

The PHYCOLOGIST



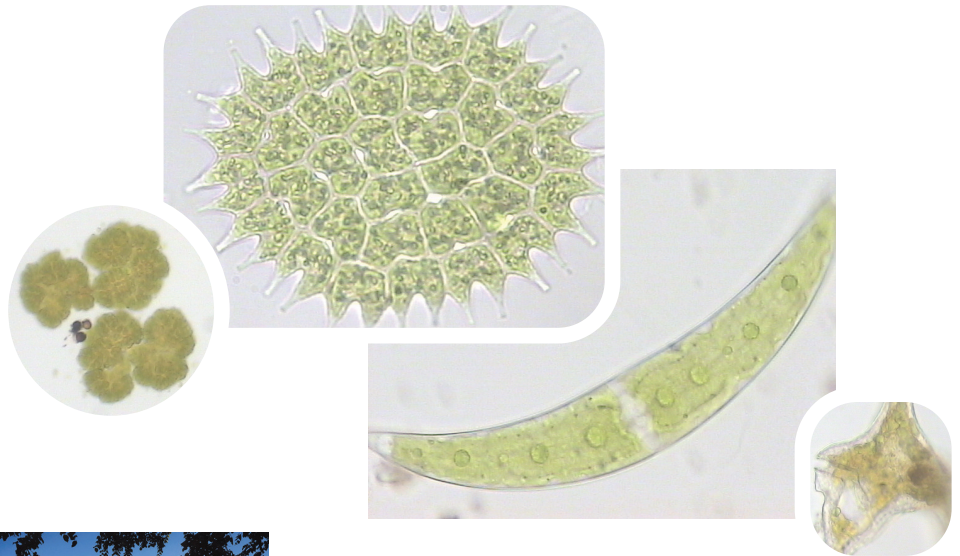
The Newsletter of the British Phycological Society

Editor: Dr Jan Krokowski

Homepage: <http://www.brphycsoc.org/>

Number 72

Spring 2007



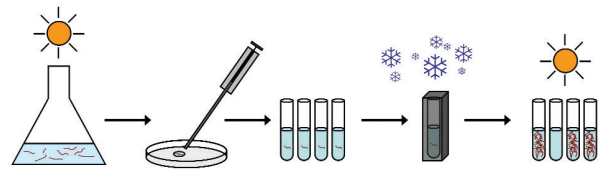
▲ Queens University Belfast,
Lanyon Building.

55th BPS ANNUAL MEETING Belfast, January 3-6, 2007



▲ Bloom of *Planktothrix rubescens*.

Manton Prize 2007



▲ 'The Winter's tale: survival of *Planktothrix rubescens* in Lake Zürich'.
Daryl P. Holland & Anthony E. Walsby.

2007 British Psychological Society

Council Officers (January to January)

President

Professor Geoffrey Codd (2007-2009)

President Elect

Dr Juliet Brodie (2007-2009)

Immediate Past President

Dr Mike D. Guiry (2007-2009)

Vice President Overseas

Professor Antonio Quesada (2007-2009)

*Secretary*¹

Dr Jackie D. Parry (2003-2009)

*Treasurer*²

Dr Michelle Tobin (2004-2009)

*Membership Secretary*³

Dr Sara Marsham (2007-2010)

*Editor of The Psychologist*⁴

Dr Jan Krokowski (2006-2009)

Webmaster

Professor Mike D. Guiry

Editors of the European Journal of Psychology

Dr Eileen Cox (2004-)/Dr John Day (2007-)

Ordinary Members of Council (3-year term of office)

Professor David Mann (2007-2010)
Dr Lydia King (2005-2008)
Professor John Anderson (2006-2009)
Dr Barry Leadbeater (2007-2009)

Dr Martha Clokie (2007-2010)
Dr Martin Wilkinson (2005-2008)
Professor Matt Dring (2007-2008)
Mr Sam Fielding⁵ (Student Rep. 2007-2009)

Dr Graham Underwood (2006-2009)
Dr Gill Malin (2006-2009)
Dr Thomas Proeschold (2007-2010)

Addresses

1. Dr Jackie D. Parry
Dept Biological Science
Lancaster University
Lancaster LA1 4YQ, UK
j.parry@lancaster.ac.uk
Tel: +44 (0)1524 593489

3. Dr Sara Marsham
Scarborough Centre for
Coastal Studies
University of Hull
Filey Road, Scarborough
YO11 3AZ, UK
s.marsham@hull.ac.uk
Tel: +44 (0) 1723 357223

5. Mr Sam Fielding
Earth & Ocean Science
University of Liverpool
4 Brownlow Street
Liverpool L69 3GP
s.r.fielding@liv.ac.uk
Tel: +44 (0)151 794 5201/5191

2. Dr Michelle Tobin
Scarborough Centre for Coastal Studies
University of Hull
Filey Road, Scarborough,
YO11 3AZ, UK
m.l.tobin@hull.ac.uk
Tel: +44 (0)1723 357290

4. Dr Jan Krokowski
Scottish Environment
Protection Agency
Redwood Crescent, Peel Park
East Kilbride G74 5PP
jan.krokowski@sepa.org.uk
Tel: +44 (0)1355 574200



Contents

The Phycologist - no. 72 Spring 2007

Editorial	
The 55th annual meeting of the BPS, Belfast, Oral abstracts	p. 4
The 55th annual meeting of the BPS, Belfast, Poster abstracts	p. 17
2007 Manton Prize and Poster Prize	p. 25
Student bursary award reports	p. 27
Annual report	p. 31
Statement of financial activities	p. 32
Announcements	p. 35
Costal soil algae	p. 36
Liverpool Algal Herbarium	p. 37
Obituary	p. 39
Instructions to Contributors	p. 40

Editorial

Welcome to another bumper spring edition! I'm sure those of us who attended the Belfast annual meeting in January would like to thank Matt, Christine and everyone at Belfast MBC and QUB for an exceptionally well arranged meeting, venue and hospitality. The meeting was very well attended with 105 delegates, and all symposia, particularly the Cyanofest were exceptionally well organised. The banquet and ceilidh on the last night was one to remember, or not as some of the photos might indicate - visit <http://www.brphycsoc.org/> to see for yourself. We also had a change to the Society's Council Officers in Belfast - in particular new President Geoffrey Codd, President Elect Juliet Brodie and Vice President Overseas Antonio Quesada. A big thanks to the Society's outgoing President Mike D. Guiry, who continues to be our Webmaster.

As is customary, the bumper spring edition contains details of the winter's meeting abstracts, posters, and Manton and Poster prize winner. A number of conference and summer bursaries have been awarded and reports are detailed from these. Please remember that application details for bursaries can be found at <http://www.brphycsoc.org/courses.lasso>. I hope you have all checked out your BPS membership account details on-line - it is extremely easy and simple to do - there you can also renew your membership. Further details can be obtained on-line and from our membership Secretary. Do remember to regularly visit the web site!

New Opportunities via BPS Membership of FEMS

As reported at the AGM at the 55th Winter Meeting in Belfast, the BPS is now a member of FEMS (the Federation of European Microbiological Societies). Alongside 46 other national societies in 36 countries throughout Europe, this presents BPS members with several potential benefits and opportunities. Details of the structure and activities of FEMS are available via the FEMS website: <http://www.fems-microbiology.org/website/nl/default.asp>, or simply Google FEMS. These include information on the FEMS Congresses, Events Calendar, jobs, member societies and, notably, available **Grants**.

Funding awards include:

- Fellowships
- Grants for organising/hosting meetings
- Grants for attending meetings

BPS members are encouraged to follow up these opportunities.

And finally please write to us with your phycological views, news, work events, or any matter you wish to share with readers of *The Phycologist*. **YOUR** input is required; all relevant material will be considered (job adverts, science reports, book reviews, news items of topical interest, meeting announcements, research news, and suggestions for future articles are always welcome). Without **YOU** the newsletter would not exist. Suggestions for discussion topics could include: ideas for making the Society more amenable to amateurs and applied scientists, ideas for additional training courses to encourage the amateur and applied members, or whether you would like to read about book reviews, or would you prefer to receive *The Phycologist* electronically rather than as a hard copy? Results from the 2003 questionnaire circulated to all members suggested that a large proportion of respondents were in favour of an electronic copy. That is not to say that hard copies would not be available, but could be sent to those that did not have easy access to computers, or those who specifically requested it. Do let us have your views.

As a reminder, previous issues of *The Phycologist* can be downloaded at:

<http://www.brphycsoc.org/phycologist.lasso>.

The 55th Annual Meeting of the BPS, Belfast

Oral Abstracts

PRESIDENTIAL LECTURE

The World's Seaweed Industry

Michael D. Guiry

National University of Ireland, Galway

The world's seaweed industry mirrors much of the rest of the world's industry in that most of production takes place in low-cost economies while much of the refining of seaweed and seaweed products takes place in developed economies with high costs. Production does take place in some developed countries, such as Japan, when the seaweeds have a high intrinsic value or are prized in some other way. Much of the traditional harvesting of seaweed in the European Union has ceased or is in the process of dying out, although collection for cosmetic and thalassotherapy applications are exceptions, as are developments in the sea-vegetable and nutritional areas. The main seaweeds being exploited in quantity worldwide are *Laminaria japonica* and a handful of other kelps; carrageenophytes (eucheumoids: *Kappaphycus*, *Betaphycus*; gigartinoids: *Chondrus*, *Mazzaella*, *Gigartina*); agar-producing seaweeds (*Gracilaria* and gelidioids); Nori (*Porphyra yezoensis* and a few other lavers); and those coralline algae referred to as maërl. Cultivation, in particular, is very labour intensive, and heavy competition in the food ingredient sector, married to cheap-and-cheerless food policies, mean that seaweed polysaccharides have a relatively low value. New applications for seaweed have been slow to develop, particularly in the area of natural products useful in the biotechnology and pharmacological industries. Where investment by government and industry has been generous and consistent, new applications, particularly at the high end of the market have been possible, but in most instances investment has been miserly, erratic and inconsistent.

CYANOFEST SYMPOSIUM

A natural history of the Burgundy-blood alga

Anthony E. Walsby

School of Biological Sciences, University of Bristol

In 1825 De Candolle discovered that the red colouration in certain Swiss lakes was caused not by the blood of Burgundian soldiers slain in the 1476 siege of Murten, but by aggregates of *Oscillatoria* (now *Planktothrix*) *rubescens*, which became known as the Burgunderblutalge. Ferdinand Schanz and I have studied the annual cycle of *P. rubescens* in Lake Zürich. In summer it stratifies in the metalimnion by regulating its buoyancy, avoiding losses by sinking to the hypolimnion or by exposure to high irradiances near the surface. Its biomass increases 100-fold in summer, exceeding all other phytoplankton. It grows phototrophically but Fritz Jüttner and I recently discovered it performs light-stimulated amino-acid uptake at very low irradiances. In autumn *P. rubescens* becomes entrained in the deepening epilimnion; in the decreasing irradiance it becomes overbuoyant and on calm days floats to the lake surface. During winter it circulates more deeply; Daryl Holland finds strains that survive 2 months of total darkness. When the lake restratifies in spring, survivors float back to the metalimnion; strains with stronger gas vesicles are selected; those in Lake Zürich are stronger than those from shallower lakes. Records of irradiance at each depth in the lake

and measurements of buoyancy change with irradiance, have been combined in computer models that explain the depth at which *P. rubescens* stratifies and why it floats up in autumn, forming the Burgundy-blood blooms.

Cyanobacterial Genes in Viruses

Martha R.J. Clokie

Department of Infection, Immunity and Inflammation, Maurice Shock Building, University of Leicester, Leicester, LE1 9HN, UK

Cyanobacteria are responsible for around one quarter of global carbon fixation. Phages which infect cyanobacteria (cyanophages) play a crucial role in cyanobacterial evolution, population dynamics and oceanic nutrient cycling.

The close physiological relationship between cyanophages and their hosts is highlighted by the large number of cyanobacterial genes that are found in bacteriophage genomes. The function of many phage acquired cyanobacterial gene products is not even known in their hosts. However, those which are understood include genes which encode proteins involved in cell surface architecture (e.g. an S-layer protein) nutrient acquisition (e.g. *phoH* involved with phosphate scavenging) and photosynthesis (e.g. *CpeT* which is involved in the construction of phycobilisomes).

Most striking perhaps, is the presence of photosystem genes *psbA* and *psbD* which encode for D1 and D2, the two proteins that form the major protein dimer at the heart of photosystem II where light energy is transformed into chemical energy. It has been established that photosynthesis genes are a common feature of cyanophage genomes and it appears that they have been acquired from their cyanobacterial hosts and have subsequently radiated within the cyanophage populations. *PsbA* and *psbD* are found in phages which infect marine *Synechococcus* and *Prochlorococcus* strains, and potentially in other cyanobacterial phages too as both genes occur in oceanic viral metagenome data sets. D1 is rapidly turned over in healthy plant and cyanobacterial cells, and turnover rate is even higher during light stress. To test the hypothesis that phages encode this gene in order to boost photosynthesis during the infection cycle I employed a model system, which uses the *psbA* and *psbD* containing myovirus S-PM2 to infect the marine *Synechococcus* strain WH7803. The transcript for the gene *psbA* is indeed highly expressed throughout the infection cycle and at the final time points more phage encoded *psbA* is present than that encoded by the host. These results imply that the S-PM2 does actively use these genes during infection.

The retention of cyanobacterial genes in phage genomes is most likely not accidental and an understanding of their function may help us reveal fundamental aspects of cyanobacterial physiology and ecology.

The above experiments were performed under optimal conditions of light intensity and nutrients. Such conditions are not typical in the oligotrophic regions of the oceans where *Synechococcus* and *Prochlorococcus* abound. Real-time PCR was used to test the level to which these genes were expressed under conditions of phosphate starvation. The results indicate that whereas phage structural and assembly genes were not expressed during conditions of phosphate depletion, the phage encoded *psbA* was expressed highly. We hope to be able to understand more about the ecological significance of phage encoded 'host genes' by studying their expression in a model system under simulated environmental conditions.



Cyanobacteria on valuable surfaces

Patrizia Albertano

Department of Biology, University of Rome "Tor Vergata", Italy

Biofilm-forming cyanobacteria colonize the stone surfaces of monuments and archaeological sites as well as in-door exposed-to-light lithic faces. In the latter case, sub-aerophytic epilithic species have developed inside ancient buildings and hypogea along light gradients found in proximity of entrances or at sites where lamps have been installed. The environment in which these biofilms have occurred are characterized by high relative humidity and also even water condensation on ceilings and walls, high carbon dioxide concentration and low air temperature variation, that favour the growth of sciaphilous cyanobacteria and associated bacteria, and to a lesser extent eukaryotic microalgae and mosses. Although diversity of these polymicrobial consortia is relatively low, a number of photoautotrophic and heterotrophic new taxa have so far been detected and described. The impact of this microbial growth on stone surfaces was examined using a variety of techniques, with special attention to the exopolymeric substances (EPS) that are secreted by cyanobacteria as they are crucial in the adhesion and cohesion of the community and any interactions with the environment. Heteropolysaccharides contribute the major fraction of the EPS-matrix of biofilms as well as the capsules and sheaths of phototrophic taxa. These polymers are rich in uronic acids and sulphated groups, which are thought to be responsible for cation removal from stone minerals and thus directly involved in the biomineralisation processes that damage lithic substrata.

Cyanobacterial symbioses

Dave G. Adams

University of Leeds

Cyanobacteria are a huge group of photosynthetic prokaryotes of enormous environmental importance. They form symbiotic associations with a wide range of eukaryotic hosts including plants, fungi, sponges and protists. The cyanobacterial symbionts are often filamentous and fix dinitrogen in specialised cells known as heterocysts, enabling them to provide the host with fixed nitrogen and, in the case of non-photosynthetic hosts, with fixed carbon. In return, the cyanobacteria receive fixed carbon from photosynthetic hosts and possibly protection from predation and from environmental extremes. The best studied cyanobacterial symbioses are those with plants, in which the symbionts are usually *Nostoc* spp. that gain entry to the host by means of specialised motile filaments known as hormogonia. The cyanobacteria can infect the roots, thallus, stems and leaves. In these symbioses, chemical signals released by the plant stimulate hormogonia formation and serve as chemoattractants to guide the hormogonia to the point of entry into the plant tissue. Once the cyanobacteria are inside the symbiotic cavity, host signals prevent further hormogonia formation and stimulate heterocyst development and dinitrogen fixation. The cyanobionts undergo morphological and physiological changes, including reduced growth rate and carbon dioxide fixation, enhanced dinitrogen fixation and release, to the plant, of much of the dinitrogen fixed. With advances in molecular genetic techniques for symbiotically competent cyanobacteria, the molecular basis of these changes is now being clarified.

Factors driving changes in the genetic structure of planktonic populations of cyanobacteria

Paul Hayes, Caroline Jenkins, Jacqueline Batley & Li Deng

School of Biological Sciences, University of Bristol

Contrary to initial expectations it has now been shown in a number of studies that populations of cyanobacteria are not clonal, but rather they comprise numerous distinct genotypes. At any given point in space and time it is usual to find that one or a few genotypes dominate the local population. In this presentation we describe the patterns of variability in population structure and speculate about those factors that could be driving successional change. These factors include the physico-chemical conditions within the water column, which are likely to be important in governing the onset and cessation of population development, and other biological components of the system, such as predators, parasites and competitors, that may influence the genotypic composition of the population.

Cyanobacterial buoyancy and bloom toxicity

Geoffrey A. Codd, Fiona M. Young, Marianne Reilly and James S. Metcalf

School of Life Sciences, University of Dundee

Bloom-and scum-forming planktonic cyanobacteria, including *Microcystis*, *Anabaena*, *Planktothrix*, *Aphanizomenon*, *Cylindrospermopsis*, *Nodularia* and *Trichodesmium* species, commonly produce a range of toxins. These include microcystins (MC), cylindrospermopsins (CYN), anatoxins (ANTX), nodularins (NODN) and saxitoxins (STX). They are among the most toxic of natural products in aquatic environments per unit weight. This paper considers the significance of cyanobacterial buoyancy regulation in influencing cyanobacterial toxicity. Does an obligate association between the production of gas vesicles and cyanotoxins exist? Apparently not, because: (a) examples of MC, ANTX, and STX production occur among benthic aquatic cyanobacteria e.g. *Phormidium* and *Lyngbya* spp.; (b) some gas-vacuolate planktonic genera e.g. *Gloetrichia* do not produce known cyanotoxins (other than lipopolysaccharide, LPS); (c) a wild-type, non-gas-vacuolate *Microcystis* strain produces the same range of about 10 MCs as a gas-vacuolate, but otherwise identical strain; (d) non-MC-producing deletion mutants of gas-vacuolate *Microcystis* and *Planktothrix* strains are available. The role of gas vesicles in concentrating cyanobacterial cell populations, e.g. as scums or sub-surface maxima, has long been recognised. Such phenomena, in both vertical and horizontal dimensions, can result in the increase in cyanotoxin concentrations by several orders of magnitude. Examples of the scaling-up of cyanotoxin concentrations and of associated risks to human and animal health are presented. Among the catalogue of potential bloom control options, proposals (sometimes dramatic) have occasionally been made to collapse their gas vesicles. This approach is currently undergoing a revival of sorts in several countries, using in-lake ultrasonication equipment, although its efficacy and implications regarding cyanotoxin fates require investigation.

Cyanobacteria and the evolution of chloroplasts

John A Raven, Birgitta Bergmann and Kayley Usher

University of Dundee at Scottish Crop Research Institute, University of Stockholm and University of Western Australia

The lecture reviews the origin of chloroplasts from cyanobacteria, with emphasis on some the cyanobacterial features retained by chloroplasts and those that were lost. Chloroplasts originate from a single evolutionary event (with one exception considered later) between an endosymbiotic cyanobacterium and a eukaryote. Chloroplasts subsequently spread among eukaryotes by secondary endosymbiosis. The chloroplast ancestor may have had a genome at the upper end of the size range for extant cyanobacteria, judging by the number of genes of cyanobacterial origin in the nuclear genome

of *Arabidopsis*, and so it could have been a heterocystous diazotroph. Most extant cyanobionts are capable of independent growth. In symbioses with eukaryotes, the cyanobiont contributes diazotrophy to photosynthetic eukaryotes, and phototrophy (often with diazotrophy) to chemoorganotrophic eukaryotes. If diazotrophy was a factor in establishing the symbiosis that ultimately led to chloroplasts, this character has been lost from the genomes of all extant chloroplast-containing eukaryotes. Other cyanobacterial characters absent from most photosynthetic eukaryotes include peptidoglycan between the chloroplast ('cyanelle') envelope membranes (only found in glaucocystophytes) and carboxysomes. Carboxysomes are possibly present in glaucocystophytes (and have been functionally replaced by pyrenoids in many algae). No chloroplasts have gas vesicles. The euglyphid (cercozoan) amoeba *Paulinella* has photosynthetic structures resembling the cyanelles of glaucocystophytes and which thus far have not proved amenable to independent culture. Molecular phylogenetic studies using the rDNA sequences from the 'cyanelle' genome show that these structures were derived from cyanobacteria independently of the 'real' chloroplasts.

CONTRIBUTED PAPERS - CYANOBACTERIA

Recurrent adenylation domain replacement in the microcystin synthetase gene cluster

David P. Fewer, Leo Rouhiainen, Jouni Jokela, Matti Wahlsten, Kati Laakso, Miikka Köykkä & Kaarina Sivonen

University of Helsinki, Finland

Cyanobacteria form toxic blooms in freshwater lakes and brackish waters throughout the world. Cyanobacterial blooms often contain microcystins. These are potent inhibitors of eukaryotic protein phosphatases 1 and 2A and are widely believed to have evolved in response to grazing pressure. Microcystins are synthesized by mixed polyketide synthases and non-ribosomal peptide synthetases. There are over 70 chemical variants of microcystin known. The two most common microcystin variants, microcystin-LR and -RR, are produced by a wide range of distantly related cyanobacteria. The simultaneous production of these two variants has been attributed either to a lack of specificity or to recombination leading to the replacement of the first adenylation domain in *mcyB*. Here we undertake a phylogenetic study to investigate the order and timing of recombination between *mcyB* and *mcyC* in the microcystin synthetase gene cluster. Our results suggest that microcystin synthesis emerged early during the diversification of the eukaryotic lineage and predates the main members of zooplankton. However, we also found evidence that recent recombination has taken place between *mcyB* and *mcyC* in strains of the genera *Anabaena*, *Planktothrix*, *Nostoc*, *Microcystis*, *Hapalosiphon* and *Phormidium*. L-Leucine is incorporated into microcystin in all strains despite recombination leading to replacement of the first adenylation domain in *mcyB*. Our results suggest that a lack of substrate specificity is not enough to explain the simultaneous production of microcystin LR and RR.

