie and Martin R. Pollock are current projects. The archives themselves may take many forms: research notebooks, correspondence with distinguished colleagues, lectures and teaching material tracing the development of a discipline over time, photographs from laboratories and symposia, and records of professional affiliations and of public service and advisory roles.

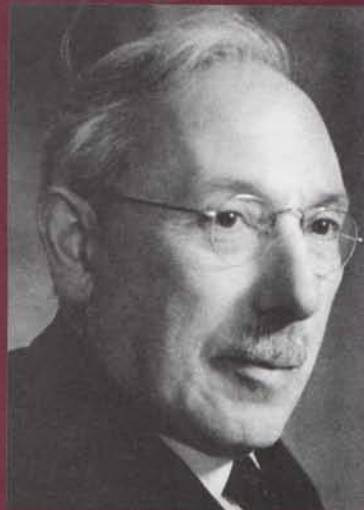
The internet has transformed the way information about archives can be accessed, and the NCUACS has sought to ensure that science archives are fully represented in national developments. Almost all the catalogues compiled since 1973, some 14,000 pages in total, have been contributed to *Access to Archives* (A2A), the English component of a scheme for a UK-wide online archival network, and are thus searchable and browsable via the A2A website (<http://www.a2a.pro.gov.uk>). Searches on microbiology and related sciences, the Society for General Microbiology and the names of individual scientists give some idea of the Unit's contribution to preserving the original source materials for the field and securing its representation on a major online educational resource.

The NCUACS is an entirely externally funded Unit whose work is supported for varying periods by grants from scientific societies, trusts and foundations and special project funding. Next April the scientific archives project will be celebrating 30 years of preserving the archives of modern British science.

To place the funding of the work on a firmer foundation the Unit is establishing a development fund and launching an appeal. Those wishing to make a donation in support of this important work should send their cheques (payable to the 'University of Bath') to the Director, NCUACS, University of Bath, Bath BA2 7AY, UK.

Further information about the work of the Unit and the development fund and appeal is available from the Unit's website (<http://www.bath.ac.uk/ncuacs>) or directly from the Director.

● Peter Harper,
Director, NCUACS



RIGHT:

Some original members of the SGM whose archives have been catalogued by the NCUACS.

From top to bottom:

David Keilin (1887–1963),
Sir Frederick Bawden (1908–1972)
and Sir Hans Krebs (1900–1981).

PHOTOS SGM

UK bathing waters: a success story, but...

Keith Jones

There may be trouble ahead...

Pressure groups believe that sewage entering the sea is dangerous to the health of bathers and to the marine environment. Keith Jones explains the current measures to protect water quality and describes some problems that may prove difficult to solve.

The EC Bathing Water Quality Directive (76/160/EEC) has been around for 25 years and in that time UK coastal bathing waters have improved their compliance from 57% in 1988/90 to 97% in 2001. In the north-west the clean up has been nothing short of spectacular. In 1994 all the bathing waters from the Ribble estuary to the northern end of Morecambe Bay failed the Directive. By 2001, they had all passed, even those at Blackpool. This success story can be put down largely to the water companies building new sewage treatment works, ceasing the discharge of untreated sewage into estuaries and coastal waters, replacing the sewer infrastructure, replacing short sea outfalls with long sea outfalls and, more recently, tertiary treatment of effluents with UV radiation.

● What caused it?

The pressure for this enormous expenditure of finance and engineering has come from unelected groups, such as Surfers Against Sewage (www.sas.org.uk) and the Marine Conservation Society (www.mcsuk.org), a pretty hostile media and above all the EU, which has threatened the UK Government with daily fines if standards are not met. The cost, around £10 billion, has been largely borne by the customers of the privatized water companies.

● Not just the UK

It is not just a UK problem. St-Tropez lost its Blue Flag award in 2000 and in the US the Natural Resources



Defence Council closed 13,410 beaches in 2001, up 19% on 2000 (<http://www.nrdc.org/water/oceans/nttw.asp>).

● The tests

The testing of the UK's 433 bathing waters is under the remit of the Environment Agency. Twenty water samples, roughly one per week, are taken during the bathing season, which runs from 15 May to 30 September. Each sample is analysed for the density of faecal indicators (representative of the animal gut) which should not exceed 10,000 total coliforms per 100 ml and 2,000 faecal coliforms per 100 ml of water. To comply with the EC Directive, 95% of the samples (at least 19 out of 20) must meet these standards.

● The standards are set to change

The EC is, at this very moment, revising and updating its legislation on bathing waters to take into account changes in science, technology and a perceived risk to health. This will almost certainly result in a much tighter bathing water quality standard [a minimum of 200 faecal streptococci (intestinal enterococci) per 100 ml water and 500 *Escherichia coli* per 100 ml water compliance is proposed]. It has been estimated (DEFRA) that this will entail a fall in compliance in the UK from 97% to 67%. Considerable further expense will be necessary to meet the new standards. However, it remains to be seen whether tangible benefits to health accrue and if the expense is justifiable in anything other than aesthetics.

● Why will compliance with the new regime be difficult?

There are fluctuating densities of faecal indicator bacteria in coastal waters which are unconnected with

BELOW:
Fig. 1. Gulls from a waste tip foraging on an estuary.
COURTESY K. JONES





sewage effluent. This is shown in the north-west by sporadic failures, each on different dates, during this year's bathing season at separate bathing waters: Southport, Morecambe North and Morecambe South. These failures are associated with two main problems, the same ones which will make compliance with the new more rigorous standards difficult.

Problem 1 – diffuse sources of pollution. Diffuse pollution is caused predominantly by agricultural run-off and flocks of birds. Agricultural run-off in wet weather can include faeces from grazing cattle and sheep, farm slurries and manures, and sewage sludge put to land. Animal faeces and farm wastes can contain large numbers of faecal indicators (Table 1).

David Kay's group at the Centre for Environment and Health in Wales has calculated the daily production of faecal coliforms by farm animals and compared them to *E. coli* equivalents from humans. Cattle are equivalent to 2.8 humans, pigs to 4.7 humans and sheep to 9.5 humans. Once on land faecal coliforms can survive for up to 8 weeks with a T_{90} (time for a log reduction in numbers) of 3.3 days in summer and 13.4 days in winter. Run-off can be minimized by farmers following DEFRA guidelines, but little can be done in wet weather.

The input from flocks of wild birds is even harder to prevent. Table 2 shows the levels of faecal coliforms excreted by wild birds on Morecambe Bay. As there are many thousands of wild birds on the Bay they have a considerable impact on indicator numbers and may be responsible for the sporadic failures during the bathing season and high densities of the bacteria in winter (Figs 1, 2 and 3).

There is an interesting situation in Blackpool, where there are roughly 125,000 starlings roosting nightly on

the resort's piers. Kay's group have calculated that each starling is equal to one human in *E. coli* equivalents. However, they have also reasoned that, as bird faeces contribute directly to bathing waters and human faeces are subject to primary, secondary and tertiary treatment, which reduces the number of *E. coli* by a factor of 2–3 or 4 logs, the 125,000 starlings are equivalent to between 1,250,000 and 1,250,000,000 humans!

A huge research effort is underway globally to pinpoint the origins of pollution and to distinguish

ABOVE LEFT:
Fig. 2. Oystercatchers on Morecambe Bay.
COURTESY K. JONES

ABOVE:
Fig. 3. (a) Faecal sample from a bar-tailed godwit and footprints. (b) Gull faecal sample with gull footprints.
COURTESY K. JONES

Table 1. Faecal coliforms in livestock faeces, farm slurry and sewage sludge

Sample	Faecal coliforms per gram
Faeces – grazing sheep	2.8×10^9 – 4.5×10^{12}
Faeces – grazing cattle	2.3×10^5 – 6.7×10^9
Farm slurry put to land	2.2×10^4 – 3.2×10^6
Sewage sludge put to land	1.7×10^6 – 2.0×10^6

Table 2. Shedding of faecal indicator bacteria by wild birds on Morecambe Bay

Bird	Faecal coliforms (per gram faeces)
Bar-tailed godwit	71×10^{11}
Oystercatcher	4.7×10^{11}
Knot	5.3×10^5
Shelduck	74×10^6
Lapwing	2.6×10^5
Gulls (bay)	1.8×10^7
Gulls (waste tip)	1.0×10^{10}
Mallard	78×10^{10}

UK bathing waters: a success story, but... there may be trouble ahead...

Keith Jones

UPPER RIGHT:

Fig. 4. Pie chart showing the monthly distribution of sunshine in the north-west UK.

COURTESY K. JONES

LOWER RIGHT:

Fig. 5. Compliance with the faecal coliform standard of bathing waters sampled in the morning (■) and afternoon (■).

COURTESY K. JONES

between faecal pollution caused by humans and by livestock and birds. At Lancaster, for example, we are using DNA fingerprinting to match genotypes of *E. coli* isolated during routine analysis of bathing waters with different animal sources.

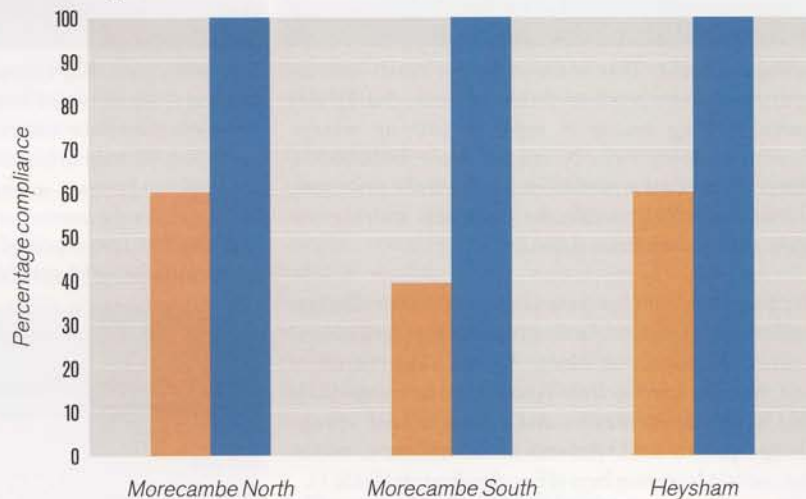
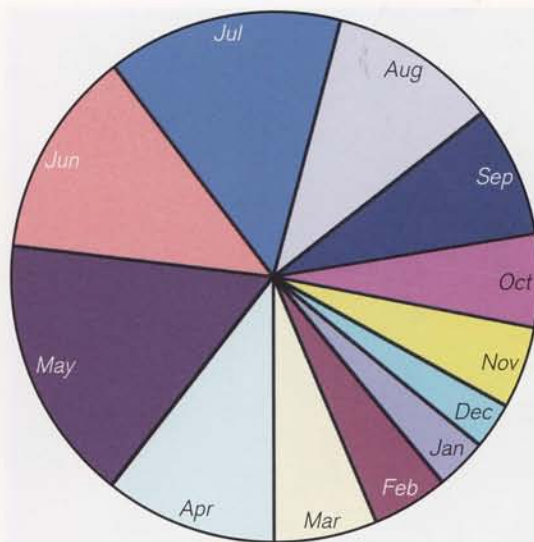
Since the clean up of sewage discharges the contribution which diffuse pollution makes to bathing waters has increased.

Problem 2 – the weather. Whatever their source, the survival of indicator bacteria in water is controlled by the weather, and nothing can be done about this. For example, at Morecambe the construction of a sewage treatment plant and the replacement of a short sea outfall with a long one resulted in a 76% reduction in faecal coliforms during the bathing season, but had no effect during the non-bathing season. This is because of increased diffuse pollution in the non-bathing season and the influence of weather. Temperature and light are the main bactericides in bathing waters.

Faecal indicators die off much faster in warm water than in cold. For example, faecal coliforms in sewage effluent survive for 2 weeks in sterile Morecambe Bay seawater at 37 °C in comparison to 7 weeks at 10 °C (in the dark). In sunlight, survival is measured in hours and minutes, not weeks. At Lancaster latitudes, the T_{90} for *E. coli* in seawater is only 30 minutes in June, but is not even reached during day-long sunshine in the winter. It is quite surprising to realize that almost half the annual amount of sunshine that occurs in the north-west UK occurs in just 3 months: May, June and July (Fig. 4).

In 1997 we showed that during the bathing season all three of Morecambe's bathing waters failed the Bathing Water Quality Directive when sampled in the early morning, but passed in the late afternoon (Fig. 5). The difference is attributed to the indicator bacteria from sewage and diffuse pollution surviving during darkness and being killed by UVB during daylight. Indeed we proposed that all bathing waters throughout the EU should be sampled in the early morning to allow for the worst case scenario.

Overall, failure to comply with the EU Bathing Water Quality Directive is more likely on cold, cloudy and windy wet days sampled in the early morning than on warm, sunny still days sampled in the late afternoon.



Further reading

Crowther, J., Kay, D. & Wyer, M.D. (2002). Relationship between microbial water quality and environmental conditions in coastal recreational waters: the Fylde coast, UK. *Water Res* 35, 4029–4038.

Crowther, J., Kay, D. & Wyer, M.D. (2002). Faecal-indicator concentrations in waters draining lowland catchments in the UK: relationships with land use and farming practices. *Water Res* 36, 1725–1734.

Obiri-Danso, K., Jones, K. & Paul, N. (1999). The effect of the time of sampling on the compliance of beaches in the north-west UK with the EU Directive on bathing water quality. *J Coast Conserv* 5, 51–58.

● 'There may be trouble ahead...'

Why do I think this? Well, it is going to be difficult to reduce further the background level of faecal indicators in bathing waters where there is substantial agricultural run-off or flocks of wild birds. In the south of the EU, where bathing waters are warm and clear and exposed to intense sunlight, the problem may be minor. However, in the north-west of the UK, where the water is cold and turbid and where there is much less sunshine, compliance with any new standards will be difficult and may not be possible.

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Red tides in the sunset

Robin Raine

'Red tides' are one type of harmful algal bloom. Robin Raine describes how the blooms are formed and the unpleasant effects they can have on marine life and its human consumers.

Marine phytoplankton are the microscopic, single-celled algae that inhabit the surface few tens of metres of the sea. They are found across all oceans in concentrations of several thousands of cells per litre. Their existence is critical to virtually all the other organisms found in the sea, as they are the primary producers of organic material and are right at the very start of the marine food chain. When there is sufficient light and nutrients they can proliferate into enormous concentrations of up to millions of cells per litre. These events are referred to as blooms. Most blooms are extremely beneficial to the marine ecosystem, either for the filter-feeding bivalve shellfish such as oysters, mussels, scallops and clams, for the larvae of commercially important crustaceans and finfish, or for other marine food chains.

About 5,000 species of marine phytoplankton are known to exist, a number that is still rising with recent advances in technology. A very small number of these species are potentially harmful. These can either contaminate seafood with toxins, cause serious human health problems, proliferate and kill fish, or otherwise alter ecosystems in ways that we perceive as harmful. The scientific community refers to these events with the generic term 'harmful algal blooms', or HABs. In the popular press they are often called 'red tides' (see Fig. 1), but this is a misnomer as it refers to only one particular form of potentially harmful event. The term HAB is likewise not at all precise, as a bloom implies a massive proliferation of phytoplankton cells, yet some species contain toxins so potent that only a small number need be present to seriously contaminate shellfish.

We recognize two basic types of harmful algal blooms.

1. Large blooms of species that cause water discolorations, that can result in foams or scums, or that indiscriminately kill fish and other fauna due to oxygen depletion.
2. Species which produce toxins. These chemicals can either be directly toxic to fish and invertebrates, or have an indirect mode of action when, though harmless to filter-feeding shellfish, they can find their way through the food chain into humans causing a range of extremely unpleasant gastrointestinal and neurological illnesses.

Red tides and other exceptional blooms

It is believed that the first written reference to a harmful algal bloom appears in the Bible as one of the plagues of Egypt (Exodus 7, 20–21): '*...all the waters that were in the river were turned to blood. And the fish that was in the river died; and the river stank, and the Egyptians could not drink of the water of the river...*'. This has been interpreted as a non-toxic bloom-forming alga which became so densely populated that it generated anoxic conditions resulting in indiscriminate kills of fish and other fauna. Oxygen depletion can be due to high respiration by the algae, particularly at night, but more commonly is caused by bacterial respiration during decay of the bloom.

Water discolorations caused by algal blooms can be quite spectacular and spread over a wide area. For the most part these are caused by a group of phytoplankton called dinoflagellates. On these occasions, the sea becomes coloured red-brown, as dinoflagellates contain a pigment known as peridinin which is brick red. Hence the term 'red tide'.

