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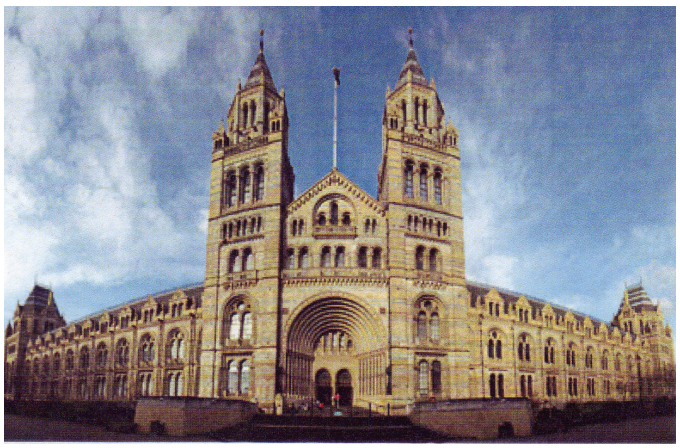
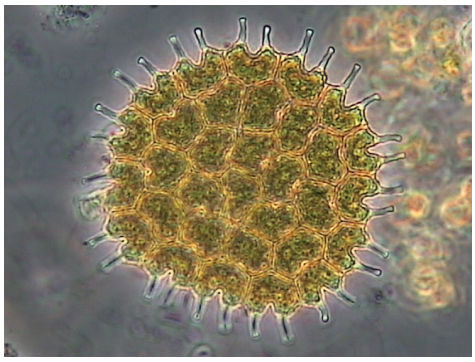
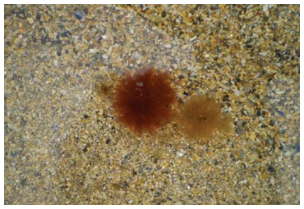


57th BPS Annual Meeting Natural History Museum, London January 5-7, 2009





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2009
British Phycological Society

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Editorial

Well here's another issue for you all to get your teeth into….and as you can see its quite a hefty one! We start off with a couple of reviews of our last winter meeting, which was located in the wonderful setting of the Natural History Museum (NHM), London. Many thanks to the local organisers! The meeting's special sessions were on *Aliens and Invasive Species* and *Algal - Non-algal Interactions*, and I personally came away thinking about Star Wars, Star Trek, E.T. (following the talk by John Raven) and inspired by the Visions of Earth gallery at the NHM, and I'm still pondering about the possibility of cyanobacteria contributing to dinosaur extinction (as eluded to in the Presidential address)….

The student Manton Prize and Poster Prize winners are detailed, as are reports from other students who have received bursaries. There is also a new student representative on the BPS Council, so students (and supervisors) please take note and contact Agnes Mortensen (agnes.mols@unh.edu) with any questions, ideas and suggestions you may have regarding the Society. Furthermore, please take time to check your membership details, and amend and renew your membership (and cancel any standing orders!). A BPS membership renewal form is attached on the inside back cover if you haven't on-line access.

Contents

The Phycologist - no. 76 Spring 2009

There are also details of a red tide of *Spermothamnion* recorded off the north coast of Scotland, and of a new species of *Vaucheria* (*V. uncinata*) also recorded from Scotland; with Scotland in mind…..it is never too early to mention the next winter meeting, which is going to be held in Oban - so hopefully see you there! Details will appear on the BPS web site http://www.brphycsoc.org.

Do keep sending in your contributions. 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.

As a reminder, previous issues of *The Phycologist* can be downloaded at http://www.brphycsoc.org/phycologist.lasso.

And to end on here is a poem that I have recently come across written by the late Ralph Lewin, which I personally find very appropriate:

The biology of algae is a duty or a task,
That consumes the better portion of your time
In the sampling of waters from an ocean, or a flask,
Or a snowfield, or a gutter full of slime.
You get cold, and wet, and grubby; you get dusty, hot, and dry;
You get dismal, and dejected, and defied;
But you'll find that, if you are lucky - if you're good - and if you try,
You can do a little science on the side.

Reviews of the 57th Annual Meeting of the BPS, Natural History Museum, London 5-7th January 2009

Clare Scanlan, Scottish Environment Protection Agency

My first BPS winter meeting for years, and it was being held in the Natural History Museum in London. The NHM and people talking about algae - how lucky can you get and still call it work? The programme looked interesting, so it was with great anticipation that I looked forward to this meeting.

Genetic research on algae is rewriting taxonomy, and quite a number of talks dealt with this subject. As something of an ignoramus on genetic analysis I confess I found the difference in approaches used slightly perplexing but fascinating. I wonder if anyone would like to write an Idiot's Guide to Genetic Analysis for *The Phycologist* outlining basic principles and evaluating variations in interpretative approach? One paper touched on possible interesting differences in potential outcomes, and further exploration of this would have been intriguing. A number of papers highlighted the value of herbarium specimens in taxonomic work from clarifying nomenclature to illuminating issues of biodiversity, ecology and biogeography. This interaction of past, present and indeed future was something of a recurring theme, and formed the subject of an entertaining and informative address on "Cyanobacteria and cyanotoxins from prehistory to the present" by the outgoing president, Geoff Codd.

The breadth of research interests among BPS members, as shown by the wide variety of talks, is impressive, and the knowledge and enthusiasm brought to bear striking. The BPS is good at supporting younger workers, and the talks for the Manton Prize were varied and interesting. The prize went to Thomas Silberfeld for his talk on his and colleagues' (Florence Rousseau and Bruno de Reviers) work on "A multi-marker inference of the phylogenetic relationships within the brown algae (Heterokonta, Phaeophyceae): towards a resolution of the former 'brown algal crown radiation'". The standard of oral and poster presentations for the meeting as a whole was high.

There were of course many opportunities for meeting old friends and acquaintances and for making new ones, and many constructive conversations were had in tea and lunch breaks. This aspect of meetings is always very valuable.

Many thanks are due to the organisers, who did a sterling job, and also to the meeting's sponsors. I will look forward to Oban in 2010, but think I'll have to do some studying for Geoff Codd's quiz before then.

Jane Pottas, University of Hull

Another winter meeting has come and gone and in the intervening period I have had time to reflect and gather my thoughts.

Thanks must go to Eileen Cox and Elliot Shubert for organising the meeting at the Natural History Museum. Everyone who went will have found something to stimulate and interest them. The highlights for me were the two special sessions on *Aliens and Invasive Species* and *Algal -non-algal Interactions*, and also Geoff Codd's Presidential address "Cyanobacteria and cyanotoxins from prehistory to the present." I also appreciated the opportunity to slip into the public galleries of the museum at lunchtime and soak up the atmosphere of such a lovely building and marvel at the exhibits. A real pleasure. As always it is also a pleasure to listen to enthusiastic researchers describing and explaining their work both in the sessions and in the more informal setting over coffee. I learn such a lot at each conference and leave with my batteries charged.

However, we are preaching to the converted and unless the BPS is to remain the repository of the best kept secret in biology I do feel that we need to widen the scope of the meeting. Whilst disseminating research is a vital part of the winter meeting there is a whole world out there which deserves to be told about the importance of algae. A Google search for "phycology" always returns the question "Do you mean psychology?" assuming a spelling mistake. Could this be addressed by including a session of more general interest to which the local naturalist group, Literary and Philosophical Society, teachers, school students - indeed, anyone and everyone, could be invited; which could be advertised in the press and on local radio and featured in articles in the local and national papers? The winter meeting is organised on a local level but we are the British Phycological Society with an international membership. A half day of talks, displays and activities could be used to widen our recognition. The Presidential address would be an ideal lecture for this purpose - Geoff's interesting and wide ranging talk about cyanotoxins this year, and from previous years Eileen Cox's talk about diatoms, Mike Guiry's guide to the seaweed industry, Barry Leadbeater on A lifetime with flagellates … to name but a few. An applied aspect of phycology would be of interest to a lay audience, for example ecological monitoring or the link between phycology and medicine such as the paper Chris Maggs gave about *Corallina* and bone replacement. There could be a display of herbarium sheets of seaweeds or photographs of diatoms showing their beautiful and varied forms. And how about a practical session on how to press seaweeds or freshwater algae or drawing phytoplankton? And a special feature on all things phycological in the local bookshop - Trevor Norton's entertaining books for instance. There must be lots of ideas out there amongst the membership.

Before I get too carried away let me say that I know there are few things worse than some Johnny-come-lately brimming with "new" ideas, some or all of which may have been suggested or tried before and rejected. I also know from experience of organising a season of seminars where I work that such suggestions would mean more work for the organisers. John Day may already be regretting offering Oban as the venue for 2010 and Rupert Perkins may be having second thoughts about Cardiff for 2011.

So, why would anyone want to take up any of the above? Surely the subject which brings us together and is our passion is worth shouting about. We must not keep it to ourselves.

As the new secretary of the society I am still feeling my way and it would perhaps be politic for the new kid on the block to remain silent and simply observe rather than appearing critical of an organisation which I have found extremely supportive and stimulating. There will no doubt be aspects of the society and all winter meetings which do not come up to expectations but that is inevitable and because, to quote The Killers, "We are human."

We must get our message out there - it's encouraging that BPS has established links with the Science Media Centre - but we need to ensure that one day soon phycology is not only recognised as a search term by Google but that a Google search for psychology returns the question "Do you mean phycology?".