Impact of variations in water availability on the photochemical capacity of cyanobacterial mats

Sarah McKeirnan, Deidre Edwards & Bruce Osborne

School of Biology and Environmental Science, University College Dublin, Ireland

Cyanobacterial-dominated microbial mats are a common feature

of a number of extreme environments, particularly those subjected to extreme water deficits. We have examined the impact of water deficits on the photochemical reactions of cyanobacterial mats collected from the Burren, Co Clare, Ireland, an area of often sparsely-vegetated limestone terrain, using a fluorescence-based approach. Despite the high rainfall associated with this region, periodic water deficits are common because of high evaporative and drainage losses, due to the physical characteristics of the limestone substrate. Cyanobacterial mats subjected to water deficits in the laboratory show environmental and morphologically-related differences in water loss and associated reductions in Fv/Fm. Despite reductions in water content of >30% full recovery of Fv/Fm often occurred within ~1 day after re-watering. Under some circumstances, however, re-hydration actually reduced Fv/Fm after a prolonged period of dehydration. There was also evidence that the response to water availability was related to the extent to which the mats had acclimated to laboratory conditions. Of the morphologies examined, the globular or ball forms appeared to be more resistant to water deficits than the flat or plate-like forms, either because of lower water losses and/or because of correlated increases in scytonemin pigmentation, based on spectral analyses. The functional significance of enhanced scytonemin production on photochemistry is, however, not known. These observations will be discussed in relation to the micro-habitats that cyanobacterial mats normally occupy in the Burren region.

Multiple chemical defence of *Microcystis* and *Planktothrix* against crustacean grazers

Friedrich Jüttner

University of Zürich, Switzerland

Microcystis and *Planktothrix* are dominating cyanobacteria in many eutrophic and mesotrophic lakes, respectively. The axenic strains *Microcystis* PCC 7806 and *Planktothrix rubescens* A7 were used as model organisms to study their chemical defence against *Eudiaptomus* and *Daphnia*. Four different types of experiments were performed: grazing experiments with solvent-treated cells from which specific constituents were removed, survival experiments of the grazers on purified compounds from both cyanobacteria which were added to the media, inhibition experiments with digestive enzymes isolated from crustacean grazers from different lakes and the ability of grazers to sense deterrents and repellents produced by the two cyanobacteria. Toxicity experiments were only positive for microcystins and the new crustacean specific toxin oscillapeptin J. Oligopeptides (cyclic peptides and depsipeptides) which are present in large numbers in both cyanobacteria turned out to be very potent inhibitors of an array of crustacean proteases (serine proteases and cysteine proteases). They affect the digestibility of the cyanobacteria when fed alone or in combination with high quality food. Taste and odour compounds produced by both cyanobacteria are signalling the infeasibility of *Microcystis* and *Planktothrix* as suitable food particles. Sensing of odour compounds was demonstrated with a camera system that allowed concomitant tracing of the swimming velocity of seven *Daphnia* in a cell. Calculations of the compound concentrations under realistic natural conditions allow the estimation of the effectiveness of the different defence mechanisms.

Thiol production by *Microcystis*: overlooked but potent metabolite with significant ecophysiological roles

Susan B. Watson & Friedrich Jüttner

Canada Centre for Inland Waters, Burlington, Canada & University of Zürich, Switzerland

Microcystis species produce sulphides, a sometimes significant



source of malodour. Although well documented in marine systems, little is known about freshwater photoautotrophic production of sulphides, which to date has been generally regarded as insignificant. However, the apparent increasing number of *Microcystis* blooms may in fact represent a significant source of these compounds in many inland waters. We investigated the physiology and cellular/ecological function of sulphide production by four axenic and non-axenic *Microcystis aeruginosa* strains. Using short-term incubations and an adapted Headspace-GC-MS technique, we found that isopropyl sulphides were of cyanobacterial in origin. More focussed studies with the axenic strain using different light regimes, metabolic inhibitors (sodium azide, DCMU), antioxidant enzymes (superoxide dismutase, catalase) and isotopically labelled precursors (hydrogencarbonate, acetate and sulphate) demonstrated that i) isopropyl thiol (ISH) is the initial cell product, with subsequent extracellular conversion to diisopropyl disulphide and trisulphide; ii) ISH is actively produced over the growth cycle, iii) is continuously excreted with no internal storage or post-lysis catalytic generation; iv) production occurs in both light and dark, increases up to an optimal light level and decreases significantly under very high irradiance; v) labelling patterns indicate ISH is synthesized via the acetate pathway. These experiments and related work using the two aquatic invertebrates *Thamnocephalus* and *Daphnia* indicate that isopropyl thiol plays several important physiological and ecological roles. It acts as an effective antioxidant against high levels of reactive oxygen species, particularly in surface blooms; it elicits avoidance-related behavioural responses in grazer communities and at high levels, can be toxic to some invertebrates.

MANTON PRIZE

Molecular, morphological and geographical investigations of the genus *Feldmannophycus*, a cryptogenic invader

F. Mineur¹, C.A. Maggs¹ & M. Verlaque²

¹School of Biological Sciences, Queen's University of Belfast, Belfast BT9 7BL, UK

²DIMAR, Centre d'Océanologie de Marseille, Luminy, France

Caulacanthus ustulatus is a common rocky shore species in southern Europe and the Mediterranean Sea. Reproductive organs, especially cystocarps, are extremely rare in the wild. Differences in the morphology of Mediterranean specimens led Feldmann to describe a new species, *C. rayssiae*. After the discovery of cystocarpic individuals, this species was later proposed as the type of a new genus, *Feldmannophycus*, which, until now, was believed to be present only in the western Mediterranean Sea. Our study shows clearly that the Asiatic strain of *C. ustulatus* introduced into Brittany is *F. rayssiae*, which is present in many Western European localities, sometimes alongside native *C. ustulatus*. We believe Mediterranean specimens are the result of an old introduction from the Pacific region.

Multivariate analyses of macroalgal assemblages in rockpools on the west coast of Ireland

Ciarán J. Loughnane & Dagmar B. Stengel

Department of Botany, Martin Ryan Institute, National University of Ireland, Galway, Ireland

As rockpools provide a refuge for marine organisms from the near-terrestrial conditions that are experienced on a rocky-intertidal shore at low-tide, they facilitate the extension of the upper distributional limits of several species of macroalgae. However, depending on shore level and the physical characteristics of the

rockpool, biodiversity and species abundances can fluctuate considerably. Rockpool species are exposed to variable and rapid fluctuations in physio-chemical parameters during a tidal cycle, including changes in salinity, temperature, gas concentrations; the degree of these fluctuations is mediated by the elevation of the rockpool above 0m MLWS, duration of emergence at low-tide, rockpool volume, surface area and overall depth. Due to the regular exposure to environmental change, rockpool algae may be expected to be tolerant of fluctuations in physico-chemical conditions, adapted to environmental change, and their physiological responses indicative of conditions in different categories of rockpools. Here, macroalgal abundances in 40 rockpools of varying shape, size and shore position from a semi-exposed rocky shore on the west coast of Ireland over 8 seasons were monitored and the seasonal and spatial fluctuations in biodiversity, abundance of species assemblages, and indicator species for different categories of rockpools were identified. Multivariate analyses (PRIMER) revealed that species diversity and dominance were not significantly affected by the physical characteristics rockpools and that elevation above 0m MLWS, surface area and depth were the most significant factors in the determination of macroalgal assemblages. Indicator species analysis identified characteristic species for different categories of rockpools, as defined by these environmental attributes.

Biomechanical variation in the kelp *Laminaria digitata* with wave and current activity

Jonathan Stewart, Graham Savidge & Fraser Buchanan

School of Biological Sciences and School of Mechanical and Aeronautical Engineering, Queen's University Belfast

One of the major predicted effects of climate change in Western Europe is an increase in the frequency and severity of storms. The larger storm waves are associated with a substantial increase in energy which may have major biomechanical implications for littoral and sublittoral organisms. A series of experiments were carried out to establish the relationship between biomechanical strength and degree of physical exposure to waves and currents in *Laminaria digitata*, a major macroalgal component of the upper sublittoral zone. Young's Modulus in both laminae and stipes of *L. digitata* was found using pull to break and pull to limit tests, respectively, in a tensometer. Results show that laminae from either high wave exposure or high current velocity or a combination of both conditions, have greater strength (higher Young's Modulus) than those from sheltered conditions. The Modulus increases along the frond from base to tip under all physical conditions. Stipe strength is similarly affected by wave and current conditions with stipes from high energy environments being stronger than those from sheltered environments. Thus *L. digitata* appears to adapt to ambient physical conditions, if climate change was slow it is possible the kelp would adapt to the new conditions. If however, the increased wave energy increased rapidly such that the resultant forces on the plants exceeded those in the experimental study the *L. digitata* population would be greatly reduced or even removed from the site.

Spectral irradiance, CDOM, and phytoplankton community composition in a blackwater-dominated estuary (Winyah Bay, SC, USA)

Evelyn Lawrenz & Tammi Richardson

University of South Carolina

Blackwater rivers supply large amounts of chromophoric dissolved organic material (CDOM) to their downstream estuaries. CDOM strongly absorbs light in the ultraviolet and visible range of the electromagnetic spectrum reducing the amount of

photosynthetic available radiation (PAR) for phytoplankton and altering the spectral quality of the available irradiance. Because phytoplankton groups vary in their pigment composition and thus their ability to utilize varying wavelengths of light, temporal and spatial changes in the concentration of CDOM may lead to alterations in the overall phytoplankton community composition. Our current research focuses on the dynamics and impacts of CDOM on phytoplankton communities in Winyah Bay, a coastal plain estuary on the south-eastern coast of the United States. We are examining relationships between phytoplankton community composition and spectral irradiance along an upstream (blackwater) to downstream (blue water) transect of Winyah Bay as well as temporal and spatial variability in these relationships.

Seaweeds and the man-made coastal environment; How we can manipulate concrete to control algal coverage?

Anne Marie Mahon¹, Christine Maggs¹, Mark Johnson¹ & M. Basheer²

¹ School of Biological Sciences and ² School of Planning, Architecture & Civil Engineering, Queens University Belfast

An increased pressure on coastal resources has resulted in a higher prevalence of concrete in the marine environment, creating and sometimes replacing coastal habitats. The aim of this project is to investigate how much the concrete mix design and surface texture can influence the resulting assemblages. Test blocks of four mixes of concrete: Micro-silica (MS), Ordinary Portland Cement (OPC), Slag and Rapid Hardening Cement (RH) were deployed and monitored for algal colonisation over an eight-month period. Test blocks of OPC with three surface finishes were also deployed during this period. Significant differences in algae coverage and species composition were found between the mixes with the highest percentage cover on MS and the lowest on OPC. Differences were also found among the different surface finishes with the roughest finish having the most coverage and the smoothest having significantly less. These differences are currently being investigated in terms of compressive strength, water sorptivity, surface roughness and surface pH of the test blocks.

What limits CO₂ assimilation in *Emiliania huxleyi*?

Richard Webster, Richard Geider & Christine Raines

University of Essex

The oceans play a major role in the global carbon cycle, with approximately 40% of the Earth's photosynthesis each year occurring in aquatic marine environments. Fossil fuel consumption is leading to higher atmospheric CO₂ levels and corresponding increases in the concentration of CO₂ in seawater. This increase in CO₂ may change the species composition of the phytoplankton community and the way in which organic carbon is cycled in the sea. *E. huxleyi* is a key photosynthetic organism in the oceans, exhibiting extensive blooms that can be detected from space by satellites. The growth rate of *E. huxleyi* is limited by inorganic carbon at current ambient atmospheric CO₂ levels, therefore this organism is likely to be a good indicator of the response of the ocean to rising CO₂. The aim of this project is to determine the factors affecting CO₂ assimilation in *E. huxleyi*, in response to light intensity and CO₂ concentration. As a first step towards this we have characterised the catalytic properties of the enzyme responsible for carbon dioxide fixation, ribulose biphosphate carboxylase oxygenase (RubisCO) purified from *E. huxleyi*. Preliminary photosynthesis measurements, made using a membrane inlet mass spectrometer, have shown that there is a difference between the photosynthetic responses of *E. huxleyi* at ambient and elevated CO₂ concentrations.

Sinking characteristics of phytoplankton

Daryl Holland & Anthony E. Walsby

School of Biological Sciences, University of Bristol, U.K.

A thorough understanding of the sinking characteristics of phytoplankton can explain how phytoplankton remain suspended or show vertical migration in natural waters. Although there is a well developed theory for simple shapes - the Stokes Equation - direct measurements are needed for complex shapes, some of which are adaptations that slow sedimentation. Phytoplankton cells, primarily owing to their small size, sink very slowly through water. This makes it difficult to measure their sinking velocities. We have developed an automated method of measuring sinking velocities by repeatedly scanning a density-stabilised sedimentation column with a laser beam and recording the forward scatter of sinking particles; the method gives results that show good agreement with theoretical values. Filamentous or long chain-forming phytoplankton sink at different velocities depending on their orientation. Theoretical and empirical values have been published for filaments oriented horizontally or vertically, but little is known about filaments sinking at oblique angles. We report on theoretical models that describe both the vertical and horizontal movement of filaments sinking at any angle. These theoretical values are compared with experimental results obtained by filming graphite rods sinking through a dense, viscous medium.

Co-operation between protozoa and phage in the digestion of freshwater picocyanobacteria

Mandy Dillon & Jackie Parry

University of Lancaster

Picocyanobacteria are important primary producers in freshwater environments yet their major predators have not to date, been elucidated. Our work has shown that these picocyanobacteria, specifically *Synechococcus* spp., are completely indigestible to a variety of single-celled protozoa, i.e. they pass straight through the protozoan cell and are egested apparently unharmed. In addition, virulent phage have yet to be isolated as it appears that the majority of phage active against freshwater *Synechococcus* is temperate. This means that their DNA is integrated within the genome of the host and host cell lysis is a rare event. However, during routine studies on the temperate phage it became clear that they could be induced into the lytic cycle, and hence lyse the *Synechococcus* host, under acidic conditions. A hypothesis was then proposed as to a possible way in which protozoa and temperate phage combine forces to digest these *Synechococcus* cells. This hypothesis states that *Synechococcus* cells containing temperate phage are ingested by protozoa and placed into food vacuoles. The acidification stage of the food vacuoles induces the temperate phage into the lytic cycle, resulting the ultimate lysis of the host cell. This paper examines the experimental evidence to support this hypothesis and addresses the possible benefits to the predators.

WATER MANAGEMENT ISSUES SYMPOSIUM

The development of seaweed-based tools to assess ecological quality for the EC Water Framework Directive

Martin Wilkinson, Emma Wells, Clare Scanlan, Jo Foden & Paul Wood

Heriot-Watt University, Edinburgh



The EC Water Framework Directive places a legal requirement on member states to use marine macrophytes, among other organisms, in quality assessment of both coastal and transitional (broadly estuarine) water bodies. Ideally both abundance and composition should be used but this may not always be scientifically valid or feasible. Problems in developing tools arise because there is not a long history of pollution control agencies monitoring seaweed communities to provide a large databank of pollutant effects on seaweeds, and there are few staff suitably qualified to work competently with seaweeds. The proposed use of species richness of intertidal seaweed communities on intertidal, open coast shores for the UK is discussed and compared with the approach for Greece based on Ecological Status Groups and for other countries based on quadrat recording and multivariate analysis. In estuaries a simpler qualitative criterion of the extent of upstream penetration by fucoid algae is proposed, but even a simple measure such as that can be complicated by differences between estuaries in the dominant fucoid species present. Whether dealing with estuaries or coastal waters a special problem arises owing to the abundance of opportunist mat-forming seaweeds, especially under conditions of nutrient enrichment, which can have serious ecosystem effects. Problems in the development of a tool for assessing such blooms will be reviewed.

The expected distribution of *Fucus vesiculosus* in the Bothnian Sea - does it agree or disagree with the actual distribution?

Charlotta Nygard

County Administrative Board, Harnosand, Sweden

The Baltic Sea is a species-poor ecosystem where marine species coexist with freshwater species, under conditions that are not ideal for any of them. The area offers low salinity levels, long cold winters, no tides and large pollution loads from its drainage area with 85 million people. One of the few marine species that can be found in the Baltic is the brown alga *Fucus vesiculosus*, which is regarded as ecologically the most important alga in this area, since many other species depend upon it for their own survival. During the last 2-3 decades, reports of reduction or even disappearance of *F. vesiculosus* in the Baltic Sea have been presented, making it urgent to study this species and to map its current distribution. The environmental condition of the Baltic Sea has reached a critical state and the Swedish Parliament has set environmental objectives to achieve 'a balanced marine environment, flourishing coastal areas and archipelagos', which include a sustainable productive capacity and preservation of the biological diversity of the Baltic Sea. The County Administration Office in northern Sweden (responsible for a great part of the Bothnian Sea) has tightened this objective even more to state that 'Before 2010, *F. vesiculosus* in the Bothnian Sea should grow to a depth of at least 7 m in all areas with a salinity >4psu.' *Fucus vesiculosus* in the Baltic differs in many ways to *F. vesiculosus* in the Atlantic, for example in morphology, photosynthesis, growth rate, depth distribution and tolerance to disturbance. By combining the physiological demands of *F. vesiculosus* in the Baltic with the physical conditions of the present seawater, an attempt is being made to map the predicted distribution of the species. This is being done using Geographical Information System (GIS), which has the capacity to filter and combine desired environmental factors. The predicted distribution of *F. vesiculosus* will be compared with actual results from field surveys to detect possible mismatches.

Off flavours in large waterbodies: Physics, Chemistry and Biology in synchrony

Susan B. Watson¹, M. Charlton¹, Y.R. Rao¹, T. Howell², J. Ridal³, B. Brownlee¹ & C. Marvin¹

¹*Aquatic Ecosystems Management Research, Canadian Centre for Inland Waters, Burlington ON, Canada*

²*Environmental Monitoring and Reporting, Ontario Ministry of the Environment, Toronto, ON, Canada*

³*Saint Lawrence River Institute of Environmental Sciences, Cornwall, ON Canada*

The Laurentian Great Lakes of North America are a drinking water source for some 24 million Canadian and US consumers. These lakes have undergone significant change over the past century as a result of widespread degradation and subsequent remediation. Many of the Lakes are prone to taste and odour (T&O) outbreaks, and although these events have, in general, been poorly characterized, evidence suggests that they are increasing in frequency. Tracing and controlling T&O in such large source-waters is a challenging task, due to their sheer physical size and complexity. This paper presents an overview of recent investigative and management approaches to T&O in Lake Ontario and the St. Lawrence River, which alone provide drinking water to the densest population base in Canada. We describe three distinct patterns of T&O in these source-waters, differing in their planktonic and benthic sources, chemistry and temporal and spatial dynamics. Each case has required a different scientific and management approach in partnership with the water industry. We show that these T&O outbreaks are caused and moderated by different physical, chemical and biological mechanisms over a spectrum of spatial and temporal scales. Canadian municipalities affected by these outbreaks have been key to the investigation of the links between T&O and ecosystem processes with the aim to develop more proactive water treatment and long-term management.

The phytoplankton of Loch Lomond, Scotland

Jan Krokowski

Scottish Environment Protection Agency, East Kilbride

A north-south trophic gradient is evident in Loch Lomond, Scotland, with highest in-loch nutrient concentrations in the southern basin compared to the north. Phytoplankton biomass and abundances were correspondingly higher in the southern than the northern basin, and were shown to be most strongly positively correlated to increasing surface water temperature (and potentially light intensity and duration) in both basins, rather than to nutrient concentrations. An increase in the trophic state of the loch is highlighted through increased abundance of certain diatom taxa indicative of nutrient enriched conditions. Fluctuations in the dominant phytoplankton of Loch Lomond will also be described.

USE AND ABUSE OF ALGAE SYMPOSIUM

Use of coralline algae in medical ceramics

Charmaine Blake, Lynn Browne, Pamela Walsh¹, Matthew Dring & Christine Maggs

School of Biological Sciences and ¹School of Mechanical and Aerospace Engineering, Queen's University Belfast

Queen's University Belfast are supplying coralline algae for use in medical ceramics under the EU funded Hippocrates program. We select various species of coralline algae, in particular *Corallina officinalis*, and transform them into hydroxyapatite/tricalcium phosphate (HA/TCP) ceramics. The HA/TCP retains the highly porous and interconnected structure of the original algal material,

which is compatible with bone. The ceramics are used to make scaffolds that are loaded with growth factors and used in tissue engineering. Algal species from temperate and sub-tropical localities are being investigated for their suitability. Growth rate, porosity, heavy metal content and internal structure of source algal material, cultured material and HA/TCP product are examined. Our results to date indicate that *Corallina officinalis* is the most suitable species for use in these implants, due to its growth rate in cultivation and internal morphology. We are developing sustainable aquaculture techniques for *C. officinalis* using long line cultivation and cultivation from spore settlement.

Acknowledgement: This work was supported by the European Union funded STREP Project HIPPOCRATES (NMP3-CT-2003-505758).

Seaweed commercialisation in Ireland and around the world

Paul McArtain & Ross Campbell

Cybercolloids Ltd., Cork, Ireland

The Irish Seaweed Industry Organisation represents a number of seaweed utilising companies in Ireland and promotes seaweeds and seaweed products through its website, www.isio.ie. The number of products worldwide that use seaweed are numerous and diverse. A brief overview of the types of products that use seaweeds as well as possible opportunities for commercial exploitation of seaweeds is presented. Research into seaweeds and seaweed uses in Ireland will be surveyed and ongoing projects and research will be outlined. Issues facing the seaweed industry in Ireland as well as how these issues have been addressed internationally will also be discussed.

Sustainable seaweed harvesting in Northern Ireland - the EHS view

Georgina Thurgate, Renny McKeown & Joe Breen

Environment & Heritage Service, Department of the Environment NI, Belfast

The Environment and Heritage Service (EHS) is committed to maintaining and conserving Northern Ireland's marine and coastal biodiversity. We recognise that, as primary producers, seaweeds play an important role in these ecosystems and unsustainable harvesting can affect their overall balance. Due to the fact that many seaweed species are sensitive to temperature, EHS aims to promote the management of the seaweed resource to ensure that it is best able to adapt to a changing climate. Seaweed harvesting is currently at a low level in Northern Ireland and EHS considers that both the biomass harvested and methods used are currently sustainable. However, we intend to publish a position statement to clarify our view on seaweed harvesting and to guide possible future expansion of the industry around the Northern Ireland coast. The EHS position statement has been drafted in consultation with NGOs, industry, academics and government departments. The industry also intends to produce a code of conduct for sustainable seaweed harvesting. EHS will continue to use the current legislative framework to protect marine and coastal ecosystems. However, we recognise the need for specific legislation to regulate seaweed harvesting. We will encourage research in order to expand our knowledge base of seaweed biomass, distribution and productivity in Northern Ireland and the impact of harvesting on biodiversity and coastal processes.