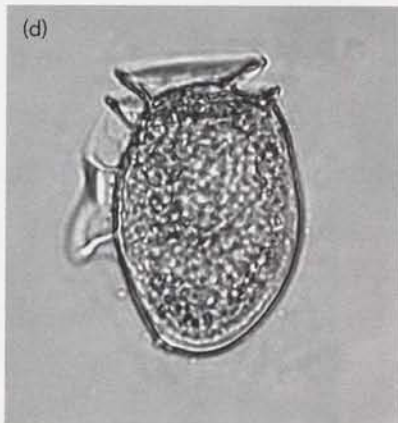
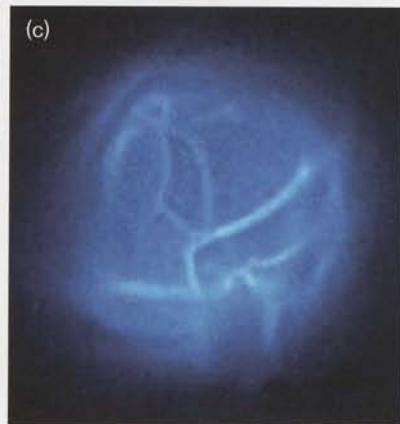
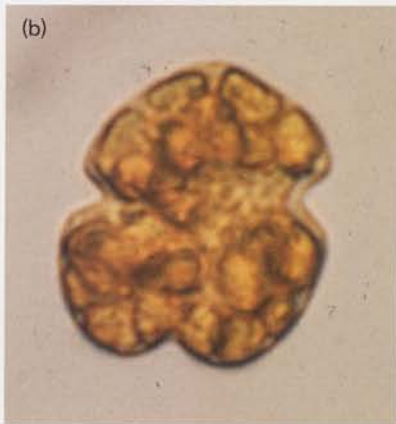
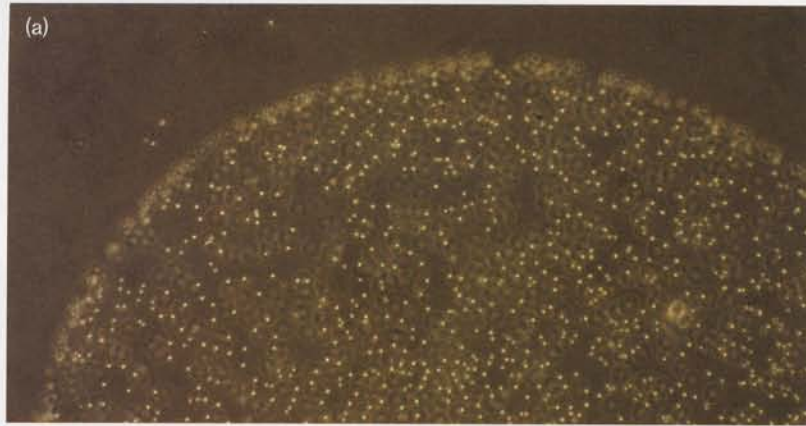
A common bloom-forming phytoplankton species in European coastal waters is known as *Phaeocystis*. This is a tiny flagellate cell, about 3 µm in diameter, which has the ability to form dense colonies embedded in mucus (Fig. 2a). Colonies are commonly 5–10 mm across and are visible to the naked eye. *Phaeocystis* blooms in May and is often associated with the accumulation of foam on beaches along the North Sea and Irish Sea. The colonies also give an odour to the sea, which can become quite evil if they are washed ashore. Another aspect of *Phaeocystis* blooms is that post-bloom sedimentation can lead to deoxygenation near the sea bed. One such event in 2001 killed 10 million kg of mussels (worth Euro 20 million) in the western Oosterschelde, Holland.

Toxic blooms

Although a number of phytoplankton species have direct toxic effects on marine organisms, these events are in practice difficult to observe. They are most likely to be observed at fish farms where fish are contained in cages and cannot escape. *Karenia mikimotoi* is a dinoflagellate that not only forms red tides but also contains toxins

BELOW:
Fig. 1. An example of a 'red tide'.
COURTESY BILL BACHMANN /
SCIENCE PHOTO LIBRARY





(Fig. 2b). It is known to kill fish, but it is extremely toxic to lugworms, and the disappearance of worm casts in an intertidal mud is highly indicative of the presence of this species. A massive bloom of a flagellate called *Chrysochromulina polylepsis* in 1988 spread over some 75,000 sq. km of the Skaggeak and Kattegat and up the Norwegian coast. It indiscriminately killed large numbers of seaweeds, invertebrates and fish.

HAB events caused by toxicity resulting from eating contaminated shellfish have been with us for a long time. An event which occurred during the surveying of British Columbia by Captain George Vancouver in 1793 was one of the first ever recorded. A landing party went ashore, at an area now known as Poison Cove, and ate shellfish contaminated with dinoflagellate toxins. On their return, there was much 'sickness, giddiness and numbness' among them. One, John Carter, died and Vancouver named the bay Carter Bay to mark this tragic episode. Interestingly, he also noted that it was taboo

for local Indian tribes to eat shellfish when the sea-water was phosphorescent, an indication that dinoflagellates are present.

The causative alkaloid toxins were what we now know as saxitoxins which give rise to a syndrome known as paralytic shellfish poisoning (PSP). These are so potent that less than a pinhead quantity, which can easily accumulate in a 100 g helping of shellfish, can be fatal (Fig. 3). Fortunately, the dinoflagellates which contain these toxins (Fig. 2c) are in general terms infrequent around the coast of Northern Europe. More commonly, particularly in summer, one finds species that contain toxins which give rise to diarrhoea and in more extreme cases nausea, vomiting and abdominal pain (diarrhoeic shellfish poisoning or DSP). The dinoflagellate genus *Dinophysis* contains many species with this group of toxins (Fig. 2d).

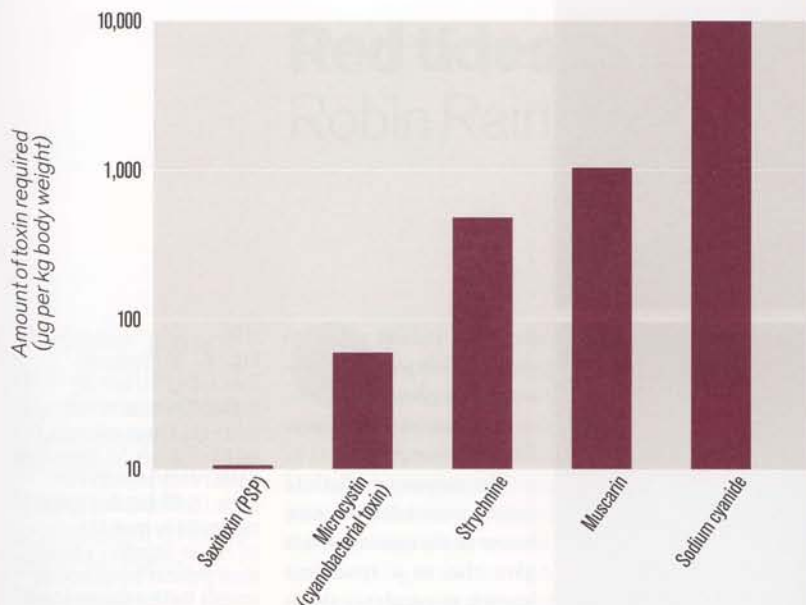
Until the late 1980s, dinoflagellates were considered as the cause of toxic events arising from shellfish poisoning. However, a new type of poisoning occurred in Prince Edward Island, Canada when over 100 people became ill after eating cultured mussels. The importance of this event was that the toxin involved, domoic acid, was produced by a diatom known as *Pseudo-nitzschia* (Fig. 2e). Diatoms had hitherto been regarded as either totally harmless or even extremely beneficial to the marine ecosystem. Contamination of some types of shellfish with domoic acid now occurs regularly in Europe. The toxin has also found its way via the marine food chain into seabirds such as cormorants, and even sea lions along the Californian coast with lethal results.

● Monitoring for harmful species

Monitoring for phytoplankton and their toxins in shellfish plays a vital role in aquaculture. The increasing use of the coastal zone for this industry demands that every precaution is taken to avoid contaminated product

LEFT:
Fig. 2. (a) *Phaeocystis*. Thousands of tiny cells are embedded in mucus in each colony. (b) *Karenia mikimotoi*, a red tide organism. (c) *Alexandrium*, a genus which produces PSP toxins. (d) *Dinophysis*, a genus responsible for much DSP. (e) *Pseudo-nitzschia* - a diatom which produces domoic acid, an amnesic shellfish poisoning toxin.
 COURTESY ROBIN RAINE (a); CAROLINE CUSACK (b); GERT HANSEN (c); GEORGINA MCDERMOTT (d); ROBIN RAINE (e)

Micro Shorts



ABOVE:
Fig. 3. Comparison of doses of algal toxins (PSP and a cyanobacterial toxin) necessary to kill humans compared with other known poisons.

ADAPTED FROM E. GRANELI ET AL. (1999) EUROHAB - SCIENCE INITIATIVE, EUROPEAN COMMISSION, BRUSSELS

being released into the market. Indeed, under the EC directives 91/492 and 2002/225, member states are required to 'check the possible presence of toxin-producing plankton in production and relaying waters, and biotoxins in live bivalve molluscs'. The actual cost of this is quite a burden. Water and shellfish sampling together with subsequent analysis for phytoplankton and toxins amounts to approximately 5% of turnover of the shellfish industry in Ireland. However, this figure can be trebled if trade losses due to harvest closures and other health costs are added on. Comparable figures are found in most states involved in shellfish production. The price of monitoring is, however, worthwhile as shown by the extremely high quality of shellfish available on the market today.

● The future

The number of recorded instances of HAB events is on the increase. It is at present difficult to discern whether this is a true reflection of a changing marine environment or simply a result of the increase in monitoring of a globally expanding industry. Attempts have been made to link the increase in HABs with climate variability and global warming, yet there is no evidence whatsoever to show this as yet. One potentially serious way an HAB species can be introduced is in the ballast water of ships, returning from long distances after off-loading their cargo. Evidence that toxic species had been introduced into Australian waters in this way was gathered in the 1980s. Many phytoplankton have dormant stages in their life cycle and can easily remain viable in ballast water for extended periods of time before being discharged in other parts of the world. Countries have been slow to respond to this threat, but at least there are now some controls on discharging ballast water near areas of aquaculture. It is up to us to remain vigilant in our activities so we may continue to enjoy the *fruits de mer*.

● *Dr Robin Raine is the Senior Researcher in Phytoplankton Ecology at the Martin Ryan Institute, National University of Ireland, Galway, Ireland.*

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email robin.raine@nuigalway.ie

Foot-and-mouth disease inquiry

● The 2001 foot-and-mouth disease (FMD) disaster highlighted the urgent necessity for a strategy based on the best science to be in place for dealing with future outbreaks in the UK and EU. The Royal Society inquiry *Infectious Diseases in Livestock*, commissioned by the government, reached some hard-hitting conclusions. Its wide-ranging recommendations were based on 400 written submissions of evidence, interviews with people involved in the outbreak and visits to affected areas. The report sets out policy measures to minimize the risk of a disease entering the country and, if it does get in, ensuring that the outbreak is localized and does not develop into an epidemic. It calls for properly funded and co-ordinated animal disease research, including the development of rapid tests, and controversially suggests that emergency vaccination should be considered as part of control strategy. The responsibility for taking most of the suggested actions is laid at DEFRA's door. The full text of the report and the evidence is available on the Royal Society website: www.royalsoc.ac.uk

Malaria genomes sequenced

● The genomes of *Plasmodium falciparum*, the parasite that causes malaria, and its carrier, the *Anopheles gambiae* mosquito, have been sequenced by two international consortia. This information will aid the battle against malaria which kills millions each year.

Life Sciences in Transition

● The June 2002 issue of *Journal of Molecular Biology* is dedicated to *European Molecular Biology Laboratory Essays on Science and Society: Life Sciences in Transition*. It includes 18 papers grouped under the following headings: Assessing the future of the biosciences; Biosciences and basic values; Genomics and the globalization of biology; Science (mis)communication; and Rethinking reproductive technologies. All the articles are available at www.idealibrary.com

LTSN activities

● The Learning and Teaching Support Network Centre for Bioscience is running a professional development programme this autumn. Themes include: Diversifying assessment; Practical work and on-line assessment (see <http://bio.ltsn.ac.uk/events/futureLTSNfeed.htm>). The LTSN Bioscience Image Bank is now open. It has a searchable catalogue of biological images for use within teaching and can be found at <http://bio.ltsn.ac.uk/imagebank/uploads>

Engaging Science grants

● The Wellcome Trust has announced the launch of a new £3 million grants programme. Engaging Science is designed to support projects that inform, stimulate debate and address the issues that biomedical sciences raise. The scheme aims to make biomedical sciences accessible to wide audiences. There are two categories of awards: People Awards (<£30k) and Society Awards (>£50k). For further information see www.wellcome.ac.uk/engagingscience

Putting marine biotechnology on the map

Graham B. Shimmield & David H. Green

There is great potential to exploit the marine environment to the benefit of us all. The new European Centre for Marine Biotechnology aims to achieve this objective.

The conception of the European Centre for Marine Biotechnology (ECMB) is one consequence of 35 years of research activity at the Dunstaffnage Marine Laboratory, located just north of Oban on the West Coast of Scotland. ECMB's challenge is to foster and stimulate the development of esoteric and applied research ideas, and to translate them into products or processes for a variety of markets from agriculture to healthcare. The rich flora and fauna of Scottish coastal waters to the Atlantic continental shelf are to be the source of both inspiration and research material. Moreover, the environmental focus of the laboratory's research will ensure that the development of marine biotechnology does not cause an impact on the very environment from which these ideas stem.

● From small beginnings

The seeds of ECMB were sown as long ago as 1967 when the Scottish Marine Biological Association (SMBA) moved from Millport, Isle of Cumbrae, to Dunstaffnage. From its new location SMBA operated under the Natural Environmental Research Council's direction, latterly changing its name to the Scottish Association for Marine Science (SAMS) to reflect its continued expansion and changes in research focus. SAMS now operates under its own management and board of trustees.

SAMS current wide-ranging research focuses on natural and anthropogenic effects on the foreshore, coastal, continental and arctic marine environments. Fields include geochemistry, biogeochemistry, marine physics, deep-sea fisheries, ecology of in-shore and off-shore vertebrate and invertebrate fauna, zooplankton, microbial ecology, ecological modelling, aquaculture and marine microalgae.

SAMS' researchers have been in the headlines through their involvement in the development of Europe's largest artificial reef, to be sited in Loch Linnhe, just north of Oban, and also with the ecological impacts of dredging in the North Atlantic on rare deep-water corals.

● ECMB ethos and function

ECMB, operating as a separate limited company within the SAMS group, will fulfil two different, but closely related, functions. First, it will conduct its own commercial marine biotechnology programme, based in large part on the research activity ongoing within SAMS. Second, ECMB will function as a business incubator for both home-grown and external ventures, nurturing new companies in a supportive environment, with access to state-of-the-art laboratory facilities and office space. It is hoped that access to sophisticated equipment, support services and facilities will obviate some of the burn associated with high-tech start-ups. Moreover, tailored business packages will be available to all incumbents of the ECMB facility.



Tenant companies will have access to a wide diversity of SAMS research, providing an ideal environment for the development of strategic alliances between companies and researchers. Collaboration will be further encouraged through use of the shared reception, library, eating and conference space that joins the new SAMS facility with ECMB. ECMB will actively encourage networking, with the long-term aim of being part of a network of facilities throughout and beyond Europe. To this end links are being established with organizations around the globe, including the University of Maryland's Centre of Marine Biotechnology in Baltimore.

● Backing for ECMB

The decision to establish ECMB was taken in 2000 as part of the wider redevelopment of SAMS and its existing facilities. The £8.3 million build programme and the appointment of a Project Executive has been part-funded by the European Union, with additional monies coming from Highlands and Islands Enterprise, Argyll and the Islands Enterprise, Scottish Executive and commercial lending sources. Dr Jo Oliver was appointed as the ECMB Project Director in mid-2002. She has extensive research experience, and has seen through the commercialization of many biotechnology ideas. Her time is presently divided between the ECMB and consultancy work associated with the wider biotechnology sector in Scotland.

● Resource availability

ECMB, and those organizations choosing to make it their home, will have access to facilities such as aquaria for aquaculture and mariculture experimentation.



Microalgal culture facilities are available through the services of the Culture Collection of Algae and Protozoa (CCAP). CCAP (marine) is the national collection of some 500 marine micro- and macro-algae species housed and maintained at SAMS, which can be accessed for academic, research and commercial purposes. Large-volume algal culture will be possible within the new CCAP facilities. Conjoined with the CCAP is the microbiology and marine algal research group, focussing on ecological and population studies of toxic algal bloom species and the associated

● Underpinning research

A number of SAMS-based projects have biotechnological potential. Current research examining the bacterial flora associated with toxin production by harmful algal bloom species, has identified some key bacterial groups with specific application and bioremediation potential. Identification and characterization of the putative biosynthetic genes involved in the production of microalgal toxins is also being pursued. Another research area is the possible harnessing of marine flora and fauna for bioremediation, and development of aquaculture methods for sustainable production of bioactive molecules. The laboratory's Marine Technology group has and continues to develop remote sensing devices and data recovery technology that have specific value and use within marine industries.

● The way ahead

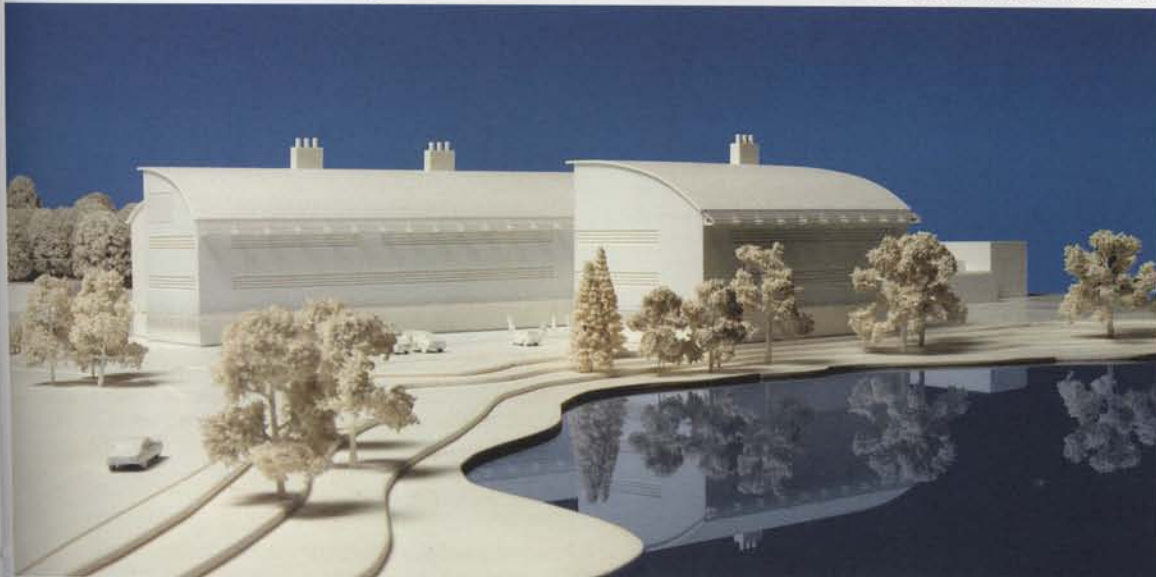
ECMB has an exciting future and is putting marine biotechnology firmly on the map. To see the site take shape, visit the SAMS website (www.sams.ac.uk) and click on the webcam. For further information about

LEFT:
Aerial view of the Dunstaffnage site and surrounding environs. The laboratory is the cluster of buildings in the centre of the photograph.

COURTESY DAVE MELDRUM

BELOW:
Model of the new SAMS laboratory being built at Dunstaffnage. The ECMB wing is the front-most building, to be ready for occupation in the autumn of 2003.