The 57th Annual Meeting of the BPS Oral and Poster Abstracts

ABSTRACTS FOR ORAL PRESENTATIONS

Special session. Aliens and invasive species

Green and red aliens: applying herbarium collections in molecular, morphological and geographical investigations of the genera *Ulva*, *Codium*, *Caulacanthus* and *Feldmannophycus*

FREDERIC MINEUR & CHRISTINE A. MAGGS

We show how using herbarium specimens both for morphological and molecular investigations can elucidate invasions by cryptogenic aliens, cryptic species and other species responsible for taxonomic nightmares. In *Codium fragile*, multiple subspecies are native to particular areas of the world and there is a single invasive subspecies. In *Ulva*, whole clades are invasive, with some haplotypes becoming globally distributed and forming green tides. The red alga *Caulacanthus ustulatus* is a common rocky shore species in Southern Europe and the Mediterranean Sea. Several species of the genus *Caulacanthus* have been described around the world, and the Mediterranean species, *Caulacanthus rayssiae* was proposed as the type of the genus, *Feldmannophycus*. Our study shows clearly that the Asian strain of *Caulacanthus ustulatus* (= *Caulacanthus okamurae*) introduced into Brittany is conspecific with *Feldmannophycus rayssiae*, and is present in many Western European shores, sometimes alongside native *C. ustulatus*, including in its type locality.

Niche models of alien and invasive species: predicting spread and areas at risk of suffering blooms

HEROEN VERBRUGGEN, KLAAS PAULY, LENNERT TYBERGHEIN, FREDERIC MINEUR & CHRISTINE A. MAGGS

We explore macro-ecological niche models for a selection of alien and bloom-forming species, including *Codium fragile*, *Sargassum muticum*, and the *Pseudobryopsis/Trichosolen* (PT) complex. Niche modelling techniques are used to predict the potential distribution range of species. They infer the macro-ecological affinities of the species using two datasets: a set of distribution records and a global macro-ecological dataset derived from satellite images. Niche affinities inferred from distribution records within the native range are extrapolated to identify areas with suitable habitat for alien species. The coral reef areas most prone to suffering PT-blooms are predicted.

Getting to the source: genetics, diversity and location matter

OLSEN, JEANINE L., COYER, J.A., HOARAU, G.G., & STAM, W.T.

Reduced genetic variation and a disjunct distribution were once thought to be the hallmark of an introduced species, e.g., *Caulerpa taxifolia* in the Mediterranean or *Codium fragile* ssp. *tomentosoides*, along the coast of Long Island, New York. However, more and more examples are being found of introduced species with high genetic diversity, e.g., *Undaria pinnatifida* and *Fucus serratus*. The finding of high diversity signals high propagule pressure through repeated introductions and sexual reproduction; the consequences of which can lead to hybridization with sister taxa or sister populations, thus increasing the potential for the development of invasiveness and downstream community effects. In a recent review of >400 seaweed introductions involving 277 species, Williams and Smith (2007) concluded that <6% of the cases studied the ecological effects of introduced species and even fewer utilized genetic data to assess diversity and source. Using a combination of assignment tests and historical information, I will reconstruct the multiple introductions of *F. serratus* that have occurred across the North Atlantic over the past 200 years. This information provides a framework for understanding the slow but sure success of *F. serratus* in it's non-native locations and raises the interesting question as to whether introductions of European populations of *F. vesiculosus* to native North American *F. vesiculosus* have occurred, but so far remained undetected.

The diatoms of Lake Baikal and the space invaders of Siberia

DAVID M. WILLIAMS

The investigation of geographical distribution relates to the concept of endemism, usually defined as an area that a particular organism lives in and lives nowhere else. An organism's endemic area can be viewed as part of its definition, to the extent that it also characterises it. If an organism is found somewhere other than its endemic area it is considered to be an introduced species, an invasive species or alien. Many invasive species are obvious, the cause - most often human activity - easily determined. Yet less obvious 'invaders' are sometimes difficult to identify if a notion of endemism is not available or poorly developed. While endemism and diatom distribution is a subject now being debated, rather than address that issue, I will discuss the relationship between Endemism and Aliens, with the diatoms of Lake Baikal.

Spatial limits to phycogeography: an astrobiological viewpoint

CHARLES S COCKELL, LISA KALTENEGGER & **JOHN A RAVEN**

No life has so far been detected on planets other then the Earth. Even the occurrence of potentially Earth-like planets (ELPs), so called Super-Earths like Gliese 581c and, especially, 581d, close to the Habitable Zone around a star (the M dwarf Gliese 581) other than the sun has only been reported very recently. However, improving spectroscopic techniques should allow, within the next few decades, the detection of the atmospheric signatures (large amounts of oxygen and ozone) of oxygenic photosynthesis on ELPs, even when the photosynthesis is cryptic in the sense of the pigments not being detectable spectroscopically. If there are such ELPs with oxygenic photosynthesisers we can ask if the phototrophs we have on Earth could have originated elsewhere in the universe and if our phototrophs could have travelled to, and become established on, ELPs. Cockell and co-workers (2007 Astrobiology 7: 1-9) showed the possibility of interplanetary travel of microorganisms, but not photosynthetic ones, on meteorites. This means that phototrophs found elsewhere in the universe are likely to be a biogeographically isolated and independent evolutionary occurrence.

Sequencing historical macroalgal specimens: where 18th, 19th, and early 20th century collections meet 21st century molecular biology

PAUL W. GABRIELSON

Herbaria are repositories of the vast, crucially important documentation of Earth's biodiversity. Tapping that knowledge has been problematic for many marine macroalgae, especially rhodophytes, whose morphological and anatomical variability have confounded classical methods of inquiry. Sequencable DNA fragments, long and variable enough to confidently identify species (>150 base pairs), have been extracted from 200 year old pressed seaweed specimens, as well as from more recently collected specimens preserved in formalin before pressing. In the northeast Pacific seaweed flora, this has resulted in the synonymy of old names whose identity was unknown, for example, *Prionitis jubata*, in the removal of species recently thought to be present, for example *Prionitis angusta* and *Prionitis cornea*, and in the clarification of names incorrectly placed in synonymy, for example the articulated coralline species, *Bossiella interrupta*, *B. ligulata* and *B. saggitata*. These examples, and others that will be discussed, demonstrate the essential and ongoing role of herbaria in preserving type and historically important specimens that are necessary to resolve questions of nomenclature, biodiversity, biogeography and ecology.

Is *Porphyra umbilicalis* (Bangiales, Rhodophyta) confined to the North Atlantic?

JULIET BRODIE, MARÍA ELIANA RAMIREZ, RACHEL WALKER, STEPHEN RUSSELL

Ever since the red alga *Porphyra umbilicalis* was described from the North Atlantic in the 19th century, the species concept has remained problematic. The name has been used for specimens of *Porphyra* with an umbilicate form in different parts of the world but evidence from molecular data indicates that it has been applied to more than one species. The recent selection of a neotype which fits the original diagnosis and current concept of *P. umbilicalis* puts us in a much better position to evaluate its distribution and relationships with *Porphyra* species from elsewhere. A comparative study of *Porphyra*, based on *rbc*L, *cox*1 and partial rDNA SSU gene regions, revealed a very close, yet distinct, relationship between *P. umbilicalis* from the North Atlantic and two species from the Chilean Pacific coast. These results raise questions about the origin of *P. umbilicalis* in the North Atlantic and whether there are similar species along the eastern Pacific coast. Given the closeness of these species, we need to question species boundaries concepts and how these should be determined.

The Marine Algal (Seaweed) Herbarium at the Natural History Museum (BM): developing the British collection for the 21st century

IAN TITTLEY, JULIET BRODIE, JO WILBRAHAM & ROB HUXLEY

The algal specimen collections at BM represent an important reference point for taxonomic, floristic and biogeographical study. The first collections were made in the seventeenth century and are some of the earliest records of marine algae for Britain. The collection has developed eclectically over the past 350 years and in order to ascertain its strengths and weaknesses, spatial, temporal and systematic data have been gathered and assessed. They reveal that out of some 650 species known for Britain and Ireland, 29 are not represented. A census reveals that the collection comprises approximately 85,000 specimens of which c. 30,000 have been registered in a database; it also shows that the backbone of the collection is of 19th century specimens. Species mapping reveals collections for most coastal 10 km grid squares in Great Britain but with gaps in northern Scotland. Comparison of species maps with those in the British Phycological Society 'Atlas' shows broad concordance; comparison of mapped species abundances also shows agreement, and has proven to be a useful tool for identifying algal biodiversity 'hot-spots'. The recent requirement for environmental surveys, conservation reviews, and site condition status monitoring has generated much species data unconfirmed by specimens with inevitable problems. We wish to promote the wider use of the collection (in addition to systematics and floristics) as an important reference point for contemporary environmental, conservation and biodiversity issues. For this to be successful, a programme for the development of the collection is required; a first approach will be presented.

Special session. Algal - non-algal interactions

Elucidating physiological responses of macroalgae to epiphytism, herbivory, and cell damage

GEORG POHNERT

Interactions of algae with their environment are often mediated by so called infochemicals. These secondary metabolites can be involved in defence, allelopathy and communication. This presentation focuses on chemical responses of algae that are triggered upon perception of different types of stress. Guided by bioassays and analytical chemical methods new regulative principles of the dynamic production or transformation of metabolites by algae were elucidated. Examples from the red alga *Gracilaria chilensis*, the brown alga *Dictyota dychotoma* and the green alga *Caulerpa taxifolia* show that these dynamic responses often involve basic enzymatic transformations and substrates from primary metabolism. It will be outlined that metabolic responses involving such fundamental biochemical processes might allow a cost-efficient and flexible response to external triggers.

Algal viruses: more than just a collection of sequences

DECLAN SCHROEDER

To my knowledge, more than 40 viruses infecting marine eukaryotic algae have been described to-date. They infect bacillariophytes, chlorophytes, cryptophytes, dinophytes, haptophytes, pelagophytes, phaeophytes and prasinophytes. Host-virus interactions are more complex and diverse in variety than previously assumed. They all play important ecological roles such as bloom prevention & termination, controlling community composition, nutrient cycling, ocean chemistry and host fecundity. This presentation will highlight a few key examples of how these unexpected relationships were uncovered.

Why do algae eavesdrop on bacterial conversations?