Dried seaweed biomass as a heavy metal biosorbent and wastewater treatment product

Vanessa Murphy, Helen Hughes & Peter McLoughlin

Waterford Institute of Technology, Waterford, Ireland

Seaweed biomass has been shown to be a highly effective biosorbent for various metals. It has been generally accepted that cationic binding to seaweeds involves an ion-exchange process and that the functionalities responsible for metal uptake on seaweed surfaces include carboxyl, amino and sulphonate. However, fewer studies have been carried out on the binding of anionic metal complexes to seaweeds and a definitive mechanism has not yet been identified. This research investigates the use of dried seaweed biomass for selective pre-concentration of heavy metals, in particular Cu (II), Cr (III) and Cr (VI). A systematic approach has been adopted by examining metal binding to seaweeds from each of the three main classes available off the South-East coast of Ireland. Key objectives of the research include determination of binding site type and the extent to which external factors such as pH influence metal binding as well as identification of the most suitable seaweed for heavy metal biosorption. An estimation of binding site numbers was carried out using potentiometric titrations while various spectroscopic techniques including FTIR and XPS analysis were used to characterise the functionality of these sites. Biosorbent behaviour also has been studied through careful manipulation of experimental parameters such as pH and equilibration time in an attempt to determine the optimum sorption parameters. Chemical treatment and modification of the seaweeds brought about altered metal binding capacities and illustrated the relative importance of carboxyl and amino groups in metal binding.

Development of a prototype seaweed biofiltration system for the control of metals in a waste-stream

Richard Walsh

Waterford Institute of Technology, Waterford, Ireland

A range of seaweed species were examined for metal uptake, including the Rhodophytes; *Polysiphonia lanosa*, *Porphyra umbilicalis*, *Gigartina stellata*, *Palmaria palmata*, *Corallina officinalis*, *Gracilaria verrucosa*, and Chlorophytes; *Ulva* species. Copper and chromium III accumulation by live seaweed species were examined over 21 day periods. Results indicate that the most rapid uptake of copper and the best overall retention of the metal were recorded in the case of *Polysiphonia lanosa*. For chromium III the most rapid uptake and retention was recorded in the case of *Corallina officinalis*. More detailed research indicated that nearly all of the copper and chromium III is taken up by the live seaweed in the first hour of exposure. Research is now concentrating on dried seaweed biomass. A plastic column 20 cm long and 8 cm diameter is packed with dried, sieved, seaweed. Glass beads are being used to reduce compaction of the seaweed and facilitate waste-water flow-through. Another approach to be examined is the use of a polymer inside the column, e.g. an alginate in which the seaweed particles can be dispersed and held.

Seaweed as biomonitors of nutrient pollution

Claire Campbell, Matthew Dring & Graham Savidge

Marine Laboratory, Queen's University Belfast

This study investigates the potential for using seaweeds to monitor the extent and development of eutrophication by nitrate and phosphate in the coastal waters of Northern Ireland. *Fucus serratus* and *Ascophyllum nodosum* samples were gathered from seven coastal sites with a range of anthropogenic nutrient inputs. This allowed comparison of sites with different nutrient loads. It was found that plants from sites closest to nutrient inputs had higher internal nitrate content than plants from low input sites. A field study was carried out on an area of coastline comprising an embayment,



open shore and areas subject to agricultural runoff and sewage input. Macroalgal and water samples were collected at each of eight sampling stations under different weather and tidal conditions and analysed for nitrate, nitrite and phosphate. Internal phosphate content was high across all sites and for all species. There was found to be significant variation in internal nitrate from *Fucus* species from different stations. Batch culture experiments were carried out to determine the effect of ambient nutrient concentrations on nutrient concentration in tissues of *F. serratus* and *Ascophyllum nodosum* over time. Both species showed an increase in internal nitrate. Phosphate concentrations were found to be consistently high in all macroalgal species studied from Strangford Lough and the Irish Sea. This and previous data collected suggest phosphate may not be a useful indicator of nutrient pollution. This study indicates internal nitrate and nitrite concentrations may provide a more sensitive biomonitor of nutrient pollution.

The utilisation of seaweeds in bioremediation of nitrogen- and phosphorus-rich urban sewage effluent: The potential and constraints

Astrid Werner, Graham Savidge & Matthew Dring

Marine Laboratory, Queen's University Belfast

Under the EU Water Framework Directives increasingly strict restrictions are placed on the quality of effluents that can be discharged into natural waters. The aim is to prevent eutrophication and especially protect environmental sensitive areas such estuaries, coastal seas and inlets with restricted water exchange. In order to comply with the EU Water Framework Directive and the Nitrates Directive, agencies and industries, which release wastewaters rich in inorganic nutrients and currently in breach of the directives, have to install means of water treatment to remove excess nutrients. The utilization of seaweeds for the bioremediation of wastewaters provides a basis for an environmentally friendly technology. At Queen's University Marine Laboratory, a flow-through biofilter system was developed and tested, using a 1:1 mix of sewage effluent and seawater. This system has nearly reached a pre-commercial stage and it is hoped to develop a modular seaweed bioremediation system for commercial use in the near future. In this presentation the potential and constraints of this biofilter system will be discussed.

Use of macroalgae to remove nutrients from sewage treatment plants: continuous flow experiments

Panos Tsagkamilis, Christos Katsaros & D. Danielidis

University of Athens, Greece

The aim of this study is to examine the ability of selected seaweeds to remove nutrients from urban sewage treatment plants. Preliminary batch experiments both on site and in the laboratory showed that among the tested species, green algae (*Ulva lactuca*, *Enteromorpha* spp., *Cladophora* spp.) indicated maximum nutrient absorption and biomass yield. Subsequently, these species were used for large scale, continuous flow experiments. The flow was adjusted to maintain a 60:40 seawater: effluent proportion in a tank with adjustable volume 200-800 lt. These recently introduced experiments showed interesting results in slow flows. Using *Cladophora* spp. there was approximately 50% decrease of phosphorus and nitrate, and approximately 65% for nitrite, compared to the control. At the same flow rates *Ulva lactuca* showed 50% decrease in nitrate and ammonium concentrations. In order to estimate the optimal salinity to maximize effluent flow, chlorophyll concentration in various salinities is currently being investigated. Apart from the above, the effect of the nutrients in the cell structure of the species used is examined, with emphasis in the cytoskeleton organization.

Developing a spore hatchery for red algae of commercial importance

Lynn Browne & Niall McDonough

Centre for Marine Resources and Aquaculture (C-Mar), Queen's University Belfast

Increasing demand for good quality seaweed for use as food, animal feed and in cosmetic and medical applications has enhanced the need for efficient seaweed cultivation methodologies. Cultivated seaweed could supply these expanding markets while protecting natural populations from overexploitation. Development of cultivation techniques for the economically important red algae, *Palmaria palmata* and *Corallina officinalis*, has been ongoing at C-Mar for several years. Both species have been cultured successfully from spores by:

1. collecting reproductive material,
2. inducing spore release,
3. settling spores onto suitable substrates in tanks,
4. optimising growth of settled spores in controlled hatchery conditions before transfer to open sea culture systems for on-growing.

The success of spore culture trials at C-Mar and the current interest in seaweed cultivation in Northern Ireland and the Republic of Ireland led to an application for infrastructure funding to the Irish Marine Institute for "Development of a Temperature-Controlled Seaweed Hatchery Facility at C-Mar". This application was successful and plans are currently being made to install a modified refrigerated container equipped with tanks, lighting, flowing seawater and aeration at the C-Mar facility in Portaferry. Funding will also be provided to fully equip a small laboratory which will be developed adjacent to the hatchery. It is hoped that this new and unique facility will underpin future applied macroalgal research and development at Queen's University.

Twin-Layer Technology - A novel approach in the cultivation of microalgae for biotechnological and environmental applications

Björn Podola, Thomas Naumann, Andreas Königs, Jing Shi, Eva Nowack & Michael Melkonian

University of Cologne, Germany

The promising use of microalgae in the field of biotechnology and environmental biotechnology is often limited by the established cultivation techniques, which basically rely on suspension cultures or, rarely, on immobilization on or in gel-like matrices. Problems such as light limitation, gas diffusion, shear forces and leaching in photobioreactors (PBRs) as well as cost intensive separation processes and PBR construction have prevented microalgal technology from reaching a mature state comparable to fermentation technologies. The novel "Twin-Layer" technology solves some of the problems inherent in previous microalgal cultivation systems by separation of immobilized microalgal cultures from the culture medium. This was achieved by the use of a combination of a sheet-like fibrous nonwoven containing the culture medium and a porous/fine-structured and liquid permeable thin layer on which the organisms are immobilized. Originally, the Twin-Layer technology was developed for the long term immobilization of microalgae in biosensor systems, but was later modified for various other applications: Twin-Layers are used for growing large numbers of microalgal (stock) cultures in the 96-well format, avoiding labour-intensive serial transfer procedures. At a larger scale, a Twin-Layer PBR (approx. 16 m² growth surface) has been constructed for the production of several marine microalgal strains (*Tetraselmis*, *Isochrysis*,

Phaeodactylum, *Navicula*, *Nitzschia*) which are important live feeds in aquaculture. The astaxanthin-producing green alga *Haematococcus pluvialis* was grown to a high cell density in a smaller prototype PBR. In the field of environmental biotechnology, Twin-Layer based systems have been used to remove nitrogen and phosphorus from urban or agricultural wastewater as well as heavy metals from mining effluents.

CONTRIBUTED PAPERS - DIATOM ECOLOGY AND SYSTEMATICS

Epilithic diatom communities from inflows to Lake Bassenthwaite

Lydia King & P.A. Barker

University of Lancaster

As part of the Bassenthwaite Lake Restoration Project, a survey of the epilithic diatom communities from 10 inflows to the lake took place in March 2006. Characterisation of the diatom communities and investigation of similarities and differences as well as calculation of TDI (Trophic Diatom Index) was carried out on three replicate samples with the aim to contribute to the understanding of catchment processes, especially sediment and nutrient transport. Overall 81 different diatom taxa were found within the 30 samples from 10 sites. The number of taxa per sample was less and ranged from 7 (Glenderamackin) to 36 (River Derwent). Considering the averages of the relative abundance of the diatom species at each site, the following species were found with more than 10% relative abundance: *Achnanthes minutissimum*, *Diatoma hyemale*, *Eunotia exigua*, *Eunotia subarcuatoidea*, *Gomphonema olivaceum*, *Gomphonema parvulum* var. *exilissimum*, *Gomphonema* sp. cf. *olivaceum*, *Navicula gregaria*, *Nitzschia dissipata*, *Planorbulina frequentissimum*. The contribution of motile taxa was generally low with the exception of two sites, which due to the larger amount of silt, exhibited a distinct diatom flora with more motile taxa. The TDI ranged from 1 to 71, with most sites exhibiting a TDI between 40 and 60. The upstream site at the Glenderamackin had an extraordinary low TDI and the TDI was highest at Dubwath Beck.

Resting stages and ecology of *Aulacoseira skvortzovii* in Lake Baikal

David H. Jewson, N.G. Granin, L.A. Gorbunova, R. Yu Gnatovsky, & A. A. Zhdanov

formerly: Limnology Laboratory, University of Ulster, Ballyronan, Co. Londonderry

Aulacoseira skvortzovii is a planktonic diatom that is endemic to Lake Baikal. It has many similarities with the widely distributed *Aulacoseira islandica* but differs in having a morphological distinct resting spore, which is unusual in freshwaters. The ecology of the spore was studied as part of an 11 year programme (1994-2005). The main period of vegetative growth was during winter, when lake temperatures were below 4°C. In culture, the optimum growth temperature was between 3.5 and 6.5°C. At higher temperatures mortality increased, so that at 12.5°C 30% of cells died and at 15°C this rose to 88%. In the lake, resting spores were formed before temperatures rose to these critical levels, so the environmental cues inducing spore formation were investigated, in both culture and field samples. Narrow diameter cells switched to size regeneration rather than spore production. Spores mainly survived summer stratification in coastal sediments, where concentrations reached 11,000 ml⁻¹. In culture, spores germinated when they were placed in new media,

both in dim light and dark. The dark-germinated spores had sufficient reserves for two to three divisions. Spores were resuspended by wave action from coastal sediments and bays less than 25 m in depth were carried offshore by currents and recolonised the open water areas each year.

Changes of the diatom exopolymer matrix in Antarctic sea-ice as a response to environmental change

Susanne Fietz, David N. Thomas* & Graham J.C. Underwood

University of Essex and *University of Wales

During sea ice formation, microorganisms are confined to hypersaline brine channels, where salinity reaches over 20‰ and temperatures can drop to below -20°C. Despite the harsh environmental conditions, the algal biomass is surprisingly high, with diatoms representing a major component of this unique community. It has been shown that sea ice diatoms produce large amounts of extracellular polymeric substances (EPS) or mucilages, that fill the brine channels. Field sampling in the Weddell Sea (Antarctica) and preliminary analyses from laboratory cultures were carried out to determine the abundance and composition of this diatom EPS in relation to the environmental changes. The majority of the dissolved organic matter present in sea ice was found to be predominantly EPS, with substantial amounts of high molecular weight polymers present. Cultures of *Fragilariopsis* grown under different salinity conditions, matching those of sea ice cores, also show increased EPS production with increasing salinity. It is suggested that the extracellular polymeric substances (EPS) may confer general benefits to ice diatoms, such as cryoprotection, salinity barriers and a localised microclimate.

Environmental requirements of the diatom *Didymosphenia geminata*

Brian A. Whitton & Neil T.W. Ellwood

School of Biological and Biomedical Sciences, University of Durham and University of Rome, Italy

Didymosphenia has recently become a sufficient nuisance in some rivers of New Zealand and the north-west of north America to merit headlines in newspapers. In New Zealand it is claimed to be a recent invader. In contrast it has been abundant in long stretches of the River Coquet, Northumberland, for at least the last forty years. There are also many other records of its occurrence in the U.K. and elsewhere in Europe. Information on the internet shows a number of theories about factors favouring its growth and especially its recent success. The theories are sometimes conflicting and, in the view of the present authors, often wild. The talk summarizes several studies. Among these are: 1) a 2-year survey of stream nutrients and surface phosphatase activities of phototrophs, including *Didymosphenia*, in Stony Gill, a N. Yorkshire stream; 2) staining experiments with *Didymosphenia* from several streams in the UK and Ireland, including Stony Gill and R. Coquet. These and other studies are brought together to suggest some of the environmental factors favouring its growth. A brief comparison is made with the ecology of the cyanobacterium *Rivularia*, because this indicates useful lines of research with *Didymosphenia*.

Diatom community response to natural climate forcing

N.J. Anderson¹, G. Simpson², V. Gällman³ & I. Renberg³

¹Department of Geography, Loughborough University, Loughborough LE11 3TU, UK.

²Department of Geography, University College London, London WC1E 6BT, UK.



³Department of Ecology and Environmental Science, Umeå University, Umeå, Sweden

Climate forcing is a major threat to freshwater systems in the temperate region and the Arctic. Discerning the effects of temperature increases on lake biota and functioning is difficult because the long ecological time series required for comparison with climate data are not available for most sites. Most contemporary long-term ecological datasets are <50 years, too short to detect longer term changes such as regime shifts and effects of altered biodiversity on ecosystem function. Moreover, the effect of climate change on contemporary aquatic ecosystems can be difficult to determine because of the confounding effects of other stressors (i.e. nutrient enrichment). In this study, diatom analysis of pre-cultural, varved (annually-laminated) lake sediments was combined with tree-ring inferred air temperatures, to determine the ecological response of a boreal lake to a natural climate variability (of $\pm 1.3^\circ\text{C}$) >2000 years ago. Kassjön is a small, dimictic lake in northern Sweden with a small part of its catchment used for agriculture, but pollen analysis indicates that forest clearances started around 1350 AD. The lake has a continuous record of varved sediments, deposited since its formation some 6300 years ago. We analysed an 880-year sequence (176 contiguous samples each representing 5 years) from 435 BC to 445 AD, a time period that predates agriculture in the catchment. Diatom variance and diversity was greater before ~ 15 AD, a period of cooler and more variable summer temperatures. Long-term structural change in species composition, notably increases in planktonic diatoms indicative of nutrient enrichment (i.e. *Asterionella formosa*), was associated with warmer and stable temperatures after ~ 20 AD. These data indicate the sensitivity of boreal aquatic ecosystems to climate forcing.

The rise of cryptic species - do we need to re-evaluate our criteria for defining species?

Eileen J. Cox

Natural History Museum, London

With increasing use of molecular techniques the discovery of genetic diversity within well-known, widespread taxa is becoming almost commonplace, and the existence of cryptic species is being claimed for many algal groups. In some cases, morphological support for taxon separation has been presented, although this often requires ultrastructural investigations that are impractical in routine ecological / monitoring studies. The presence or absence of particular genotypes may be correlated with seasonal and distributional patterns, invoking ecological (and ecophysiological) constraints. Such correlations might support the recognition of ecotypes, but there is currently little empirical data on the ecophysiology of different genotypes. Studies of reproductive behaviour, sexual compatibility or reproductive isolation tend to be used to support the application of the biological species concept, but again only a tiny fraction of the algae have been investigated. In practise, morphology remains the basis of taxon recognition and delimitation.

This talk will seek to place the rise of cryptic species in an historical context and to explore the issues of genetic diversity, physiological response, breeding behaviour and morphological variation, in relation to the delimitation of taxa, particularly species, with special reference to diatoms.

CONTRIBUTED PAPERS - EVOLUTION AND PHYSIOLOGY OF ALGAE

Snapshot in the evolution of a plastid - Chromatophores of *Paulinella chromatophora* evolved from a second primary endosymbiosis

Eva C. M. Nowack, Birger Marin & Michael Melkonian

Botany Department, University of Cologne, Germany

One of the key steps in the evolution of life was the origin of photosynthesis in nucleated cells, giving rise to diverse lineages of photoautotrophic eukaryotes. It is well accepted that this process was initiated when a cyanobacterium was engulfed by a colourless host cell more than a billion years ago and was transformed into a plastid during a process known as primary endosymbiosis. The thecate amoeba *Paulinella chromatophora* was first described by Robert Lauterborn in 1895. Its most unique features are two sausage-shaped plastid-like inclusions, termed chromatophores, that support the photoautotrophic lifestyle of the amoeba. We could demonstrate by phylogenetic analyses of the almost completely prokaryotic rDNA operon and the rbcL-sequence that the chromatophores of *Paulinella* do not share the monophyletic origin of the other plastids but evolved by a more recent endosymbiosis process, which involved a cyanobacterium distinct from the ancestor of the plastids. To what extent the chromatophores of *Paulinella chromatophora* have been genetically altered in this process is currently under investigation. First results indicate that the genome experienced a significant reduction in size. Thus the chromatophores of *Paulinella chromatophora* can be regarded as an intermediate state between a cyanobacterium and a plastid, and provide a snapshot into early stages of the evolution of a photosynthetic organelle.

Simultaneous determination of photosynthetic performance and elemental composition of microalgae

Tracy Lawson, R. Geider, G. Underwood & K. Oxborough

Department of Biological Sciences, University of Essex, Colchester, UK.

We have developed an instrument capable of simultaneous determination of phytoplankton photosynthetic performance and elemental composition, by combining chlorophyll a fluorescence imaging with Laser Induced Breakdown Spectroscopy (LIBS). Chl a fluorescence imaging is a well-established, non-invasive technique for assessing photosynthetic efficiency. The high-resolution system incorporates an inverted optical system with a LED light source and CCD-based camera. LIBS is an extremely versatile method for determining elemental composition. With this technique, a brief, high powered laser pulse focused onto a sample creates a plasma plume from the vaporisation and atomisation of the targeted material. Spectroscopic analysis of the light emitted as the plasma cools allows the identification of elements within the sample from their unique spectral signatures. We have used this technique to determine nutrient effects on photosynthetic capacity in phytoplankton cultures grown under different nutrient or environmental conditions. The effects of heavy metal pollutants on photosynthesis and elemental composition have been monitored. Single cell elemental analysis in conjunction with photosynthetic efficiency has been successfully conducted on diatom species.

Phytoplankton bloom dynamics and primary production in the North Sea and UK shelf waters observed from space and moorings

Rodney M. Forster, F. Gohin, A.K. Dennis, D.A. Purdie & D.J. Mills

CEFAS, Pakefield Road, Lowestoft, IFREMER, Brest, France and SOC,

Southampton

The concentration of phytoplankton, with chlorophyll *a* as its proxy, is a widely used index of water quality in both national and international marine legislation. To meet these requirements, the capabilities of two monitoring techniques for quantifying the magnitude and frequency of phytoplankton blooms are being investigated. An annual cycle of real-time data from a network of calibrated, moored fluorometers around the UK coast showed good agreement with chlorophyll values extracted from the relevant MODIS-AQUA scenes. The algorithm used was developed for French coastal waters (Gohin et al. 2002, IJRS 23, 1639), and appears to be a good candidate for robust retrievals of phytoplankton pigment in the case-II waters of the UK shelf. A simple Eo.Zeu.B type model was then used to calculate daily primary production both for mooring sites and for selected regions such as the southern North Sea and eastern Irish Sea.

Seaweeds as agents of rock deterioration: a geophycologist's perspective

Liam Morrison¹, Martin Feely², Nigel Blamey^{2,3} & Dagmar B. Stengel¹

¹ Department of Botany, Martin Ryan Institute and Environmental Change Institute, National University of Ireland, Galway

² Department of Earth and Ocean Sciences, National University of Ireland, Galway

³ Department of Chemistry, National University of Ireland, Galway.

This multidisciplinary study investigated the interactions between seaweed holdfasts and their underlying substrate. Structural and chemical characteristics of the interface between seaweed holdfasts and bedrock are essential for understanding the mode of attachment of seaweeds and their biological action on rock. Scanning Electron Microscopy (SEM) with Energy Dispersive Spectroscopy (EDS), Structured Light Illumination Microscopy (SLIM) and Laser Raman Spectroscopy (LRS) were used in the examination of the interface between *Ascophyllum nodosum* (Fucales, Phaeophyceae) and crustose red algae *Lithothamnion* sp. (Rhodophyta) on granite and limestone substrates. The results obtained from SEM characterise the ultrastructure of the holdfast, the holdfast-bedrock contact zone and the penetration of rock forming minerals by the holdfast. Electron imaging of the interface between the holdfast and individual minerals, i.e. feldspar, quartz and biotite, provided textural evidence that seaweeds cause physical disaggregation and fragmentation of minerals, underlying their important role in the weathering of rock. EDS allowed the identification of key elements associated with the attachment of seaweed holdfasts and X-ray mapping of different samples compared the presence and distribution of different elements. SLIM was used to map biophysical structures at the seaweed-bedrock interface, facilitating the capture of a series of image stacks that offered a rapid method for the generation of 3-D images of structures related to biophysical deterioration of the bedrock minerals by the seaweed holdfast. LRS has been very useful in the identification of oxalate salts in lichens, which are indicative of biochemical weathering. LRS was used here to search for salts of organic acids within the seaweed holdfast and the bedrock interface that could be involved in the seaweed-induced biodeterioration of the substrate.