COURTESY SAMS



bacteria. A key feature of this group is the molecular genetics facility, housed next door to CCAP, with both facilities designed for class II biological containment. The laboratories are well equipped for bacteriological work and genetic manipulation. SAMS also currently operates two research vessels, both berthed at Dunstaffnage and available for a range of tasks within Scottish coastal waters. The laboratory also houses the NERC National Centre for Scientific Diving, from which qualified staff undertake a range of underwater activities. The value of immediate access to coastal waters, cannot be overstated as one of ECMB's greatest assets.

the ECMB, see the website (www.ecmb.org) or contact Dr Jo Oliver (jjol@dml.ac.uk) or Professor Graham Shimmield.

● *Professor Graham Shimmield FRSE is the Director of SAMS (gbs@dml.ac.uk) and David Green is a New Zealand Foundation for Research, Science & Technology Postdoctoral Fellow hosted by SAMS (dgreen@dml.ac.uk). Both can be contacted at Scottish Association for Marine Science, Dunstaffnage Marine Laboratory, Oban, Argyll PA37 1QA, UK. Tel. 01631 559000; Fax 01631 559001*

Putting
the map
Graham B. Stanfield & David

July Council Meeting

Council Membership

● The General Secretary, chairing in the absence of the President, warmly thanked the retiring members of Council, **Professor Colin Harwood**, **Professor Richard Elliott** and **Dr Lynne Macaskie** for their dedicated work as elected members on behalf of the Society. We wish all our retiring colleagues well in the future.

Council and postgraduate/postdoctoral members

● Council spent some time discussing the range of activities aimed at this section of the membership. Among the activities already planned, there will be a young members' workshop at the Spring 2003 meeting of the Society in Edinburgh, hosted by the Education & Training Group (see p. 202). It is also hoped to arrange regional events for this sector of the membership.

Industrial liaison

● Council has decided to seek the views of its members in industry and approved the distribution of a questionnaire this autumn (see p. 200). It hopes the replies will provide a basis for looking at the concerns of members in this important sector of microbiology in relation to future plans of the Society.

Finance

● Members may rarely stop to consider that much of what the Society is able to do in its promotion and fostering of microbiology relies upon prudent financial management of the Society and its charitable assets. The Society continues to benefit from the unglamorous, but dedicated work of its Treasurers and it may be timely to note that Council spent some time this year reviewing its budgets for the future in the light of the turbulence of the markets, which have recently affected all investments. At present Council hopes to maintain its full range of activities, but we should all remember that this does not just happen automatically.

Proposed Biosciences Federation

● The Executive Secretary reported that the Interim Executive Committee of the proposed Biosciences Federation had met and Council approved a nominal per member subscription to provide funding to establish the Federation, which it is hoped will represent life sciences on generic issues.

New covers and styles for the SGM journals

● A report from the Publications Committee of the Society to Council revealed that a new uniform and recognizable house style would be introduced for all four of the Society's journals from January 2003. See p. 213 for a preview of the new design. The Society will take over the *Journal of Medical Microbiology* from the present publishers, from that date.

● Alan Vivian, General Secretary

New Members of Council and Group Committees 2002

Council

With effect from 17 September 2002, **Professor Ian Poxton** (University of Edinburgh) commences his 5-year term as Editor-in-Chief of *Journal of Medical Microbiology*.

Following the call for nominations to fill four vacancies for elected members of Council, the following have been elected unopposed to serve from 17 September 2002:

■ Professor Peter Andrew	University of Leicester
■ Professor Jeff Cole	University of Birmingham
■ Professor Jeff Errington	University of Oxford
■ Professor Geoffrey Smith	Imperial College, London

Biographies of the new Council Members appear on p. 198. By drawing of lots, it was decided that Professors Andrew, Cole and Smith will serve for 4 years; Professor Errington will serve for 1 year, being the unexpired portion of Professor Ian Poxton's term as an elected member, with eligibility to stand for re-election for a further 4-year term.

Groups

New Committee Members, elected by postal ballot (Clinical Virology and Microbial Infection) or elected unopposed (all other Groups) to serve for 3 years are as follows:

Cells & Cell Surfaces

■ Dr David Smith	University of Edinburgh
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Clinical Microbiology

■ Professor Brian Spratt	Imperial College, London
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Clinical Virology

■ Ms Fiona Irwin	National Virus Reference Laboratory, Dublin
■ Dr David Paton	Institute of Animal Health, Pirbright
■ Dr Peter Simmonds	University of Edinburgh

Education & Training

■ Dr Sue Assinder	University of Wales, Bangor
■ Dr Bob Cooper	University of Manchester
■ Dr Christine Jones	Manchester Metropolitan University
■ Dr Brian Martin	University of Birmingham
■ Dr Jackie Parry	University of Lancaster
■ Dr Joy Perkins	University of Huddersfield
■ Dr Joanna Verran (Manchester Metropolitan University) takes over as Convener	

Environmental Microbiology

■ Dr Jon Porter	University of Exeter
■ Dr David Naseby	University of Hertfordshire

Eukaryotic Microbiology – No vacancies

Fermentation & Bioprocessing – 1 vacancy

■ Dr Frans Hoeks	Biotech Fine Chemicals, Lonza
■ Dr Julie Miller	CBD Porton Down

Food & Beverages

■ Dr Jerry Wells	Institute of Food Research
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Irish Branch

■ Dr David Dowling	Carlow Institute of Technology
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Microbial Infection

■ Dr Neil Fairweather	Imperial College, London
■ Dr Craig Winstanley	University of Liverpool

Physiology, Biochemistry & Molecular Genetics

■ Dr Mary Phillips-Jones	University of Leeds
■ Dr Maggie Smith	University of Nottingham
■ Professor George Salmond (University of Cambridge) takes over as Convener	

Systematics & Evolution – No vacancies

Virus

■ Dr John Carr	University of Cambridge
■ Dr Paul Digard	University of Cambridge
■ Dr John McLaughlan	Institute of Virology, Glasgow
■ Professor Richard Randall (University of St Andrews) takes over as Convener	

Microbiology Awareness Campaign

In pursuit of Council policy to raise the profile of microbiology to government, the Professional Affairs Officer, **Dr Geoffrey Schild**, has begun to organize a Microbiology Awareness Campaign, starting in Scotland. The first planning meeting was held at the Royal Society of Edinburgh in September. A group of eminent microbiologists based in Scotland and representing a range of specialisms discussed how to approach the Scottish Parliament and Scottish Executive to raise microbiological issues and to offer expertise. Two representatives of the Scottish Microbiology Society were present. Dr Schild was also delighted to welcome the chairman of the Scottish Science Advisory Committee (SSAC), Professor Wilson Sibbett, and Head of the SSAC Secretariat, Dr Avril Davidson, to the meeting and receive their advice. The next stage in the campaign will be to hold an event in Edinburgh early in 2003 to which ministers, MSPs and officials will be invited. There will be short presentations on microbiological issues of importance in Scotland and an exhibition.

For further information or to become involved in the campaign, please contact Dr Schild (theschilds@btinternet.com) or Janet Hurst at SGM HQ (j.hurst@sgm.ac.uk).

First Corporate Member of SGM

We are delighted to welcome **Constant Systems Ltd** as the first Corporate Member of the Society. Constant Systems is a British company, part of the Score Group plc. Providing niche biotechnical products and services, the company has been involved in the design, development and manufacture of high-pressure cell disruption equipment since 1989. Clients include pharmaceutical and biotechnology companies, universities, research institutes and agencies. The company supplies a versatile range of models, suitable for many different applications in microbiology and cell biology. Full details of products and services are available on the website: www.constant-systems.com or from the company's Head Office: Constant Systems Ltd, Low March, Daventry, Northants NN11 4SD (Tel. +44 (0)1327 314146; Fax +44 (0)1327 314147; email constant@score-group.com). Overseas clients are served through a global distribution network.

For information on the benefits of Corporate Membership of SGM, see www.sgm.ac.uk or contact the Membership Office (0118988 1803, email members@sgm.ac.uk).

News of Members

The Society notes with regret the deaths of **Dr Arthur A. King** (Member since 1984) and **Dr Richard Powell** (Member since 1991).

Staff News

Congratulations to **Ian Atherton**, Deputy Managing Editor, *Microbiology* and Production Editor, *Microbiology Today*, on his engagement to Alex. We wish them every happiness in the future.

New Group Conveners



Education & Training Dr Jo Verran

My first degree was in bacteriology and virology at the University of Manchester and my PhD was on the effect of potential sucrose substitutes on *in vitro* aspects of tooth decay. One of these aspects was the attachment of organisms to tooth surfaces and my research has primarily continued to focus on attachment and biofilm formation, particularly on the effect of substratum chemistry and topography on cell retention. I am therefore heavily involved in interdisciplinary work as a member of the University Materials Research Group.

I am delighted to be the new Convener of the SGM Education Group. I have been involved in undergraduate teaching throughout my career in the Department of Biological Sciences at Manchester Metropolitan University. As a Reader in Microbiology I have managed to maintain activity in both research and teaching, even publishing papers in both areas! In undergraduate courses I have been interested in student centred learning activities, including group work. The Education Group looks forward to promoting and supporting microbiology education within the Society and beyond...



Physiology, Biochemistry & Molecular Genetics Professor George Salmund

After a microbiology degree (Strathclyde), I studied bacteriophage-host interactions for a PhD (Warwick), then did postdoctoral research on *E. coli* cell division genetics (Edinburgh). I lectured for 2 years at Kent, then returned to Warwick working on *E. coli* cell division, and *Erwinia* and *Serratia* (protein secretion, antibiotic and pigment production, phytopathogenesis, gene regulation and quorum sensing). Since 1996, I have been in Cambridge working on quorum sensing, virulence and secondary metabolite regulation. I have served on Council and Group Committees for C&CS, PB&MG and F&B. Please contact me with suggestions for future PB&MG meetings or committee membership.



Virus Professor Richard Randall

Rick studied Biochemistry and Microbiology at the University of Leeds, where he then undertook a PhD on herpes simplex virus supervised by Dick Killington. At Leeds he was fortunate to become a close friend and colleague of the late Bob Honess, who he followed to the NIMR, London. After 6 years studying herpesvirus saimiri, in 1985 Rick moved to a lectureship with Professor W.C. Russell at the University of St. Andrews, where he began work on the molecular biology of paramyxoviruses. Currently, his main research effort is directed towards understanding how paramyxoviruses circumvent intracellular anti-viral defence mechanisms, particularly those induced by interferons.

New Members of Council

Following the call for nominations to fill four vacancies for elected members of Council, the following have been elected unopposed to serve from 17 September 2002.

Professor Peter Andrew



I graduated as a biochemist in 1973 from the University of Wales, Aberystwyth, where I remained to do a PhD on the ferredoxins of red algae with Lyndon Rogers. I moved to London in 1976 to work at the MRC Unit for Laboratory Studies of Tuberculosis. I spent 8 years there working on the interaction of *M. tuberculosis* and macrophages. This time, together with a great year at Cornell University, New York, was the foundation of my current research interests. In 1984 I moved to Leicester University, where currently I am Professor of Microbial Pathogenesis in the Department of Microbiology and Immunology. The theme of my research is the interaction of bacterial pathogens and their environments, but I like to take a broad approach to the topic. The work in my lab varies from structure and function analysis of virulence factors, biofilm formation to host response to infection, vaccine development and new methods of diagnosis. In addition, I am co-ordinator of the Biological Sciences (Microbiology) degree.

Professor Jeff Cole

Jeff Cole has published over 150 refereed papers



on how bacteria, especially *E. coli*, adapt from aerobic to anaerobic growth. He was the SGM Honorary General Secretary from 1979 until 1984. He persuaded Council to form the Microbial Physiology and Biochemistry Group, for which he was both the first and last Convener (after his tenure, the group was merged with the Genetics Group). As the Chairman of the Microbial Physiology Section, he is a member of the Executive Board of the European Federation of Biotechnology. He will soon become Editor-in-Chief of *FEMS Microbiology Letters*.

Professor Jeff Errington



Jeff did his first degree at the University of Newcastle-upon-Tyne, and then a PhD in microbial genetics with Alan Vivian at Thames Polytechnic. In 1981 he joined Joel Mandelstam's group at the Biochemistry Department

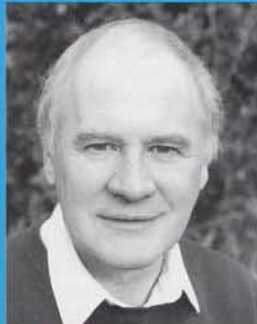
in Oxford, working on the molecular biology of spore formation in *Bacillus subtilis*. He has remained at Oxford since then, via a Royal Society University Research Fellowship and then a lectureship at the Sir William Dunn School of Pathology. He was recently appointed to the new Chair of Microbiology at the Dunn School. Jeff's main research interests currently lie in the cell cycle and cell morphogenesis of *B. subtilis*.

Professor Geoff Smith



Geoffrey Smith is Wellcome Trust Principal Research Fellow and Head of Department of Virology at Imperial College, London. He obtained his PhD studying influenza virus in NIMR, Mill Hill in 1981. As a postdoctoral fellow at NIH, USA (1981-84) he developed vaccinia virus as an expression vector and continued working with poxviruses after returning to the UK, first in Cambridge (1985-89), then in Oxford (1989-2000) and now at Imperial College. His research group studies the interactions of poxviruses with the host cell and immune system. For the last 5 years he has been Convener of the SGM Virus Group.

New JMM Editor-in-Chief



Professor Ian Poxton

Ian gained his BSc in microbiology at Edinburgh in 1971 and completed a PhD with Ian Sutherland in 1974. He was awarded a DSc in 1992. Following a post-doc in Newcastle with Sir James Baddiley, he returned to Edinburgh as Lecturer in 1977, Senior Lecturer in 1989 and Reader in 1993. He was awarded a personal chair in Microbial Infection and Immunity in 1999.

Ian was elected to Council in 1999. He served on the Cell Surfaces & Membranes (1984-88) and Microbial Infection (1996-99) Group committees and is currently Council representative for the Clinical Microbiology and Microbial Infection Groups. He was Editor-in-Chief of *Rev Med Microbiol* (1996-2002) and a Member of the Editorial Board of *JGM* (1985-90).

Interests include bacterial pathogenicity and medical microbiology, specializing in host responses to LPS and vaccine development, anaerobic pathogens, mucosal immunity in the gastrointestinal tract to normal flora and *E. coli* O157, equine GI microbiology and aetiology of equine grass sickness. 'Outside' interests include ornithology, bird photography and 'bagging' the 284 Munros (200 completed).

More glittering prizes

Congratulations to SGM member **Dr Sydney Brenner** (The Molecular Sciences Institute, Berkeley, CA, USA) who has won The Nobel Prize in Physiology or Medicine for 2002. The award is shared with Professor H. Robert Horvitz (Massachusetts Institute of Technology, USA) and Sir John E. Sulston (Sanger Centre, University of Cambridge, UK) for their discoveries concerning genetic regulation of organ development and programmed cell death.

Cakes and ale aid Macmillan Cancer Relief

SGM staff recently participated in the annual Macmillan 'Biggest Coffee Morning in the World'. Delicious homemade cakes were on sale at morning coffee time on Friday 27 September and for several subsequent days to raise funds. The money was added to donations from delegates who had joined in the charity pub quiz at the SGM meeting in Loughborough the week before. Executive Secretary Ron Fraser took on the role of quizmaster, testing the knowledge of teams such as the 'Yeastie Boys' and 'I'm a Scientist Get Me Out of Here'. 'Mixed Cultures' had the highest score and won a bottle of sparkling wine. Pickled gherkins were awarded to the lowest scoring team, Archer's Conscript, whose members will remain anonymous. The total amount sent to Macmillan Cancer Relief was £366.

Grants

President's Fund

The President's Fund offers financial support to younger members of the Society for one of the following:

1. Travelling to present a paper or a poster on a microbiological topic at a scientific meeting
2. Attending a short course (up to two weeks)
3. Making a short research visit – larger awards are available for short research visits

1 & 2 – Smaller Awards

Maximum grants are:

- £125 for attendance at meetings/courses in the country of residence
- £200 for travel to another European country
- £300 for travel outside Europe

3 – Larger Awards (research visit)

Up to £2,000 is available for making a short research visit of up to two months. The host institution may be overseas or in the country of residence.

All applicants must be resident and registered for a higher degree, or in a first postdoctoral position, in a country in the European Union. Only one application may be made to the fund during the term of a studentship or fellowship. The full rules of the scheme are published on the SGM website, from which application forms may be downloaded.

Postgraduate Conference Grants

Postgraduate Student Members of SGM currently resident and registered for a higher degree in the UK or another European Union country are eligible for a grant to cover the costs of accommodation and travel in attending ONE of the following Society meetings in 2003: University of Edinburgh, April; UMIST, Manchester, September; or any other SGM Group or Branch meeting. Application forms giving full details of the scheme were sent to all Student Members in the EU with their subscription invoices. The form can also be downloaded from the SGM website.

Seminar Speakers Fund 2002/2003

The purpose of the Seminar Speakers Fund is to promote talks on microbiological topics in departmental seminar programmes. Applications are invited from Higher Education Institutions where microbiology is taught for grants of up to £200 towards the travel, and if necessary, accommodation, expenses of an invited speaker. See website for full rules. Applications will be dealt with on a first come, first served basis during the academic year, which is defined as running from September 2002 to June 2003. Written submissions should be sent to the Grants Office at SGM Headquarters.

Details of all Society grant schemes are available on the SGM website at www.sgm.ac.uk. Please consult these before making an application. You can download the application forms for schemes where these are required. Click on the 'Grants & Funding' button for details.

Any enquiries should be made to the Grants Office, SGM, Marlborough House, Basingstoke Road, Spencers Wood, Reading RG7 1AG (Tel: +44 (0)118 988 1821; Fax: +44 (0)118 988 5656; email: grants@sgm.ac.uk).

Vacation Studentships 2003

The Society offers a limited number of awards to enable undergraduates to work on microbiological research projects during the summer vacation. The purpose of the awards is to provide undergraduates with experience of research and to encourage them to consider a career in scientific research. The studentships provide support at a rate of £150 per week for a period of up to 8 weeks. An additional sum of up to £400 for specific research costs may also be awarded. Applications on behalf of named students are now invited from SGM members in higher education institutions and research institutes. Details of the scheme are given below.