IAN JOINT, KAREN TAIT, GLEN WHEELER & LENA GRANHAG

Bacteria are now known to have complex systems of communication between cells, which is referred to as quorum sensing. We have shown that *Ulva* zoospores use the signal molecules with which bacteria 'talk' to each other as a cue for settlement. Zoospores are able to detect the N-acylhomoserine lactone (AHL) group of quorum sensing molecules - the best understood molecules involved in bacterial cell-to-cell signalling. AHLs modify the swimming behaviour of zoospores so that they settle in the vicinity of AHL-producing bacterial-producing biofilms. This does not involve chemotaxis but rather it is a chemokinetic response. Bacteria are also important for the development of *Ulva*. In the absence of bacteria, the alga is deformed and bacteria are necessary for the normal development of the seaweed. Bacteria also appear to enhance the growth rate of plantlets. There are clearly many complex interactions between bacteria and *Ulva* in the natural environment. These will be reviewed and we will speculate on the advantages that are conferred on *Ulva* by 'eavesdropping' on bacterial conversations.

Symbiotic interactions of cyanobacteria, algae and plants

DAVE G. ADAMS

Cyanobacteria are photosynthetic prokaryotes of great environmental importance. They form symbiotic associations with a wide range of eukaryotic hosts including plants, fungi, diatoms, dinoflagellates, sponges and protists. Many of the filamentous cyanobionts fix nitrogen in specialised cells known as heterocysts and release much of this nitrogen to the host. In the case of non-photosynthetic hosts the cyanobiont can also provide fixed carbon. The benefit to the cyanobiont is less clear, but they receive fixed carbon from photosynthetic hosts and probably protection from predation and environmental extremes. The best studied cyanobacterial symbioses are those with plants, in which the symbionts are usually *Nostoc* spp. and the infective agents are specialised motile filaments known as hormogonia, the formation of which is stimulated by chemicals released by the host plant. The hormogonia can infect the roots, thallus, stems and leaves, depending on the particular plant, and are guided to the sites of infection by chemoattractants released by the host. Once inside the plant the cyanobionts undergo morphological and physiological changes and release to the plant, much of the nitrogen they fix. Less well understood, but nevertheless widespread, are the cyanobacterial symbioses with marine diatoms and dinoflagellates. For example, diatom symbioses with the heterocystous cyanobacterium *Richelia intracellularis* can form enormous blooms and provide an important source of combined nitrogen in oligotrophic seas.

Interactions between phytoplankton and grazer

LOTHAR KRIENITZ

The abundance and appearance of planktonic algae and their evolution within freshwater ecosystems is a result of interactions such as grazing and resource competition. This presentation is focused on two main topics:

i) Defence mechanisms of phytoplankton algae against grazing and digestion.

ii) Food contents such as essential fatty acids or toxins as benefit or danger for the grazer.

The following case studies of possible phytoplankton-grazer-interactions will be discussed: Phenotypic adaptations in green algae: large colonies (*Scenedesmus*), spines (*Micractinium*), mucilage (*Dictyosphaerium*), hard loricae (*Phacotus*). Are these adaptations inducible? The picoplanktonic Eustigmatophyceae *Nannochloropsis limnetica* has a tenfold higher content of essential fatty acids than other picoplankton such as green algae. Can the zooplankton respond to these differences in food composition? The cyanobacterial communities in saline-alkaline Rift-Valley-Lakes in East Africa are invaded by toxic chemotypes. Are the Lesser Flamingos as main consumer birds interfered by this changing food quality? Challenges in the frame of research on these interactions consist in:

i) Discovering of the nature of chemical communication: Mode of action of infochemicals and genes.

ii) Better understanding of evolution: Differentiation between phenotypic and genotypic plasticity, sharpening of taxonomic criteria.

iii) Use of practical aspects: Food web regulation in lake restoration; protection of biodiversity.

Algal functional group models: do they predict grazing resistance by temperate macroalgae in a multi-grazer system?

SARA MARSHAM, MICHELLE TOBIN & GRAHAM SCOTT

The functional group model of Steneck and Watling (1982) was used to predict feeding preferences of *Littorina littorea* and *Idotea granulosa* with the premise that algal susceptibility to grazing would decrease as algal structural complexity increased. The recorded rank order of feeding preference matched the predicted order when *L. littorea* were presented with whole plant material, though *I. granulosa* showed no relationship with the predicted order of preference. When the effect of algal morphology was investigated by presenting grazers with algal homogenates in agar, both grazers displayed a preference for algal extracts in agar over whole plant material, though neither displayed any relationship between the recorded rank order of preference for artificial food and the predicted functional group preference. *L. littorea* consumed significantly more algae as whole plants from functional group two, though displayed no preference between artificial food. The opposite was found for *I. granulosa*, as they displayed no preference for algae between functional groups when presented with whole plant material, but preferentially consumed agar discs containing extracts of algae from functional groups two and four, suggesting feeding preferences are influenced by the chemical and/or nutritional composition of algae. The feeding preferences of *L. littorea* seem to be affected by algal morphology as functional group differences were observed between whole plants with differing morphologies but not between agar discs with similar morphologies. However, the functional group model proposed by Steneck and Watling (1982) cannot be accurately used to predict the feeding preferences of *L. littorea* or *I. granulosa*.

The influence of priority effects and zooplankton grazing on the assembly of *Microcystis* populations

WIM VYVERMAN, INEKE VAN GREMBERGHE, PIETER VANORMELINGEN, KATLEEN VAN DER GUCHT, SOFIE D'HONDT, ANTONIYA MANCHEVA, CAROLINE SOUFFREAU & LUC DE MEESTER

We conducted laboratory experiments to investigate intraspecific interactions within *Microcystis* populations, the importance of priority effects in determining population structure, and the impact of zooplankton grazing on these interactions. In a first experiment, we investigated defences induced by infochemicals of *Daphnia magna* in *Microcystis* strains that differed in important ecologically relevant traits. In a second experiment, we studied interactions between *Microcystis* strains in mixed populations in presence and absence of *Daphnia magna*. In a third experiment four different *Microcystis* ITS genotypes (two toxic and two non-toxic), were grown during four weeks in all possible pairwise combinations with the two strains inoculated at the same time or one strain inoculated one week after the other, in both directions, and this in the presence and absence of grazing *Daphnia magna*. The relative abundances of the strains were followed through time using Denaturing Gradient Gel Electrophoresis, and the growth rate of each strain in the populations was compared to its monoculture growth rate to determine the sign and magnitude of the interactions. Our data suggest that zooplankton has a relatively weak and strain-specific influence on the growth rate, microcystin production and colony formation of *Microcystis* strains compared to inter-strain differences in these traits. Grazing also impacted the interactions between strains in important ways. The presence of *Daphnia* resulted in weaker competitive interactions between strains and in strain-specific cases of facilitation. Strong priority effects occurred in some *Microcystis* populations but were strain-specific and influenced by *Daphnia* grazing. Interestingly, priority effects were found in two directions: the first strain could have a negative or positive effect on the growth rate of the second strain. Arriving first can be advantageous for inferior competitors while arriving second seemed to be mainly important in the presence of grazers depending on the toxicity and colony formation of the strains. We interpret these results in the light of the maintenance of genetic diversity in cyanobacterial populations.

ITS-2 as universal DNA barcode marker for green algae

THOMAS PRÖSCHOLD & ANNETTE W. COLEMAN

DNA sequences are a powerful tool in systematics and molecular phylogeny of green algae and have given new insights about the evolution of this group of organism. However, it has not yet proven as rewarding for taxonomic categorization. DNA Barcoding has now been considered to close this gap. The goal is to find a single, universal, short DNA fragment, which is easy to sequence and leads to a clear species identification. The mitochondrial cytochrome oxidase subunit I (*cox*I) was proposed by the barcoding initiative and is mostly used by zoologists. However, for certain groups like higher plants and green algae coxI is too conserved to separate organism at species level. In our study we used the second Internal Transcribed Spacer (ITS-2) of the nuclear ribosomal gene cistron. This locus has suggested a high degree of predictability across eukaryotes, is easy to sequence and its secondary structure is used for comparison at species and generic level. The main objection to the ITS-2 usage as barcode marker was the difficulties to align these sequences and the prediction of the secondary structure. However, the easy recognition of two hallmarks in the secondary structure, these problems are resolved. ITS-2 also gives additional information about the species concept. For example, compensatory base changes (CBC) in the highly conserved region of Helix II and III correlate with the extent of sexual compatibility. A difference of even one CBC in this region predicts a total failure of crossing. This highly conserved region of ITS-2 can be consequently used as DNA Barcode marker for green algae.

Development of molecular tools to study the interaction between the brown algal pathogen *Eurychasma dicksonii* and its host *Ectocarpus*

MARTINA STRITTMATTER, CLAIRE MM GACHON & FRITHJOF C KÜPPER

The brown algal oomycete pathogen *Eurychasma dicksonii* has first been described in the 19th century and since then has been mentioned in numerous observations from the field. So far, detection and quantification of this pathogen have been performed using conventional microscopic observation and symptom scoring. Since *Eurychasma* is an intracellular pathogen, microscopy is difficult and time-consuming, especially if infection density is low. Here we describe the application of a Real-Time PCR assay to detect and quantify oomycete infection in brown algae - using our model system of *Ectocarpus siliculosus* and *Eurychasma dicksonii*. We could demonstrate that the assay is suitable to assess the presence of *Eurychasma* as well as the severity of infection in *Ectocarpus*. First developed on defined laboratory cultures, this technique is also suitable to accurately monitor the prevalence and abundance of pathogens in natural algal populations in the field. The assay has been used to screen 45 *Ectocarpus* strains to disease susceptibility and resistance. We could observe that the severity of *Eurychasma* infection in *Ectocarpus* varies with *Ectocarpus* strains showing no symptoms as well as strains being highly susceptible towards the pathogen. A comparative proteomic approach using two-dimensional electrophoresis will address the question of resistance-related proteins in *Ectocarpus*.