CONTRIBUTED PAPERS - BIOACTIVE PRODUCTS OF ALGAE

The structure and extracellular polymeric substance composition of different diatom- and cyanobacteria-dominated intertidal stromatolites from Highborne Cay, Bahamas

Graham J. C. Underwood

Department of Biological Sciences Essex University, Wivenhoe Park, Colchester CO4 3SQ

Stromatolites are geological features made by laminated microbial mats that have a fossil record as old as 3.5 billion years ago. In modern stromatolites growing on wave-exposed beaches in the Bahamas, layers of cyanobacteria and diatoms, with associated extracellular mucilages (EPS), sediment particles and CaCO₃ precipitate from the matrix of the sedimentary structure. Various types of stromatolites from the Bahamas show significant differences in quantity and vertical distribution of high and low molecular weight EPS fractions, and of EPS with different binding properties. These differences correlate with taxonomic composition, and the relative abundance of filamentous and coccoid cyanobacteria and stalked, tube-dwelling and motile diatoms. Despite low nutrient concentrations, the biomass and EPS concentrations within these mats is high, exceeding that found in more eutrophic tropical coastal environments. These stromatolites are islands of biological activity in an otherwise oligotrophic environment.

Beating bacteria the diatom way

Andrew P Desbois, Andrew Mearns-Spragg & Valerie J Smith

Gatty Marine Laboratory, University of St. Andrews

With the increasing prevalence of antibiotic resistant strains of pathogenic bacteria, such as MRSA, the need for new classes of effective therapeutic antibiotics is escalating. Cell extracts from the marine diatom, *Phaeodactylum tricoratum*, are known to have antibacterial properties but few of the bioactive compounds have been conclusively identified. We have isolated four putative antibacterial compounds from large-scale cultures of *P. tricoratum* by silica gel chromatography and RP-HPLC. They have all been structurally characterised and identified using ¹H-NMR, ¹³C-NMR and high-resolution mass spectrometry. The molecules share structural homology with certain unsaturated fatty acids and derivatives thereof. Quantitative data on yield, spectrum of activity and potency of these compounds will be presented and the biological significance of these compounds discussed.

Phenolic compounds from *Ascophyllum nodosum* (Fucales, Phaeophyceae): seasonal variation and environmental control

Solene Connan¹, Erwan Ar Gall² & Dagmar B. Stengel¹

¹Dept of Botany, Martin Ryan Institute and Environmental Change Institute, National University of Ireland, Galway, Ireland

²European Institute for Marine Studies, University of Western Brittany, Brest, France

Phenolic compounds of brown seaweeds are secondary metabolites or stress compounds involved in thallus protection against, for example, grazers, pathogens and UV-radiation; however, they have primary functions as in the cell wall formation during early stages of zygote development. Together with alginates and fucoidan, phenols are also involved in the metal binding capacities of brown seaweeds. In situ macroalgae are exposed to a range of



environmental conditions, and phenol contents have been previously reported to fluctuate according to environmental factors. Being able to quantify reliably the environmental effects on the production of phenols that bind divalent metals, and therefore contribute to seasonal and local variation in algal metal concentrations, would significantly improve the application of seaweeds as biomonitors. We report here on seasonal and spatial variations of phenol content in *Ascophyllum nodosum* from two sites in Galway Bay, western Ireland, with different environmental conditions, particularly salinity and nutrient levels. The intra-thallus variations of phenol content are also presented, together with preliminary results in phenol composition.

Confronting disease: not all algae are equal

Claire M.M. Gachon, Dieter G. Müller, Gosia Gaj, Frithjof C. Küpper

Scottish Association for Marine Science, Oban

Like any other living organism, brown algae are plagued by diseases caused by fungi, bacteria or viruses. Although numerous pathogenic or parasitic interactions involving marine algae have been described, molecular data in this field are scarce. In the context of the ongoing genome sequencing of the brown algal model *Ectocarpus siliculosus*, we are currently setting up a defined pathosystem between this alga and *Eurychasma dicksonii*. The latter is an oomycete pathogen of particular evolutionary interest since it is the most basal member of this group currently available in culture. Preliminary results show that *Ectocarpus* strains exhibit a differential susceptibility to the same *Eurychasma* strain, suggesting a genetically-determined basis for resistance in the alga. Conversely, several *Eurychasma* strains exhibit different host specificities, pointing to a genetically-determined basis for pathogenicity. These results and the methods currently developed to further study this interaction will be presented.

CONTRIBUTED PAPERS - BIODIVERSITY OF ALGAE

Variations in morphological structure of invasive green alga, *Caulerpa taxifolia*, from SE Australian estuaries

Maria J. Schreider, J. Klages & K. Hammond

School of Environmental and Life Sciences, University of Newcastle, Ourimbah Campus, PO Box 127, Ourimbah 2258 NSW, Australia

Caulerpa taxifolia is a native alga of sub-tropical and tropical Australia, but gained notoriety for its highly invasive aquarium strain, which occupies vast areas in Mediterranean Sea and marine habitats in other parts of the world. It was discovered in temperate Southeast Australia in 2001 and has since been found in 11 estuaries of New South Wales. *C. taxifolia* from different estuaries appear to differ in general morphology quite significantly. The main aim of our study was to conduct detailed comparison of morphological structure of *C. taxifolia* from different estuaries of NSW to identify differences and similarities among different populations of *C. taxifolia*. We measured a range of morphological characteristics of the alga (length and density of rhizoids; length and thickness of stolons; length, width and density of fronds; number of pinnules and secondary fronds, etc.). Several groups of estuaries were identified on the basis of similarity of algal morphology, which indicates the possibility that SE Australian estuaries might have been invaded independently from different sources. Alternatively, different environmental conditions may have influenced growth pattern of the alga.

Population analysis and taxonomic status of *Bangia maxima* Gardner and *Bangia vermicularis* Harvey (Bangiales, Rhodophyta)

Kerstin M. Muller¹, M.D.J. Lynch¹ & R.G. Sheath²

¹ *Department of Biology, University of Waterloo, Waterloo, Ontario, Canada*

² *Department of Biological Sciences, California State University, San Marcos, CA, USA*

In April 2004, collections of *Bangia* were obtained from the type localities of *Bangia vermicularis* Harvey (Golden Gate Bridge, San Francisco) and *Bangia maxima* (Bolinas, Marin County) in California, USA. *B. maxima* is the only readily distinguishable *Bangia* morphotype due to its large size (up to 35 cm long x 6 mm in diameter) and is potentially an important species for resolving taxonomic problems in the genus *Bangia* and possibly within the order Bangiales. An inter-simple sequence repeat (ISSR) PCR-based DNA fingerprint analysis was used to study the genetic variation within the population of *B. maxima* located on seven littoral boulders in Bolinas Bay. Banding patterns from 13 male filaments from each of the seven boulders for five ISSR primers were used to develop both band presence/absence and distance matrices (using the Dice coefficient). Banding patterns of *B. maxima* isolates were highly polymorphic among different boulders but consistent among individuals from the same boulder. UPGMA analysis indicated limited genetic transfer among boulders, and most isolates grouped within their boulder. In addition, two other populations of *Bangia fuscopurpurea* (Bolinas1 and Bolinas2) were also collected within Bolinas Bay and these collections were very similar to *B. maxima* (< 0.3% sequence divergence) using the highly variable mitochondrial cytochrome oxidase 2-3 spacer, suggesting a recent divergence despite considerable differences in morphology. According to Gardner (1927), *B. maxima* and *B. vermicularis* are similar in gross morphology and colour and may indicate an affinity between these two species. In our study, however, we noted that cell shape was very different between these two species and sequence divergence using the COX 2-3 spacer exhibited of ~3%. Phylogenetic analyses of the rbcL gene of all *Bangia* collections show affinity with other previous collections made in California. Our analyses suggest that *B. vermicularis* is a unique species from *B. fuscopurpurea* and that *B. maxima* may represent a recent speciation event.

Multiple interoceanic dispersals revealed by phylogeographic analysis of the red seaweed *Rhodochorton purpureum*

Christine A. Maggs, David P. Fewer, Jim Provan, Jaanika Blomster, Michael J. Stanhope & Michael D. Guiry

Queen's University Belfast, University of Helsinki, Finland & National University of Ireland, Galway

The relative contributions of vicariance and dispersal in determining the distributions of taxa are still hotly debated. For seaweeds two patterns of disjunct distributions are particularly pertinent to comparisons of the relative roles of these processes: (1) Pairs of species/sibling species in the North Pacific and North Atlantic Oceans, inferred to date from the opening of the Bering Strait 5.5-3.5 Ma. (2) Bipolar or antitropical disjunctions. Both disjunction patterns are exhibited by the red seaweed *Rhodochorton purpureum* which is circumpolar in both hemispheres. We chose this species because its exceptionally wide environmental tolerances might have permitted it to survive glaciations and hence reveal evidence of old vicariant events.

25 cultured isolates and field collections from throughout the global range of *R. purpureum* were sequenced for a nuclear marker (ribosomal ITS2) and a plastid marker (tufA-rps7-rps12-rpl31). Pronounced geographic structure revealed a complex biogeographic history. The centre of genetic diversity and origin of the species is

the North Pacific; three cryptic species there are interpreted as the imprints of vicariant diversification, probably in the Miocene. Multiple crossings of different *R. purpureum* lineages through the Bering Strait at various times, possibly by ice rafting through the Arctic, are indicated. High genetic diversity in the North Atlantic shows that *R. purpureum* survived Pleistocene glaciations, and hybridization between different lineages was detected. The shallow divergence between Arctic and Antarctic isolates indicates recent transequatorial passage. Phylogeographic analysis of *R. purpureum* has thus revealed the importance of both vicariance and dispersal in its evolutionary history.

Using phenotypic plasticity of algae and bioassays to characterise Polish reservoirs

Elliot Shubert & Elzbieta Wilk-Wozniak

Natural History Museum, London

Freshwater reservoirs are very important aquatic ecosystems, because they provide potable drinking water, recreational space and impoundments for industrial and agricultural effluents. The forces of nature such as oxbow lakes form most reservoirs, but increasingly more reservoirs are being purpose built. Reservoirs differ from each other based on their morphology, surrounding habitat, functionality, nutrient dynamics, species composition, trophic levels, etc. Three reservoirs (two shallow and one deep) in Poland were investigated for algal biodiversity and nutrient fluxes. Field data from the three reservoirs was compared to laboratory data using algal bioassays. A novel bioassay was developed that relied on the morphological change of *Desmodesmus abundans* isolate V-3 (Vistula River, Poland) to switch between colonies and unicells, thus acting as a proxy bioindicator organism. An axenic culture of *D. abundans* was

inoculated into 4-well titre plates containing sterile-filtered water collected from the three reservoirs during four seasons. The results demonstrated that *D. abundans* responded to the temporal and spatial levels of nutrients measured analytically and could be used as a proxy bioindicator for assessing water quality and nutrient availability. SEM observations on the diversity and phenotypic plasticity of *Desmodesmus* species inhabiting the three reservoirs substantiated the premise that reservoirs are complex ecosystems that require further study.

A novel algal division, the Picobiliphyta

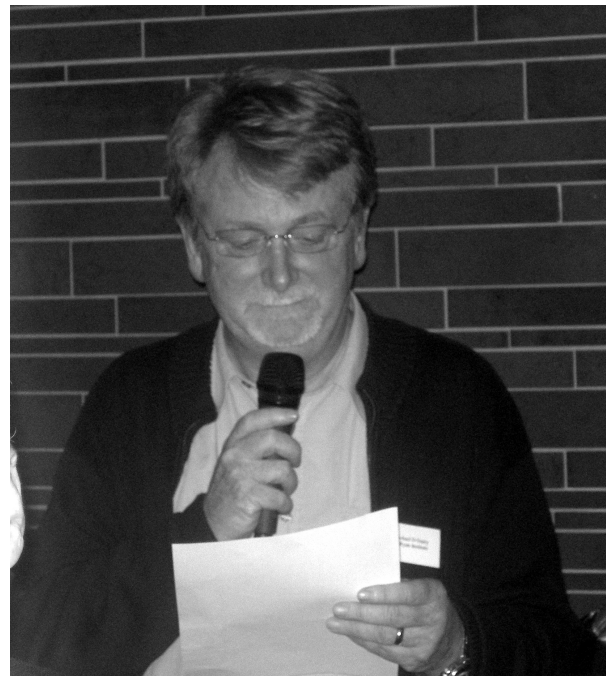
Fabrice Not, Klaus Valentin, Khadidja Romari, Connie Lovejoy, Ramon Massana, Kerstin Töbe, Daniel Vaultot & Linda Medlin

Alfred Wegener Institute for Polar and Marine Research, PO-BOX 120161, D-27515 Bremerhaven, Germany

Using environmental 18s rDNA libraries we have detected a novel group of organisms in the marine eucaryotic picoplankton. Based on phylogenies, the novel group has the rank of a division. Full 18s sequences were used to design specific oligos for the novel group and with the help of these oligos and fluorescence in situ hybridization (FISH) we were able to identify the corresponding cells. They are small (approx. 3 x 6 nm) and possess an organelle-like structure showing an orange fluorescence. Similar fluorescence after the same treatment was observed in Cryptophytes and Rhodophytes. Consequently, we could enrich for the novel cells by sorting the phycobiliprotein-containing fraction of the picoplankton, previously thought to contain the Cryptophytes. We conclude that the novel cells contain a plastid with phycobiliproteins and that they occur predominantly in the picoplankton fraction. Therefore we tentatively name them "Picobiliphyta".



Quiz team winners



Quiz master at work



The 55th Annual Meeting of the BPS, Belfast

Poster Abstracts

POSTERS - APPLIED PHYCOLOGY

1. Use of the *Biomphalaria glabrata* Snail Bioassay for Detection of Molluscicidal Compounds in Marine Algal Extracts

Maricela Adrian-Romero, Asmita V. Patel, David Wright & Stephen Sumner

Faculty of Pharmacy, University of Los Andes, Mérida, Venezuela and School of Pharmacy & Biomedical Sciences, University of Portsmouth

In the search for novel molluscicidal agents, methanol extracts of a selected range of marine algae have been tested against adult *Biomphalaria glabrata* snails. The extracts were evaporated to dryness and, based on the residues, 5000 ppm solutions were prepared by initially dissolving the material in methanol and then diluting with water to make a final water/methanol ratio of 99.5: 0.5. These solutions were used in the snail bioassay. Two x 10 snails were used in each test and they were examined after 24 hours to determine the number killed. Distilled water was used as the control. The extracts of the majority of species tested produced no noticeable effect on the snails. The most active extract was that of *Fucus serratus*; other active extracts were obtained from *F. vesiculosus*, *Halidrys siliquosa* and *Polysiphonia lanosa*. The extract of *F. serratus* killed all the snails at concentrations down to 500 ppm, whereas a 400 ppm solution was inactive.

2. The search for antiplasmodial compounds from marine algae

Gerald Blunden, Colin W. Wright, Peter A. Linley & Nagwa A. S. Shoeib

School of Pharmacy & Biomedical Sciences, University of Portsmouth

Methanol extracts of over 60 species of marine algae have been screened for antiplasmodial activity against *Plasmodium falciparum* (strain K1) using the in vitro parasite lactate dehydrogenase assay. The most active extracts were those obtained from *Cladophora rupestris*, *Cystoseira baccata*, *C. tamariscifolia*, *C. nodicaulis*, *Halidrys siliquosa*, *Saccorhiza polyschides* and *Polysiphonia lanosa*. The methanol extracts of some of the species were concentrated, partitioned between chloroform and water, and both fractions tested, as before. In every case, the activity was found in the chloroform fraction. The lowest IC₅₀ (µg/mL) values of these fractions were obtained for *P. lanosa* (2.48±0.65), *S. polyschides* (4.21±0.8) and *Cystoseira baccata* (8.67±1.56). Bioassay guided fractionation of the chloroform extracts was used to isolate the antiplasmodial compounds. For *Polysiphonia lanosa*, these were the bromophenols lanosol, the n-propyl- and methyl ethers of lanosol, and the aldehyde of lanosol.

3. Seaweed consumption in the West: sociocultural resources as a base for industry development

Duika Burges Watson

Institute of Health and Society, University of Newcastle-upon-Tyne

4. The Culture Collection of Algae and Protozoa: A unique source for microbial biodiversity

Debra Brennan, U. Achilles-Day, C.N. Campbell, J.G. Day, M. Gaj, S. McNeill, T. Pröschold, R. Saxon & F.C. Küpper

Scottish Association for Marine Science, Oban

The Culture Collection of Algae and Protozoa (CCAP) is the UK national collection for marine, freshwater and terrestrial protists and cyanobacteria, performing all the roles of a 21st century Biological Resource Centre (BRC) including: ex situ conservation of protistan and cyanobacterial biodiversity; provision of biological materials and their associated bioinformatic data to the scientific community; acting as a source of advice on all aspects of algal and protozoan science (marine, freshwater and terrestrial). The collection is located in a purpose-built, world-class facility in the European Centre for Marine Biotechnology (ECMB) hosted by the Scottish Association for Marine Science (SAMS). The CCAP collaborates with all the major protistan collections world-wide and is an International Depository Authority under the terms of the Budapest Treaty (1977). Since the relocation and remerging of the CCAP in 2004 the collection has been expanded and currently the CCAP holds 2,700 strains including >300 Authentic (Type) cultures. Recently diatoms isolated from polar habitats have been added to the collection and the macro-algal section has increased with the addition of a range of Rhodophyceae and Phaeophyceae cultures. In collaboration with other scientists and with support from funding agencies, CCAP is actively investigating potential avenues for the exploitation of its cultures, including the production of secondary metabolites and the culture of algal-associated bacteria. Details of all CCAP strains are accessible at www.ccap.ac.uk

5. The commercial aquaculture of *Palmaria palmata*

Maeve Edwards, Lynn Browne & Matthew Dring

Queen's University Marine Laboratory, Portaferry, Co. Down

The edible red alga *Palmaria palmata* (Dulse) is harvested by hand from the lower intertidal, where it grows on kelp stipes and rocks. It is abundant on the shores of Northern Ireland and is so popular when eaten as a dried product that demand regularly outstrips the supply. The alga has now been successfully cultivated in open-sea conditions in Strangford Lough. Currently, the only way to make a seaweed farm commercially viable is to grow *Palmaria* from settled tetraspores on culture string. Optimum laboratory culture conditions of low irradiance (5-10 µmol m⁻² s⁻¹) and high-nutrient media are required for a minimum of two weeks before sporelings on culture string are placed out on culture rigs in the sea. By growing *Palmaria* on culture string nets and removing only the larger plants in a series of successive harvests, whilst leaving the smaller plants to continue growing, the total harvest can be of sufficient size to make the seaweed farm a commercial success.

6. Bioremediation in a natural ecosystem: The potential uses of macroalgae

Amanda Guy, Graham Savidge & Matthew Dring

Queen's University Marine Laboratory, Portaferry, Co. Down

Anthropogenic nutrient enrichment caused by elevated levels of nitrate and phosphate in freshwater discharge has been identified as being a primary cause of eutrophication in coastal ecosystems throughout the UK. Sources of such nutrient enrichment include the release of wastewater from domestic households, industrial processes and sewage treatment works and leachates released by agricultural practices. The Blackstaff River estuary, located between Portaferry and Kircubbin on the shores of Strangford Lough has

been selected as an example of a coastal zone enriched by nutrients largely derived from agriculture. Excess nutrients are released into the system from one point source, namely the Blackstaff River, and several non-point sources including submarine and surface groundwater discharge, all of which are loaded with nutrients. This study aims to whether local species of macroalgae can be utilized in situ to remove excess nutrients within the water column. In order to do so, species with a high tolerance to freshwater conditions and rapid nutrient uptake rates need to be identified. Species of interest include *Fucus ceranoides*, *F. vesiculosus*, *F. serratus*, *F. spiralis*, *Ulva lactuca* and *Sargassum muticum*. Suitable species of algae will be strategically located on the muddy shores of the estuary. This will involve establishing a substrate such as concrete blocks or ropes to which the algae can attach. An integrated monitoring system assessing nutrient concentrations in the water at different states of the tide, in the seaweeds, and in the sediment porewater will be used to provide an indication of the impact of the seaweeds on the nutrient status of the system.

7. Ecology in the Scottish Environment Protection Agency and its role in the management of cyanobacterial problems

Jan Krokowski

Scottish Environment Protection Agency, East Kilbride

The Scottish Environment Protection Agency - SEPA, was established by the Environment Act 1995, and became operational on 1 April 1996. In broad terms, SEPA regulates activities that may pollute water; activities that may pollute air; storage, transport and disposal of waste; and keeping and disposal of radioactive materials. It is funded through the Scottish Executive and through charges to regulated industries. SEPA staff are in wide range of occupations, including amongst others ecology. The main role of the Ecology function within SEPA is to monitor the state of the environment; to support regulatory and enforcement activities; and to advise internal and external customers. There are a number of consequences of nutrient enrichment, including increasing frequencies of blooms and scums of potentially toxic cyanobacteria, which are an obvious public health concern. SEPA is responsible for ensuring compliance with environmental legislation, and amongst its other duties, carries out surveillance for prevalence and consequences of eutrophication, carries out laboratory analysis of water samples from high-risk recreational waters, and provides advice to local authorities and others. The management of cyanobacteria is achieved through Local Action Plans (LAPs) which are compiled and agreed by the Local Authority Environmental Health, Scottish Water, the local NHS Board (lead), and SEPA. The LAPs include assessing the nature and intensity of algal blooms, assessments of the risks to human and animal health, provide actions that might arise from these assessments, and provide information to the public. The triggers for action are based on the World Health Organisation guidance for recreational waters.

8. The potential for seaweed aquaculture in the Falkland Islands

Jim McAdam¹ & Brendan Gara²

¹*Agri-Food and Biosciences Institute, Belfast, and United Kingdom Falkland Islands Trust*

²*Falkland Islands Development Corporation*

The Falkland Islands (52 °S; 57-62 °W) are economically self-sufficient and the sale of offshore fishing licences is the primary income source. Agriculture, tourism and service provision are secondary income sources. There is a general need to diversify income and a National Aquaculture Strategy has been proposed to

investigate the aquaculture potential of a range of indigenous species. The islands have a rich seaweed flora and some commercially important species for phycocolloid extraction such as the carragenophytes: *Gigartina skottsbergii*, *Sarcobalia crispate*, *Callophyllis variegata* and the alginophytes: *Macrocystis pyrifera*, *Lessonia* spp., *Durvillaea antarctica* may be abundant. Harvesting or culturing some of these could supply either an indigenous source of fertiliser and animal feed for organic-based farming systems or higher value product for partial processing and export. A scoping exercise based on a suite of criteria screened a number of potential options but ruled out seaweed aquaculture at the present time, keeping open the option for inclusion at a later date, possibly as part of an integrated aquaculture development programme. Advantages include, an extensive, sustainable natural resource, unpolluted waters, dry windy climate, available shipping. Disadvantages include lack of infrastructure and local experience, high labour and electricity costs. There is also a key lack of background research information on the size of the resource, suitable aquaculture methodology and of market potential.