Rules

1. Applicants must be members of the Society working in a higher education institution or research institute in the UK or Republic of Ireland. Applications must be made on behalf of a named student. More than one application from a department/school will be considered, but in the case of several applications being submitted, departments/schools may be asked to rank the applicants.
2. Students must normally be in the penultimate year of their undergraduate course and registered at an institution in the UK or Republic of Ireland. Applications for students in their final year will not be considered. Medical

students will be accepted at the end of their intercalated studies, but not during their elective period.

3. The research project must be on a microbiological subject. Studentships will not be awarded for projects that are part of degree work. A studentship may be held in a laboratory away from the normal place of study, but it must be located within the UK or Republic of Ireland.

4. Applications will be assessed by a Council Award Panel, based on the reports of two referees. The scheme is competitive and applications will be judged primarily on the scientific merits of the project and the suitability of the student. Once an award has been offered, it cannot be transferred to another student.

5. The awards will provide support for the student at a rate of £150 per week for a period of up to 8 weeks, and not usually less than 6 weeks. An additional sum of up to £400 for specified research costs may also be awarded. Grants are made to the institution to which the applicant belongs, not to the supervisor, on the understanding that it will administer the award.

6. It is a condition of the award that the student submits a brief report of the research at the completion of the studentship.

7. Applications must be made on the appropriate form, which is downloadable from the SGM website.

The closing date for applications is **28 February 2003**.

Undergraduate Microbiology Prizes

The scheme to encourage excellence in the study of microbiology by undergraduate students continues to be well received in universities in the UK and Republic of Ireland. Institutions offering an appropriate microbiology course were invited to nominate a student for an SGM prize, based on good performance in microbiology in the penultimate year of study for a BSc. The department was able to choose the type of assessed work for which the prize was awarded. Of the 70+ departments circulated, 48 made nominations. Each prizewinner will receive a certificate, a cheque for £50 and a year's free Undergraduate Membership of the Society.

Undergraduate Microbiology Prizes are awarded annually and the invitations for nominations in 2003 will be circulated next May. Details are also available on the SGM website.

Public Understanding of Science Awards

Are you planning any projects to promote the public understanding of microbiology? Have you got a National Science Week event in mind? SGM can help. Grants of up to £1,000 are available to fund appropriate activities. Applications are considered on a first come, first served basis throughout the calendar year.

SGM Membership Subscriptions 2003

The following rates were agreed at the AGM of the Society on 17 September 2002.

Ordinary Member	£	US\$
■ Membership subscription (including <i>Microbiology Today</i>)	43.00	74.00
Additional concessionary subscriptions for publications:		
■ <i>Microbiology</i>	78.00	145.00
■ <i>Journal of General Virology</i>	78.00	145.00
■ <i>Int J Syst Evol Microbiol</i>	78.00	145.00
■ <i>Journal of Medical Microbiology</i>	40.00	71.00
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■ <i>Journal of General Virology</i>	37.00	70.00
■ <i>Int J Syst Evol Microbiol</i>	78.00	145.00
■ <i>Journal of Medical Microbiology</i>	40.00	71.00
Undergraduate Member (UK and Republic of Ireland)	£	US\$
■ Membership subscription (including <i>Microbiology Today</i> - no concessionary subscriptions to journals are available to Undergraduate Members)	10.00	NA
School Member (UK and Republic of Ireland)	£	US\$
■ Membership subscription (including <i>Microbiology Today</i> - no concessionary subscriptions to journals are available to School Members)	10.00	NA
Corporate Member	£	US\$
■ Membership subscription (including <i>Microbiology Today</i> - no concessionary subscriptions to journals are available to Corporate Members)	500.00	NA

Members are reminded that their 2003 subscriptions are due for payment by **1 December 2002**.

As in previous years, no journal or meetings information will be despatched to members who are in arrears, and there will be no guarantee of provision of back numbers of journals for members who pay their subscription late.

Payment by direct debit or continuous credit card

Subscription notices were despatched recently to all members paying by direct debit or by continuous credit card arrangement. To

continue your present status and journal requirements, no further action is necessary. However, if you pay by continuous credit card, you should check that the card number and expiry date on the subscription notice are correct. To change your membership status or journal requirements for 2003, or your credit card details, you should have amended your subscription notice and returned it to the membership office by **15 November 2002**. However, if you have missed this deadline, your amended notice will be accepted if it is submitted immediately.

Payment against invoice

Invoices were despatched recently to all members who pay by this method. If you did not receive one, please inform the Membership Office.

Subscriptions waived for unemployed members

As in previous years, subscriptions may be waived at the discretion of the Society for unemployed members under the age of 35 who are resident in the UK. If you are eligible and wish to benefit in this way in 2003, you should send a signed statement that you are currently unemployed

to the Membership Office before **29 November 2002**. (Please note that no increase in journal requirements will be permitted.)

Income tax relief on membership subscriptions

Members who are liable for UK income tax are reminded that their annual subscriptions to the Society have been approved by the Inland Revenue as qualifying for income tax relief. Any member who would like further information or has difficulty in obtaining this relief should contact the Executive Secretary.

Member questionnaires

SGM Council is constantly seeking to improve the services provided to all sectors of the membership and to ensure that the Society caters for all microbiologists. Strategy Group identified two areas which it felt could be better served: industrial microbiologists and young scientists. Different questionnaires have recently been circulated to members working in industry and to Postgraduate Student Members, seeking both information and their views on various aspects of SGM activities and benefits. The response from industrial members was excellent and the results are now being analysed. These will be reported in a future issue of the magazine. Replies from postgraduates are currently being received and will be assessed in due course. Council is most grateful to all respondents for participating in the surveys.



FEMS CONGRESS
OF EUROPEAN
MICROBIOLOGISTS

SLOVENIA

LJUBLJANA, CANKARJEV DOM

June 29 - July 3, 2003

www.fems-microbiology.org/congress2003.htm

PLENARY LECTURES

- Microbial Diversity
- Food safety
- Emerging Pathogens,
- Environmental Microbiology

MORNING PROGRAMM WITH SYMPOSIA:

- Development of new antibiotics against resistant bacteria
- Emerging pathogens
- Environmental microbiology
- Food biotechnology
- Food safety
- Functional genomics
- Metabolic engineering of microbes
- Microbial diversity
- Microbial interactions
- Microbial physiology and biochemistry
- Modern diagnostic methods
- Prokaryotic evolution and systematics
- Stress in microbes

AFTERNOON PROGRAMME

The afternoon programme will consist of sessions with topics emerging from submitted abstracts (deadline 2002 December 31). Those themes may include: Brucellosis, Mycorrhiza, Bioremediation, Biofilms, Fish microbiology, Metabolism, Mycoplasmas, Plant microbiology, Microbial symbiosis, Antibiotic resistance, Degradation of xenobiotics, Fungi in medicine, etc.

BACILLUS SATELLITE SYMPOSIUM

ROUND TABLES (Bio-terrorism, Bio-informatics, Culture collections, etc)

WORKSHOPS

EXHIBITION

For further information about programme visit or contact:

Email: FEMS2003@ed-cc.si

Website: www.fems-microbiology.org/congress2003.htm



Meetings

Future Meetings

SPRING 2003 – 152nd Meeting
University of Edinburgh (7–11 April 2003)

● Main Symposium 7–8 April Microbial subversion of host cells

Organizers: H.F. Jenkinson, D.G.E. Smith, C.D. O'Connor & A.R.M. Coates
Speakers:

M.J. HUMPHRIES (Manchester) *Current perspectives of the integrin field and their relationship to cellular microbiology*

G. FRANKEL (Imperial College London) *Pair protein interactions and structural analysis of enteropathogenic E. coli virulence determinants*

R. ISBERG (Boston, USA) *Setting up a nest and maintaining it: intracellular replication of Legionella pneumophila*

P. COSSART (Paris, France) *Entry of Listeria monocytogenes into mammalian cells: from cell biology to physiopathology*

G.L. SMITH (Imperial College London) *Vaccinia virus egress using the cytoskeleton*

E. GALYOV (Compton) *Induction of proinflammatory signals by Salmonella*

A.G. BOWIE (Trinity College Dublin) *A52R and A46R from vaccinia virus as antagonists of Toll-like receptor signal transduction*

B. KENNY (Bristol) *Co-ordinate subversion of host cellular processes by enteropathogenic E. coli (EPEC)*

R. COMPANS (Atlanta, USA) *Regulation of viral glycoprotein traffic and virus-induced membrane fusion*

C.R. ROY (Yale, USA) *ARF-dependent transport of Legionella pneumophila to the endoplasmic reticulum*

J. PIETERS (Basel, Switzerland) *Molecular mechanisms involved in phagocytosis: lessons from the intracellular pathogen Mycobacterium spp.*

C. MONTECUCCO (Padova, Italy) *Cellular and inflammatory activities of virulence factors of Helicobacter pylori*

P. SANSONETTI (Paris, France) *The proinflammatory response (Shigella)*

B. ROIZMAN (Chicago, USA) *Herpes simplex virus and apoptosis*

A. ZYCHLINSKY (Berlin, Germany) *Toll-like receptor–toxin interactions in Shigella*

● Other symposia and workshops

● Type IV secretion systems Cells & Cell Surfaces Group (10 April)

Organizer: I. Henderson (i.r.henderson@bham.ac.uk)

● Septicaemia Clinical Microbiology Group (7–8 April)

Organizer: C. Gemmell (cgglg@clinmed.gla.ac.uk)

● Water- and environment-related infections Clinical Microbiology/Clinical Virology/Food & Beverages Groups (10 April pm)

Organizers: S. Cameron (scameron@udcf.gla.ac.uk) & P. Molyneaux (p.molyneaux@arh.grampian.scot.nhs.uk)

● The management of outbreaks Clinical Virology Group (9 April)

Organizers: S. Cameron (scameron@udcf.gla.ac.uk) & P. Molyneaux (p.molyneaux@arh.grampian.scot.nhs.uk)

● Clinical virology network Clinical Virology Group (10 April am)

Organizer: T. Wreghitt (tim.wreghitt@addenbrookes.nhs.uk)

● Successfully surviving your PhD Education & Training Group (10 April am)

Organizer: J. Verran (j.verran@mmu.ac.uk)

● Biological control: mechanisms, function and application Environmental Microbiology/Systematics & Evolution Groups (9–10 April)

Organizers: Gerry Saddler (gerry.saddler@sasa.gov.uk), Frans de Leij (f.de-leij@surrey.ac.uk) & Kirk Semple (k.semple@lancaster.ac.uk)

● Advances in the understanding of microbial contributions to alcoholic beverage fermentations Fermentation & Bioprocessing/Food & Beverages Groups with Scottish Microbiological Society (10 pm–11 April)

Organizers: Martin Collins (m.collins@qub.ac.uk) & Glyn Hobbs (g.hobbs@livjm.ac.uk)

● Endothelial cell–pathogen interactions Microbial Infection Group (9 April)

Organizer: P. Langford (p.langford@ic.ac.uk)

● Molecular aspects of anaerobes Physiology, Biochemistry & Molecular Genetics Group with Society for Anaerobic Microbiology (7–8 April)

Organizer: N. Minton (nigel.minton@camr.org.uk)

● Vaccines Virus Group (7–8 April)

Organizer: M. Skinner (michael.skinner@bbsrc.ac.uk)

● Viruses and cancer Virus Group (10–11 April)

Organizer: K. Leppard (keith.leppard@warwick.co.uk)

● Workshops Virus Group (9 April)

Oncogenic viruses
Organizers: J. Neil (j.c.neil@vet.gla.ac.uk) & J. Doorbar (jdoorba@nimr.mrc.ac.uk)

Pathogenesis
Organizers: S. Macfarlane (s.macfarlane@scri.sari.ac.uk) & A. Alcamí (aa258@mole.bio.cam.ac.uk)

Gene expression
Organizers: J. Carr (jpc1005@hermes.cam.ac.uk) & C. Preston (c.preston@vir.gla.ac.uk)

Meetings on the web

For up-to-date information on future Society meetings and to book on-line see: www.sgm.ac.uk

Meetings organization

The SGM meetings programmes are organized by the committees of the special interest groups, co-ordinated by the Scientific Meetings Officer, Dr Howard Jenkinson. Suggestions for topics for future symposia are always welcome. See p. 223 for contact details of Group Conveners.

Administration of meetings is carried out by Mrs Josiane Dunn at SGM Headquarters, Marlborough House, Basingstoke Road, Spencers Wood, Reading RG7 1AG. Tel. 0118 988 1805; Fax 0118 988 5656; email meetings@sgm.ac.uk

Offered posters

Offered posters are welcome but should be associated either with the main symposium or a Group. General Offered Posters will not be accepted. The content should relate to the main symposium topic or the remit of a Group (see website for details); it does not have to relate to the topic of the Group Symposium taking place at the particular meeting. Titles and abstracts are required in a standard format and must be submitted by email – see website for details or contact the Events Administrator.

Abstracts book

151st Meeting

University of Loughborough
16–20 September 2002

The full text of the abstracts book is now available as a PDF file on the SGM website.

Irish Branch

Microbial diseases and the immunocompromised patient

Maynooth
24–25 April 2003

Organizer: Sean Doyle
(sean.doyle@may.ie)

Six talks

Speakers include:

P. LJUNGMAN (Stockholm)

P.G. MURPHY (Dublin)

N. GOW (Aberdeen)

W. MEIJER (Dublin)

Plus Offered Papers

Biocatalysis

UCD
Autumn 2003

For details of Irish Branch activities contact the Convener, Catherine O'Reilly (coreilly@wit.ie)

Virus vectors

Organizers: A. Whitehouse (a.whitehouse@leeds.ac.uk) & G. Atkins (gatkings@tcd.ie)

Virus entry, morphogenesis and exit

Organizers: N. Stonehouse (n.j.stonehouse@leeds.ac.uk) & T. Wileman (thomas.wileman@bbsrc.ac.uk)

Nucleic acid replication

Organizers: I. Clarke (inc@soton.ac.uk) & N. Stow (n.stow@vir.gla.ac.uk)

Molecular organization of submembrane protein shells in enveloped viruses

Organizer: M. Nermut (mvnrmnt@nibsc.ac.uk)

● Offered papers and posters

These are welcome for all Group sessions. Posters are also welcome for the main symposium. Please submit titles and abstracts to the Events Administrator by **6 December 2002**.

See p. 202 for general conditions for submitting posters.

A leaflet about the meeting is enclosed with this issue. A poster is also available from the Events Administrator if you would like to help publicize the meeting.

AUTUMN 2003 – 153rd Meeting

UMIST, Manchester 8–12 September 2003

● Main Symposium

Exploiting genomes: bases to megabases in 50 years

● Other symposia

● Microbial sensing and signalling

Cells & Cell Surfaces Group

● Teaching bioinformatics: how and why?

Education & Training/Systematics & Evolution Groups

● DNA-based detection methods

Food & Beverages/Environmental Microbiology Groups

● Post genomics applied to processes: advances in eukaryotic microbiology

Eukaryotic Microbiology Group/BMS/BSMM

● Production of DNA and protein

Fermentation & Bioprocessing Group

● Bacterial gene expression in vivo

Microbial Infection Group

● DNA 1952–2003: from structure to function

Physiology, Biochemistry & Molecular Genetics Group

Deadline for receipt of titles and abstracts for Offered Posters: **9 May 2003**.

december 02

LEGIONELLA PREVENTION TRAINING COURSE (JOINT ORGANIZERS: HCINFO AND VIRGINIA DEPARTMENT OF MENTAL HEALTH)

VDMH Northern Virginia Training Center, Fairfax, Virginia, USA
5–6 December 2002

CONTACT: Tel. +1 800 801 8050; email seminars@hcinfo.com; www.hcinfo.com)

BIOCHEMICAL ASPECTS OF HEALTH AND DISEASE. BIOCHEMICAL SOCIETY CHRISTMAS MEETING

Imperial College, London
16–18 December 2002

CONTACT: Meetings Office, Biochemical Society, 59 Portland Place, London W1B 1QW (Tel. 020 7580 3481; Fax 020 7637 7626; email meetings@biochemistry.org; www.biochemistry.org/meetings/)

january 03

'LAB ON A CHIP' - DIAGNOSIS AND ONSITE TESTING, WINTER MEETING OF THE SOCIETY FOR APPLIED MICROBIOLOGY

Holiday Inn, Birmingham
8–9 January 2003

CONTACT: Dr. John Coote (email j.coote@bio.gla.ac.uk)

may 03

3RD WORLD CONGRESS ON ANAEROBIC BACTERIA AND INFECTIONS

Glasgow, Scotland, UK, 7–9 May 2003

CONTACT: Congress Secretariat, International Society for Anaerobic Bacteria, 181 Longwood Avenue, Boston, MA 02115, USA (Tel. +1 617 738 9351; Fax +1 617 731 1541; Email info@intl-anaerobe.org)

ACHEMA 2003: 27TH INTERNATIONAL EXHIBITION-CONGRESS ON CHEMICAL ENGINEERING, ENVIRONMENTAL PROTECTION AND BIOTECHNOLOGY

Frankfurt am Main, Germany
19–24 May 2003

CONTACT: DECHEMA eV, PO Box 1501 04, D-60061 Frankfurt am Main, Germany (Tel. +49 69 7564 0; Fax +49 69 7564 201; email achema@dechema.de; www.achema.de)

june 03

5TH INTERNATIONAL SYMPOSIUM ON E. COLI-VTEC 2003

Edinburgh
8–11 June 2003

CONTACT: Mia Walker, In Conference Ltd, 10b Broughton Street Lane, Edinburgh EH1 3LY (Tel. 0131 556 9245; Fax 0131 556 9638; email mia@in-conference.org.uk; www.vtec2003.com)

NEGATIVE STRAND VIRUSES 2003. TWELFTH INTERNATIONAL CONFERENCE ON NEGATIVE STRAND VIRUSES

Pisa, Italy
14–19 June 2003

CONTACT: Negative Strand Viruses 2003, PO Box 33799, Decatur, GA 30033-799, USA (Tel. +1 404 728 0564; Fax +1 404 728 0032; email meeting@nsv2003.org; www.nsv2003.org)

july 03

22ND ANNUAL SCIENTIFIC MEETING OF THE AMERICAN SOCIETY FOR VIROLOGY

Davis, California
12–16 July 2003

CONTACT: Sidney E. Grossberg, Secretary-Treasurer, American Society for Virology, Department of Microbiology and Molecular Genetics, Medical College of Wisconsin, 8701 Watertown Plank Road, Milwaukee, WI 53226-0509, USA (Tel. +414 456 8104; Fax +414 456 6566; email segrossb@mcw.edu; www.mcw.edu/asv)

september 03

4TH INTERNATIONAL CONFERENCE ON TULAREMIA

Centre Parcs, Longleat
15–18 September 2003

CONTACT: email Tularemia@indexcommunications.com; www.tularemiacconf.co.uk

december 03

13TH INTERNATIONAL SYMPOSIUM ON THE BIOLOGY OF THE ACTINOMYCETES

Melbourne, Australia
1–5 December 2003

CONTACT: Symposium Secretariat, c/o Conference Strategy Pty. Ltd, PO Box 1127, Sandringham, Victoria 3191, Australia (www.conferencestrategy.com.au)

Promega Young Microbiologist of the Year

If you have any stories or news for publication in Gradline, or if you would like to see any topics featured, please contact mtoday@sgm.ac.uk

This year the Promega Prize rules were changed. Promega will no longer be holding the *Young Life Scientist of the Year* contest, where finalists from five different societies compete for £2,000. Thus the ten SGM finalists for the 2002 Promega Prize who were judged on their oral presentations on 17 September at the Loughborough meeting, vied to win £600, a trophy and the title of *Young Microbiologist of the Year*. The second prize was £400 and the third prize £200.