Diversity of *Ectocarpus* (Ectocarpales, Phaeophyceae) in Britain

AKIRA F. PETERS, **MATTHEW HALL** & DECLAN C. SCHROEDER

Based on morphological characters, cross-fertility and molecular systematics, the current consensus is that there are two species in the ubiquitous temperate brown algal genus *Ectocarpus*: the type species *E. siliculosus* (Dillwyn) Lyngbye and *E. fasciculatus* Harvey. This however contrasts with the 119 taxa of *Ectocarpus* flagged as "current" in AlgaeBase. To clarify this apparent inconsistency, we set out to re-examine the genetic diversity of *Ectocarpus*. Collections in England, Scotland and Wales in May/June 2008 and subsequent genotyping using ITS1 length and sequences revealed nine clearly distinguishable genotypes, which may deserve species rank, three thereof frequent, in a total of 320 samples. A proportion of 5% of the field thalli were putative hybrids. One of the genotypes (found in a marina) is possibly an alien.

Are there any true marine *Chlorella* species?

CAMPBELL CN, PRÖSCHOLD T, DARIENKO T, BOCK C & RAD MENENDEZ C.

Species of the genus of spherical green algae, *Chlorella* are generally considered to be freshwater organisms and phylogenetic studies have shown that it is a polyphyletic group. However, so far, only freshwater strains have been studied. Here we describe 12 strains of "marine" *Chlorella* held in public culture collections which we studied using a polyphasic approach. These strains were largely isolated from marine rock pools and brackish estuaries. SSU and ITS regions of the nuclear encoded ribosomal DNA were sequenced, ribosomal secondary structures were analysed and cell morphology, salinity tolerance and reproduction were examined. Sequences of the authentic strains originally described by Butcher (1952) are found to be identical to *Chlorella vulgaris*, the type species of the genus. Results are discussed and we propose reclassification of the strains studied and to answer the title question posed.

Species structure and biogeography of the marine diatom *Pseudo-nitzschia pungens*

KOEN SABBE, WIM VYVERMAN & GRIET CASTELEYN

Regional and global variation in molecular markers, sexual compatibility and morphological characteristics were studied in populations of the marine pennate diatom *Pseudo-nitzschia pungens*. Sequence variation of rDNA ITS and rbcL revealed three distinct genetic clades, corresponding to the morphological entities var. pungens, var. *cingulata* and var. *aveirensis*. The capacity for inter-clade hybridization was shown in laboratory experiments and in the field for vars *pungens* and *cingulata*. A population genetic survey using 6 microsatellite markers of the most widespread clade pungens demonstrated significant geographical differentiation between the populations at a global scale with geographical isolation being significantly correlated with population genetic differentiation, while at a regional scale significant gene flow appears to occur resulting in uniform, unstructured populations. We compare these results with other recent studies on marine and freshwater diatoms to discuss the roles of species sorting mechanisms, migration and speciation rates as determinants of diatom geographies.

Pursuit of a natural classification of diatoms: Do not compare apples with oranges

LINDA K. MEDLIN

Williams and Kociolek (2007), in the *European Journal of Phycology*, have presented an opinion paper in which they review some principles of classification and criticize the most recent classification of the diatoms by Medlin and Kaczmarska (2004). In their criticism of the most recent classification system of the diatoms, they have misinterpreted and misrepresented some of the molecular data that they have used as evidence against this classification system. They have dismissed the use of centrics and araphids because they represent paraphyletic. Evidence is presented to show that these terms can be used in a descriptive sense because they connotate a specific valve shape or type of sexual reproduction. They have also dismissed studies on the evolution of araphid diatoms because they have no biological reality. Evidence is presented to show that the two

groups of araphid diatoms are distinguished by their type of auxospore. Thus their rejection of the current classification of the diatoms is unsupported.

Shedding light into a coloured mess: phylogenetic relationships and species circumscription in *Trentepohlia* and *Printzina* (Trentepohliales, Ulvophyceae)

FABIO RINDI, DARYL W. LAM & JUAN M. LÓPEZ-BAPTISTA

Trentepohlia and *Printzina* are widespread genera of terrestrial microalgae distributed in regions with humid climates. Despite of intensive investigations in the past, their taxonomy is still one of the most problematic areas in green algal systematics. Phylogenetic relationships in these genera were inferred from separate and combined analyses of the rbcL and 18S rRNA genes. In all analyses, three main clades were recovered with moderate to high support. A clade that was sister to all other Trentepohliales included species of *Trentepohlia* and *Printzina* with widespread geographical distribution (*Printzina bosseae*, *Trentepohlia flava*, *T. iolithus* and *T. umbrina*). The second clade included mainly strains of tropical origin, morphologically referable to *Printzina lagenifera* and *Trentepohlia arborum*. The third clade corresponded to the genus *Cephaleuros*, but included also *Trentepohlia dialepta*. *Trentepohlia aurea*, the type species of *Trentepohlia*, formed an individual lineage, and its position in relation to the three main clades could not be resolved. The rbcL and 18S rRNA datasets provided convergent phylogenetic signals and similar topologies were recovered in single-gene analyses. Analyses performed on the combined rbcL-18S rRNA dataset provided generally higher support. The results clarified several taxonomic problems (in particular, the distinctness of *Trentepohlia flava* from *T. aurea*) and showed that the evolution of these algae has been characterized by extensive morphological convergence. Incongruence between phylogenetic relationships and traditional morphological classification was demonstrated, showing that the morphological characters commonly used in the taxonomy of the Trentepohliales are phylogenetically irrelevant.

Manton Prize presentations

The photophysiology of rocky shore biofilms

NAOMI GINNEVER, DAVID PATERSON & RUPERT PERKINS

To date little is known about the down regulation processes of rocky shore diatoms, which provide an important base to near shore webs. Photoacclimation and primary productivity of rocky shore epilithic/endolithic microalgae and cyanobacteria were investigated using PAM variable chlorophyll fluorescence as well as LTSEM and ENVSEM. Data will be presented comparing the use of vertical migration and physiological down regulation as methods of photoacclimation. LAT to prevent migration and DTT to inhibit non-photochemical quenching will be utilised to ascertain whether reductions in Fo15 observed are as a result of migration or down regulation. Further work will investigate whether environmental factors such as ambient water temperature, emersion period, nutrient levels and water pH affect methods of down regulation. Microcosms will be used to isolate biofilms on rock chips in order to manipulate environmental conditions. The effect of biotic factors including grazing by mollusca on productivity and biomass is also presented.

The effect of morphological complexity on sediment trapping capacity of macroalgae

HELEN CHURCHILL, MICHELLE TOBIN & SUE HULL

The capacity of intertidal macroalgae to trap sediment is well documented and it has been recognised that the degree to which algae trap sediment varies between algal species. This has, in part, been attributed to the species' morphology. Morphological complexity of algae consists of a number of aspects of shape, space, texture, architecture and surface structure which may affect the alga's capacity to retain sediment. In an attempt to assess which aspects of macroalgal morphological complexity affect their capacity to trap sediment, five replicates of each of ten morphologically different macroalgal species were collected from the lower mid shore at three sites near Scarborough, North Yorkshire. Samples were collected on four separate occasions at three monthly intervals throughout a 12 month period. Differences in the mass of dried sediment g-1 dry algal weight between different species was assessed. For each sample morphology complexity was quantified using the following methods: frond density, interstitial volume, branching organisation, algal volume and proportion of height before first branch were measured. The relationship between morphological complexity and the mass of sediment g^{-1} dry algal weight was assessed for each method.

The effects of multi-frequency ultrasonics on algal bloom species, *Scenedesmus subspicatus*, *Melosira* sp. and *Aphanizomenon flos-aquae*

DIANE PURCELL, SIMON PARSONS & BRUCE JEFFERSON

Eutrophication of a water source is the generic cause of algal blooms, abundant nutrients triggers excessive growth of the dominant species in the water body and a bloom is formed. Ultrasound technology to treat algal blooms is a relatively new option for water companies which have huge potential as an alternative to chemical water treatment. It works by concentrating the energy of sound waves through cavitation causing the compression, rarefaction, and finally implosive collapse of bubbles producing intense local heating (5,000°C) and high pressure (2000 atm). The aim of this study was to produce a comprehensive catalogue of the effects that low and high frequency ultrasound has across problematic blooming algal species. The range of algal species were tested includes blooming species in the Cyanophyta, the Chlorophyta & the Bacillarophyceae. The experiments were performed using laboratory scale ultrasonic equipment covering frequencies from 20 kHz - 1.15 MHz, & power from 200-400Watts. Key results demonstrated a relationship between energy and frequency input per unit volume and cell removal. Cyanobacterial species *Microcystis aeruginosa* needed 100kWh/M^3 at a frequency of 20-30 KHz to remove 60% of cells, without bloom recovery. Field samples of the diatom *Melosira* sp. also required 100kWh/M^3 to achieve 50% kill rate also without growth recovery. *Aphanizomenon flos-aquae* required 70% less energy than the other species tested to date at only 20-30kWh/m^3 but at a higher frequency of 1144 kHz for 100% cell removal. Combining removal data, Chlorophyll fluorescence, TEM imaging and toxin detection enables the impact of ultrasound on algal physiology to be established.