9. Integrating monitoring, phytoplankton production and modelling to develop methods for the assessment of water quality and sustainable aquaculture

Adam Mellor, Elisa Capuzzo, James Strong & Heather Moore

Agri-Food and Biosciences Institute, Belfast and Queen's University Belfast

Primary production is the base of the food web in marine ecosystems and is of use as 1) a measure of ecosystem vigour, 2) a component of the assessment of coastal eutrophication and 3) a factor in assessing the carrying capacity for aquaculture (Tett, 1990; Ferreira et al., 1998; Tett et al., 2007). Traditional methods of measuring primary production, such as the 14C method or the light/dark bottle oxygen method, are poorly suited for routine use because they are time consuming, expensive and require trained personnel. The objectives of this study are to develop and test models that estimate planktonic production by using environmental parameters that are routinely monitored such as chlorophyll concentration. Carlingford Lough was monitored at high temporal and spatial resolution to identify the dynamics of water quality parameters and to quantify the relationship between chlorophyll concentration and fluorescence. This relationship is used to predict phytoplankton production by integrating parameters from the Lough such as light availability and the photosynthetic parameters μ_{455} and P_{Bmax} , which were measured over two years (using the 14C method). It is anticipated that estimates of primary production from these studies can be used to assess the trophic status of the Lough and to estimate the carrying capacity for shellfish cultivation e.g. through the integration with the SMILE (Sustainable Mariculture in Irish Lough Ecosystems) programme.

10. The use of marine macroalgae as selective pre-concentration media for heavy metals

Vanessa Murphy, Helen Hughes & Peter McLoughlin

Estuarine Research Group, Waterford Institute of Technology, Waterford

The presence of heavy metals in the environment is of major concern because of their toxicity and threat to plant and animal life. Recovery of heavy metals from industrial waste streams is becoming increasingly important as society realises the need for recycling of metals. Biological materials such as marine macroalgae (seaweed) play an important role in metal binding and help to regulate the residual concentration of metal ions in aquatic systems. These materials are referred to as biosorbents. Seaweeds possess a high metal binding capacity with cell wall polysaccharides playing an



important role. It has been found that certain metals can bind in different ways on and within seaweeds and has generally been accepted that the binding process is essentially one of ion exchange. Functional groups responsible for metal uptake include carboxyl, sulphate and hydroxyl groups. These groups are strong ion-exchangers, and are therefore important binding sites for metal cations. Metal concentrations in seaweed often increase by a factor of 103 to 105 in comparison to metal ion concentrations in solution. This research looks at the potential of various red, green and brown seaweeds found in the South-East of Ireland to act as selective pre-concentration media for heavy metals. Biosorbent behaviour can be controlled through careful manipulation of experimental parameters such as pH, metal concentration and contact time thus allowing potentially selective biosorption between different metals as well as between different oxidation states of the same metal. Work to date has focussed on surface characterisation of the seaweeds and identification of the functionalities involved in heavy metal binding using a variety of analytical techniques including Potentiometric Titrations, FTIR Spectroscopy, Scanning Electron Microscopy and X-ray photoelectron Spectroscopy. Equilibrium and kinetic studies of metal sorption identified the parameters of metal binding while chemical modification of the surface functionalities was carried out with the aim of enhancing metal binding and elucidating a binding mechanism.

11. An investigation into the potential of seaweed species (Rhodophytes and Chlorophytes) for the uptake of metals from contaminated water

Richard Walsh & Eddy Fitzgerald

Estuarine Research Group, Waterford Institute of Technology, Waterford

The utilisation of seaweeds for the removal of metals from wastewater has advantages over conventional chemical methods. The widespread availability of seaweed species make it inexpensive and they have a potentially high metal sorption capacity. These, combined with the environmental benefits, make seaweed an attractive wastewater treatment resource. Research included the screening of rhodophyte and chlorophyte seaweeds, from unpolluted locations in the South East region of Ireland, to establish metal uptake ability. Exposure to copper and chromium III have been completed. A total of 8 species, 6 rhodophytes (*Corallina officinalis*, *Gigartina stellata*, *Gracillaria verrucosa*, *Palmaria palmata*, *Polysiphonia lanosa*, *Porphyra umbilicalis*) and 2 chlorophytes (*Ulva lactuca* and *Enteromorpha* spp.) were investigated. The seaweed species were exposed to metal concentrations in seawater ranging from 0 to 200ppb. They were placed in aerated tanks of seawater with pumps for circulation/agitation and subjected to a light: dark regime of 16:8 hours. Samplings of seaweed and seawater were carried out over two exposure periods; 3 and 21 days. AAS analysis was carried out to determine metal concentrations. Results to date indicate *Polysiphonia lanosa* as the leading seaweed in terms of Cu uptake and *Corallina officinalis* in terms of Cr III uptake.

POSTERS - ECOLOGY AND PHYSIOLOGY OF ALGAE

12. Have epilithic diatom communities around Bassenthwaite Lake changed from 1998 to 2006?

Natalie Bibby, Lydia King & P.A. Barker

University of Lancaster

Although diatoms are now used more frequently to monitor ecological water quality through the implementation of the Water

Framework Directive, basic questions regarding temporal and spatial variability of diatom communities are still under discussion. This is also true for indices calculated from the relative abundance of diatom species occurring at a site and is especially the case in lentic environments. Therefore we repeated an investigation carried out in the autumn 1998 and collected samples of epilithic diatoms from around Bassenthwaite Lake, English Lake District. Several stones were removed from the lake littoral, brushed using a toothbrush and the algal suspension collected for analysis of the relative abundance of diatom species. Here we present the results comparing the spatial variability of epilithic diatom communities from twelve sites around Bassenthwaite Lake from 1998 and 2006 using SIMI, an Index of similarity. However, the main aim of this project will be to assess the spatial variability of epilithic diatom communities around Bassenthwaite Lake next spring. This study of temporal and spatial variability in the epilithic diatom community forms part of the Bassenthwaite Lake Restoration Project (www.lake-district.gov.uk/bassenthwaite/home/index.php).

13. An exceptional bloom of the harmful dinoflagellate *Karenia mikimotoi* in Scottish waters during 2006

Keith Davidson, S.C. Swan, T. Wilkinson & Debra Brennan

Scottish Association for Marine Science, Oban

Harmful algal blooms are of concern in terms of their potential to impact on human health, the environment, and the sustainability of the aquaculture industry. The ichthyotoxic marine dinoflagellate *Karenia mikimotoi* (*Gyrodinium aureolum*) was first recorded in European coastal waters in 1966 in Norway, and has become one of the most common dinoflagellates in northern European waters. *K. mikimotoi* is capable of forming very dense blooms of "red tide" proportions, which can induce night time hypoxia and result in the death of farmed fish. Bloom senescence and the subsequent settling of large quantities of algal biomass may also result in benthic anoxia and the death of the fauna of the affected region. *K. mikimotoi* is also thought to induce fish kills through the production of haemolytic cytotoxins. While sporadic incidences of *K. mikimotoi* have been reported in Scottish waters, its harmful impact has remained relatively inconsequential in comparison to species of the genera *Alexandrium*, *Pseudo-nitzschia* and *Dinophysis*. However, in 2006 a large and protracted bloom of *K. mikimotoi* was observed in Scottish waters. This bloom reached densities of over 3 million cells per litre in the Orkney Islands, but also impacted a larger part of the west and north Scottish Coastline. The development and progression of the 2006 Scottish *K. mikimotoi* bloom is discussed in relation to environmental variables, as is its potential as a major threat to aquaculture in UK waters.

14. Characterisation of temperate phage active against freshwater phycocyanin-rich *Synechococcus*

Mandy Dillon & Jackie Parry

University of Lancaster

This poster presents the first description of temperate phage active against freshwater *Synechococcus* spp. Sixteen strains of lysogenic *Synechococcus* were induced with mitomycin C and the resultant temperate phage were characterised using TEM. All phage had morphologies typical of the family Siphoviridae. The head diameters ranged from 40 to 48 nm and the tail lengths ranged from 135 to 186 nm. The burst sizes ranged from 80 to 139 phage/bacterial cell.

15. The effect of diatom-derived aldehydes on aquatic organisms

Hannah J. Dunstan, Gary S. Caldwell & Matthew G. Bentley
University of Newcastle-on-Tyne

Exposure to diatom-derived aldehydes including 2,4-decadienal has been shown to cause undesirable effects on a range of invertebrate organisms ranging from infertility and abortion to pronounced larval malformations. In this study 2,4-decadienal was assayed on *Daphnia magna* and *Salmo salar* L. Exposure led to increased physiological stress in *Daphnia* (as determined by monitoring heart beat rate) and reduced growth. The effects on salmon included reduced hatching success and increased incidence of morphological abnormality, providing further evidence of the teratogenic properties of decadienal. This work demonstrates that decadienal is toxic to invertebrates and vertebrates alike and may represent a stress factor limiting the recovery of salmon populations in rivers containing aldehyde producing microalgae.

16. Coccolithophorid morphology under varying salinity and temperature in cultures and in the fossil record

Sam Fielding

Department of Earth & Ocean Sciences, University of Liverpool

The planktonic Coccolithophorid algae are a major component of oceanic algal blooms in waters ranging from fjords and coastal seas to the true pelagic, and are thus important for many marine food-webs. They also play a key role in mediating atmosphere-biosphere-geosphere carbon interactions, and are therefore integral to global carbon cycle models. In the past, sea surface temperature has changed causing changes in bloom intensity and dynamics. I present data showing differential culture growth rates under varying temperature of the coccolithophorid *Emiliana huxleyi* (Lohm) Hay & Mohler. Such data has wide implications for statistically determining and interpreting palaeo- and future marine productivity. Preliminary data from these culture experiments also show the morphology of the calcite shields of coccolithophores (coccoliths) have potential to be used to reconstruct past temperatures. Using this morphological proxy alongside palaeoproductivity estimates from growth rate experiments will provide a powerful combined tool for palaeoreconstruction and palaeoenvironmental interpretation. Extension of this type of analysis to salinity will provide valuable insight into the combined effect of these two major chemical driving forces in the marine environment.

17. The Winter's Tale: survival of *Planktothrix rubescens* in Lake Zürich

Daryl P. Holland & Anthony E. Walsby

School of Biological Sciences, University of Bristol

The filamentous cyanobacterium *Planktothrix rubescens* grows during summer and autumn in Lake Zürich. Over winter, filaments remain in the water column, circulating to progressively greater depths where darkness reigns and the temperature falls to 4°C. In spring, when the lake restratifies, the filaments float back to the metalimnion, forming the inoculum for the summer population. We tested the ability of several Lake Zürich strains of *P. rubescens* to survive periods of incubation in continuous darkness at 4°C, using two procedures. (1) Single filaments removed at 2-4 week intervals from the incubated suspensions were cultured in light at 20°C. (2) Single filaments incubated in separate tubes were transferred to light at 20°C after two months. Results varied with different strains. In several, filaments disintegrated after four weeks of darkness; some remained whole but did not grow; others remained viable after two months. There was some correlation between long survival time and

higher gas vesicle strength, which permits buoyancy retention at greater depth. The results indicate that some filaments left at great depth in Lake Zürich can remain viable and contribute to the summer population if they circulate or float back to the metalimnion in time. Different strains of *P. rubescens* may have different winter-survival strategies. If the recent trend for warmer winters with incomplete mixing of Lake Zürich continues, prolonged cold-dark survival times may become less important.

18. Organic inclusions in epilithic diatom frustules as a host for C and N isotopes

Lydia King, P.A. Barker, S.R. Fielding, P. Deines, J. Grey & S.C. Maberly

University of Lancaster

Two developments led to this investigation of the relationship between stable isotope signatures from proteins in freshwater diatom frustules, with the signature of bulk periphyton and environmental parameters. Firstly, Kroeger et al. (2002) showed that diatom frustules contain proteins, which are protected from diagenesis and, secondly, C and N stable isotope signature of bulk sediment have often been used to infer lake history, but it is difficult to separate productivity signals from source effects without compound specific isotope analysis. Therefore epilithon was collected from 14 lakes in the English Lake District. Diatom frustules were cleaned (H₂O₂ and HCl), sieved, separated from silt with SPLITT, and dried. All samples were then analysed for C and N stable isotopes. The results showed that isotope values of the diatom inclusions are less heterogeneous than bulk periphyton and indicate that $\delta^{13}\text{C}$ of diatom inclusion relates well to lake productivity (Chl a and Secchi depth), and $\delta^{13}\text{CDIC}$, whereas none of these are related to $\delta^{13}\text{C}$ of the bulk epilithon. Diatom inclusion carbon stable isotope signature was elevated at the less productive lakes indicating less carbon availability in these systems, in contradiction to classical fractionation by algae. Further analysis of the relationship between the stable isotope signature of diatoms and the protein inclusions will be required from a wider range of lakes and cultures. Nevertheless, this method has great potential as an indicator of trophic changes and can be used to generate time series from lake sediments.

19. Biochemical and molecular changes in response to high-light stress in the diatom *Thalassiosira pseudonana*.

Markus Klenell, Neil Baker & Graham Underwood

Department of Biological Sciences, Essex University, Wivenhoe Park, Colchester CO4 3SQ

Phytoplankton and microphytobenthos inhabit environments with highly variable light regimes and frequently encounter light intensities in excess of that required for photosynthesis. They are thus prone to suffering from the effect of excess excitation energy (EEE) and the production of deleterious reactive oxygen species (ROS). Previous studies on the diatoms *Thalassiosira pseudonana* and *Nitzschia epithemioides* in our laboratory indicated that these have a higher degree of oxygen reduction during exposure to excess light, after acclimation to high light (300 $\mu\text{mol m}^{-2} \text{s}^{-1}$) compared to when acclimated to low light (50 $\mu\text{mol m}^{-2} \text{s}^{-1}$). These results suggest that part of the high-light acclimation in diatoms is a biochemical setup that allows them to divert a larger portion of the incoming light to oxygen reduction. The aim of this study is to investigate the presence of a biochemical defence against photo-oxidative stress, in the form of superoxide dismutase (SOD) and ascorbate peroxidase (APX) (key enzymes involved in the water-water cycle) and their regulation at the molecular level. We have used the planktonic species *T. pseudonana* for this purpose since its genome has recently



been fully sequenced and annotated. The initial studies indicate that the activities of both SOD and APX are roughly equal in samples that have been adapted to low and high light. However, at least one gene coding for APX is more strongly expressed in high-light acclimated cells.

20. The *Daphnia* - *Desmodesmus conundrum*

Xiyu Phoon & Elliot Shubert

Natural History Museum, London

It is well known that the cladoceran, *Daphnia magna*, a common zooplankton in freshwater ponds and lakes relies on a variety of green algae as a food source. Environmental variables change at different temporal and spatial scales and algae and zooplankton can respond to these changes with respect to morphology, growth, physiology and/or reproduction. It is well known that species of the green alga, *Desmodesmus*, exhibit phenotypic plasticity in the laboratory and in the field. The purpose of this investigation was to investigate the defence mechanism of *Desmodesmus subspicatus* UTEX 2532 in the presence of *Daphnia magna* and sterile-filtered culture extracts of *Daphnia* with respect to morphological change. The results of preliminary experiments demonstrated that axenic *Desmodesmus* unicells (100%) fed to *Daphnia* were significantly altered (15% uni: 85% col), and axenic *Desmodesmus* colonies (100%) fed to *Daphnia* were also significantly altered (93% uni: 7% col). Axenic cultures of *Desmodesmus* unicells (100%) and colonies (100%) were grown in used *Daphnia* filtered-sterile water resulting in a similar morphological shift (unicells inoc: 30% uni: 70% col; colony inoc: 93% uni: 7% col). There were no significant morphological shifts in control cultures. The grazer-induced morphological transformations may be due to the interacting presence of infochemicals and nutrients produced by the grazers. The results suggest a *Daphnia* - *Desmodesmus conundrum*.

POSTERS - ECOLOGY OF SEAWEEDS

21. 'Hotspots' of intertidal diversity at different scales

Andrew J. Blight, Mark Johnson, Christine Maggs & Louise Allcock

School of Biological Sciences, Queen's University Belfast

'Hotspots', areas with exceptionally high biodiversity, are often used to justify management and conservation programmes but have been relatively understudied in intertidal zones. The focus of this project is a hotspot approach to the diversity of intertidal habitats, with a view to examining the patterns of diversity at a number of different scales. A relational database was constructed out of a number of UK biodiversity datasets. This contains details of the surveys that have taken place in each 10 km square, including all the algal and mollusc species recorded by each survey. Potential hotspots were identified from the data and selected sites are being surveyed to examine the extent to which the regional patterns of diversity are reflected at smaller scales. At small scales, productive and diverse assemblages of algae are predicted to support the most diverse assemblages of molluscs. These local patterns exist within a background of large-scale gradients in species diversity. The larger scale patterns will be analysed with particular attention to the potential effects of changes in habitat availability or near shore hydrography.

22. Algal morphological complexity: investigating temporal variation in rockpool algal assemblages

Helen Churchill, Michelle Tobin & Sue Hull

Scarborough Centre for Coastal Studies, University of Hull

Algal morphological complexity has been investigated in a wide range of individual species. However algal species contribute to the overall habitat complexity within a community and it is the complexity at the habitat level that remains poorly understood. The current study aims to quantify the variation in habitat morphological complexity of a temperate rockpool habitat by examining the algal morphological complexity of its constituent species. Three replicate samples of thirteen dominant macroalgal species were collected from each of two intertidal rockpools at Crook Ness, Burniston, on the north east coast of England. Samples were collected each month between May 2004 and April 2005. Four measurements of algal morphological complexity were recorded for each species. Temporal variation was investigated using each complexity measure at the level of the species and also at the level of the habitat (all species pooled). All algal species showed variation in morphological complexity over time; however the extent of this variability differed between species. Within a species patterns of variation were similar for both rockpools. The algal morphological complexity of the rockpool habitat as a whole remained constant throughout the study period, despite changes at the level of individual species. The findings are discussed in the context of habitat use by intertidal algal epifauna.

23. Preliminary findings of an investigation into the effects of increasing sedimentation on rocky intertidal community structure

Helen Churchill, Michelle Tobin & Sue Hull

Scarborough Centre for Coastal Studies, University of Hull

The influence of sediment on the structure of rocky intertidal communities is well documented. Recruitment, survival and diversity of both fauna and flora have all been shown to be affected by the levels of sediment present within a system. The rocky intertidal zones at Holbeck, Scarborough, North Yorkshire have been subject to increasing levels of accumulating sediment, which whilst not identified as being caused by alterations to local sea defences, the timing of occurrence suggests a possible link. Recent observed changes to community structure include the filling of previously *Corallina* dominated rock pools, the spread of sediment trapping algal turfs and also the increasing extent and residence time of an upper shore sediment zone. Mass mortality of littorinids and patellids as a result of smothering by sediment has also been observed. In an attempt to quantify the observed changes and assess the levels of sedimentation, a spatial and temporal study of the community structure on the shore was initiated. 54 fixed 50cm² quadrats were established across the shore and were sampled on one neap and one spring tide each month. Within each quadrat the percentage cover of algal species and sediment distribution, sediment depth and the abundance of macrofauna were recorded. The extent and depth of the upper shore sediment zone was recorded and sediment samples were collected for grain size analysis. This poster presents the preliminary findings of this study and outlines the aims of further work.

24. The effects of tidal range and intertidal extent on species richness of intertidal seaweed assemblages on British shores

Sarah Holt & Martin Wilkinson

School of Life Sciences, Heriot-Watt University, Riccarton, Edinburgh, EH14 4AS.

Under the European Water Framework Directive, coastal water

bodies are to be assessed for ecological quality status using several biological quality elements including macroalgae. In the United Kingdom seaweed species richness is to be used. This has been shown to be relatively constant over time on individual shores not subjected to environmental change. However, on a spatial basis species richness varies greatly between different shores with differences in physical factors, such as wave exposure, natural water turbidity and sub-habitat diversity. These variations have been taken into account in the proposed monitoring tool. As yet no account has been taken of the effect on species richness of tidal range and shore extent. Tidal range is important since it is one aspect of the water body typology required for the directive. Associated with tidal range is the intertidal extent of the shore which depends on slope. Could longer shores give more opportunity for sub-habitat diversity? In the present work the effects of these two factors were investigated by seeking correlations between species number and the tidal range and horizontal extent of shores using two databases. One was 128 rocky shores studied from 1984-88 for the Northern Ireland Littoral survey and the other was a listing of 217 rocky shore surveys in England, Scotland and Wales that was compiled for Water Framework Directive. For Northern Irish shores a significant ($P=0.05$) correlation was found with tidal range but not with intertidal extent. For England, Scotland and Wales there was a highly significant ($P=0.01$) correlation with intertidal extent but none with tidal range. These apparently contradictory results may be a consequence of the considerable variation between shores in features other than the two being tested. Further work is directed at determining whether or not any particular functional type of seaweed is responsible for the greater richness on those shores where a positive correlation was found between richness and the factors tested.

25. Can juvenile *Fucus* really deter grazing by *Littorina littorea*?

Sara Marsham, Graham W. Scott & Michelle L. Tobin

Scarborough Centre for Coastal Studies, University of Hull

Grazing by herbivores has been shown to induce chemical defences in algae. To investigate the possibilities that these chemical defences are a property of the plant or of the water surrounding the plant we assigned *Littorina littorea* to one of four experimental treatments and measured the amount of alga consumed. We also used the results to determine if juvenile *Fucus* sp. can deter grazing by snails. Our results show that previously grazed plants are just as palatable as ungrazed plants and chemical deterrents do not seem to accumulate in the seawater surrounding the plant. We suggest that juvenile *Fucus* sp. plants do not produce chemicals that effectively deter the herbivore.

26. *Ascophyllum* and climate change- A preliminary study

Helen McGrath & Dagmar Stengel

Martin Ryan Institute, National University of Ireland, Galway

This review looks at the effects of predicted climate change on the productivity of the furoid *Ascophyllum nodosum*. Earth's global climate is undergoing significant changes. Anthropogenic activities have augmented atmospheric CO₂ levels and average global temperatures. UV-B radiation levels, reaching the Earth's surface, are also increasing. However, increases in these abiotic factors are not necessarily favoured by *A. nodosum*. Increases in temperature can affect the phytogeographic limits of algae and the phenology of *A. nodosum*. Photosynthetic rates of some brown macroalgae do not increase with increased CO₂ levels. Increases in UV-B radiation are negatively correlated with growth in *A. nodosum* due to the production of UV screening compounds, phlorotannins. In light of

the possible effects climate change may have on this species and the contribution that harvesting of *A. nodosum* has to the Irish economy, strategic plans to maintain ecologically and economically viable populations of this species are required. So further investigations on the individual and combined effects of the predicted climate change on the productivity of *A. nodosum* is required to advise adequate management for this species. These aspects will be investigated through a PhD project to be undertaken in the Martin Ryan Institute, NUI, Galway.