As usual the standard was amazingly high and the judges, chaired by Peter Wyn-Jones, had a very difficult job. The lecture theatre was packed. The winner was **Dr Andrew Macdonald** (University of Leeds) for his talk *The hepatitis C virus NS5A protein inhibits activating protein 1 (AP1) function by interfering with MAPK signalling pathways*. Second prize went to **Douglas West** (University of Cambridge) who spoke on *Characterization of a Δ hasA allelic replacement mutant of *Streptococcus equi* subspecies *equi** and third prize to **Natalie Simpson** (University of Cambridge) who covered *Antibiotic production by *Erwinia carotovora* subsp. *carotovora*: what's driving the car?* The winners were announced at the Society Dinner and President David Hopwood presented the prizes. The runners-up each received a cheque for £25 from the SGM and all finalists will have free Society membership next year. Congratulations to everyone who took part in the competition.

The view from the top...

Microbiology Today took the opportunity to find out the winners' views on the competition and their opinions of career prospects for microbiology PhDs.



Winner **Andrew Macdonald**, who gained his PhD in 2001, and who works in the Molecular Virology Research Group at Leeds, said, 'I was incredibly pleased when I heard I had received the Virus Group nomination. However, my pleasure turned to worry when I realized that I would have to return to give a second talk in the finals! On the day I was incredibly

nervous. I arrived at the conference first thing in the morning and spent the rest of the day wandering around trying to think of anything but my talk. When I entered the lecture theatre and started listening to the other speakers, I realized that it would not be an easy ride! When I heard the results I was overjoyed. I felt a huge amount of pride and shock.'

Outlining the reasons for his success, Andrew added, 'I am a very confident public speaker and I think that this came across in my talk. I also believe that I presented clear, concise PowerPoint slides which helped to put my point across, especially to an audience that did not work in the same field.'

Giving the reasons for choosing his research topic, Andrew said, 'I am fascinated by host-virus interactions and I strongly believe that by understanding how viruses manipulate cellular pathways we shall move one step closer to better treatment of chronic viral infections. I jumped at the chance to study in the labs of Mark Harris and Dave Rowlands. We believe we may have highlighted a novel mechanism by which hepatitis C virus (HCV) causes oncogenesis. Although the data are preliminary, they are very exciting and we are currently expanding our knowledge in this area. We hope that in time we can use novel inhibitors of the NS5A protein from HCV as a therapeutic treatment!'

Currently Andrew is working as a postdoc in the lab where he did his PhD. His contract lasts for the next 18 months. He hopes to continue life in academia and progress to a senior level; applying for a fellowship that allows him to spend time working abroad, preferably in Europe, whilst still being based in the UK. What are his opinions of current career opportunities in microbiology?

'I think that life as a biological scientist is bleak! There is very little money in this field of work and fewer grants appear to be renewed. I think that it is a very worrying time for us all. Until the problems of low pay, slow career progression and uncertain renewal of contracts are addressed, I believe that people will continue to leave science. This will be very bad for microbiology and biological science in general!'

Andrew concluded with some kind words for the SGM, 'I would just like to thank the SGM for its continued support of my research. During my PhD I was awarded a President's Fund grant to work in Finland under the tutorship of Prof. Kalle Saksela. It was during this time that I first began the work that ultimately won me the Promega Prize, so I am very grateful.'

Douglas West, who is beginning the third year of his PhD in the Department of Clinical Veterinary Medicine, Cambridge, won second prize. He was amazed to reach the finals. 'I displayed a poster at the Warwick meeting and saw just how much effort everyone had made to present their work. The standard was very high, so to be selected for the final was fantastic. On the day before the competition I was nervous! I must have spent most of the time in a seminar room practising - people must have thought I was mad talking to myself for so long! But I wasn't leaving for Loughborough until I was happy with it.'

How did Doug feel when he heard the results? 'At the conference dinner the Promega Prizes were awarded. As people were presented with awards and left their seats my heart began to pound in my chest. Then to hear I was awarded second prize - I was ecstatic! At Cambridge I have extremely good supervision. In particular Professor Duncan Maskell, Dr Josh Slater and Dr James May provide invaluable advice both scientifically and on other work related skills, such as presentation, so I think I can thank them for the success I have encountered and the confidence to believe in myself.'

Of his research, Doug said, 'The opportunity arose to work in Professor Maskell's lab on the equine respiratory pathogen *Streptococcus equi* subsp. *equi*. Not only is this a fascinating bug, but the fact that the laboratory provided the chance to work with both pathogen and natural host was just too good to pass by. My talk was based on the poster I presented at Warwick, which described the work I completed at the beginning of the second year of my PhD. I am characterizing targeted deletion/insertion mutants in *S. equi* with the aim of creating an attenuated strain. I have achieved some interesting results so far, but there is so much more to do.'

Future plans have not yet been set, although Doug is seriously considering his career options. 'I do not think I will continue my research in academia here or abroad. The standard of scientific researchers is very high, so securing a job is increasingly difficult, with so many young scientists of calibre applying for the same posts. I hope that winning second place in the Promega Young Microbiologist of the Year will hold me in good stead for job applications!

Generally he feels that current career opportunities in microbiology are good. 'There are so many fields of research to pursue – something for everyone's taste. I am interested in human/animal pathogens and their host interactions. Thanks to the work of the research councils and societies, careers in microbiology and science in general are receiving much better publicity. This can only be a good thing and raise the profile of science in society.'

Doug would like to thank the BBSRC who fund his studentship and all the staff at Cambridge who are making his PhD a fun and rewarding experience.

Third prize-winner

Natalie Simpson is in the final year of her PhD in the Department of Biochemistry at Cambridge. Speaking of the contest, Natalie said, 'I put a great deal of effort into my poster and was very happy when I was told it had been put forward for the Promega Prize competition. However, when I learned that I had to do a talk I was



a bit scared! On the day I felt really ill. I was told I looked like I was going to pass out! When I heard I'd got third prize I was really surprised and delighted. Everyone who participated gave very good talks and it must have been a nightmare to judge. The factors which contributed to my success? Well, an understanding supervisor and lab colleagues who gave me advice and who had to sit through endless repetitions of my talk! Some of them travelled up to support me on the day which was much appreciated.'

'I work on the production of carbapenem antibiotic by *Erwinia carotovora* subsp. *carotovora* and for my presentation I talked about a small part of my work

which concerns strains which harbour mutations in the S12 subunit of the 30S ribosome and do not produce carbapenem. This is very interesting as many other species with mutations at the same site, such as *Bacillus subtilis*, have been documented to overproduce antibiotics. This particular *Erwinia* causes significant economic loss through soft rot of potatoes, so I would like to think that my studies on the regulation of antibiotic and other virulence factors might help in a better understanding of the pathogen and the design of strategies to prevent infection.'

What of the future? Natalie's plans are undecided, although she would like to stay in science. 'I imagine that finding a science-related job in Cambridge won't be too difficult due to the large number of molecular biology firms in the area. I believe that current career opportunities in microbiology are generally good, especially if you have molecular biology experience, although if you want to do research without yourself becoming a supervisor, then no.'

Postgraduate Student Membership

■ Postgraduate Student Membership of SGM is available to postgraduate students worldwide who have no taxable income. For an annual subscription of only £20 (US\$35) Student Members can take advantage of benefits such as special registration fees at Society meetings and the purchase of SGM publications at greatly discounted prices. In addition, Postgraduate Student Members who are resident and registered for a higher degree in any European Union country may apply for awards from the President's Fund and Postgraduate Conference grants (see p. 199 for details) which provide financial assistance for attendance at scientific meetings.

Undergraduate Membership

■ Undergraduate Membership is open to students resident and registered for a first degree in the UK or Republic of Ireland. For the bargain subscription of £10 Undergraduate Members receive *Microbiology Today* and may attend SGM meetings without payment of a registration fee. Careers advice is also freely available. However Undergraduate Members are not eligible for travel or conference grants.

Life Science Careers 2002

- 2 November 2002 University of Sheffield
- 16 November 2002 University of Glasgow
- 30 November 2002 King's College, London

These all day conferences are for life science undergraduate (graduating in 2003 or 2004) and postgraduate students. Each conference includes a range of talks on career choices and further training, an exhibition and a CV clinic. Full details and a booking form were published in the August issue of *Microbiology Today*. Don't miss the chance to attend the nearest event to your institution – further information and a booking form are available on the web at www.uklsc.org/careers2002.htm

Organized by members of the UKLSC, including SGM.

From lecture room to laboratory

Schools Membership costs only £10 a year. For this, a named teacher representative will receive *Microbiology Today* each quarter, advance notification and copies of new microbiology teaching resources, and discounted fees for attendance on SGM training courses and workshops. Application forms are available at www.sgm.ac.uk

Website:
www.microbiologyonline.org.uk
Enquiries:
education@sgm.ac.uk

Over to you...

Contributions are welcome from teachers who have interesting microbiology material to share, such as novel investigations, useful tips or good sources of information. A copy of the post-16 resource *Practical Fermentation* (worth £15) will be sent to any school whose submission is published. The editors of *Microbiology Today* reserve the right to edit any material.

ABOVE:
Hands-on in the laboratory.

UPPER RIGHT:
Working in small groups on science communication projects.

LOWER RIGHT:
The group listens to John Grainger.

PHOTOS LIZ SOCKETT & DARIEL BURDASS, SGM

Comments from some of the participants are also shown.



into a wider educational context showing how it can be used to teach other issues, such as bioethics and science communication – also a requirement for education in citizenship. Participants had a day out at the Institute for Animal Health, Compton, and spent their afternoons in the laboratory carrying out both traditional and molecular microbiology investigations. Short workshops were also run and sponsored by Unilever and Bio-Rad.

A boat trip down the river Thames, wine tasting and a Gala dinner provided light relief in the evenings. The feedback from the teachers was extremely positive and they left feeling confident and enthusiastic about microbiology.

● **Dariel Burdass, SGM Education Administrator**

A model of how INSET should be. Thank you.

Keith House.

You wonderful
we all love you &
went to take you home!
Thank you for all the hard work
& attention & detail. — Dave.

Brilliant!
Joey Maki

What can be said!
— only thank you so
much for a brilliant
course. — David Cambridge

SGM Post-16 Summer School 15–19 July 2002 University of Reading

Fifty teachers attended this residential course, which was kindly hosted by Reading University School of Food Biosciences. The programme was carefully designed to reflect the microbiology content of the current post-16 examining body specifications, but aimed to go beyond the basics by covering the latest research findings in each topic, put into context.

There was a range of cutting edge talks by experts in their field where issues such as the use of pre- and probiotics, microbial genomics, biofilms, quorum sensing and antimicrobial resistance were explored. The Summer School put microbiology



Thank you to all the staff for a fantastic week!
Nicola O'Donnell
(Dartford High School)

Thanks for the best course we ever had the pleasure of attending! I return to school revitalised!
S.A. Walsham
(Netterhall)

I'm not going to use the word excellent, because I would imagine everybody else will. So... superb, thank you
Lee O'Brien
Sexey's School.

International Research Fellowship report

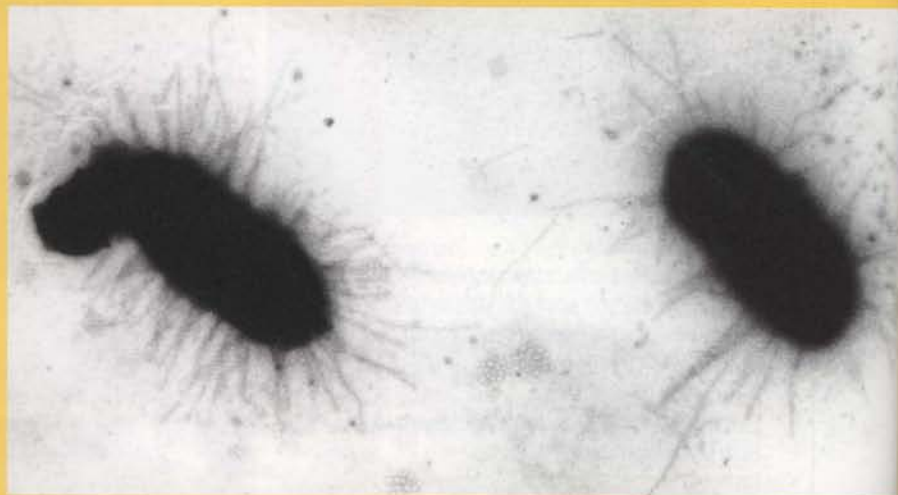
Uropathogenic fimbriae of *Proteus mirabilis*

■ Pablo Zunino

When I landed at London Heathrow on 12 May 2002, it brought back happy memories. I remembered when I first arrived in the UK during the unusually hot summer of 1995. Then, I stayed for more than 3 years doing my PhD under the supervision of Professor Duncan Maskell, studying the role of *Proteus mirabilis* fimbriae in urinary tract infections.

This time I was generously awarded an International Research Fellowship by the SGM to work again in Professor Maskell's lab in the Department of Clinical Veterinary Medicine at the University of Cambridge. This gave me the chance to do further research on uropathogenic *P. mirabilis* fimbriae and their potential role in urinary tract infections, continuing the collaborative activities between Professor Maskell's lab and my lab in Uruguay.

P. mirabilis is an opportunistic, Gram-negative bacterium that can cause serious urinary tract infections (Fig. 1). It has a wide variety of potential virulence factors that may act in a concerted way to colonize the host, including different kinds of fimbriae that could mediate bacterial adhesion to the uroepithelium.



will need further characterization in Uruguay and in the UK.

I used several different techniques to characterize other *P. mirabilis* fimbrial mutants, including transmission electron microscopy (TEM) (Fig. 2) and adhesion to cultured uroepithelial cells. All the single fimbrial mutants tested showed a significant decrease in the number of adhered bacteria when they were compared to the wild type, although no differences could be noted when the wild type and the mutants were analysed by TEM. This may be explained by the fact that *P. mirabilis* expresses several types of fimbriae simultaneously and that there could therefore be redundancy in the system.

Finally, I sequenced different genes of the operon that encodes UCA. During my previous stay in Cambridge for my PhD, I cloned different UCA genes using a λ -Zap vector. During this last visit I characterized some of those clones and one of them was selected for primer walking sequencing. Sequence data already collected indicate that UCA fimbriae are secreted and assembled through the chaperone-usheer pathway.

After this new stage of a very productive history of collaborative research work between both labs, we are planning to prepare a new grant proposal related to different aspects of uropathogenic *P. mirabilis* pathogenesis.

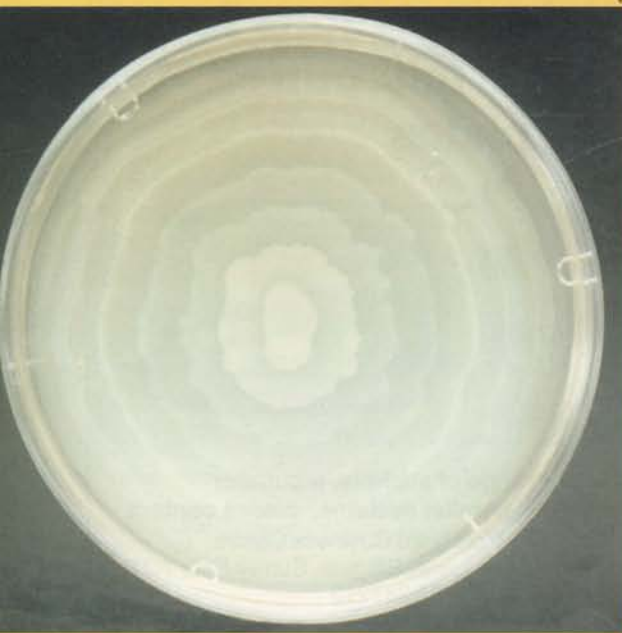
I would like to thank the SGM for the fellowship and I am particularly grateful to Dr Jane Westwell for all her help. I extend my thanks once more to Duncan Maskell for receiving me in Cambridge and to all the people in his lab, especially to Dr Andrew Preston. I really enjoyed my 3 months stay in Cambridge, a small, warm and always exciting town.

■ Dr Pablo Zunino, Instituto de Investigaciones Biológicas Clemente Estable, Montevideo, Uruguay.

BELOW:
Fig. 1. Typical *P. mirabilis* swarming motility.

TOP RIGHT:
Fig. 2. *P. mirabilis* fimbriae (TEM).