Development of a biosorption column utilising seaweed based biosorbents for the removal of metals from industrial waste streams

ADIL BAKIR & EDDY FITZGERALD

The use of seaweeds as biosorbents has its advantages over conventional chemical and biological treatment of industrial effluents due to their widespread distribution and their ability to accumulate heavy metals in both living and non-living form. Three different species of non-living seaweeds (*Fucus vesiculosus*, *Polysiphonia lanosa* and *Ulva lactuca*) and a seaweed waste product derived from *Ascophyllum nodosum* (referred to as WAP) were studied for the biosorption of single and combined heavy metals (Ni^{2+}, Zn^{2+}, Al^{3+} and Sb^{3+}) in a 10 mg/l aqueous solution. Removal efficiencies of 96%, 93% and 68% were achieved for Zn^{2+}, Ni^{2+} and Al^{3+} respectively

using WAP. An antagonistic effect was observed when Sb^{3+} was mixed with the other metals resulting in a significant reduction in uptake of the above metals by WAP. However, 91% of Sb^{3+} alone and in combined metal solutions was removed by non-living biomass of *P. lanosa*. WAP immobilized in agar was used to investigate the sorption of Zn^{2+}, Ni^{2+}, Al^{3+} and Sb^{3+} using a laboratory scale fixed-bed sorption column fed with a metal solution containing single and combined heavy metals at a concentration of 10 mg/l. Both short and long term studies were investigated. Sorption isotherm studies as well as an investigation of the antagonistic effect of Sb^{3+} on the sorption of the other metals were also carried out. On-going research includes the testing of a scaled-up model of a fixed-bed sorption column to treat industrial pollutants.

A multi-marker inference of the phylogenetic relationships within the brown algae (Heterokonta, Phaeophyceae): towards a resolution of the former 'brown algal crown radiation'

THOMAS SILBERFELD, FLORENCE ROUSSEAU & BRUNO DE REVIERS

Our understanding of phylogenetic relationships within the brown algae (Heterokonta, Phaeophyceae) has recently undergone significant improvements. Nevertheless, the ten later-diverging brown algal orders clustered in a large polytomy, the so-called "brown algal crown radiation". This polytomy could be explained by a lack of phylogenetic signal of the sequence data sets, in terms of quantity or quality. Therefore, in order to unravel phylogenetic relationships within this polytomy, we built a multi-marker phylogeny of the brown algae from ten mitochondrial, plastidial and nuclear loci, through the largest data set (*ca* 10,000 bp) hitherto built in a phylogenetic purpose. A supported (Sporochnales, Scytothamnales) clade was the first diverging lineage following the Desmarestiales. The remaining orders of the previously unresolved polytomy clustered in a trichotomy encompassing the fully-supported (Laminariales, Ectocarpales) and (Fucales, Nemodermatales, Ralfsiales, Tilopteridales) lineages, as well as the monotypic order Ascoseirales, which remained of uncertain affinity. Furthermore, by using this topology as a guideline for morphological optimizations, we propose consistent scenarios of evolution of plastidial features as well as thallus structure and growth in brown algae.

Phylogenetic analyses of the *Laurencia* complex (Rhodomelaceae, Ceramiales) support recognition of five genera: *Chondrophycus*, *Laurencia*, *Osmundea*, *Palisada*, and *Yuzurua* stat. nov.

JULIE MARTIN-LESCANNE, FLORENCE ROUSSEAU, BRUNO DE REVIERS, CLAUDE PAYRI & LINE LE GALL

The genus *Laurencia* has been proposed by Lamouroux in 1813, and included at the time only height species. Thereafter its taxonomic history has been convoluted; a large number of species have been proposed and the genus has rather appeared as a taxonomic complex. Today, the complex encompasses almost 200 species which are distributed from temperate to tropical waters. During the last three decades, three new genera have been proposed successively to reflect its morphological and anatomical diversity. Therefore the Laurencia complex now encompasses four genera: *Laurencia* sensu stricto, *Osmundea*, *Chondrophycus* and the recently described genus *Palisada*. 16 new rbcL sequences were produced and added to the 23 existing available sequences in order to infer molecular phylogenies with representatives of the four currently recognized genera. Our molecular phylogenies confirmed the four genera currently recognized within the complex: *Laurencia* sensu stricto, *Osmundea*, *Chondrophycus* and *Palisada*. Furthermore, *Palisada poiteaui* was resolved as a fifth independent lineage suggesting that the complex would actually be composed of five rather than four genera. *P. poiteaui* being the type species of the subgenus *Yuzurua*, elevation of this subgenus to generic rank was proposed. Except the strong alliance between *Laurencia* s.s. and *Yuzurua* stat. nov., phylogenetic relationships between the five genera were not well supported, suggesting that rbcL sequences are not sufficient alone to fully clarify supra-specific relationships within the *Laurencia* complex.

Asexual life history by biflagellate zoids of *Monostroma latissimum* (Kuetzing) Wittrock, (Ulotrichales, Monostromataceae)

FELIX BAST, SATOSHI SHIMADA, MASANORI HIRAOKA & KAZUO OKUDA

Monostroma latissimum (Kuetzing) Wittrock is a monostromatic green algae of commercial importance in Japan. Here we report the serendipitous discovery of asexually reproducing specimens collected from Usa, on the Pacific coast of Kochi Prefecture, south-western Japan. Zoids were found to be biflagellate and negatively phototactic. Germination of settled zoids was observed to follow erect-filamentous ontogeny. Further, homology of nuclear ribosomal internal transcribed spacer DNA (ITS nrDNA) revealed that the newly discovered asexual strain has identical nucleotide sequences to that of the previously identified sexual strain of *Monostroma latissimum*. The ITS nrDNA sequence data also differentiate this species from the closely related species *Monostroma nitidum* Wittrock and *Gayralia oxysperma* (Kuetzing) K.L. Vinogradova. Phylogenetic relationships were investigated among *Monostroma latissimum* and other monostromatic taxa within class Ulvophyceae using ITS nrDNA sequences to find the systematic position of this genus.

Toxins and toxin genes in environmental samples of cyanobacteria archived since 1839

ESME L. PURDIE, JAMES S. METCALF & GEOFFREY A. CODD

Under non-sterile conditions, cyanotoxins do not typically persist in environmental materials beyond a few weeks. Under dry conditions, e.g. after lyophilisation, hepatotoxic microcystins and nodularin and the neurotoxin BMAA (ß-N-methylamino-L-alanine), remain detectable after at least 20 years. These findings suggested that it may be possible to investigate historic samples of cyanobacteria if stored under dry conditions. We have carried out an initial examination of 30 cyanobacterial samples collected between 1839 and 1948, dried and now held at the Natural History Museum, London. The samples had been collected from fresh- and brackish waters, terrestrial habitats and included materials from high profile recreational lakes and visitor sites (e.g. Stonehenge). Samples were from the UK (14), USA incl. Hawaii (7), with one each from Bohemia, Chile, France, Germany, Jamaica, The Philippines, Sierra Leone and Zanzibar. They were selected as high potential microcystin-producers and with the possibility that all cyanobacteria may produce BMAA. All were dominated by *Anabaena*, *Microcystis*, *Nostoc*, *Oscillatoria* or *Planktothrix*. 27 samples contained traces of microcystins and all contained traces of BMAA (pg to ng/mg). These low concentrations (e.g. at one thousandth of those in freshly-grown or -collected materials) represent the residuals after storage for up to 169 years). 4 samples were positive for the microcystin synthase gene mcyD by PCR. The findings indicate the potential for dried archived cyanobacterial samples for the investigation of long-term issues in ecotoxicology.

Offered papers

Development of commercial hatchery and ongrowing methodologies in Ireland for *Palmaria*, *Laminaria* and *Porphyra* spp.

EDWARDS, M., O'MAHONY, F., MINEUR, F. & DRING, M.J.

The 'seaweed hatchery project' is one of two major seaweed projects funded in 2008 by Ireland's Marine Institute investigating the potential of Ireland's seaweed resources. The project aims to develop

seaweed hatcheries for three species of commercial importance in Ireland (*Palmaria palmata*, *Laminaria digitata* and *Porphyra* spp.) and establish practical techniques for deploying cultured material at sea. Different sites around Ireland will be tested as sources of fertile material and for their suitability for ongrowing each species, none of which has previously been cultured on a commercial scale in Ireland. The consortium undertaking the work consists of the Irish Sea Fisheries Board, Queen's University Belfast and the National University of Ireland, Galway, together with six small Irish companies involved in aquaculture and seaweed processing. Consequently, the project has three separate culture facilities in the north, west and south of Ireland and numerous licensed ongrowing sites around the coast. Since March 2008, spores of *P. palmata* have been settled and cultured at the three hatcheries, and then deployed successfully on several occasions to four ongrowing sites. Early results show that Strangford Lough offers exceptional growing conditions for *P. palmata* with plants from each hatchery developing equally well. Cultures of *L. digitata* gametophytes from the west and south of Ireland have also been established, and commercial seeding techniques are currently under investigation. If successful, this will be the first time *L. digitata* has been cultivated at sea. Irish species of *Porphyra* will also be studied in the second year of the project.

Iodide accumulation provides kelp with an inorganic antioxidant impacting atmospheric chemistry

FRITHJOF C. KÜPPER, LUCY J. CARPENTER, GORDON B. MCFIGGANS, CARL J. PALMER, TIM J. WAITE, EVA-MARIA BONEBERG, SONJA WOITSCH, MARKUS WEILLER, RAFAEL ABELA, DANIEL GROLIMUND, PHILIPPE POTIN, ALISON BUTLER, GEORGE W. LUTHER III, PETER M.H. KRONECK, WOLFRAM MEYER-KLAUCKE & MARTIN C. FEITERS

Brown algae of the Laminariales (kelps) are the strongest accumulators of iodine among living organisms. They represent a major pump in the global biogeochemical cycle of iodine and in particular, the major source of iodocarbons in the coastal atmosphere. Nevertheless, the chemical state and biological significance of accumulated iodine have remained unknown to this date. Using X-ray absorption spectroscopy, we show that the accumulated form is iodide, which readily scavenges a variety of reactive oxygen species (ROS). We propose here that its biological role is that of an inorganic antioxidant, the first to be described in a living system. Upon oxidative stress, iodide is effluxed. On the thallus surface and in the apoplast, iodide detoxifies both aqueous oxidants and ozone, the latter resulting in the release of high levels of molecular iodine and consequent formation of hygroscopic iodine oxides leading to particles, which are precursors to cloud condensation nuclei.