27. Elemental distribution in *Fucus vesiculosus* (Fucales, Phaeophyceae) from basalt, chalk and granite substrates

Liam Morrison¹, Lynn Browne², Dagmar Stengel¹ & Matthew J. Dring²

¹ Department of Botany, Martin Ryan Institute and Environmental Change Institute, National University of Ireland, Galway

² School of Biological Sciences, Queen's University Belfast

Concentrations of 21 elements (Li, Ti, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Rb, Sr, Mo, Ag, Cd, Ba, La, Ce, Hg, Pb and U) were determined in the brown alga *Fucus vesiculosus* (Fucales, Phaeophyceae) growing on chalk, basalt and granite bedrock from the Irish west and north coasts using inductively coupled plasma mass spectrometry. The aim of this study was to examine the relationship between seaweed chemical composition and its underlying geological substrate. The geochemical composition of these bedrock types were examined using total (hydrofluoric acid extraction) and sequential (hydroxylamine hydrochloride extraction) digestion techniques and compared with the seaweed chemistry. The results showed that concentrations of Li, Ti, Cr, Fe, Ni, Cu, Mo, Ag, Cd, La, Ce and U were significantly greater in holdfasts than in actively growing tissue regions, while Mn, Sr and Ba levels were greater in actively growing tips. Both tissue regions had similar concentrations of Co, Zn, As, Rb, Hg and Pb. Differences also existed in the elemental content of the seaweed growing on the different rock types and the results suggested that bedrock geochemistry may specifically influence Mo and U abundance in seaweed tissue.

28. Morphological and ecological variation in two forms of *Fucus spiralis* L.

Jane Pottas, Sue Hull & Graham W. Scott

Scarborough Centre for Coastal Studies, University of Hull

Fucus spiralis is an intertidal brown seaweed of the upper littoral zone found growing on rocky substrata on sheltered to moderately exposed shores. It exhibits great variation in morphology across its distribution range and several forms have been described. This poster focuses on some of the key findings of a comparative study of the morphology, ecology and survivorship of two morphs, forma *spiralis* and forma *nanus*. The two formae have discrete morphologies which are maintained over time. *F. nanus* grows at a higher tidal level above chart datum than does *F. spiralis* and is always found on north facing aspects suggesting a clear ecological separation. Survival time is associated with both forma and location (shore). *F. nanus* has a shorter survival time than *F. spiralis* and populations of both formae at Filey had a shorter survival time than populations at Saltwick. Such differences in survivorship may be related to a combination of environmental factors and genotype. Future work could examine the role of desiccation on survivorship and distribution of the two formae.

29. An ecological characterisation of an *Ascophyllum nodosum* ecad *mackeanii* population on the Irish west coast



Dagmar Stengel & Mark Loughnane

Department of Botany, Martin Ryan Institute, National University of Ireland, Galway

Free-living forms of the intertidal seaweed *Ascophyllum nodosum* (Fucales, Phaeophyceae) have been reported from a number of locations in Britain, Ireland, the Baltic and on western Atlantic shores. The ecads '*mackaii*' and '*scorpioides*' have been described from sites characterised by extreme shelter from wave exposure, generally low salinities (or fluctuating salinities) and muddy substrata. However previous descriptions of morphological characteristics considered important in distinguishing between '*mackaii*' and '*scorpioides*', and several forms within and between these, are not consistent in the literature, and a considerable overlap of characteristics and morphological variability has contributed to this confusion. Although the distribution of the free-living forms is usually patchy and limited in area, which has made it difficult to assess within-shore variation and shore height-related features of populations, an extensive population has recently been found on the Irish west coast. This preliminary study reports on morphological variability within this population, with respect to previously described forms of both '*mackaii*' and '*scorpioides*'. Standing crop, individual plant size, productivity and growth, as well as movements of individual plants and the population as a whole are being monitored.

30. Ecophysiological studies on *Fucus distichus* in relation to its possible use as a sentinel of rising sea temperature in Britain

Gail Twigg & Martin Wilkinson

School of Life Sciences, Heriot-Watt University, Riccarton, Edinburgh, EH14 4AS.

Fucus distichus is a northern species which occurs only at a few localities in the north of the British Isles, which is its southern limit in Europe. In Britain two subspecies are restricted to sharply contrasting habitats. Subspecies *anceps* only occurs under the most severe Atlantic wave exposure while subspecies *edentatus* is restricted to a few harbours. This poster concerns *ssp. anceps* which is the most widespread subspecies. As a visually obvious plant at its southern limit it has been proposed by JNCC as a sentinel species for monitoring change owing to sea temperature rise. Germlings of *ssp. anceps* from Orkney did not show a lower optimum temperature for growth than those of *F. spiralis*, *F. vesiculosus*, and *F. serratus*. All four species showed the same pattern with a significantly higher growth rate over c.80 days in culture at 15°C than at 5°C or 10°C. Against expectation, *F. spiralis* f. *nana* from Orkney differed from all other isolates, including typical *F. spiralis*, in showing a statistically significant optimum for germling growth at 5°C. *Ssp. anceps* also occurs on the west coast of Ireland, e.g. Co. Clare; again only in the most severe wave exposure. Germlings from Co. Clare showed a significantly greater growth rate than Orkney plants of the same subspecies at 10°C. Excised apical segments of adult plants showed a broadly similar pattern. Considering the marked restriction of this subspecies to extreme exposure compared with wider occurrence north of Britain, it seems that more than temperature may be involved in determining its occurrence.

POSTERS - FLORISTICS

31. Brazilian species of Ceramieae (Ceramiaceae, Rhodophyta): Morphological and molecular data

Beatriz Barros-Barreto¹, M.A. Jaramillo², Lynne McIvor³, Christine

Maggs³ & P.C.G. Ferreira¹

¹ Universidade Federal Rural do Rio de Janeiro, Brazil

² University of Missouri-Columbia, USA

³ Queen's University Belfast

Morphological and molecular studies consider the Ceramiales to be monophyletic. The order comprises the families Ceramiaceae, Dasyaceae, Delesseriaceae, Rhodomelaceae and Sarcomeniaceae, Ceramiaceae being the most basal. The tribe Ceramieae, the largest within this family, is represented in Brazil by *Ceramium*, *Centroceras*, *Corallophila*, *Centrocerocolax* and *Spyridiocolax*. *Ceramium*, *Centroceras* and *Corallophila* contain epiphytic, filamentous, branched species with nodal articulations. The taxonomy of this group remains confused due to the lack of diagnostic morphological characters, so molecular data are useful for delimitation of taxa. The *rbcL* gene is frequently employed in phylogenetic studies of the Ceramiales because it is informative, with an appropriate level of variation. The aim of this study is to use morphological and molecular data to delimit non-parasitic genera of the tribe Ceramieae in Brazil. Samples have been collected in SE and NE Brazil. Phylogenetic analyses were based on an alignment generated from sequences of newly collected samples and from GenBank. These were inferred through parsimony, Maximum Likelihood and Bayesian analyses. *Ceramium*, as currently circumscribed, is not monophyletic with respect to *Centroceras* and *Corallophila*. These analyses allowed us to delimit most Brazilian *Ceramium* species and confirmed the position of *Corallophila atlantica*. Three *Ceramium* species were added to those already known for the Brazilian coastline: *Ceramium affine*, *Ceramium filicula*, and *Ceramium fujianum*. *Ceramium* aff. *diaphanum* and *Ceramium* sp. have morphological and molecular differences from samples previously studied, suggesting that they are additional species.

32. Diversity of the genus *Porphyra* (Rhodophyta) in the southern Pacific: Species of the Chilean coast

María Eliána Ramírez¹, Juliet Brodie², Stephen Russell² & Barbara Rinkel²

¹ Museo Nacional de Historia Natural, Santiago, Chile

² Natural History Museum, London

The genus *Porphyra* has one of the largest number of species of the red algae and is found throughout the world in warm to cool temperate waters. It is also ecologically and economically important. In Chile *Porphyra* can form a distinct zone in the upper intertidal and species harvested by fisherman and sold under the name 'Luche'. Until recently there were five species of *Porphyra* reported for the Chilean coast but the taxonomic status of these species is unclear. The main aim of this project is to determine the number of species of *Porphyra* in Chile and to establish the taxonomic relationship of these species with those from other parts of the Pacific and other parts of the world. Preliminary studies including, field observations, morphological and molecular data indicate that there is considerably more diversity within the genus in Chile than previously thought. This work shows some of these results.

33. The Fritsch Collection of Algal Illustrations - Freshwater, Brackish and Terrestrial

Elizabeth Y. Haworth, Elaine Monaghan, Gina Devlin & Lynda Durrell

Freshwater Biological Association, Ambleside, Cumbria

This Collection comprises several million published figures and taxonomic entries on fresh- and brackish-water algae from around

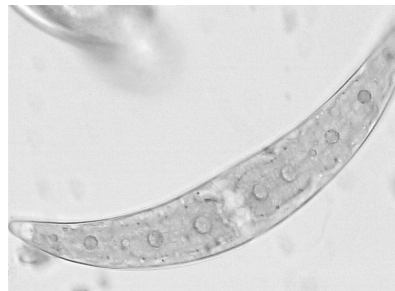
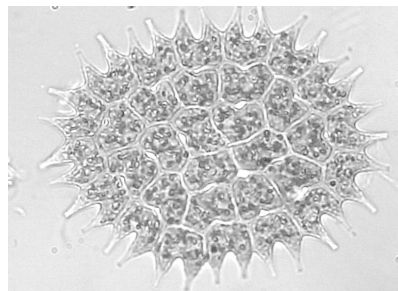
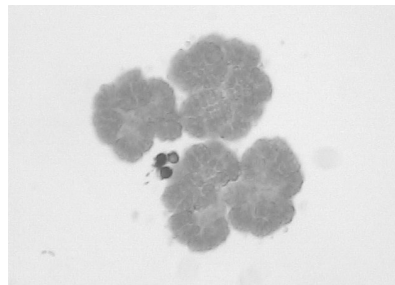
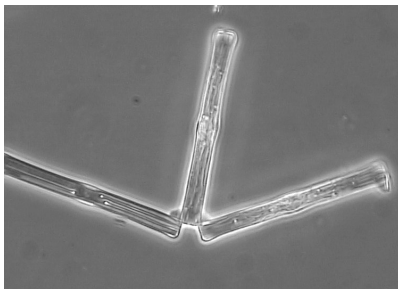
the world. Started by Professor F.E. Fritsch in 1912, it is held by the Freshwater Biological Association at Windermere in north west England. The Fritsch Collection consists of species sheets organised by genus within major groups, e.g. Cyanophyta, Chrysophyceae, diatoms, colonial green algae, etc. With comprehensive author citations, this unique reference collection, has traditionally been used by researchers to assist in identification and for the resolution of taxonomic problems. The Collection contains floristic information from a worldwide variety of papers, not only major works, which have been published from the eighteenth century to the present day. Constantly updated, the Fritsch Collection illustrates the diverse and changing views that have been, or are still, held about the identification and taxonomy of many algae. Microfiche copies are available from IDC.

34. Long-term comparisons of the desmid flora of mid-west Ireland

David M. John, David B. Williamson & Ciarán J. Loughnane

Martin Ryan Institute, National University of Ireland, Galway, Ireland and Natural History Museum, London

The desmid floras of South Mayo and Connemara (mid-west Ireland) have been investigated by us since 1990. Our findings are compared to those of surveys conducted in 1890 by William West and in 1904 by William and his son George West. Site-specific comparisons are made of 14 'acid'/circumneutral loughs sampled in July 1890. Of more than 280 desmid taxa recorded at that time only 25% have been discovered again. In all of the loughs, including the two most desmid diverse (Derrycare and Loughaunearin; >80 spp), there were relatively few taxa in common (<15) when new and old survey findings were compared. If all the desmids recorded for Connemara and South Mayo are compared, then about half of the taxa mentioned by the Wests (ca. 800) have been rediscovered. Differences in spatial distribution patterns within a lough and time of sampling are not considered important factors accounting for the dramatic changes in the diversity and composition of the desmid floras. Only in the three loughs studied in County Mayo (Baheh, Moher, Creggan) are changes in the desmid floras probably related to differences in water chemistry; pH and conductivity are higher in these three loughs compared to those studied in Connemara. In the absence of comprehensive water chemistry data, reasons for the dramatic changes in the desmid floras over the 20th century are mere speculation.



Top left, *Tabellaria flocculosa* var. *asteronelloides*

Top right, *Botryococcus*

Bottom left, *P. boryanum*

Bottom right, *Closterium*



2007 MANTON PRIZE AND POSTER PRIZE WINNER

Daryl Holland
PhD Student, Cyanobacteria
School of Biological Sciences
Bristol University

- Oral Presentation:

Sinking characteristics of phytoplankton

- Poster Presentation:

The Winters's Tale: survival of Planktothrix rubescens in Lake Zürich

I was an undergraduate at Monash University in Melbourne, Australia, studying a combined Arts/Science degree, majoring in Biology and Archaeology. I found biology the more interesting subject, and decided to pursue this in my honours year. I took a project with Dr. John Beardall, studying ways of measuring nutrient limitation in natural phytoplankton communities. After successfully completing my honours, I was employed on a number of short term positions, first with Dr. Beardall in the Phycology lab, and then in the Monash University Water Studies Centre. I did field work in a number of locations that regularly suffer from toxic cyanobacterial blooms, including the Gippsland Lakes, the Darling River and the Royal Botanic Gardens, Melbourne. I found that monitoring programmes were generally adequate, but site- and species-specific information on the ecology of bloom formers was in many cases lacking, making interpretation of monitoring data and modelling of bloom formation problematic. While I am particularly interested in the environmental issues surrounding blooms, I felt that I needed to better understand these organisms at a more personal level if I was to make an impact.

After 11 years at Monash, I decided that I needed a change of scene. There has long been an unofficial exchange programme between Australia and the UK, where young Brits travel to Australia to pick fruit, and young Aussies head to the UK to pull beers. Having neither the



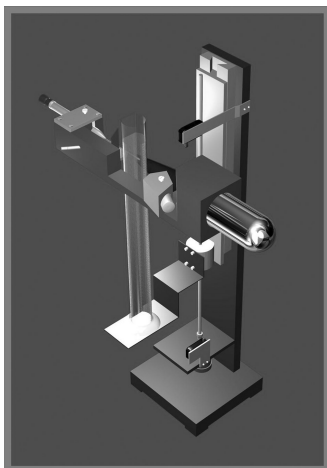
skill nor inclination to work in a bar, but not wanting to miss out on the chance to complain about the weather, I decided to stick with what I knew, and apply for a PhD in phycology. This led me to Prof. Tony Walsby and Bristol University, where I am now in the third year of my PhD, funded by an Overseas Research Studentship from Universities UK.

My funding arrangement does not tie me to any particular project, so I have been pursuing a number of disparate topics around the broad field of phytoplankton ecophysiology, hence my presentation of a talk and poster that were seemingly unrelated. I have spent most of my time looking in depth at improving the measurement of sinking velocities of phytoplankton, and this has led me to examine in detail the fundamental physics behind sinking, and how we can use this to better understand the planktonic form. While I am not a physicist, I have enjoyed the challenge of interpreting the physical laws in a biological context.

I have also been measuring the over-winter survival of *Planktothrix* from Lake Zürich. While these two topics seem unrelated, both help to build a picture of the phytoplankton lifestyle. For example, if a *Planktothrix* filament is mixed to the depths of Lake Zürich during the winter and we know how long it can survive without light, and how fast it floats, we can work out whether it is likely to contribute to the following growing season.

I believe the ability to communicate research is an important skill for any young scientist to learn, and the best way to learn is to do, so I am grateful to the BPS for giving me the opportunity to present my work in such a friendly, supportive and stimulating atmosphere.

I hope to take the knowledge, contacts and experience I gain in the UK back to Australia, where I will pursue a career in limnology. I have thoroughly enjoyed my time in the UK, and I have probably seen more rain than I will in the rest of my life. I am yet to pull a beer, but I have enjoyed the results of other people's endeavours in that area.



Laser scanner used to measure sinking velocities of phytoplankton

Ed: The judging panel for the 2007 Poster Prize also wished to acknowledge the following poster, which although did not win the Poster Prize was judged to be particularly noteworthy in its scientific content and impact, design detail, and ease of read criteria.

Maeve Edwards
Queen's University, Belfast
m.edwards@qub.ac.uk



Poster Presentation: The commercial aquaculture of *Palmaria palmata*

Several weeks ago I was reflecting on how I became interested in phycology, and in particular, the macroalgae. Like so many people, I have happy memories of investigating rock pools, but few can claim to have called a toy dog 'Seaweeds' at the approximate age of four.

My initial idea when I applied to for University places (1999) was to study Botany, but I was a year too late - the Botany department had been merged into a larger department (Queen's University, Belfast), and so I had to settle for Biological Sciences. The

course opened up many fascinating avenues of study, but I stuck to my original idea of Botany as closely as I could until I discovered the Marine Biology modules. From there it was easy to combine both Botany and Marine Biology in the study of algae. My Honours project with Christine Maggs and Matthew Dring investigated the recruitment of juvenile *Ascophyllum nodosum* in Strangford Lough. Since that short introduction to seaweed, I was involved in another project with Christine and Francis Bunker identifying epiphytic macroalgae on Welsh *Zostera marina* as part of the UK Biodiversity Action Plan.

Both of these projects have led to a CAST PhD (part-funded by Dolphin Sea Vegetable Co.) with Matthew Dring, entitled 'the cultivation of the edible red alga *Palmaria palmata*', which I hope to finish in the next one to two months. This is a commercially important species, and is still eaten in quantity in Northern Ireland, where the local suppliers cannot meet the demand. In an effort to do so, the aquaculture of *Palmaria* has been

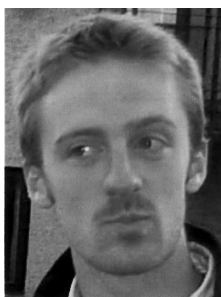


Palmaria palmata on culture string from tetraspores.

considered, and the project made recommendations about best methods for culturing the alga from settled tetraspores on culture string etc. It has been an unforgettable experience, not only from the point of view of the research, but also from the opportunities to meet new people in conferences and from similar fields. I hope to continue to study macroalgae in the future and develop what I have learnt already.

The BPS meetings I've been to have always been very interesting and entertaining (in that order), and I would like to thank the poster prize judges for mentioning my poster at the 2007 Belfast meeting.

Student Representative of Council



Sam Fielding
s.r.fielding@liv.ac.uk

As the new student representative of the BPS Council I shall be the first port of call for any issues concerning student interaction with BPS activities. What do you feel is missing? Why did you feel it wasn't worth coming to the last meeting? How do our meetings compare with those of other organisations? If you have answers to questions like these, turn them into positive action. The sooner we know of any problems or shortcomings the sooner we can provide students with a better BPS experience.

I am in my first year of a PhD studying at the University of Liverpool after graduating last year with an Ecology degree from Lancaster. My research now covers both algal culture and palaeoreconstruction in both the Biological Sciences, and Earth & Ocean Sciences departments. Like myself there are a lot of students out there who work in a

field which may seem slightly outside that of the "average BPS member" but who are equally welcome at our meetings. I'm sure student presentations and posters on more diverse topics would make a valuable contribution, and would help to broaden the outlook of the BPS as a whole.

If you aren't a member and would like to show your research to the BPS, student membership is very affordable (see the web site) and you can apply for financial support to attend meetings. There are also prizes awarded for the best student poster and the best student presentation.

In the past there has been talk of students giving short presentations in front of their posters and of student-only workshops and discussion sessions. These are still realistic possibilities (perhaps at the next meeting) and your opinions on such events would be much appreciated.

If anyone has any other ideas on how they would like to see the BPS improved for students, let me know by email, or you catch up with me at the next annual meeting in Bristol, January 2008.



STUDENT BURSARY AWARD REPORTS



Alison Curtis & Alexander Boughton.

Alison and Alexander were funded partly by a BPS bursary and partly by NERC grant NE/D003598/1.

Beginning on Monday 14th August 2006, our studentship ran for the duration of four weeks, based at the University of Essex Biological sciences department, and was overseen by Professor Graham Underwood.

As undergraduates who have only just completed our first year of the Marine and Freshwater Biology degree scheme at the University, this was an opportunity too good for us to miss. Our aim was to investigate the diversity of microphytobenthic communities in salt marsh surface sediments and salt marsh pans. Initially reading the brief and having some further details explained to us we walked away with blank faces, because of our very limited knowledge of the subject area.

Over the four weeks we have surprised ourselves with the level of interest and enthusiasm we have gained in this subject area. Having seen plenty of organisms new to our knowledge, and even had some fun along the way! The project took us to four sites along the Colne estuary; Colne Point Salt Marsh, Alresford Creek, The Strood, and Hythe. At each of these sites cores of mud were sampled and then returned to the labs at the University for analysis.

We sampled our first site, Colne Point Salt Marsh, on Thursday 17th August, having spent the days previous familiarising ourselves with the labs, equipment and procedures we would use for our analysis, and reading up on the various species we hoped that we would find. At Colne point, we took fifteen samples, five samples from three different sub-sites: creeks, salt marsh pans, and marsh tops. For each sample, a note was made of the location and appearance by eye of the sample. At each sampling site we took one core, and two minicores. This meant that for each sub-site, we had five cores and ten minicores to analyse back at the labs.

This process was repeated for our second set of cores, extracted from The Strood, Mersea the following week on Thursday 24th August. However, for our third and final sampling trip to collect data for the study, on Thursday 31st

August, we sampled ten sets of cores at Alresford Creek, five within the creek, and five within salt marsh pans; then five cores from Hythe, where our only option was to sample from the creek itself. The decision was made not to sample the marsh top at Alresford creek because at other sites we had seen very little in the way of microbial activity on marsh tops.

Once returned to the lab, each set of cores were dealt with in the same way. The surface layer of the main cores were used to make up wet slides in order to observe live organisms; lens tissues were set up and left overnight to lift cyanobacterial mats in order to create acid cleaned permanent slides, and preserved samples in glutaraldehyde, then the remains were sieved for invertebrates; while the minicores were used to obtain data for chlorophyll a analysis, percentage water content, and percentage ash free dry weight.