PHOTOS P. ZUNINO



The plan was to generate a double mutant lacking two of the most potentially important fimbriae related to adhesion to the uroepithelium, to characterize other fimbrial mutants that we had previously generated and to sequence different genes of the operon encoding the *P. mirabilis* fimbriae called Uroepithelial Cell Adhesin (UCA). Although fimbriae are not essential for bacterial viability, the generation of a double fimbrial mutant was not an easy task. However, after trying different approaches, I obtained a variety of very promising clones that

International Development Fund report

6th Workshop in Molecular Biology and Disease, Vietnam 12–16 August 2002

■ Simon Cutting

Once again the SGM has supported the ongoing program of training in Vietnam by sponsoring the 6th Workshop in Molecular Biology and Disease held at the National Institute of Hygiene and Epidemiology (NIHE) in Hanoi. NIHE is the premier research institute in Vietnam (formerly known as the Hanoi Pasteur Institute), employing over 350 scientists dedicated to the control of infectious disease, preventive health care and the study of microbiology and immunology. NIHE has large and unique animal facilities including various simian species and is an



important centre for vaccine development as well as co-ordinating phase II–III trials. Its own company, VaBioTech, produces a number of important vaccines including rabies, Japanese encephalitis virus, hepatitis B and a new oral cholera vaccine.

Our programme consisted of two practical labs. The first '*Mutation Analysis of Inherited Diseases*' was organized by Dr Maria Pohlschmidt (Royal Holloway University of London, RHUL), Dr Ann Walker (Royal Free and University College Medical School) and Dr Darek Gorecki (University of Portsmouth) and had 16 students. The detection of mutations in disease genes has become increasingly important for the diagnosis of inherited and somatic diseases. Hence, the analysis of human DNA using rapid PCR techniques is now an integral part of the procedure used for the diagnosis, assessment and prevention of these diseases. This lab course was designed to understand the underlying rationale of the current approaches, and to assess their contribution to diagnostic medicine. Analysis of patients' DNA of

three major inherited diseases (Duchenne muscular dystrophy, β -thalassaemia and familial adenomatous polyposis) was performed using well-established PCR methods.

The second practical lab course '*PCR Diagnosis of Microbial Pathogens*' used real-time PCR to demonstrate a number of important PCR applications, including the detection of *Mycobacterium tuberculosis* in sputa, hepatitis B, hepatitis C and dengue virus in human sera, and PCR-ELISA to detect white spotted virus syndrome (WSSV) and monodon baculo virus (MBV) from shrimp samples. Each of these pathogens presents a major problem to Vietnam with contaminated blood being used for transfusions, and an increase in TB and viral diseases severely affecting their aquaculture industry. This course, given to 46 students, was organized by Dr Pham Hung Van (Ho Chi Minh City University of Medicine), Dr Huynh Anh Hong (RHUL) and Dr Simon Cutting (RHUL) and we thank Bio-Rad Laboratories (Vietnam) for the generous loan of their iCycler and reagents for the duration of the course.

The SGM has now supported four workshops in Vietnam and this has had a measurable impact on the quality of research in Vietnam, including the use of PCR in disease diagnosis. Indirectly, these workshops have enabled five Vietnamese workshop students to enter PhD programs in overseas labs as well as three to obtain post-doctoral positions. Some of the lecturers who have attended these workshops have also developed research collaborations with Vietnamese scientists, including Dr Ann Walker who is working with the Hanoi Medical School to evaluate inherited disorders in Vietnam and Dr Cutting who is working on a cholera vaccine project with NIHE. In summary, we offer our thanks to the SGM for supporting these workshops and making an impact on preventive health care in Vietnam.

For information on this and future workshops in Vietnam contact Dr Simon Cutting (s.cutting@rhul.ac.uk)

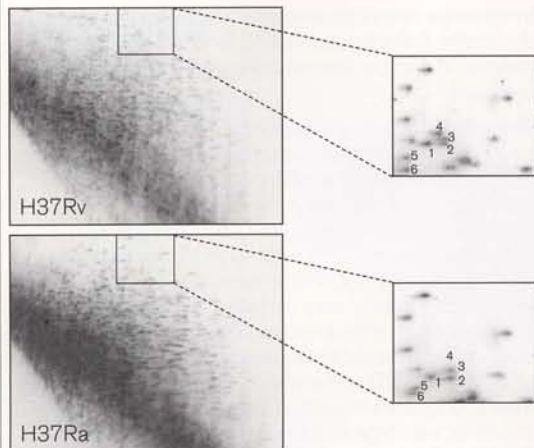
LEFT:
Simon Cutting demonstrates to Vietnamese colleagues during a PCR workshop.

BELOW:
NIHE, Hanoi, Vietnam.

PHOTOS S. CUTTING



Microbiology Today Editor Meriel Jones takes a look at some papers in current issues of the Society's journals which highlight new and exciting developments in microbiological research.



A new weapon in the war against TB

The bacteria that cause tuberculosis kill about three million people every year, and cause misery to many more. Although both vaccination and antibiotics work well against some strains of *Mycobacterium tuberculosis*, other strains, and its close relatives, have developed methods to shrug off these efforts. In addition, no one really understands exactly how mycobacteria evade the immune system and cause disease. Canadian researchers, led by Edith Dullaghan at the University of British Columbia, have been developing a new technique to compare all the genes from several strains of these bacteria to search for ones that are essential for causing disease, or to pinpoint vulnerabilities that could lead to new treatments. They call it two-dimensional bacterial genome scanning, or 2DBGS for short.

This technique involves isolating the DNA from the bacteria and then using enzymes to cut it up into small pieces. Then they separate the bits on a gel, as in DNA fingerprinting, except that the researchers use two characteristics, not one, to separate the pieces. The result is a slab of gel that looks as if it has caught the droplets from the spray-can of a graffiti artist. An arc of dots runs diagonally across the gel, each corresponding to an individual snippet of DNA. Although they are all smeared together at one edge, away from it individual spots stand out.

Unlike spray paint, the pattern of these dots is remarkably reproducible. Simply looking at a small region is enough to identify *Mycobacterium* species and strains. Indeed, when the researchers compared two strains that they knew were identical except for a small change in one gene, all the spots were in the same places except for the one corresponding to that gene. Although their work is very much 'proof-of-concept' at present, 2DBGS is an addition to the methods that will be needed to unravel the genetic differences between virulent and avirulent forms of mycobacteria.

Dullaghan, E.M., Malloff, C.A., Li, A.H., Lam, W.L. & Stokes, R.W. (2002). Two-dimensional bacterial genome display: a method for the genomic analysis of mycobacteria. *Microbiology* 148, 3111–3117.

TOP RIGHT: Identification of differences in a virulent and avirulent laboratory strain of *M. tuberculosis*. Strains H37Ra and H37Rv were subjected to 2DBGD after digestion with *Hinf*I. The two samples were run in parallel in separate denaturing gradient gels. Corresponding areas of the gels (2.5 × 3.5 cm) from H37Rv and H37Ra (inset boxes) show numerous spots that are identical between the two strains. However, one spot (4) that is present in H37Rv is absent from H37Ra while another spot (6) appears to migrate differently in the two strains.

COURTESY E.M. DULLAGHAN, B.C. RESEARCH INSTITUTE FOR CHILDREN'S AND WOMEN'S HEALTH, VANCOUVER, CANADA

LOWER RIGHT: Coloured transmission electron micrograph of measles virus particles budding out from an infected cell (at bottom)

COURTESY NIBSC / SCIENCE PHOTO LIBRARY

OPPOSITE PAGE: Transmission electron micrograph showing part of a negatively stained cell of *Halomonas halocynthiae* strain KMM 1376^T. Bar, 0.5 μm.

COURTESY DR. MANFRED ROHDE, GBF, GERMANY

The fight against measles

Although vaccination campaigns have significantly reduced the number of measles cases worldwide, there are still outbreaks of the disease, even in Europe. According to WHO and UNICEF, there have been 30 million cases in recent years, resulting in 900,000 deaths, most of them occurring in regions with a low rate of vaccination and malnutrition. However, the proportion of children who are vaccinated varies, even in Europe, and researchers at the Robert Koch Institute in Berlin have recently pulled together information to give a fascinating insight into the effects of different rates of vaccination.

Vaccination against measles was introduced into Germany in the 1970s. In the former East Germany, vaccination was compulsory, and >95% of children were vaccinated. In the former West Germany, it was voluntary, and 60–70% of children were covered. After

reunification in 1990, the rate remained high in the East, and increased in the West, so that now 90% of 6-year-olds are vaccinated. Between 1999 and 2001, the researchers monitored the situation through a German Measles Sentinel programme. This involved a network of 1,273 paediatricians and general practitioners across the country, to report cases and collect clinical samples: 1,755 suspected measles cases were reported, and samples from about half were tested in the laboratory.

Measles virus, like everything, comes in different versions called genotypes. Its presence in clinical samples can be shown using the polymerase chain reaction for the detection of the viral genome. Then the researchers checked the genotype from the sequence of one of the virus genes in about 12% of the confirmed cases. After



amassing data for 2 years, there were two very obvious trends. First, there were many fewer cases of measles in eastern Germany than in western or southern regions, indicating the protection given to young children by a consistently high rate of vaccination. The other feature was the assignment of the genotypes. There were one or two predominant genotypes in the west and south each year, each involved in a number of infections. This pattern is typical of regions of the world where the virus circulates from child to child as they act as a permanent reservoir of infection. The situation was very different in the east, where there were a few scattered cases, caused by many different varieties. It was very clear that these infections did not originate locally, but were brought into the area.

The survey threw up a number of cases caused by a new genotype, D7. This was interesting because its nearest relative came from an infection in Illinois, USA, that had supposedly been caught in Europe. There was a dramatic shift from C2 and D6 to D7 in one year in Germany. The distinguishing features of D7 are changes in an antigen that the body's immune system uses to recognize the measles virus. However, the survey data indicate that high rates of vaccination in any case give protection regardless of genotype.

Santibanez, S., Tischer, A., Heider, A., Siedler, A. & Hengel, H. (2002). Rapid replacement of endemic measles virus genotypes. *J Gen Virol* 83, 2699–2708.

Bacterial clock-watching

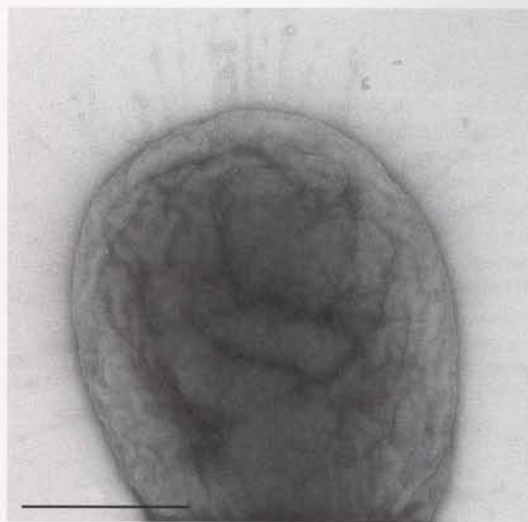
Animals, plants, fungi and some bacteria have biological clocks. They have in-built circadian rhythms so many of their activities change in a rhythmic fashion over about 24 hours. This extends from obvious things like sleeping and waking to the levels of individual proteins in the cell. It is all controlled from a series of clock proteins that set up and maintain the rhythms. In the cyanobacterium *Synechococcus elongatus* three genes, *kaiA*, *kaiB* and *kaiC*, encode the clock proteins and disruption of any *kai* gene affects the rhythm.

Researchers in Nagoya University in Japan are trying to understand how these three proteins work. They already knew that KaiA was crucial to establishing and maintaining the rhythm, although the bacterium could still grow if this protein was totally absent. It controls its own level within each cell, and also increases the levels of KaiB and KaiC. To understand KaiA better, the researchers devised a system to measure the length of the circadian rhythm easily. To see the rhythm, they inserted an extra gene that would make the cells glow whenever they produced KaiB and KaiC. They measured the brightness of the bacterial cells with a sensitive camera that automatically recorded its waxing and waning.

To create the mutations, they exploited one of the well-known problems with the polymerase chain reaction (PCR). This reaction allows short lengths of DNA to be copied many times, and is the basis of many molecular biological techniques. The problem is that because the reaction takes place in a test-tube, if the enzyme makes a copying mistake, all the cell's usual methods for detection and correction are missing. Molecular biologists go to great efforts to avoid these errors, but the Japanese researchers realized that this was a perfect way to create lots of random mutations within the *kaiA* gene. They could put the mutated copies of the *kaiA* gene back into the bacterial cells, let the cells grow and then look for ones where the rhythm of brightness had changed, indicating that the circadian rhythm had been affected.

Out of about 4,000 copies of the gene, almost a tenth caused abnormalities in the circadian rhythm. In three-quarters of these, the length of the rhythm was longer, and the remainder were arrhythmic, with no obvious pattern at all. These arrhythmic cells had a lot less activity of the *kaiB* and *kaiC* genes, confirming the researchers' previous idea that KaiA activated these genes. There was only a single cell where a change to the *kaiA* gene had made the circadian rhythm shorter. One obvious implication is that KaiA somehow has a direct role in determining the timing of the circadian rhythm. The researchers discovered that the mutations affecting the length of the circadian rhythm were clustered together in two regions of the KaiA protein. The arrhythmic mutants had mutations in other parts of KaiA, suggesting that different regions are important in controlling the levels of KaiB and KaiC. The researchers intend to follow up this study, to discover exactly how KaiA can play a dual role in circadian time-keeping in this cyanobacterium.

Nishimura, H., Nakahira, Y., Imai, K., Tsuruhara, A., Kondo, H., Hayashi, H., Hirai, M., Saito, H. & Kondo, T. (2002). Mutations in KaiA, a clock protein, extend the period of circadian rhythm in the cyanobacterium *Synechococcus elongatus* PCC 7942. *Microbiology* 148, 2903–2909.



A peach of a new species

The sea peach, known to the scientific community as *Halocynthia aurantium*, lives in the cold waters of the Arctic Sea near Japan. It is a member of the ascidian (sea-squirts) group of animals that spend their adult lives immobile and attached to a rock where crabs and star-fish find it a tasty meal. The barrel-shaped body of this animal is peach-coloured and it lives alone or in small groups. A close relative is picked, skinned, boiled and eaten in Korea and Japan, but the sea peach has escaped the human table, although the Hands and Mind Company in Japan is trying to develop a market for freeze-dried sea-peach flakes.

For microbiologists of the Russian Academy of Sciences and the German Collection of Micro-organisms and Cell Cultures, one interesting feature of this animal is a bacterium that they isolated from its gills. They ran it through a battery of tests to discover what it was, and realized that it was a brand new species. It fitted into the genus *Halomonas*, which was recently redefined to accommodate a wide range of bacteria that require a saline habitat. However, there were sufficient differences in some of its fats, genes and the compounds that it consumes, to distinguish it from any known species. Considering its source, the researchers decided that it was only appropriate to name it *Halomonas halocynthiae*.

Romanenko, L.A., Schumann, P., Rohde, M., Mikhailov, V.V. & Stackebrandt, E. (2002). *Halomonas halocynthiae* sp. nov., isolated from the marine ascidian *Halocynthia aurantium*. *Int J Syst Evol Microbiol* 52, 1767–1772.

Transmission of prion disease by blood transfusion

Only time will reveal the full consequences to the health of people living in the UK of eating meat from cows infected with BSE in the mid-1980s and early-1990s. So far, over 100 people have died from a disease that is probably caused by infection with the same agent that causes BSE in cattle, a so-called prion protein. Reasons for the uncertainty are the difficulty in detecting prions, the decades that it may take before people show any disease symptoms and the lack of any treatment to offer. The disease is now called variant Creutzfeldt–Jacob disease (vCJD) because of its similarity to the very rare Creutzfeldt–Jacob disease, a neurological disorder that was identified in the early years of the 20th century.

Nevertheless, many things have been done to try to eradicate the disease in cattle and to remove any further opportunities for people to become exposed to the cause of the disease. One of these is changes to the Blood Transfusion Service in the UK, because of the possibility that vCJD, unlike CJD, could be transmitted through blood. Recent results from a long-term experiment by researchers at the Institute for Animal Health in Edinburgh and Compton are indicating that this might have been a very wise precaution. Two years ago Dr Nora Hunter and others reported that they had managed to infect one

sheep with BSE by using a blood transfusion from another BSE-infected sheep. In a recent paper in *JGV*, they have reported on the progress of this study over the following two years. Another animal has developed symptoms characteristic of the disease, and two more appear to have the very first signs of illness. The remaining 19 sheep that have received either whole blood or cells from infected animals are still in good health.

The researchers have a second group of 21 sheep that have been infused with blood and cells from sheep that had naturally contracted scrapie. This is a disease of sheep, caused by a prion, which has been present in the UK for centuries and has never, as far as anyone can tell, been passed on to people. Four of these sheep became ill with scrapie. The researchers confirmed their identification of the disease by testing the brains and other tissues of these sheep for prion proteins. Two further groups of sheep, that have received blood from perfectly healthy sheep, have shown no signs of neurological disease.

One of the most interesting, and worrying, features of these results is that several of the transfusions were of blood that came from pre-clinical, apparently healthy sheep. This suggests that the level of infectivity in animals that appear to be perfectly healthy may be much higher than anyone had imagined. All the sheep

have so far taken around 600 days to start to show signs of disease after the blood transfusions. Several have not reached this time limit yet, so the researchers do not know if the current result of about 10% of transfusions resulting in disease is the final total, or whether it will be higher.

Hunter, N., Foster, J., Chong, A., McCutcheon, S., Parnham, D., Eaton, S., MacKenzie, C. & Houston, F. (2002). Transmission of prion diseases by blood transfusion. *J Gen Virol* **83**, 2897–2905.

Microbiology mycobacteria special issue

Microbiology's October 2002 issue was a special issue, partly devoted to the molecular genetics and immunobiology of mycobacteria.

For further information and an order form see www.sgm.ac.uk/mic_main.htm



Turbot-charged systematics

Turbot is one of a number of species of fish that are being farmed, as well as caught in the wild. It is important that the young fish acquire the correct microflora in their gut, and researchers at Ghent University have discovered that some bacterial strains can actually help the fish-fry survive and grow. They have now studied 22 different bacteria from the guts of healthy young turbot to learn exactly what they are, and whether particular molecular biological techniques are more suitable than others for their identification.

One technique allowed the researchers to generate a large number of bands of DNA, representing the whole of the bacterial genome. Although the patterns were obviously from members of the family *Vibrionaceae*, all 22 isolates fell into a distinctive cluster that was completely separate from all the currently known species of this family. When the researchers tried comparing the sequences of a single gene, they came up with a similar result; all the bacterial strains from the turbot were similar to each other, but distinct from other members of the *Vibrionaceae*. Other tests that looked at the composition of bacterial DNA and also at sensitivity to antibiotics, internal fatty acids and the sugars that they could digest, added to the picture of the characteristics of these novel bacteria.