A comparison of the cost effectiveness of protein detection between wide range 2d electrophoresis, and multi-gel narrow range 2d electrophoresis with sample pre-fractionation in *Chlamydomonas reinhardtii*

BRICKLEY MR, LAWRIE E, COBB AH & HAWES C.

The model organism *Chlamydomonas reinhardtii* has been subjected to few proteomic studies, generally with isoelectric focusing over pI values 4-7. This study determined the extent to which proteome analysis beyond this range (pI 3-10) yielded additional proteomic data and the extent to which pre-fractionation into 3 fractions (pI 4.4-7.1) followed by 2D electrophoresis using 3 separate narrow range gels increased dynamic range and sensitivity. The majority of proteins were concentrated in the pI 4-7 range but several additional proteins could be visualized on the wider pI 3-10 gel though with reduced resolution in the mid range. Use of pre-fractionation and multiple gel electrophoresis over the pI 4.4-7.1 range resulted in significantly greater sensitivity (numbers of detected proteins) and greater dynamic range. This system involved significant additional costs both in time and resource terms. The overall cost effectiveness was lower in terms of spots detected per unit expenditure though the additional resource allocation may be justified when examination of the whole proteome is essential. Pre-fractionation required greater sample volumes (with lower relative protein yield per sample volume) but facilitated higher protein loads, increasing both sensitivity and ability to detect lower abundance proteins. The pre-fractionation / multiple gel method is ideal for development of proteomic maps and such a map is now being constructed for *Chlamydomonas reinhardtii*.

Harmful algal blooms in UK coastal waters; determining the environmental triggers and developing new detection methods

CRÉACH V., FORSTER R.M., MILLIGAN S.

Blooms of toxic or nuisance phytoplankton species are perceived to be a growing problem for the aquaculture industry and for water users in general. A national monitoring programme has been in place since 1992 to provide an early warning and to quantify the extent of blooms. Analysis of an extensive database of microscope counts has revealed details of the timing of species- specific blooms. For the diatom *Pseudo-nitzschia* sp. the magnitude of blooms varies greatly between years, but the timing of peak cell numbers changes in a predictable manner according to locality. The environmental conditions preceding each bloom event have been investigated, in order to increase our predictive ability and the contribution of *Pseudo-nitzschia* bloom to bulk phytoplankton chlorophyll has been examined using remote-sensing of ocean colour. Additionally, automated ribosomal intergenic space analysis (ARISA) and flow cytometry have been developed to identify cells at the species level. The first results are very promising. In 2007, 7 blooms events have been analysed and showed the presence of 3 different species *P. delicatissima*, *P. fraudulenta* and *P. multiseries*. The rapidity and the accuracy of the results make these techniques very attractive for use in monitoring programmes and to investigate the diversity of the *Pseudo-nitzschia* populations in UK waters.

Green algae as indicators of heavy metal pollution along the Saudi coast of the Arabian Gulf

ALI A. AL-HOMAIDAN

Several species of green algae have been used as indicators of heavy metal contamination in coastal areas. The concentrations of Cu, Zn, Fe, Cd, Pb and Ni were determined in the green algae *Chaetomorpha aerea* (Dillwyn) Kutzing *Enteromorpha clathrata* (Roth) Greville and *Ulva lactuca* Linnaeus collected from three sites on the Saudi coast of the Arabian Gulf. The algal samples were dry digested using hot concentrated nitric acid and the metals were analyzed by atomic absorption spectrophotometer. Levels of heavy metals similar to those of polluted coastal areas were detected for all elements except Cd. The mean concentrations of the examined algae were as follows: Cu 8.41-48.52, Zn 34.16-68.18, Fe 812-2,335, Pb 13.90-30.50 and Ni 25.51-44.51µg-1 dry weight. The levels of Cu, Zn, Fe, Cd and Ni in *C. aerea* were significantly higher than in the other two algae, and this species could serve as bio indicator for heavy metal pollution in this part of the world. No significant differences were detected for the heavy metal levels in the three areas studied indicating a high degree of pollution at all sites. High levels of industrialization and urbanization and oil spillages, which are taken place in the Arabian Gulf region, are probably responsible for the elevated levels of pollutants in this area.

Presidential address

Cyanobacteria and cyanotoxins from prehistory to the present

GEOFFREY A. CODD

Oxygenic photosynthesis, responsible for transforming Earth's chemosphere and biosphere and for the support of all aerobic life today, is widely regarded as having arisen in ancestral cyanobacteria. The process was already transforming Earth's environment about 2.3 million years ago, although even older cyanobacteria-like microfossils occur in Precambrian rocks. Phylogenetic and biosynthetic intermediate analyses indicate that several classes of the cyanotoxins produced today (microcystins, saxitoxins, cylindrospermopsins) were probably produced by ancestral cyanobacteria, before cyanobacterial diversification. The uneven occurrence of cyanotoxin production among cyanobacterial genera, species and strains today, a practical challenge to water quality monitors and managers, may be due to repeated gene loss, rather than horizontal gene transfer. The cyanotoxins themselves vary in their susceptibility to photo-, chemical- and bio-degradation and their long-term survival in environmental materials, including animal remains, has received little attention. However, evidence exists for the association of microcystins with the deaths of large mammals found in Pleistocene shale deposits in Germany. Cyanobacterial poisoning has also been suggested as a plausible cause of mass mortalities involving multiple dinosaur genera at a Cretaceous Era, former lakeside site in Montana, USA. Coming almost up to the present by palaeontological standards, we have recently identified cyanotoxins in dried environmental samples of cyanobacteria collected, documented and stored since 1839. Early accounts of the human recognition of cyanobacterial blooms and scums and effects of the cyanotoxins are reviewed. A gallery of some of the key cyanotoxin researchers and some pointers for future investigation are also presented.

Offered papers

Upside Down/Inside Out: How a major evolutionary leap could result from a minor regulatory switch - and have no intermediates

BARRY S.C. LEADBEATER

One of the challenges in molecular and evolutionary biology is to explain the link between 'giant' evolutionary leaps and the underlying genetic changes. For a long time it was thought that profound changes in morphology would be accompanied by equally dramatic upheavals at the genetic level. However, several examples have come to light whereby relatively minor changes in regulation, rather than the modification or creation of genes, have driven major evolutionary innovations. The loricate choanoflagellates, with their unique basket-like loricae, present an interesting example at the morphological level of how a relatively minor regulatory change could explain a major evolutionary innovation. The uniqueness of the lorica demonstrates the unequivocal monophyly of this choanoflagellate group and yet there are two major clades that differ in the order of events leading to lorica assembly. The result is that one clade (nudiform) contains only five extant species, limited in both morphology and ecological diversity, whereas the other (tectiform) comprises more that 150 species that have successfully colonised many microniches within the marine environment. Could the difference be due to a regulatory change which not only produced viable offspring but conferred an advantage over its antecedents?

Sexual reproduction in *Haslea ostrearia*: size, partner, and atmosphere matter

ROMAIN GASTINEAU, NIKOLAÏ DAVIDOVICH, PIERRE GAUDIN & JEAN-LUC MOUGET

The pennate marine diatom *Haslea ostrearia* (Gaillon) R. Simonsen is an ubiquitous species, which can be erratically dominant in Atlantic French oyster ponds. This species is the only alga able to produce a peculiar blue pigment, the so-called marennine, responsible for the greening of oyster gills. This pigment gives added value to the oysters, and it has also demonstrated allelopathic activity *in vivo* that could play an important role in interspecific competition, and antioxidant and free radical-scavenging activity in vitro. In pennate diatoms, long-term maintenance of culture collections poses problems because of cell size reduction according to the MacDonald-Pfitzer rule. Maximum species-specific cell size is usually restored with an auxospore, which follows zygote formation by sexual reproduction. In *H. ostrearia*, the pattern of sexual reproduction can be classified as type IB2a according to Geitler's system. Auxospore formation was dependent on the compatibility between clones and on the mean cell size of populations (upper threshold for sexual induction close to 50% of the maximal initial cell size, *ca.* 140 μm). Light was another key factor controlling auxospore formation in *H. ostrearia*. Higher reproduction frequencies (number of paired gametangia containing gametes, zygotes, auxospores and initial cells per total number of cells) were observed at low irradiances (20-50 μmol photons m^{-2} s^{-1}), and short photoperiods (6h-10h of light per day). No auxospore was formed in darkness, and it was very rare in continuous light. Moreover, auxosporulation needed red monochromatic light, and did not happen under blue or green radiations.

Gamete release of *Ulva mutabilis* and *Ulva lactuca* (Chlorophyta): Regulatory effects and chemical characterization of the "swarming inhibitor"

THOMAS WICHARD & WOLFGANG OERTEL

Gametophytes of *Ulva mutabilis* Føyn and *Ulva lactuca* Linnaeus were induced to form gametangia by removal of sporulation inhibitors. On the morning of the 3rd day after induction of *U. mutabilis*, and 1-2 days later for *U. lactuca*, gametes were matured and ready for swarming. While gamete release in *U. lactuca* was triggered by the first light in the morning solely, the discharge of gametangia from *U. mutabilis* required additionally the dilution of the "swarming inhibitor" (SWI), which was excreted transiently by both *Ulva* species early during gametogenesis. The SWI was purified to homogeneity from both species and turned out to be identical determined by mass spectroscopy. Whereas the SWI in the medium of *U. mutabilis* stayed constantly above the inhibitory concentration until the gametangia were mature, the SWI concentration in the *U. lactuca* medium dropped rapidly below this concentration long before. Also, *U. lactuca* gametangia were completely insensitive to added SWI at this time. Contrary to *U. lactuca* mature gametes of *U. mutabilis* remained immobile within the gametangia in the presence of sufficient SWI despite light and open exit pores. Observation of swarming gametes by time lapse microscopy and experiments with the myosin-kinase-inhibitor BDM suggest that release is driven by a myosin like motor protein causing gliding-movement out of the pores. The possible functions of the SWI in the natural habitat will be discussed for both *Ulva* species.