We were able to look at the surface of each core under a dissection microscope, and then once slides had been made, we went through them using both brightfield and phase contrast microscopic techniques, and used a digital camera mounted to the microscope to photograph our finds at 10, 40 and 100X magnification under phase.

The main aim of our investigation was to establish what species were actually present within the areas sampled, therefore various books and keys were used in order to help us identify what we were seeing on the slides we were making, and put names to the individuals we were taking photographs of.

We came across several species of diatom including *Diploneis bombus*, *Gyrosigma limosum*, *Gyro. fasciola*, *Scolioneis tumida*, *Cylindrotheca signata*, *Navicula phyllepta*, *Navicula digitoradiata*, and *Actinocyclus* sp. We managed to photograph these both alive and fixed, to get a true representation, however we always found that we could get a better idea of the internal structures when photographing at 100X with oil under phase contrast, as it was clearer to see the raphe and striae, therefore making the individuals easier to identify.

Cyanobacterial species identified from the samples included *Spirulina*, *Oscillatoria* and *Lyngbya*, which in dense populations formed mats on the surface of the marsh.

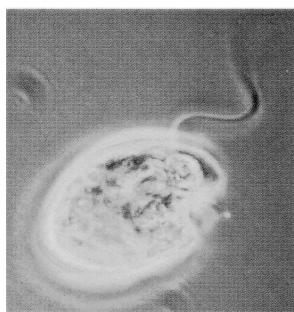


Through both examining the samples under the dissection microscope and sieving the samples, we found a range of crustacean copepods, nematode and oligochaete worms, gastropod molluscs and insects, present within the sediments ranging in size from a few mm to microscopic.

We were also lucky to observe the flagellate *Chromulina* which is a form of single celled motile algae, so all in all, a fairly wide range of organisms were present within the samples we had taken, providing much for us to process back within the labs.

From the data we have collated, images we have taken and the identifications we have made over the past weeks, we have managed to display our finds in the form of A0 posters, which we can proudly say are displayed within the department of biological sciences at the university.

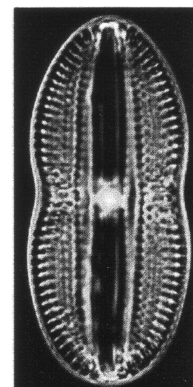
During this four week experience we gained invaluable experience in several areas, firstly in the field. During our first year course we only had limited experience in this area, so being able to go out in the field regularly to collect samples has provided us with some valuable skills. We also found it much more



interesting to look at slides of samples we had collected ourselves as opposed to ones made by someone else. The experience of working on mud flats and creeks has provided an invaluable ability to walk on wet mud and sediments, on every sampling trip there was an incident where one of us was either stuck or struggling to get out of the mud. We are sure this will have prepared us well for the estuarine field course we have June 07, where we will be able to watch every one else struggle!

The lab work we have been doing is also going to help us immensely in any practicals we have to do involving microbes, specifically diatoms and cyanobacteria. And also in the future with our final year dissertation, any postgraduate work we may do, and in our jobs. The experience has allowed us to work in a functioning research lab and wetted our appetite for carrying out further research in the future.

The four weeks we have spent working with Prof Graham Underwood has quite literally flown by. It has been fascinating to look at the intricate structure of these organisms, in particular, the diatoms; and we think that our experience over the last four weeks has given us a new appreciation for the microbial world and a desire to undertake further work within the field.

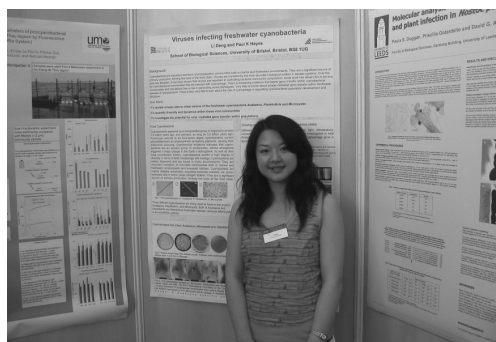


Li Deng, School of Biological Sciences, University of Bristol

The 12th International Symposium on Phototrophic Prokaryotes, 27th August - 1st September, Pau, France

I am currently a third year PhD student at Bristol University. My research involves studying cyanophages able to infect strains of the freshwater cyanobacteria *Microcystis*, *Anabaena*, and *Planktothrix*, to quantify diversity and dynamics within phage communities and to investigate the potential for phage mediated gene transfer within cyanobacterial populations. Thanks to funding from the British Phycological Society I had the fantastic opportunity to attend the 12th International Symposium on Phototrophic Prokaryotes in Pau, France last summer. The conference convenes every three years focusing on the current knowledge and most recent advances in all aspects of research performed on phototrophic prokaryotes.

The meeting was spread over 6 days and included 12 topics. The particular emphasis this year was the recent technologies towards understanding the functioning of phototrophic prokaryotes, from the cellular and subcellular level to the highly integrated mechanisms that allow cell to cell communications in microbial community, give evidence to their evolution and acclimation to complex and changing

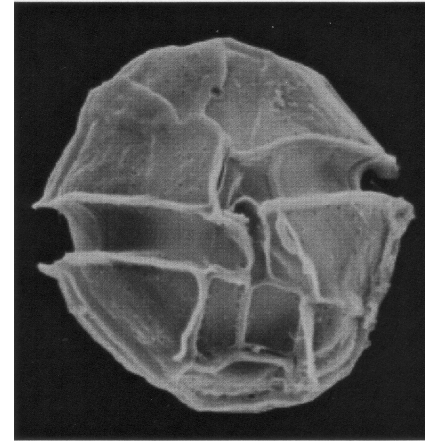
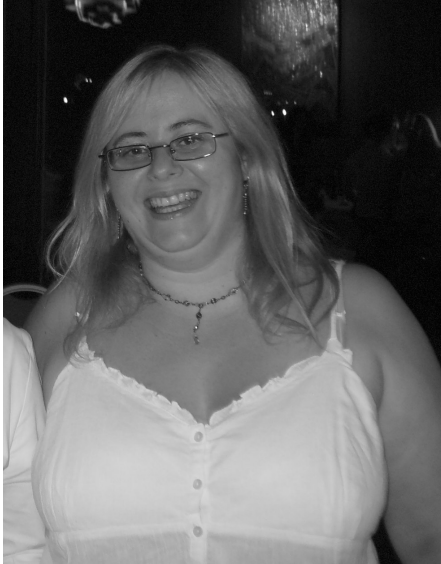


environments, and demonstrate their potential for biotechnological applications. Over eight hundred scientists from around the world had this wonderful chance to discuss and share their knowledge, discoveries and ideas. This symposium represents the largest international gathering of cyanobacteriologists and as such it provided me with the opportunity to discuss my work with all of the leading people in my field. Especially when I presented a poster summarizing my novel cyanophage isolations, I got a lot of brilliant suggestions on technologies and also the further possible directions to pursue my project, I really learned a lot during these 6 days.

Overall, the conference was enlightening and thoroughly enjoyable. I almost can not wait for the next ISPP meeting. I am really grateful to the BPS for the financial support towards this conference!



12th International Conference on Harmful Algae, September 2006, Copenhagen, Denmark



Alexandrium tamarense

Lynn Carter
PhD student
University of Westminster

Conference funding from the British Phycological Society enabled me to attend the 12th International Conference on Harmful Algae in Copenhagen, Denmark in September 2006. This conference had approximately 500 attendees from over 40 countries worldwide. Lecture categories were diverse and included allelopathy, climate change and its impact on harmful algae, genetic diversity, population dynamics, public health and economic impacts, monitoring and observing systems, toxicology and taxonomy/phylogeny.

Our group from the University of Westminster presented three posters. I was first author on a poster entitled "RNA content and growth rates in *Alexandrium* species cultured under varying environmental conditions" and a co-author upon a second poster presented by Professor Jane Lewis entitled "The distribution of *Alexandrium* species in British coastal waters". The third poster was presented by Linda Percy and was entitled "An investigation of the relationship between *Pseudo-nitzschia* species and domoic acid in *Mytilus* sp. in the Fal Estuary, UK".

There were eight plenary lectures given prior to the beginning of the morning and afternoon lecture sessions including "what is new in toxins?" by Dr Phillip Hess in which he discussed liquid chromatographic techniques and their potential to provide quick and cost effective analysis of toxins. Another of the plenary lectures was given by Dr Robin Raine on "the physical oceanographic control of harmful algal blooms". In this he stated that to obtain

robust prediction models it is necessary to have a good understanding of the physical oceanographical processes that act upon algae, for example, local currents, gyres, upwellings and coastal jets.

In the main lecture sessions there were many very interesting lectures and posters including a lecture by Santiago Fraga on the *Alexandrium tamarense* complex. This highlighted the importance of the current research taking place in our laboratory since at present the UK seems to be the only place where both the North American (toxic) and Western European (non-toxic) ribotypes of this species are found. A groundbreaking presentation by R Kellman discussed work carried out on cyanobacteria where they have found the gene for saxitoxin (STX). If this gene is present in all species that produce STX it could be very helpful in distinguishing between toxic and non-toxic strains of cyanobacteria and may also be relevant to dinoflagellates.

On the social side there was a reception held on the Tuesday evening in the beautiful Copenhagen town hall, and the ISSHA auction which took place on the Thursday night at which all sorts of strange and wonderful things were sold. The midweek excursions included a tour of the city, canals and opera house, a visit to a viking museum and a tour of two castles in North Sealand, which I attended. On the final evening of the conference the Mermaid Banquet took place at Langelinie Pavillionen near to the Little Mermaid. There was plenty of food, drink and dancing at this event as well as views across the bay.

I would like to thank the BPS for the financial support that enabled me to attend this conference which I found to be very informative and enjoyable and from which I gained valuable experience in presenting my work. Further support was also provided by the University of Westminster student development fund.



Xiyu Phoon
Natural History Museum, London

In the summer of 2006, I had recently freshly graduated from Imperial College, having completed my Biology degree, and I dived into a summer placement at the Natural History Museum, London. It is here that I reveal the story of what I did over the summer months.

The project bestowed upon me was to investigate predator induced morphological changes to the alga, *Desmodesmus* in response to *Daphnia*. One of the main objectives of this project was to produce axenic cultures of a strain of *Desmodesmus subspicatus*, which I was to be using. It was no easy task as method after method did not work. When things looked promising, I would return the next day only to find that colonies of bacteria had appeared on the nutrient agar plate. A whole cornucopia of ideas was considered. Even the more obscure methods I used did not give me much success. But eventually, there was a plate which was appeared free of bacteria and fungi. It was left for over a week and while the alga proliferated, there was still no sign of any contaminants. The culture is now 'clean'.

Another component of the project was culturing *Daphnia magna*. A culture of the wee beasties was kindly provided by Ralph Tollrian from Lancaster University. They were well behaved, grew and proliferated more successfully than could be expected. There came a point when there were more *Daphnia* than there were flasks to contain them.

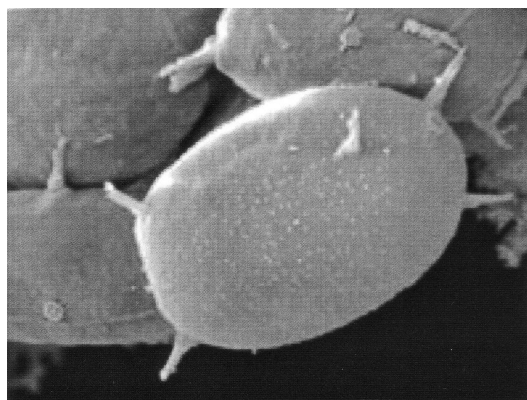
During this project, I was also given the opportunity to have first hand experience preparing and fixing samples for view under the SEM. This proved to be less daunting than

Summer placement at the National History Museum

I first thought. It was interesting to see some of the finer details lining the surface of the *Daphnia*, which would otherwise not have been seen under a compound light microscope. As the ultrastructure of *Daphnia* is not as well studied as in other organisms, it was rather exciting to be seeing something which quite possibly no one else had seen before. I presume that it is comparable to visiting an exotic and far flung place.

Not only has this summer bursary allowed me to implement some of the skills I had attained from my undergraduate degree, I have also learnt some new techniques and procedures. Above all, I learnt that a little patience goes a long way. Our preliminary titre plate experiments demonstrated that *D. magna* altered the morphological state of *D. subspicatus*, since unicellular inocula transformed to colonies and colony inocula reverted to unicells. More experiments are planned. SEM observations of starved *D. magna* fed *D. subspicatus* revealed that the algae were 'captured' by fine filaments wrapped around the cells.

For this project, I thank the British Phycological Society for their support as well as Professor Elliot Shubert who was a super supervisor. I also wish to thank Steve Russell, Botany (NHM), Alex Ball and Ben Williamson, EMMA Unit (NHM) for technical support as well as Ralph Tollrian (Lancaster University). From Imperial College, I give my gratitude to Drs. Bob Coutts and Zisis Kozlakidis for their assistance in clearing the *Desmodesmus* of their fungal and bacterial contaminants.



SEM of *Desmodesmus subspicatus* unicell
(Shubert & Massalski unpubl.)



Annual Report for the year ended 30 September 2006

The British Psychological Society Registered Charity No. 246707

The Society is an unincorporated association governed by its constitution and administered by its Council (trustees). The addresses of the current office bearers are set out in the *European Journal of Psychology*.

Membership of the Council of the Society:

Executive Members

President:	Professor M.D. Guiry	Treasurer:	Dr M.L. Tobin
Vice President:	Professor G.A. Codd	Eds (<i>Eur. J. Physc</i>):	Professor M.J. Dring
Overseas President	Dr S. Fredericq		Dr E.J. Cox
Immediate Past President:	Dr B.S.C. Leadbeater	Ed. (<i>The Psychologist</i>):	Dr J. Krokowski
Secretary:	Dr J.D. Parry	Webmaster:	Professor M.D. Guiry
Membership Sec:	Dr G.W. Scott		

Ordinary Members

Dr F. Küpper	Dr D.M. John	Professor E. Shubert	Dr L. King
Dr M. Wilkinson	Dr G. Malin	Dr J. Brodie	Professor G. Underwood
Dr J. Anderson	Miss S. Marsham		

Principal bankers:	Bank of Scotland, 39 Albyn Place, Aberdeen
Solicitors:	Wolferstans, 60/64 North Hill, Plymouth
Independent Examiner:	Flannigan, Edmonds and Bannon, 2 Donegal Square East, Belfast

This is the third Annual Report presented by the current Treasurer. It is made in this form to meet the requirements of the Statements of Recommended Practice (SORP), issued by the Charity Commission and serves as an annual record of the resources entrusted to the Society and the activities it has undertaken.

The Society has continued to give financial support to activities that promote psychological research, disseminate psychological knowledge and assist young psychologists to present their findings at scientific meetings. The 2006 annual winter meeting and AGM were hosted by the Marine Biological Association of the UK in Plymouth. The standard of presentations was as usual very high and congratulations go to Barbara Rinkel who received the 2006 Manton Prize, and Sarah Henkel, who received the 2006 Poster Prize. Thirteen students received support to attend this meeting from the Scientific Meetings Fund (SMF) (nine in 2005). The auction and quiz raised £751, with thanks going to Alison Taylor and Elliott Shubert for their organisation and enthusiasm. The meeting returned a surplus of £4161 (due in part to a refund from one of the hosting hotels) and this money has been used to support the 2007 meeting.

The society supported student attendance at 2 identification courses (Plymouth and Kindrogan) and supported one student to attend a Genetics Symposium at the Natural History Museum. Three summer studentships were awarded in 2006 and four students were awarded bursaries to enable them to attend international conferences to present their work.

During 2006 honoraria were awarded to the following council members: the Membership Secretary, Secretary and the Editor of *The Psychologist* each received £750, the Treasurer received £1000 and the Editors of the *European Journal of Psychology* received a total of £1500.

Members should note that the status of the bank account at the end of the financial year partly reflects the fact that money that will be transferred to the short term deposit account had not been processed by Sep 2006. In addition, interest on this account for 2006 will be presented in the 2007 financial report.

The Journal has performed well financially and the balance to the Society from Volume 40 was £27,230.42 (£25,979.93 for Volume 39) due to the current guaranteed annual income of at least £20,000 from the publishers, Taylor and Francis.

The Society's financial situation remains good. Membership payments have been monitored carefully and all 2006 membership payments received to date have been processed. The Scientific Meetings Fund was topped up to a total of £25000 to allow the Society to support students with travel awards, summer bursaries and field courses from the interest it receives.

Finally, I would like to thank all Council and Society members for their co-operation and support during this financial year.

The British Psychological Society

Registered Charity No. 246707

Statement of Financial Activities for the Year ended 30th September 2006

	Unrestricted General	Designated S.M.F.	Restricted Manton	Total 2006	Total 2005	
Note	£	£	£	£	£	
Income and Expenditure						
Incoming Resources						
Subscriptions 2004				-	2,158.50	
Subscriptions 2005	1,638.50			1,638.50	8,254.63	
Subscriptions 2006	8,596.00			8,596.00	-	
Surplus from Journal	27,320.42			27,320.42	25,979.93	
Auction proceeds	-	751.00		751.00	-	
FW Atlas	-			-	1,111.03	
Interest	3,406.45			3,406.45	3,314.80	
Winter Meeting 2006 surplus	3,911.00			3,911.00	1,253.66	
Miscellaneous (cash return)	85.00			85.00	300.00	
Total Incoming Resources	44,957.37	751.00		45,708.37	42,372.55	
Resources Expended						
Grants, studentships & awards	2	5,052.00	2,795.00	250.00	8,097.00	4,136.07
Publications expenditure	3	11,848.01			11,848.01	23,756.02
Meetings & Committee Expenses	4	5,562.72			5,562.72	3,372.35
Administration Costs	5	6,607.19			6,607.19	9,380.71
		29,069.92	2,795.00	250.00	32,114.92	40,645.15
Net Incoming (Outgoing) Resources for the Year		15,887.45	-2,044.00	-250.00	13,593.45	1,727.40
Fund at 1 October 2005		44,088.42	25,000.00	5,444.09	74,532.51	72,805.11
Transfer (General to SMF)		-2,044.00	2,044.00		-	-
Fund at 30 September 2006		57,931.87	25,000.00	5,194.09	88,125.96	74,532.51

Balance Sheet as at 30 September 2006

	2006	2005	
	£	£	
Current Assets			
Debtors	7	4,725.00	2,001.58
Prepayments		4,161.00	-
Short term deposits		57,149.21	57,149.21
Cash at bank		35,222.64	29,028.69
		101,257.85	88,179.48
Liabilities: amounts falling due within one year	8	13,131.89	13,646.97
Net Assets		88,125.96	74,532.51
Funds			
Unrestricted	9	57,931.87	44,088.42
Restricted		5,194.09	5,444.09
Designated		25,000.00	25,000.00
		88,125.96	74,532.51

Signed on behalf of the British Psychological Society
Dr Michelle Tobin
Treasurer



The British Psychological Society

Notes to the Account for the Year ended 30 September 2006

1 Accounting Policies

The accounts have been prepared in accordance with applicable Accounting Standards and the SORP - Accounting and Reporting by Charities issued in October 2000. A summary of the more important policies, which have been applied consistently, is set out below:

Basis of Accounting

The Accounts are prepared in accordance with the historic cost basis of accounting.

Subscriptions

Subscriptions include amounts received from members during the year. No amount is included in respect of subscriptions outstanding at the year end. Subscriptions received in advance for future years are included in deferred income.

Funds

Restricted funds comprise unexpended balances of donations and interest to be applied for specific purposes. At 30 September 2005, the Society's only restricted fund was the Manton Fund. Designated funds are those set aside out of unrestricted funds for specific purposes. At 30 September 2006, the designated fund of the Society was the Scientific Meetings Fund ("S.M.F").

Cash Flow Statement

The Society has taken advantage of the exemptions provided in FRS 1 "Cash Flow Statements" for small entities and has not prepared a cash flow statement.

	Unrestricted General £	Designated S.M.F. £	Restricted Manton £	Total 2006 £	Total 2005 £
2 Grants, Studentships & Awards					
Travel awards for 2006 Winter Meeting		2,825.00		2,825.00	1,036.07
Awards for courses, travel, Summer Bursary	4,052.00			4,052.00	2,700.00
Manton Prize			250.00	250.00	250.00
Poster prize at Winter Meeting		150.00		150.00	150.00
Special Project Grants	1,000.00			1,000.00	-
Old cheque written off		-180.00		-180.00	
	<u>5,052.00</u>	<u>2,795.00</u>	<u>250.00</u>	<u>8,097.00</u>	<u>4,136.07</u>
3 Publication expenditure					
Journal	6,102.00			6,102.00	17,313.75
Hon. Editor's Honorarium (2004)	-			-	1,500.00
Hon. Editor's Honorarium (2005)	-			-	1,500.00
Editor's Honorarium (2006)	750.00			750.00	
E.J.P. Management Committee	219.27			219.27	1,136.74
The Psychologist	4,660.74			4,660.74	2,305.53
Miscellaneous (Brochures)	734.00			734.00	-
Old cheques written off	-618.00			-618.00	
	<u>11,848.01</u>	<u>-</u>	<u>-</u>	<u>11,848.01</u>	<u>23,756.02</u>
4 Meetings & Committee Expenses					
Council Meeting 2004	-			-	813.50
Council Meeting 2005	195.25			195.25	2,558.85
Council Meeting 2006	3,116.08			3,116.08	-
Biodiversity Committee Expenses	349.06			349.06	-
Winter Meeting 2006	2,003.00			2,003.00	-
Old cheque written off	-100.67			-100.67	
	<u>5,562.72</u>	<u>-</u>	<u>-</u>	<u>5,562.72</u>	<u>3,372.35</u>
5 Administration Costs					
Executive expenses	-			-367.50	100.00
Public liability insurance	367.50				367.50
Independent Examiner's Fee	921.25			921.25	802.50
Credit Card Charges	580.65			580.65	460.80
Bank Charges	82.79			82.79	252.01
Executive Honoraria (2004)	-			-	1,400.00
Executive Honoraria (2005)	-			-	3,250.00
Executive Honoraria (2006)	3,250.00			3,250.00	
Archivist Expenses	-			-	37.50

The British Psychological Society

Notes to the Account for the Year ended 30 September 2006 (cont.)

	Unrestricted General £	Designated S.M.F. £	Restricted Manton £	Total 2006 £	Total 2005 £
5 Administration Costs (cont.)					
Web page maintenance	-			-	1500.00
Miscellaneous (cc refund)	-			-	36.50
Federation of Bioscience Federation Subscription				-	398.00
Hon. Secretary Expenses	-			-	75.74
Attendance at Bioscience Federation	339.80			339.80	700.16
	<u>5,541.99</u>	<u>-</u>	<u>-</u>	<u>5,541.99</u>	<u>9,341.96</u>

6 Reimbursement of Council members' expenses

Fourteen (2004: Four) Council members received £3,142.16 (2004: £420.96) as reimbursement of travel and overnight accommodation or expenditures incurred during the year on Society business. No monies were paid to any Council member in respect of subsistence.