With all the data pointing in the same direction, the researchers feel confident that they have discovered a new bacterial genus, which they propose to call *Enterovibrio*, in recognition of both its gut habitat and membership of the *Vibrionaceae* family.

Thompson, F.L., Hoste, B., Thompson, C.C., Goris, J., Gomez-Gil, B., Huys, L., De Vos, P. & Swings, J. (2002). *Enterovibrio norvegicus* gen. nov., sp. nov., isolated from the gut of turbot (*Scophthalmus maximus*) larvae: a new member of the family *Vibrionaceae*. *Int J Syst Evol Microbiol* **52** (in press).

ABOVE:

The turbot has adapted to a life on the seabed and is a master of camouflage. The turbot looks like any other fish when it is born, but as it matures the body flattens and the right eye moves to the left side, eventually to become the fish's topside.

COURTESY PAT O'REILLY
(WWW.FISHING-IN-WALES.COM)

When is a pathogen not a pathogen?

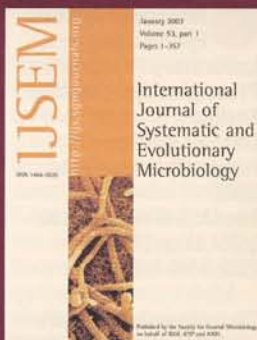
Molecular biology methods, which detect pieces of DNA, have provided microbiologists with a puzzle. If they can detect the DNA of a bacterial pathogen in something, but cannot get the bacteria to grow, is it, or is it not, a potential source of infection? The argument has continued, as both DNA detection and bacterial culture methods have improved. Researchers have also become more knowledgeable about the lives of bacteria in the normal environment, rather than in pampered laboratory conditions. Consequently, there is intense interest in the hypothesis that some bacteria can adopt a 'viable but non-culturable' state. This proposes that some bacteria that are normally easy to grow can change in adverse environments so that although they are no longer detected by conventional culture methods, they are still alive, and can perhaps be enticed to grow again. The bacteria that appear to do this include major pathogens, such as the bacteria that cause cholera and various sorts of food poisoning, so it is obviously important to get to the bottom of this potential for resurrection.

Researchers in the Departments of Microbiology and Immunology in the Universities of Leicester and Newcastle in the UK have now done a very careful evaluation of *Salmonella enterica* serovar Typhimurium, which can cause food poisoning. Apart from its being a real pathogen, they chose this species because there are several methods to detect it and its activities. Some have been used for over 20 years, so there is a lot of experience in how they work. One of them, which involves injecting the bacteria into mice, is so sensitive that it detects between 1 and 10 living bacteria.

The researchers grew the bacteria and then starved them for days to get cells that, although not capable of reproduction, were still biochemically active. They used very precise procedures to grow and test the bacteria so they could be confident that their experiments were reproducible. When they tried to infect mice with these cells, the animals remained perfectly healthy, and the researchers could not detect the bacteria in either the guts or droppings from the mice. This was a very definite demonstration that this well-known pathogen was unable to cause infections after it had been through a particular procedure to convert its cells into an active but non-culturable state. The researchers hope that this example will encourage others to test the extent to which temporarily non-culturable bacteria form a reservoir for infectious diseases in a similarly precise fashion.

Smith, R.J., Newton, A.T., Harwood, C.R. & Barer, M.R. (2002). Active but nonculturable cells of *Salmonella enterica* serovar Typhimurium do not infect or colonize mice. *Microbiology* 148, 2717–2726.

A new look for the SGM journals



Things have been even busier than normal in our Editorial Offices in the last few weeks. The acquisition of *Journal of Medical Microbiology* at the end of 2001 has brought the number of journals that we publish to four, and to enable us to produce them as efficiently as possible this has necessitated the harmonization of working practices and journal design. A little history first. Over the years, the editorial procedures and style of *Microbiology* (formerly *Journal of General Microbiology*, published since 1947) and *Journal of General Virology* (published since 1967) have diverged considerably. When SGM acquired *International Journal of Systematic Bacteriology* (now *International Journal of Systematic and Evolutionary Microbiology*), its format was based on that of *Microbiology* and wherever possible, procedures were harmonized; JMM has a completely different format again, and so to pull all four journals together under the SGM 'brand', it was decided to produce a new look for January 2003. To this end Ian Atherton proposed some cover designs, the final one being shown on the left, as well as new layouts for the inside covers, the contents lists and articles themselves. As you can imagine, this has been no small undertaking, and we hope that the readers will approve. On the covers, the major features are that each journal will have a colour that will change each year, a picture that will change with each issue and SGM is clearly identified as the publisher.

The articles will have a more modern and fresh look, and all journals will use the same stylistic conventions – this should have great benefits for the production side of the operation, as those little differences can cause big problems. For example, we will be able to use the same manuscript-processing macros and share staff (including freelance copy editors and proofreaders) across the journals more easily. JMM will be introducing the name-year referencing system and JGV will be introducing abbreviated journal titles. On the pre-acceptance side of the operation, all journals are using the ESPERE online submission and peer review system, and we are promoting more open interactions between the Editors and the authors, although referees are still anonymous.

An added factor in all this is that we are learning to work with JMM's typesetters, Keytec, based at Bridport in Dorset. The other three journals will from January 2003 be typeset by Charlesworth, based at Huddersfield in Yorkshire, after a long and fruitful partnership with Cambridge University Press. CUP will continue to publish our Symposium Volumes. So far, all the signs are looking good, and we are looking forward to an exciting, and hopefully not too eventful, start to 2003.

● Aidan Parte, Managing Editor, IJSEM and JMM



Reviews

If you would like your name to be added to our database of book reviewers, please complete the book reviewer interests form now available on the SGM website.

A classified compendium of book reviews from 1996 to the present is also available on the website.

A list of publisher's website addresses is given on p. 215.

Manual of Environmental Microbiology, Second Edition

Edited by C.J. Hurst, R.L. Crawford, G.R. Knudsen, M.J. McInerney & L.D. Stetzenbach
Published by American Society for Microbiology (2001)
US\$124.95, pp. 1,138
ISBN: 1-55581-199-X

At 1,138 pages this must be the biggest publication on environmental microbiology. Big does not always equate with quality, but in this case it does. In reviewing this I admit to not having read the whole manual, but I tried to use it as it is intended, i.e. as a reference manual. It works well, there is much to recommend. The range of subjects is vast with virtually every aspect of the topic covered, including methods, public health, environments, including aquatic, soil (rhizosphere/phylosphere) and subsurface, aerobiology and a final section on biodegradation. The authors provide detailed background information, techniques for measurement and analysis, they discuss the limitations and each section (there are 98 of them) is supported by many references. Whatever your interest is in environmental microbiology it will be covered, but the strength lies in that there will be new information that may allow you to extend your thoughts and maybe your research. An excellent book.

■ **Roger Pickup**
CEH Windermere

The Horizontal Gene Pool: Bacterial Plasmids and Gene Spread

Edited by C.M. Thomas
Published by Harwood Academic (2000)
US\$110.00/£69.00/Euro 92.00, pp. 419
ISBN: 90-5702-462-4

Bacterial genome sequencing, especially multiple genome sequencing is revealing that many organisms possess core genomes around which there may be significant variation. This book

examines many of the elements responsible for this variation. It provides useful background information cataloguing plasmids and extrachromosomal units that replicate in step with the chromosome and compose from 1 to 10% of the genetic material within an organism. These elements are a particularly fluid part of the genome that can be lost or gained by bacteria at high frequency. They function as vehicles which can maintain genes at high dosage and enable genes with a strong selective advantage to spread horizontally across what are otherwise apparent clonal barriers. This represents a very useful book that is well referenced enabling an entrée into the field and a timely reminder that the genome sequence of one isolate does not represent the full potential for genetic diversity within a given species.

■ **Chris Dowson**
University of Warwick

Molecular Genetic Epidemiology – A Laboratory Perspective. Principles and Practice Series

Edited by I.N.M. Day
Published by Springer-Verlag (2002)
Euro 49.95/SFr83.00/£35.00/
US\$54.95, pp. 214
ISBN: 3-540-41387-1

This book provides an overview of high throughput systems for molecular genetic studies of population samples. As such it provides a grounding for those who are already comfortable with the principles of molecular genetics. The book is cleverly written by authors who are clearly leaders in their field. However, the reader may feel overwhelmed by the opening chapter, which deals with the statistics involved in population genetics. Basics such as the collection, storage and management of DNA banks, which are extremely valuable resources in this post-genomic era, are covered well. Cutting edge technologies such as DNA fingerprinting and microplate arrays are described in plain

English and valuable advice for their implementation is provided that I have never seen brought together into a single volume before. This useful book would be well placed on the shelf in any laboratory conducting large-scale population genetics research.

■ **William G MacKay**
*Yorkhill Hospitals,
University of Glasgow*

Medicinal Plants: Culture, Utilization and Phytopharmacology

By T.S.C. Li
Published by Technomic (2000)
£104.00/Euro 182.00, pp. 517
ISBN: 1-56676-903-5

This is a comprehensive and well-structured reference book that would be extremely useful for anyone working with or interested in medicinal plants. Each chapter presents data for more than 400 species using a very clear table format arranged in alphabetical order by the scientific name followed by the common name. It includes current information on the major constituents and medicinal values of medicinal herbs. Microbiologists will appreciate the excellent section on the major diseases found in medicinal plants.

■ **Daniel Burdass**
*SGM, Marlborough
House*

Harmful Marine Dinoflagellates

M.A. Faust & R.A. Gullledge
Published by ETI Information Services Ltd (2002)
Euro 49.00/£29.95, CD-ROM
ISBN: 90-75000-21-9

In addition to being one of the most species-rich groups of flagellate protists, the dinoflagellates also include many toxin-producing forms. This CD-ROM is an authoritative and detailed multimedia guide to some 50 dinoflagellates which are capable of releasing various kinds of toxins in the environment, or are otherwise noxious in some other way. There is a wealth of information on taxonomy, nomenclature, morphology,

ecology and distribution, all of which is presented in a very user-friendly format. There is also a remarkable identification guide, which overcomes the notorious difficulties associated with traditional dichotomous keys by working in a 'bottom-up' rather than 'top-down' fashion. This key prompts the user for those characters which are effectively visible in the specimen to be identified, rather than listing the whole set of characters which are necessary for identifying any given species (many of which are never actually seen by the observer!). The language is very intelligible and clear throughout the guide, and there is little in the way of jargon. The quality of the illustrations is also very high. Overall I think that this is a truly excellent piece of work, and very good value for money too. I strongly recommend it to the novice and the expert alike.

■ **Gianfranco Novarino**
*The Natural History
Museum, London*

Encyclopedia of Arthropod-transmitted Infections of Man and Domesticated Animals

Edited by M.W. Service.
Advisers: R.W. Ashford,
C.H. Calisher, B.F. Eldridge,
T.W. Jones & G. Wyatt
Published by CABI Publishing (2001)
£99.50/US\$185.00, pp. 608
ISBN: 0-85199-473-3

This book succeeds in presenting in a single, compact volume basic information on a broad range of arthropod-transmitted infectious diseases. Bacterial, viral, rickettsial, spirochaetal, protozoan and nematode infections of both humans and domesticated livestock are included, as are separate entries for different categories of biting arthropod, such as mosquitoes, midges, lice and ticks. This prevents unnecessary repetition of classification, vector biology and control for named infections. The focus is on the management of disease, from diagnosis to treatment. Each A-Z entry is

aimed at a generalist readership, but with an appropriate specialist bibliography. Although this book will find its principal use in a clinical and veterinary teaching context, at both undergraduate and postgraduate levels, research scientists in microbiology, parasitology and tropical medicine should also consider it a valuable reference text. The price may dissuade many from making a personal purchase but a recommendation to your institutional library is entirely appropriate.

■ **Andrew Taylor-Robinson**
University of Leeds

Things Come to Life: Spontaneous Generation Revisited

By H. Harris
Published by Oxford University Press (2002)
H/B £20.00, pp. 256
ISBN: 0-19-851538-3

Science and common sense rarely cohabit comfortably. For is it not glaringly obvious that the sun and moon rotate round the earth? That the world is flat? That mud generates frogs, or that decaying flesh produces flies? Such ideas die hard indeed, and among the most resilient historically was the belief that living things arise from inanimate matter. Philosophers, savants, even theologians, had problems with mediaeval political

correctness: to challenge spontaneous generation seemed to challenge divine creation – yet to admit it would trivialize such creation. Later, air-borne microbes, unrecognized, fouled up even the most meticulous experimental tests. Another problem was human obduracy: the conclusive demolition work of Pasteur and Tyndall, etc., was still being questioned in the early 20th century. Harris's fluent account is short, scholarly and highly entertaining – and carries a clear moral for today's researchers and teachers: *nullius in verba*.

■ **John Postgate**
University of Sussex

Candida and Candidiasis

Edited by R.A. Calderone
Published by ASM Press (2001)
US\$99.95, pp. 472
ISBN: 1-55581-212-0

As with many other areas of microbiology, research on *Candida* and candidiasis has advanced in leaps and bounds over the last 15–20 years. This book, edited by Richard Calderone and containing chapters by more than 40 leading experts, admirably satisfies the need for an authoritative account of current knowledge in the field. There are seven sections which deal with topics such as *Candida* biology, genomics, virulence, and immunity, as well as superficial

and systemic diseases, diagnostics and treatment. The book will inevitably be compared with the landmark monograph by Frank Odds which has long been relied upon as a compendium of information on *Candida*. However, recent progress in *Candida* molecular biology is such that, for example, 6 pages on genetics in the second edition of Odds' text (published in 1988) have evolved into 4 chapters on genomics in this new volume. Calderone's book can be recommended as a worthy successor; it will serve as an essential reference for everyone involved in *Candida* research and will also provide invaluable reading for all with an interest in medical mycology.

■ **Julia Douglas**
University of Glasgow

Immunotherapy for Infectious Diseases

Edited by J.M. Jacobson
Published by Humana Press (2002)
US\$125.00, pp. 333
ISBN: 0-89603-669-3

The information provided in this book is wide-ranging and very complex. Chapters on principles of immunity are followed by reviews on the production of monoclonal antibodies (including 'humanized' chimaeras), immune cells and various types of therapeutic vaccines and their application to a number of viral infections (particularly HIV disease), bacterial sepsis and fungal infections.

The Editor states that immunotherapy has a place where other treatments like antimicrobial chemotherapy fail. However, for HIV and other viral infections, the true correlates of protection are not fully understood, and success of therapeutic antibodies or vaccines has been limited. On the other hand, intensive antiviral chemotherapy (e.g. HAART for HIV disease), has the effect of immune reconstitution. For non-viral infections, the extent of chemotherapy by far outweighs that of immunotherapy. Chapters on preventative vaccines and gene therapy sit uncomfortably

in the context and are too short. Whilst theoretical aspects of immunotherapy are reviewed well, the balance of immunotherapy and chemotherapy in clinical practice is not optimally presented.

■ **Ulrich Desselberger**
Addenbrooke's Hospital,
Cambridge

Dictionary of Microbiology and Molecular Biology, 3rd Edition

By P. Singleton & D. Sainsbury
Published by John Wiley & Sons Ltd (2002)
£45.00, pp. 908
ISBN: 0-471-49064-4

This third edition, like the two before it, is still a useful reference book for students, and may be useful to others for the occasional dip into. Containing background information and references for further reading, it is a comprehensive tool for introducing oneself to subjects not covered by individual textbooks. However, I would think that much similar information, and indeed more up-to-date facts and figures could be dug up using a quick search on the Internet.

■ **Tracey Duncombe**
Institute for Animal Health, Compton

Molecular Biology of Fungal Development. Mycology Series, Vol. 15

Edited by H.D. Osiewacz
Published by Marcel Dekker, Inc (2002)
US\$195.00, pp. 607
ISBN: 0-8247-0744-3

This book is a welcome addition to the list of mycology texts. The book's title provides both its attraction and problem. It is an attraction because fungal development is interesting and, despite increasing knowledge, there remains much to learn. The problem is that a comprehensive coverage is not possible in one volume and the Editor has necessarily been selective. I liked the key division of the book into

two sections: basic developmental biology and the interaction of fungi with different hosts. In the latter section, a contribution on lichens would have been appropriate, but perhaps the Editor considered the available molecular data to be too sparse. Our understanding of fungal development will be enhanced by the emergence of genome sequence data from several fungal species, permitting more global analyses of the molecular basis of development. So, read the book with enjoyment now, but look forward to a revised version in a few years.

■ **David Archer**
University of Nottingham

Compendium of Cotton Diseases, Second Edition

Edited by T.L. Kirkpatrick & C.S. Rothrock
Published by APS Press (2001)
US\$49.00, pp. 104
ISBN: 0-89054-279-1

This is a substantial update on the first edition. As with other publications in the APS Press series, the *Compendium of Cotton Diseases* provides practical and up-to-date information on diagnosis and control. There are expanded sections detailing pathogens, disease cycles and control measures, and a helpful introductory section on the host's origin and development with a brief but informative section on crop losses. The inclusion of abiotic disorders is also beneficial. Although there are substantially more colour photographs than the first edition, they are located in the central pages and separated from the related text. This is hardly a major criticism, but it is not ideal flicking backwards and forwards between the text and photographs. In essence this is a book targeted towards growers, researchers and extension workers. If you are working on disorders of cotton it's invaluable; if not it would only be of marginal interest.

■ **Gerry Saddler**
Scottish Agricultural Science Agency,
Edinburgh

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Irradiation for Food Safety and Quality

Edited by P. Loaharanu & P. Thomas
Published by Technomic (2001)
£82.00, pp. 216
ISBN: 1-58716-081-1

This book makes a valuable addition to the wide range of publications already available on the subject of food irradiation with contributions being made from many world-leading experts in this field of food processing technology. It summarizes the proceedings of an international conference on 'Ensuring the Safety and Quality Control of Food through Radiation Processing' convened by FAO, IAEA and WHO. The book is mainly concerned with the legal and economic implications of food irradiation, its role in the prevention of food-borne illness, usefulness as a phytosanitary treatment and in the control of post-harvest losses of grain, fruits and vegetables. Consumer attitude in the US to this 'controversial at times' food processing technology is also addressed. The book is of benefit to those with an interest in learning more about food irradiation, especially people within the food industry and consumer organizations. It is certainly suitable for purchase by well-funded libraries as it provides the results of many years of research on food irradiation in a readable, succinct fashion.