Physiological characteristics of co-limiting conditions in *Chlamydomonas*

ELLY SPIJKERMAN

The phytoplankton species *Chlamydomonas acidophila* inhabits acidic mining lakes. These lakes are characterised by low pH (2.3 - 3.4), low concentrations of inorganic carbon (only present as CO_2; 0.04 - 0.8 mmol C L^{-1}) and high concentrations of metal ions, such as iron (0.2 - 10 mmol Fe L^{-1}). Often inorganic phosphorus limits the growth of this species in the upper layers of the lakes (0.03 - 1.35 μmol P L^{-1}). Experiments on the uptake capacity for CO_2 and P in P-limited

cultures indicated co-limiting conditions. This was visualised by recording the highest maximum P uptake rates in the high CO_2 cultures and highest maximum CO_2 uptake rates in the low CO_2 cultures. Two mechanisms are postulated through which low P and CO_2 might interact.

1) Low P concentrations inhibit the CCM capacity by decreased ATP content

2) Space limitation of the membrane forces the cells to either invest in the uptake (/binding) proteins for P or CO_2, not both.

In my contribution I will address these two mechanisms and present data on the acclimation of *C. acidophila* to two potentially limiting nutrients.

Carbon concentrating mechanisms in acidophilic algae

STEPHEN MABERLY & MONICA DIAZ

Seven phylogenetically-diverse strains of microalgae were isolated from a naturally-acidic lake (c. pH 2) and river system in Patagonia. Half saturation constants for CO_2 at atmospheric levels of oxygen varied between 2 and 12.7 μmol L^{-1}. CO_2-uptake was oxygen sensitive in the spheroidal form of *Watanabea* sp., *Pallmellopsis* sp. and an unidentified Prymnesiophyte but insensitive in the ellipsoidal form of *Watanabea* sp. and in *Euglena mutabilis*. The kinetic evidence suggests that a CCM is absent in *Palmellopsis* sp. and *Gloeochrysis* sp. and the spheroidal form of *Watanabea* sp. but present in the ellipsoidal form of *Watanabea* sp. The low K½, 2 μmol L^{-1}, in the unidentified Prymnesiophyte suggests that a CCM may be present but the kinetic responses were oxygen sensitive, although K½ was not affected by oxygen. Carbon uptake in *Euglena mutabilis* was not oxygen sensitive but the K½ was 6.4 μmol L^{-1} which makes the diagnosis of the presence of a CCM equivocal. The results for Watanabea sp. appear to be the first where different forms of the same species possess or lack a CCM when grown under identical conditions. Rates of growth of *Watanabea* sp., largely comprising the spheroidal form, were between 86 and 95% of maximal rates at air-equilibrium concentrations of CO_2 depending on the oxygen concentration. The high affinity of these species for CO_2, even in the apparent absence of a CCM, suggests that when an acid lake is close to atmospheric equilibrium, rates of photosynthesis and growth are unlikely to be limited by CO_2.

ABSTRACTS FOR POSTER PRESENTATIONS

Molecular characterisation of diversity in an exceptional harmful algal bloom forming species, *Karenia mikimotoi*, in the Celtic Sea shelf break region

MANAL AL-KANDARI, DECLAN C. SCHROEDER, MARTIN EDWARDS, MARIAN YALLOP & PAUL K. HAYES

Karenia mikimotoi (previously classified as *Gyrodinium aureolum*) is one of the most dominant harmful algal species that has been reported to regularly bloom in the Celtic Sea shelf break since 1975. It often blooms in the warmer months during summer and is associated with the frontal region in coastal areas. Some of these blooms are toxic, causing fish kills and other marine fauna mortality. This red-tide causative organism has been associated with a very high chlorophyll concentration which can be observed from satellite sensors, such as the Sea-viewing Wide Field-of-view Sensor (SeaWiFS). Our study seeks to use a powerful combination of molecular biology, satellite imagery and plankton recorder survey analyses to characterise the diversity within *K. mikimotoi* blooms, in the Celtic Sea shelf break waters both temporally and spatially in order to i) to confirm the timing of its first reported introduction of 1975 and ii) to determine whether *K. mikimotoi* is responding to climate change.

The influence of light intensity on the growth rates of *Alexandrium* Halim (Dinophyceae) from Scottish waters

ANA LUISA AMORIM & EILEEN BRESNAN

The dinoflagellate genus *Alexandrium* shows considerable diversity in Scottish waters. To examine the influence of high and low light intensity (120 & 60 μmol. $m^2.sec^{-1}$) on the growth rate and physiology of this genus, batch culture experiments were performed on three species detected in Scottish waters; *Alexandrium tamutum*, *A. minutum* and *A. ostenfeldii*. The growth rates of the three species differed at high light intensity with population doubling rates ranging from 0.35 per day for *A. minutum* to 0.15 per day for *A. ostenfeldii*. Low light intensity had the greatest influence on *A. minutum*, reducing its population doubling rate by 30%. The growth rate of *A. tamutum* was reduced by 10% and by 5% in *A. ostenfeldii*. The cell volume of *A. tamutum* and *A. minutum* decreased during exponential growth at both light intensities, while the cell volume of *A. ostenfeldii* remained variable. This study highlights the individual response of different *Alexandrium* species from Scottish waters to changes in light intensity.

Far field effects of oceanic climate indices on community

BAPTIE, MC & DELANY, JE

The response of the phytoplankton community sampled by the long running Dove Time Series to basin scale hydroclimatic shifts is presented. Striking changes in the composition and semiquantitative abundance of the local phytoplankton community from 1971 to 2008 coincided with periods of intrusion of colder, fresher water, and warmer, more saline water into the North Sea. Uncharacteristic species were found during these major perturbations to the hydroclimatic regime and the month of first appearance of generally cosmopolitan species was disrupted. The relationship between physicochemical parameters, basin climate indices and groups within the phytoplankton is discussed.

Induction of gametogenesis and gametangial ontogeny in intertidal green algae: *Monostroma latissimum* (Kütz) Wittrock

FELIX BAST, MIYUKI MAEGAWA & KAZUO OKUDA

The light-microscopical cytology of gametangial ontogeny in dioecious green alga *Monostroma latissimum* is described for the first time. Gametogenesis was induced by floating the algal fronds in autoclaved seawater and incubating at 20-25° C with a luminous intensity of 100-150 μmol photons m^{-2} s^{-1}. Migration of chloroplast towards the proximal side of the paired gametangial mother cells (GMCs) marks the beginning of gametogenesis. Each GMC is found to produce only one gametangium at its distal side that appears as a colourless vascular body in the light microscopy. Gametangial dehiscence is found to be destructive to the GMCs and on the basis of this observation, retention of an earlier classification system within family Monostromataceae based upon this particular diagnostic feature is proposed. In the present study, we have also attempted to provide empirical reasons behind the two fundamental characteristics of monostromatic green algae for the first time, viz., the typical arrangement of cells in groups of two and the change of colour from pale green to pale yellow for the thalli that reach maturation.

Effects of iron on growth and photosynthesis of *Chlamydomonas acidophila* under different phosphorus conditions (S)

HELLA BEHREND & ELLY SPIJKERMAN

Chlamydomonas acidophila is a main primary producer in acidic mining lakes (pH 2-3). These lakes have a lower primary production than

neutral ones and contain high concentrations of heavy metals, such as iron (17 - 800 mg Fe L^{-1}). Former studies revealed that growth of *C. acidophila* in acidic lakes is often phosphorus limited and that primary production is negatively correlated with lake iron concentrations. To answer the question if low primary production is caused by high iron concentrations, *C. acidophila* was cultivated in medium with different iron concentrations (1-400 mg Fe L^{-1}). In addition, experiments with saturating or limiting phosphorus supply were performed to study the interaction between P-limitation and iron toxicity. Growth rate, photosynthetic parameters (e.g. quantum yield, PQ pool) and cellular quotas of C, P & Fe were determined. In P-replete cells an increase of the iron concentration from 1 to 100 mg Fe L^{-1} resulted in a decreased Chl a content but did not influence the growth rate. In contrast, under P-limiting conditions both growth rate and Chl a content increased over this range of iron concentrations. The results show a different reaction of *C. acidophila* to high iron concentrations depending on the P supply, and indicate an interaction between both factors. Supposedly, low P and high iron concentrations influence the primary production in acidic lakes. Further results on this interaction and the effect of high iron and low P concentrations on photosynthesis will be presented.

Variation in betaine yields from marine algal species commonly utilised in the preparation of seaweed extracts used in agriculture

G. BLUNDEN, M. CURRIE, I. MÁTHÉ, J. HOHMANN, & A. CRITCHLEY

Seaweed extracts and suspensions derived from marine brown algae are marketed for use in agriculture and horticulture. In Europe and North America, the alga most commonly used is *Ascophyllum nodosum*, although other species are also utilised (*Fucus serratus*, *Laminaria digitata* and *L. hyperborea*). A wide range of beneficial effects has been reported from the use of these products, in particular increased resistance to stress conditions, such as frost, and attack by nematodes, fungi and insects. Betaines have been proposed as the compounds responsible for these beneficial effects. Betaines have been isolated and characterised from all four species used for the production of the seaweed extracts and suspensions, as well as from the products themselves. However, possible variations in the yields of these compounds from material collected from different locations and at different times of the year have not been ascertained. As a result, collections have been made from widely different places (UK, Ireland, France and Canada) and at different times of the year. Each sample was analysed for its betaine content, both qualitatively (thin layer chromatography) and quantitatively (1H NMR spectroscopic method). There was no significant qualitative difference in the betaines detected in the various samples of each individual species. In all cases, betaine yields were low and did not vary widely between the different collections, irrespective of place and time of collection.