7 Debtors

	2006 £	2005 £
Interest receivable	4,725.00	2,001.58
	<u>4,725.00</u>	<u>2,001.58</u>

8 Liabilities: Amounts falling due within one year

	2006	2005
Accruals	2,631.89	3,146.97
Provision for the Journal and The Psychologist	10,500.00	10,500.00
	<u>13,131.89</u>	<u>13,646.97</u>

9 Analysis of Net Assets between Funds

	Unrestricted Funds £	Restricted Funds £	Designated Funds £	Total Funds £
Fund balances as at 30 September 2006 are represented by				
Current assets	72,128.96	5,194.09	25,000.00	102,323.05
Current liabilities	-13,131.89			-13,131.89
Total Net Assets	<u>58,997.07</u>	<u>5,194.09</u>	<u>25,000.00</u>	<u>89,191.16</u>

Report of the Independent examiner to the Members of the British Psychological Society

We report on the accounts of the Society for the year ended 30 September 2006, which are set out on pages 32 to 34.

Respective responsibilities of trustees and examiner:

The Council Members are responsible for the preparation of the accounts. The Council Members consider that an audit is not required for this year (under section 43 (2) of the Charities Act 1993 (the 1993 Act)) and that an independent examination is needed.

It is our responsibility to:

* examine the accounts (under section 43 (3) (a) of the 1993 Act):

* to follow the procedures laid down in the General Directions given by the Charity Commissioners (under section 43 (7) (b) of the 1993 Act); and

* to state whether particular matters have come to our attention.

Basis of independent examiner's report:

Our examination was carried out in accordance with the General Directions given by the Charity Commissioners. An examination includes a review of the accounting records kept by the charity and a comparison of the accounts presented with those records. It also includes consideration of any unusual items or disclosures in the accounts, and seeking explanations from the Council Members concerning any such matters. The procedures undertaken do not provide all the evidence that would be required in an audit, and consequently we do not express an audit opinion on the view given by the accounts.

Independent examiner's statement:

In connection with our examination, no matter has come to our attention which gives us reasonable cause to believe that in any material respect the requirement:

* to keep accounting records in accordance with section 41 of the 1993 Act and;

* to prepare accounts which accord with the accounting records and comply with the accounting requirements of the 1993 Act; have not been met.

Flannigan Edmonds Bannon;

Chartered Accountants and Registered Auditors

Belfast, Northern Ireland

22 December 2006



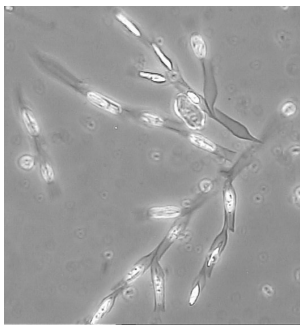
Announcements

Seventh International Chrysophyte Symposium Connecticut College, New London, Connecticut, U.S.A.

We are pleased to announce that the Seventh International Chrysophyte Symposium will be held at Connecticut College, New London, Connecticut, U.S.A. the week of June 23, 2008. The three to four day symposium is expected to bring together experts from around the world representing a broad spectrum of disciplines. Although the overriding theme of the symposium will focus on "Chrysophytes" in a broad sense, we anticipate significant contributions representing allied heterokont groups and an infusion of ideas from other fields.

In addition to regular paper sessions, we are planning mini-symposia in paleolimnology/paleobiology, taste and odor issues, heterokont phylogeny and use of geometric morphometric concepts in the study of algae. The symposium will include several keynote speakers who work in peripheral areas to chrysophyte biology, allowing for a cross fertilization of ideas. Our goal is to provide a forum to advance the study of chrysophytes. There will be a Proceedings volume published by Cramer under the Nova Hedwigia Beiheft series.

As has been the case in the previous six symposia, we will strive to have non-concurrent sessions and foster an environment that allows significant opportunities for people to interact in small groups. We also plan to take advantage of our local setting, including collecting opportunities in both freshwater and marine habitats, a traditional New England clambake and trips to Mystic Seaport, Mystic Aquarium and possibly a behind the scenes tour of the Peabody Museum at Yale University. In addition, tours of Pfizer's Global research facility may be possible.



The organizing committee consists of:

- Peter Siver (Department of Botany, Connecticut College, U.S.A.)
- Anne Lizarralde (Department of Botany, Connecticut College, U.S.A.)
- Jim Wee (Department of Biology, Loyola University, U.S.A.)
- Robert Andersen (Bigelow Laboratory for Ocean Sciences, U.S.A.)
- Sue Watson (National Water Research Institute, Burlington, Canada)
- Christian Kamenik (Institute of Plant Science, University of Bern, Switzerland)
- Hwan SuYoon (University of Iowa, U.S.A.)

Since we are still in the planning stages of the symposium we welcome any and all ideas and suggestions. Please direct any comments, suggestions and special needs to Peter Siver via peter.siver@conncoll.edu with a copy to Anne Lizarralde via anne.lizarralde@conncoll.edu. All symposium information, including registration and abstract forms, will be posted on this website. If you would like to be included on the symposium mailing list in order to receive announcements please contact Anne Lizarralde at anne.lizarralde@conncoll.edu. We look forward to seeing all of you in 2008!

Dr. Susan B. Watson, sue.watson@ec.gc.ca, on behalf of organising committee.
Research Scientist, Aquatic Ecosystem Management Research, National Water Research Institute, CCIW, P.O. Box 5050, Burlington, ON L7R 4A6 Canada.
Phone: 905-336-4759 Fax: 905-336-4699
<http://www.nwri.ca/staff/susanwatson-e.html>

56TH ANNUAL GENERAL MEETING

The 56th Annual Meeting of the Society will be held at the University of Bristol between January 3rd and 5th 2008, and will be organised by Paul Hayes. Current plans are that the meeting will start with an afternoon session on the 3rd, to be followed by two full days of talks on the 4th and 5th. Details of the programme have yet to be finalised, but there will be a special session on "Algae and Global Processes" to be organised by Gill Malin. Watch the web site for further details.

Coastal soil algae of Canadian Arctic islands

Ralph A. Lewin,
Scripps Institution of Oceanography
University of California, San Diego
La Jolla, CA 92093, USA.
Email: rlewin@ucsd.edu

In the summer of 1954, the new Canadian icebreaker "HMCS Labrador", with a stout stainless-steel hull, successfully sailed among islands and ice floes through the Northwest Passage from the Atlantic to the Pacific Ocean (Ackerman et al. 1982). At each of eight landing sites on various islands en route (see map), Lieut. R. Lindsay kindly collected for me a few grams of terrestrial soil and stored them at 5 deg. C in a refrigerator for several weeks. Receiving them on his return (via the Panama Canal) to Halifax, I set up enrichment cultures at the National Research Council (now the Atlantic Research Council) laboratories, incubated them in constant-light chambers at 10 deg. C and at 20 deg. C for 4 weeks, and then recorded genera of algae that had grown, identified as well as I could by light microscopy. Clonal sub-cultures were established and sent to the late Dr G.W. Prescott in Michigan. Specific names were not determined. To my knowledge none of these cultures now survives.

Algal genera are listed in Table 1.

The data indicate that whereas Arctic soil algal floras are like those of more temperate zones (cf; Reisigl, 1964; Round, 1965) some (e.g. *Bumilleria* sp., *Pseudendoclonium* sp.), like the Antarctic cyanophyte *Phormidium frigidum*, are adapted to cold soils and do not grow at temperatures as high as 20 deg. C.

References

- Reisigl, H. 1964. Zur Systematik und Oekologie alpiner Bodenalgae. *Oesterreichischen Botanischen Zeitschrift* 111, 401-499.
- Round, F.E. 1965. *The Biology of the Algae*, St Martin's Press, New York. The soil flora, pp. 57-60.
- Ackerman et al. 1982. *Exploration of the Northwest Passage*. Arctic Canada 1, 3rd edn.

Site locations are listed below:
(all but H in Canada)

A. Alexandra Fjord, Ellesmere I.	79°N	79°30'W
B. Navy Board Inlet, Baffin I.	73° N	81°W
C. Cape Joy, Baffin I.	73°30'N	82°W
D. Dundas Harbour, Devon I.	74°30'N	82°30'W
E. Erebus Bay, Devon I.	74°30'N	92°W.
F. Resolute Bay, Cornwallis I.	74°30'N	94°30'W
G. Bridgport Inlet, Melville I.	75°N	100° W
H. West Point, Unimak I., Alaska, USA	54°30'N	165°W

Table 1. Sample sites yielding algal growth in enrichment cultures.

	Sample site (see Table 1)							
	A	B	C	D	E	F	G	H
Genus								
<i>Bumilleria</i>			+/-		+/-			
<i>Chlorella</i>		-/+	-/+	+/+	+/+		+/+	+/-
<i>Chlamydomonas L</i>	+/-	+/-	+/-	+/-	+/-	+/-		
<i>Chlamydomonas S</i>		+/-	+/-					-/+
<i>Chlorococcum</i>		-/+	+/+		+/-			+/+
<i>Chlorogonium</i>			+/-					
<i>Coccomyxa</i>	-/+	-/+						
<i>Euastrum</i>		-/+						
<i>Hormidium</i>		+/-						
<i>Palmellococcuss</i>	+/-		-/+		-/+			-/+
<i>Pleurococcus</i>			+/-	+/+	+/-			
<i>Pseudendoclonium</i>		+/-	+/-	+/-	+/-			
<i>Stigeoclonium</i>			+/-					

Key: +/+, algal growth at 10 and 20 deg.C; +/-, algal growth only at 10; -/+, algal growth only at 20; blank spaces, no growth at either temperature; L, large cells ca.7-8 micrometres wide; S, small cells ca 3-4.



The Algal Herbarium at National Museums Liverpool

John Edmondson
Head of Science, National Museums Liverpool
World Museum Liverpool, William Brown Street,
Liverpool L3 8EN, UK
email: john.edmondson@liverpoolmuseums.org.uk

The algal collections of National Museums Liverpool (NML), excluding lichenised fungi and Charophyta, consist of some 7,700 dried specimens and 700 fluid-preserved specimens. The collection dates back to the early 19th century, when the untimely death of the noted algologist Thomas Velley led to his collections of 8 bound volumes of algae being offered for sale by his widow. They were purchased by William Roscoe (1753-1831) for the Liverpool Botanic Garden herbarium in 1810, at a cost of 150 guineas (£157.10s). The set was transferred to Liverpool Museum in 1909. Helen Blackler, formerly assistant keeper at Liverpool Museum, discovered several types in the Velley herbarium. Also in 1909, the collections of the Liverpool Botanic Garden, mounted on loose sheets, were acquired. These included a few algal specimens from Sir James Edward Smith (1759-1828), Thomas Jenkinson Woodward (1745-1820) and Dawson Turner (1775-1858). Few other algae were acquired by the museum in the 19th century, with the exception of a collection of mainly Isle of Man seaweeds believed to have been amassed by W. Shillitoe, and a set of Tasmanian seaweeds presented by Capt. Cawne Warren, both being acquired in 1877.

In the first half of the 20th century only two collections of note were acquired: in 1909 a set of Orkney seaweeds was presented by George Ellison (1862-1941) of Warrington and Liverpool, and in 1935 a large set of plants which included some marine algae collected from Innellan near Dunoon on the Firth of Clyde, and from Iona (near Mull), was presented by C. Theodore Green (1863-1940) of Birkenhead.

The most significant addition to the algal collections came in 1974, when the University of Liverpool transferred their herbarium (LIVU) to the museum. This comprised some 4,000 dried specimens, mostly of seaweeds but with a significant number of freshwater algae. Most had been collected by staff of the Port Erin Marine Laboratory between 1945 and 1970, and about a quarter of the collection was from the Isle of Man, a large proportion having been collected by Else M. Burrows (South & Russell, 1987). It also includes an important set of algae collected mainly from the island of Anglesey by Henry Gustave Hiller (b. 1864) who retired there after a career as a stained glass artist. Many of the sheets are accompanied by his attractive watercolour sketches of seaweed reproductive structures.

In 1981 two previously uncatalogued 19th century

seaweed collections were mounted and incorporated into the herbarium. The first was compiled by John Boswarva of Plymouth; a similar set is preserved in the herbarium of the Marine Biological Association, though with slightly different labels. The second was made by John Ralfs of Penzance, a retired surgeon who became a noted expert on Desmids. This collection was acquired by Arthur A. Dallman from Professor H.L. Bowman; Dallman's herbarium was purchased by the museum in 1963. More recently, the Port Erin Marine Laboratory transferred 700 jars of fluid-preserved seaweeds to the Museum.

Staff collections have added a few locally provenanced specimens to the collection; the earliest were made by William S. Laverock (1865-1947), the Museum's first botanical curator. Most came from Llandudno in 1909. More recently specimens were obtained by Ian D. Wallace and Nora F. McMillan, zoologists at the museum. Dr Helen Blackler, who worked as an assistant curator in the Museum just prior to the 2nd world war, donated a small set of seaweeds collected by her uncle, Captain Jackson, in Pitcairn Island and also researched the types in the Velley herbarium. In 1986, 1990 and 1993 Dr George Russell, now retired from the University of Liverpool, presented sets of beautifully preserved seaweeds; these were mainly from the British Isles but also included collections from the Faeroes, Norway, Finland, the Egmont and Maldive Islands, and Hawaii. Most recently, slide collection of the Liverpool Microscopical Society, acquired in 2001, included 2,106 diatom mounts.

A full index of collectors has been extracted from a recently prepared database of specimens, and is available by email on request. Collectors of type material held at LIVU are listed below:

BATTERS, EDWARD ARTHUR LIONEL. U.K., 1883-1901; Ireland, 1906. Some were distributed in A. Holmes' *Algae Britannicae Rariores fascicles VII-X*.

CHAUVIN, FRANÇOIS JOSEPH (1797-1859). France (Calvados), 1826-31. *Algues de la Normandie*, fasc. 1-7 (full set). Co-collected with M.R. ROBERGE; also includes material from DE BREBISSON, LE BAILLY and PELVET DE VIR.

COLLINS, FRANK SHIPLEY (1848-1920). U.S.A.: Connecticut, 1892; Maine, 1894-1901 (some distributed as *Phycotheca Boreali-Americana*); Massachusetts, 1878-1910; Missouri, 1918; Rhode Island, 1901. Some distributed by Hauck & Richter, *Phykotheka Universalis*.

DIÁZ-PIFERRER, M. Brazil, 1963, co-collected with A.B. JOLY; Curaçao, 1966; U.S.A.: Florida, 1964-65; Puerto

Rico, 1962-69; Venezuela, 1964-66, distributed as Coleccion Evangelina, algas marinas de Venezuela.

GARDNER, NATHANIEL LYON (1864-1937). U.S.A.: Alaska, 1917; California, 1902-33; Washington, 1910-36. Most were distributed as "Algae of California" from the herbarium of the University of California, Berkeley.

GERSTENBERGER, C. Germany, 1885 & 1892.

GUIRY, MICHAEL DOMINIC RICHARD (1949-). Ireland: Co. Clare, 1979; Co. Cork & Waterford, 1972.

HENNINGS, PAUL CHRISTOPH (1841-1908). Germany: Berlin, 1882-1892.

HIERONYMUS, GEORG HANS EMMO WOLFGANG (1846-1921). Austria, Czech Republic, Poland, 1889-92.

HUNTER, JOHN (1737-1821). Australia: Sydney Cove, c. 1795-1800; in herb. Velley (q.v.).

KÜTZING, FRIEDRICH (1807-1893). France: Corsica; Germany: Helgoland; Italy: Venice, Trieste. All undated; distributed ex herb. Leiden as "ex herb. Kützing"; they may not therefore have been collected by him.

MANZA, ARTEMIO VALDERRAMA (1896-1964). U.S.A.: California, without date.

MAY, ELISABETH. Germany: Saxony, 1889-95. Distributed in Phykotheke universalis. CRY.

PHILLIP, ART HUR (1738-1814). Australia: Port Jackson, New South Wales. Ex herb. THOMAS VELLELEY, q.v. PHILLIP retired to Bath in 1792 after serving as first Governor of the colony of New South Wales; he evidently became acquainted there with THOMAS VELLELEY, and presented him with Australian seaweed material.

REINBOLD, THEODORE (1840-1918). Germany: Kiel, 1886-91; Leipzig, 1890; Singapore, n.d.; Jamaica, n.d. Mostly distributed in Hauck & Richter, Phykotheke universalis.

RICHTER, PAUL GERHARD (1837-1913). Germany: Saxony (Leipzig), 1885-92; Switzerland, 1847.

TURNER, DAWSON (1775-1858). U.K.: Dorset, Suffolk.

VELLEY, THOMAS (1748-1806). U.K.: Devon, Dorset, Isle of Wight, Kent, Norfolk, 1789-1802. One of the most important algal collections in LIV, kept in 8 bound volumes and comprising 332 specimens, many accompanied by watercolour sketches of algal reproductive structures.

WEBER-VAN BOSSE, ANNA ANTOINETTE (1852-1942). Indonesia: Java & Sumatra, 1888; Netherlands, 1893; South Africa, 1894.

ZACHARIAS, EMIL OTTO (1846-1916). Germany, 1893.

Following the award of a Heritage Lottery Fund grant, and with financial support from the European Union and other sources, a new herbarium was built in the basement of World Museum Liverpool to house the botanical collections. Specimens accompanied by watercolour illustrations (notably the Velley and Hiller herbaria) are being digitised, and some of Hiller's more elaborate drawings of algal reproductive structures have been exhibited in the public gallery (as "Details from an Underwater Garden"). These framed and mounted specimens are available for loan to other museums for display. Herbarium specimens on loose sheets are also available on loan to recognised institutions for research, and digital images can be supplied on request.

Enquiries would be welcome and data can be sent as an attachment or PDF.



Obituary

Dr Hilda M. Canter-Lund DiplEd, PhD, DSc, FRPS (1922 - 2007)

Hilda died in Lancaster Hospital on January 15th 2007; she will be greatly missed not only by all her family but as a rare expert in photomicroscopy, an expert in a biological field of science that has not really received proper appreciation, and as a colleague and friend to many.

Hilda was born in London and was a graduate of the University of London, becoming Prof. C. T. Ingold's first research student at Birkbeck College: at the time of writing he is now aged 101. She first came to the Freshwater Biological Association at Wray Castle, on the shores of Windermere, as an undergraduate attending a summer botany course and returned as a visiting research worker 'occupying the British Association table' in the mid 1940s. She joined the staff in October 1948 and married fellow scientist John Lund in 1949. In 1954 she became an Honorary member of staff whilst bringing up their two children and returned to FBA as a part-time member of staff in 1963.

Hilda's own personal interest was in fungal parasites, her first publication in 1946 being on Chytrids which remained her major interest, dominating her many publications. In 1949 she published a paper entitled 'The importance of fungal parasitism in limnology', a thought beginning to resurface in discussions today.

Algae were of course the hosts for her organisms, hence the joint interest of the Lunds in *Asterionella formosa* and other diatoms which dominated the spring phytoplankton of Windermere. Plankton, especially diatoms and desmids, and also *Oscillatoria*, formed the background to Hilda's own studies and she was aided in her experimental research on the interrelationship of host and parasite by George Jaworski. With scrupulous attention to detail, she perfected the techniques of photographing fungi, algae and protozoa to the extent that she was elected a Fellow of the Royal Photographic Society and was awarded a grant from the Royal Society of London which enabled her to acquire a more suitable Zeiss microscope for microphotography. Over the years she made many thousands of photographs both black and white and colour.

Arriving at Athens Airport for the International Diatom Symposium I was astonished to find that Hilda's *Asterionella* photograph was used as the meeting point symbol and was also on Symposium documents. The same species also made the front page of the UK's 'Radio Times' to publicize one of David Attenborough's TV series.

I had the opportunity of working with her on *Aulacoseira* species in Lake District lakes and shared a portacabin with her when the laboratory had to be re-roofed, so I had first hand experience of how careful she was that everything should be perfect.

The culmination of her algal photography, and lasting monument, has to be the book, the 'Freshwater algae: their



Photo by T. Furnass, FBA Collection.

Dr Hilda Canter-Lund

N.B. The Radio Times illustration behind her microscope.

microscopic world explored' (1995), based on her photography and supported by John's text - Hilda's book as the latter calls it; a point I have had to mention on several occasions as, with all eminent partnerships, it is all too easy to get it wrong! Copying is said to be the sincerest form of flattery so I suppose that the frequency with which these pictures have appeared elsewhere must also be regarded as such? Hilda herself took a long time to recognize the book's success, saying that it set her own studies back by too many years! Not until the American Phycological Society made Hilda and John recipients of the Prescott Award in 1997, did she really begin to appreciate this success.

I first knew Hilda when I first came to the Freshwater Biological Association at Ferry House on Windermere in 1965, to study for an M.Sc. with her husband, John Lund. As she had her own microscope at home, and Richard and Hilary were then teenagers, she was at the lab. part-time. Over the years, as their children grew up and left home, Hilda could spend more time at the laboratory although home was very much a work place too. It was apparent to any visitors that the Lunds regarded gardening as including the myriad of dishes, bowls, etc of microscopic plants as well as the colourful array of trees, shrubs and perennials that grew on the hillside surrounding their home at Ellerbeck, above Amble side and from which she produced so many attractive floral table decorations for the Ferry House.

To remember Hilda, is to see her in her laboratory wearing that attractive smile.

Elizabeth Y Haworth, February 2007

Instructions for Contributors

Copy which is submitted for publication in *The Phycologist* should be concise and informative. Articles should be scientifically sound, as jargon free as possible and written in a readable scientific magazine style. Unless absolutely essential, references should not be included. All types of relevant material will be considered, these include job advertisements, scientific reports, book reviews, news items of topical interest, meeting announcements, grant awards, promotions, appointments, profiles of eminent phycologists and obituaries. If you are interested in submitting material that does not fall within any of these broad categories, or you are unsure of the appropriateness of a potential article, then contact the editor. Suggestions for future articles or a series of articles are welcomed.

Copy should be submitted, preferably as attachments to email or on disc (MS Word for Windows or Rich Text Format). **Illustrations and photos to accompany copy are welcomed and should be supplied in JPEG or TIFF file-format no less than 600 dpi resolution.** The editor reserves the right to edit the material before final publication.

Submission of Copy and Deadlines

Copy should be submitted to:

Dr Jan Krokowski
Scottish Environment Protection Agency,
Redwood Crescent, Peel Park, East Kilbride,
Glasgow G74 5PP
Tel. +44 (0)1355 574200
Fax. +44 (0)1355 574688,
E-mail: jan.krokowski@sepa.org.uk

Deadlines are **March 1st** for the April issue, **September 1st** for the October issue

Typesetting by Agnès Marhadour
Printed by Monument Press, Stirling, UK.