■ **Eileen Stewart**
The Queen's University of Belfast

Gut Ecology

By A. L. Hart, A. J. Stagg, H. Graffner, H. Glise, P. Falk & M. A. Kamm
Published by Martin Dunitz Ltd (2002)
£29.95, pp. 160
ISBN: 1-84184-139-0

Gut Ecology is a concise textbook that manages to cover many aspects of the gut in its 160 pages. It provides superior coverage of the human gut, and rodent models, but contains no information on other gut

ecosystems. The short chapters range from general overviews of the gut microflora, immunology of the gut, and pre- and probiotics, to more specialized chapters on specific gut diseases and defensins. Inevitably some subject areas are not covered, e.g. antibiotic resistance and gene transfer. One criticism of the book is the lack of figures and tables throughout. Additionally, I felt that the 'end of part' summaries were unnecessary, and that the space may have been better spent on another chapter or two. The book will be of particular interest to final year undergraduates and postgraduates embarking on MSc or PhD studies in a related field.

■ **Derry K. Mercer**
Rowett Research Institute, Aberdeen

The Rise of Experimental Biology. An Illustrated History

By P.L. Lutz
Published by Humana Press (2002)
H/B US\$59.50, pp.216
ISBN: 0-89603-835-1

This book may look like a coffee table ephemeron, but it is in fact an erudite and entertaining gallop through the history of experimental biology, from cave paintings to the present day. In Ancient Egypt, classical Greece, Christendom and under Islam, religious ritual and myth have underpinned bursts of growth in biological knowledge, only to stultify them later with magic, mysticism or dogma. In Western Europe experimental biology revived, with religious blessing, in the renaissance, only to clash with both religion and romanticism during the Enlightenment; today it is under assault again, from fundamentalism, New Age romanticism and post-modern gobbledegook. Lutz's melancholy but ultimately uplifting tale is rendered fascinating by judicious illustrations and examples, some comic, some gruesome. Despite a startling assertion (p. 108) that Malpighi, not Leeuwenhoek, first observed microbes (a publication error which, I learn, an erratum will amend), I strongly commend

it to students, teachers and researchers.

■ **John Postgate**
University of Sussex

Antibodies in Viral Infection. Current Topics in Microbiology and Immunology, Vol. 260

Edited by D.R. Burton
Published by Springer (2001)
DM198.91/sFr171.20/£68.50/
US\$115.00, pp. 309
ISBN: 3-540-41611-0

This is a volume in the series *Current Topics in Microbiology and Immunology*, of which I am a fan. It consists of relatively short, but highly focussed reviews by experts, and is therefore both readable and up to date. For a while the world view was that T cell responses were all you needed for immunity to viruses and all the antibody made is a bit of a physiological extravagance. This book makes me think the paradigm is changed. It includes chapters on molecular and structural interactions between neutralizing antibodies and viruses which are interesting but hardly explain neutralization to my mind, reviews of the very difficult topic of mechanisms of virus neutralization, and finally real situations, including the function of antibodies in disease, the mucosal immune system and complement pathways and how things might be improved on. The range is wide and well covered. I recommend this volume.

■ **Philip Minor**
NIBSC, South Mimms

Molecular Biology and Pathogenicity of Mycoplasmas

Edited by S. Razin & R. Herrmann
Published by Kluwer Academic/Plenum Publishers (2002)
US\$125.00/£87.50/Euro 144.00, pp. 588
ISBN: 0-306-47287-2

There is a general dearth of publications concerning mycoplasmas, and if only for that reason this book is to be recommended. However, whilst it

is fairly detailed and offers good coverage of many aspects of mycoplasma pathogenesis and molecular biology, it suffers from inconsistent coverage. To some degree this is inevitable for a multi-authored book of this type; each chapter tends to be written as a self-contained unit detailing the author's own area of expertise and interest, and it therefore suffers in comparison to a properly planned textbook. Most of the material is there; however, gaps do exist, whilst there is excessive duplication across several chapters in other areas (most noticeably phylogeny and a discussion of the most important human pathogen, *M. pneumoniae*). The advantage is that the material is very up-to-date. Not an easy undergraduate read, but highly informative nonetheless, and ideal as a reference book.

■ **John March**
Moredu Research Institute, Penicuik, Scotland

The Enterococci: Pathogenesis, Molecular Biology, and Antibiotic Resistance

Edited by M.S. Gilmore.
Associate Editors: D.B. Clewell, P. Courvalin, G.M. Dunny, B.E. Murray & L.B. Rice
Published by ASM Press (2002)
US\$115.95, pp. 440
ISBN: 1-55581-234-1

In 1990 ASM published an authoritative review entitled *The Life and Times of the Enterococcus* and in many ways *The Enterococci* represents an updated and greatly expanded version of this earlier work. It too is authoritative, very easy to read, well-referenced, and up-to-date e.g. the *vat(E)* and *vanG* resistance genes are mentioned, as is the variant *esp* virulence-associated gene of *E. faecium*. The book is readily accessible to anyone with an interest in microbiology, and it should be essential reading for all engaged in research on this fascinating genus. Criticisms are few and minor. The shortest chapter is, frustratingly, that which discusses the *E. faecalis* genome

sequence, and it does not mention the *E. faecium* project. The latter was found, after some searching, in other chapters, thereby highlighting that cross-referencing between chapters is not as complete as it might be. An excellent volume destined to become tattered through frequent use.

■ **Neil Woodford**
Antibiotic Resistance Monitoring & Reference Laboratory, CPHL, London

Rapid Cycle Real-Time PCR - Methods and Applications. Microbiology and Food Analysis

Edited by U. Reischl, C. Wittwer & F. Cockerill
Published by Springer (2002)
Euro 42.95/SFr71.50/£30.00/
US\$48.00, pp.258
ISBN: 3-540-41881-4

This book comprises clearly described and tested routine diagnostic protocols for the LightCycler, an instrument that combines rapid cycle PCR with real-time fluorescent monitoring. The book is not intended as a comprehensive guide to every real-time PCR assay a diagnostic laboratory might want to run, but it should provide clear information to diagnostic laboratory professionals who are considering applying these types of assays for routine use, especially if they have access to a LightCycler. The logically laid out tables of reaction conditions and oligonucleotide sequences, the screen shots used throughout and comments given make it easier for those seeking to adopt any of these assays. Anyone with an interest in diagnostic real-time PCR may increase their understanding of what factors should be considered when designing their own assays for diagnostic use and what level of performance to expect from these techniques in comparison to more traditional diagnostic methods.

■ **Chantelle Ward**
GlaxoSmithKline, Stevenage

Meningococcal Disease: Methods and Protocols. Methods in Molecular Medicine, Vol. 67

Edited by A.J. Pollard & M.C.J. Maiden
Published by Humana Press (2001)
US\$145.00, pp. 721
ISBN: 0-89603-849-1

This is a comprehensive and detailed set of, mostly, laboratory protocols useful not only in studies of meningococcal disease and *Neisseria* species, but also for many other bacterial pathogens. My only reservation is that the order of contributions is rather haphazard, ranging from an overview of population biology, epidemiological management considerations, through clinical and diagnostic methods, to basic molecular biology and models of virulence, in no apparent logical order. The contributors are generally highly regarded experts in their fields and they provide authoritative background information as well as a very useful selection of methodologies, covered in a total of 40 separate contributions. The book will therefore be valuable to workers in the field as well as in many other studies of bacterial pathogens and I recommend it very highly for researchers at all levels. It may be a little expensive for the average personal purchaser, but is well worth considering.

■ **Charles Penn**
University of Birmingham

Medically Important Fungi: A Guide to Identification, 4th Edition

By D.H. Larone
Published by ASM Press (2002)
US\$79.95, pp. 410
ISBN: 1-55581-172-8

This is a book for practitioners! Identification of micro-fungi is never easy. However, the precise descriptions of morphology and colony characteristics, the clear diagrams and associated black and white photographs of

individual fungal species, all make *Medically Important Fungi* an invaluable resource for the expert mycologist, as well as for those less experienced in fungal identification. Descriptions are given in unambiguous language, with a lack of mycological jargon, which can so often cause confusion; for example, *Tinea versicolor* is described as having a 'spaghetti and meatball' appearance. The new section of high quality colour plates is a valuable addition to the previous edition, as is the information on microscopic examination of specimens, which is particularly helpful. *Medically Important Fungi* is a user-friendly text and should be kept in the laboratory beside the microscope of everyone involved in identifying pathogenic fungi.

■ **Alistair R. McCracken**
The Queen's University of Belfast

Tropical Mycology, Vol. 1: Macromycetes and Tropical Mycology, Vol. 2: Micromycetes

Edited by R. Watling, J.C. Frankland, A.M. Ainsworth, S. Isaac & C.H. Robinson
Published by CABI Publishing (2002)
Vol. 1: £40.00/US\$75.00, pp. 208
ISBN: 0-85199-542-X
Vol. 2: £40.00/US\$75.00, pp. 224
ISBN: 0-85199-543-8

The above volumes are based upon papers presented at a British Mycological Society symposium held at Liverpool John Moores University in April 2000. However, to broaden this survey of tropical fungi, additional contributions were invited. Given that less than 5% of the 1.5 million species of fungi thought to exist have been identified, with most of the 'missing' fungi likely to be found in the tropics, it is commendable that this meeting was held and its proceedings published. The first volume focuses on macroscopic fungi found in the tropics and covers ectomycorrhiza formed by basidiomycetes, wood-degrading basidiomycetes, the collection of mushrooms as a

food source and aspects of the rapidly expanding commercial production of a range of mushrooms. My favourite chapter in this volume describes laboratory studies of a (basidiomycete) fungal garden cultivated by attine ants. The second volume focuses on microfungi found in the tropics and covers traditional systematics, relationships with plants, tropical lichens, diseases of invertebrates caused by fungi, and mycoses of man. Here, my favourite chapter assesses the potential value of tropical fungi to the pharmaceutical industry. It is clear that in the future much will be learned about the novelty and phylogeography of tropical fungi by the application of molecular techniques, which have not been used in the studies reported in the present volumes. Hopefully, this will be the focus of the next BMS symposium volume on this very important topic.

■ **Tony Trinci**
University of Manchester

Matthews' Plant Virology, Fourth Edition

By R. Hull
Published by Academic Press (2002)
£59.95, pp. 1,001
ISBN: 0-12-361160-1

This is the classic text in plant virology, appearing as new editions every 10 years. The first three were written by Dick Matthews, and now that he is sadly no longer with us, the fourth has been produced by Roger Hull. He has continued the high standards and comprehensive coverage of the book. Plant virology has developed enormously over the last decade with new insights from sequencing, transgenic plants and gene silencing, and welcome progress in the rationalization of virus taxonomy. These factors are reflected in a radical restructuring of the 4th edition; parts of the text of the 3rd edition can be tracked down, but they are few. The book is strong in its coverage of recent developments. The number of

references has risen from 3,000 to 4,500. This is a book for the advanced student and researcher. The encyclopaedic treatment means that it will be read more on a chapter-by-chapter basis than cover-to-cover. This is helped by extensive cross-referencing between chapters. Refreshingly, the book is excellent value for money, although this has inevitably led to some economies in production standards by the publishers.

■ **Ron Fraser**
SGM, Marlborough House

Lentiviral Vectors. Current Topics in Microbiology & Immunology, Vol. 261

Edited by D. Trono
Published by Springer (2002)
Euro 99.95/SFr165.50/£70.00/
US\$109.00, pp. 258
ISBN: 3-540-42190-4

The efficiency by which viruses infect their host cells has stimulated considerable interest in their exploitation for gene therapy. Lentiviruses have great potential in this regard since they are able to infect a wide variety of cell types, both proliferating and terminally differentiated, and mediate long-term gene expression by integrating their genomes into the chromosomes of their host cells. This book is written by respected researchers in the field and describes the development and potential uses of human, simian and non-primate lentiviruses. Their basic molecular biology is described in detail as are the issues of vector scale-up, targeting and safety. The potential applications of lentivirus vectors to treatment of HIV disease, as well as disorders of the CNS and lympho-haematological systems are also described. This book is very specialized and is likely to be of most interest to those who already have considerable experience with viral vectors.

■ **Chris Ring**
Glaxo SmithKline R&D, Stevenage

Yeasts of the World: Morphology, Physiology, Sequences and Identification

By T. Boekhout, V. Robert, M. Th. Smith, J. Stalpers, D. Yarrow, P. Boer, G. Gijswijt, C. P. Kurtzman, J. W. Fell, E. Guého, J. Guillot & I. Roberts
Published by ETI Information Services Ltd (2002)
Euro 95.00/£59.95, CD-ROM
ISBN: 90-75000-47-2

This CD-ROM on yeast taxonomy and biodiversity (part of a bigger Dutch project) requires a PC with a modern specification. Written by many of the world's leading experts, it is well designed, much cheaper (and lighter) than the recent corresponding books, has lots of sequence data and is easy to use, with extensive hyperlinks. I have a few quibbles; there is no search function, the CBS type strain list is by number and is not cross-referenced in the species descriptions; you can copy images but not the rDNA sequences or the excellent texts, and there are no phylogenetic trees. Disappointingly, molecular identification methods (e.g. RFLPs) don't feature and there is no means of adding new species to the database (and no mention of updates). Excellent for all labs that work on yeasts rather than 'yeast'. I look forward to the next version with an interface to a maintained web database.

■ **Alan Wheals**
University of Bath

Books received

Manual of Clinical Laboratory Immunology, Sixth Edition

Edited by N.R. Rose, R.G. Hamilton & B. Detrick
Published by American Society for Microbiology (2002)
US\$139.95, pp. 1,348
ISBN: 1-55581-215-5

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Comment

Fighting infection – the creation of a new UK Health Protection Agency

SGM Professional Affairs Officer Geoffrey Schild takes a look at the new UK government strategy to combat infectious disease.

● The Challenge of Infectious Disease

'At the beginning of the 21st century infectious diseases remain a major global threat to health, prosperity and security', according to the Chief Medical Officer's report *Getting Ahead of the Curve*. The World Health Organization (WHO) estimates that infections account for 40% of total global disease with, in particular, HIV/AIDS, malaria and TB responsible for rapidly growing disability and mortality which is especially devastating in poorer countries. But infections continue to present a serious problem in developed countries, despite sophisticated health care provision, availability of antibiotics and well managed vaccination programmes. In the UK infections are said to account for some 70,000 deaths annually and 40% of all medical consultations.

Infections are unpredictable. At least 30 new human pathogens have emerged in recent decades, many from animal sources. Infections transmitted by food and water and blood still cause concern, although safety standards have greatly improved. Hospital-acquired infection is increasing rapidly, often involving antimicrobial-resistant organisms. In itself, microbial resistance to antibiotics is a serious public health problem.

Vaccination is one of the great success stories of modern medicine, yet much research is still needed to develop new vaccines. Added to natural sources of infection, we now live in fear of the deliberate release of pathogens and other forms of bioterrorism.

● The Health Protection Agency

Given the above scenario, the challenge of combating infectious disease is clearly enormous and justifies a new approach involving many different areas of expertise. The UK has opted to set up the Health Protection Agency (HPA) which will be responsible for protecting the public not only against infectious disease, but also radiation and chemical hazards. In my view this is a bold and timely response to the challenges which lie ahead.

The HPA will be formed from four existing institutions, the Public Health Laboratory Service (PHLS), the Centre for Applied Microbiology and Research (CAMR), the National Radiological Protection Board (NRPB), and the National Focus for Chemical Incidents (NFCI). I believe the proposed structure is a rational one in which the individual expertise of the component parts will be complementary and enable the provision of a cohesive, integrated and multidisciplinary approach.

It is also proposed that the HPA working with the National Health Service (NHS) and local authorities will provide a local health protection service in relation to infection and other hazards. A strengthened and extended system of infectious disease surveillance will integrate information on human and animal infections and from environmental monitoring. Rationalization of

the microbiology laboratory network is envisioned with the introduction of standards for diagnosis and genetic profiling of micro-organisms.

The development of new and improved vaccines will sit alongside a strengthened programme of innovation and research in other HPA areas.

The PHLS, established in WWII to deal with infectious disease emergencies, was the first in the world to develop a national network of microbiology laboratories. This has been of great value in the diagnosis, surveillance and epidemiology of infection. The PHLS comprises the Central Public Health Laboratory (CPHL) and Communicable Diseases Surveillance Centre (CDSC) at Colindale and other specialized reference laboratories as well as a network of local microbiology laboratories. It is proposed that CPHL, CDSC and several reference laboratories will merge into HPA. While several of the local laboratories will transfer to NHS trusts, at least one in each region will be retained within HPA. The partial disbandment of the PHLS network is causing concern and the new structure must not reduce the effectiveness of surveillance, diagnosis and epidemiological investigation. Intensive discussions between PHLS, the Department of Health and others are currently ongoing. The timescale for the formal establishment of HPA, by April 2003, is short and demanding. Will there be adequate time for consultation and the complex reorganization envisaged? The report mentions little in respect of international collaboration. It is critically important that the Agency develops close working relationships with WHO and the European Union, as well as major bodies such as CDC and NIH in the USA. HPA will also have a major role in co-ordinating national efforts to fight bioterrorism. It must provide training in respect of recognition and handling of bioterrorism agents.

The success of the new strategy for the control of infection is heavily dependant on the availability of well-trained microbiologists in clinical and laboratory settings. UK Academy of Medical Sciences reports have expressed great anxiety about the shortage of microbiologists in general and the serious threat this presents for the future of clinical bacteriology and virology. The HPA may need to take urgent action to attract people into this field and to ensure that appropriate training is available.

The task of the HPA will be huge. The challenges will often be difficult and unpredictable. The Agency will require inspired management and a strong scientific basis for its work and access to specialized and high quality R&D programmes and, of course, adequate funding. It will also need to rely on firm government and ministerial commitment and support. We wish it well.

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● Please note that views expressed in *Comment* do not necessarily reflect official policy of the SGM Council.