The biochemical basis of immunity of plants treated with seaweed extracts

G. BLUNDEN & E. TYIHÁK

Plants treated with brown algal extracts have been reported to be more resistant to attack by insects, mites, nematodes and fungi than untreated plants. The marked reduction in infestation of tomato plant roots by the root knot nematodes *Meloidogyne incognita* and *M. javanica* resulting from treatment of the plants with seaweed extract has been directly correlated with the N-methylated compounds present in the extract (glycinebetaine, δ-aminobutyric acid betaine and λ-aminovaleric acid betaine). When glycinebetaine was applied to bean plants in the concentration ranges applicable to those when seaweed extracts are used, two concentration ranges were found that resulted in low infection rates after inoculation with fungal spores of *Uromyces phaseoli*. With an induction time of two days prior to infection of the bean plants with the fungal spores, effective concentration ranges were about 10^{-5} to 10^{-6} and 10^{-12} to 10^{-13} mol/L. Between these active ranges there was an inactive range characterized in general by high infection rates. This double immune response was also produced when other N-methylated compounds were used. The results obtained show that the N-methylated compounds present in the seaweed extracts are capable of producing significant reductions in fungal infection, even when applied at low concentrations. N-Methylated compounds are potential formaldehyde (HCHO) generators and it is not surprising that HCHO and its reaction products play a crucial role in the manifestation of induced (adaptive) resistance.

Preliminary investigations into the diversity of *Chrysochromulina* (Prymnesiophyceae) in Scottish coastal waters

EILEEN BRESNAN & ØJVIND MOESTRUP

Current phytoplankton monitoring programmes in Scottish waters rely on light microscopy to identify and enumerate diatoms and dinoflagellates. Components of the phytoplankton community requiring specialised preservation and microscopy techniques are not included as part of routine analysis. As a result, our knowledge of the diversity of these groups remains limited. During 2008 a preliminary investigation into the diversity of *Chrysochromulina* (Prymnesiophyceae) in Scottish waters using shadow casting and transmission electron microscopy was performed. Scales of *C. pringsheimii*, *C. hirta* and *C. polylepis* as well as an unidentified *Chrysochromulina* species were identified in samples from the east coast of Scotland. Scales from *C. elegans* as well as an intact cell of *C. alifera* were observed in samples from the west coast. This small scale study highlights the diversity of this genus in Scottish waters and the requirement for further investigations into its seasonality and abundance.

Sequencing the *Porphyra* genome

JULIET BRODIE

Porphyra sensu lato is one of the largest genera of red algae. Its complex biphasic, heteromorphic life history, ancient fossil record and value as a source of human food (e.g. laver, nori) make it a compelling model for genome sequencing. *Porphyra umbilicalis* is currently the subject of a Joint Genome Initiative (JGI). Clonal material from an asexual isolate of the species from the northwestern Atlantic has been grown in culture and in now undergoing genome sequencing. In addition, an award from the National Science Foundation's Division of Integrative Organismal Systems is providing opportunities for a large group of scientists directly involved in analysis of the *Porphyra* genome. The first meeting of this Research Coordination Network (RCN) took place in June 2008 and brought together 31 senior scientist, postdocs and students from the US, Canada, China, Britain, Brazil and France. In addition to training, discussions took place on comparative and experimental approaches with the genomic data culminating in the development of a 'White Paper' covering evolution, co-evolution, life histories, taxonomy, sexual reproduction, physiology, biochemistry, endosymbiosis, comparative developmental biology, lateral gene transfer and transposable elements in *Porphyra*. These discussions provide the basis of projected areas of focus, including metabolism and gene networks, cell development and differentiation, evolutionary biology and applied and environmental biology. The project is also providing opportunities for public outreach in the wider community.

Why does *Fucus ceranoides* not dominate all estuaries in the British Isles?

HOLLY BROWN, MARTIN WILKINSON & MIKE BEST

One of the tools for assessment of ecological quality in transitional waters (estuaries) for the UK for the Water Framework Directive is the extent of fucoid penetration into estuaries. This is based on observations that as water quality improves the fucoid dominated reach moves upstream. In c. 75% of British estuaries surveyed the dominant upstream fucoid is the brackish-water species, *Fucus ceranoides*, but in the other 25% it is mainly *F. vesiculosus*, which does not penetrate as far where it occurs. Examination of physical and chemical data on estuaries dominated respectively by these two species, suggests that there are statistically significant differences in their occurrence in different estuary types. *F. ceranoides* is favoured by smaller, less turbid, more stratified estuaries with lower levels of nutrient, metal and pesticide pollution while *F. vesiculosus* dominates in turbid, large, well-mixed estuaries with high loadings of nutrients, metals and pesticide pollution. In laboratory cultures all common, British *Fucus* species can be shown to tolerate reduced salinity but it is hypothesised that it is the magnitude of change during the tidal cycle that is important with highly stratified estuaries giving very large salinity swings that favour *F. ceranoides*. This accords with the absence of this species form the stable reduced salinities of the Baltic Sea. Since natural as well as anthropogenic factors are involved in the occurrence of *F. ceranoides* as opposed to *F. vesiculosus*, it is difficult to use the particular species occurrence as a feature in the quality assessment tool.

Diversity of *Alexandrium* (Dinophyceae) in Scottish waters

LYNDSAY BROWN, E. BRESNAN, J. GRAHAM, C. COLLINS, J-P. LACAZE AND E. A. TURRELL

In Scottish waters, the dinoflagellate genus *Alexandrium* is associated with the enforced closures of shellfish harvesting areas due to high concentrations of paralytic shellfish toxins on an almost annual basis. To investigate the diversity and toxicity of *Alexandrium* species in this region, phytoplankton cultures for morphological, molecular and toxin analysis were established from sediment and water samples taken from around the Scottish coast. Twenty *Alexandrium* cultures were established and four species of *Alexandrium* identified: *A. tamarense* (Group I and Group III strains), *A. minutum*, *A. ostenfeldii* and *A. tamutum*. Identification to species level using thecal plate morphology was confirmed by LSU analysis. Toxin analysis using LC-MS confirmed the production of paralytic shellfish toxins in *A. tamarense* (Group I strain) and *A. ostenfeldii*. Spirolides were detected in *A. ostenfeldii* cultures. No toxins were detected in the *A. minutum*, *A. tamutum* or *A. tamarense* (Group III) cultures established. This study highlights the diversity of *Alexandrium* in Scottish waters and identifies the presence of a number of non-toxic species.

The neglected seaweeds of Somerset

NIGEL CHAFFEY, JULIET BRODIE & LINDA M. IRVINE

There is almost certainly bias in the choice of areas sampled for marine benthic algae (seaweeds). This impacts on our knowledge of species diversity and distribution with implications for coastal management and conservation. In the UK the county of Somerset is a case in point as studies have been extremely limited. Situated in the west of England, Somerset's coastline extends along the Severn Estuary. The coast has the second highest tidal range in the world and is characterised by high silt loading and reduced salinity. There are extensive mud banks and exposed rock with considerable seaweed cover. Early studies included species lists in the second half of the 19th century and a survey in the 1970s was prompted by a proposal for a tidal barrage. Supporting herbarium specimens are very few. A renewed interest in a tidal barrage across the Severn Estuary and proposals for Marine Protected Area status, coupled with taxonomic advances in the identification of the algae, prompted us to embark upon a survey of the seaweed diversity of Somerset in 2008. The aim is to provide a baseline specimen-based record of the red, green and brown seaweed species of the Somerset coast that will provide a comparison with earlier studies, and which can be used by governmental and other agencies involved in conservation or developmental work in the area. We report here on the first phase of the study.

Inspiring the phycologists of tomorrow

PETER CHANIOTIS, SARA MARSHAM & JANE DELANY

As part of the Inspiring Seas project, a marine-themed educational initiative between Newcastle University and NYK Group Europe Ltd., engaging and interactive phycological teaching resources have been developed, piloted and delivered to Key Stage 3 pupils as part of the National Curriculum. The activities focused on highlighting the importance of algal-based derivatives in everyday life, and culminated in the development of a largely algal-based module. The 'Desert Island Survival Guide' is aimed at educating 11-14 year olds about the role of algal products and is available for download free of charge from the Inspiring Seas website. During the module pupils were set the scenario of being stranded on a rocky shore desert island with the task to survive until rescued. Pupils considered the practical value of phycological resources available to them, ranging from aspects of nutrition, medicinal use, industrial and commercial application. For example, pupils devised seaweed-based menus, participated in shelter-building activities, designed an iodine extraction experiment and considered how algal products are utilised in their everyday lives, including their use as thickeners and natural dyes in sweets, ice cream and cakes. This study has shown that phycological teaching materials have a key role to play in the development of enquiry-based and cross-curricular teaching and learning in the School National Curriculum. They can be used to inspire pupils regarding the important value of our marine environment as a resource and the need to protect it.

Biodiversity and systematics of terrestrial Ulvophyceae

TATYANA DARIENKO, THOMAS PRÖSCHOLD

Most phylogenetic analyses of SSU rRNA sequences have shown that coccoid and filamentous green algae are distributed among all classes of Chlorophyta. One of these classes, the Ulvophyceae, mostly contains marine seaweeds like *Ulva*, or marine filamentous microalgae, which grow as epiphytes on other seaweeds. However, new studies showed that there are freshwater and terrestrial species (including symbionts in lichens) among the Ulvophyceae, but very little is known about these species. Most marine coccoid and filamentous green algal species have traditionally been placed within genera dominated by species from freshwater or soil habitats. Molecular data have confirmed that these marine species are members of the Ulvophyceae: In contrast, most of the freshwater and terrestrial species belong to the Chlorophyceae or Trebouxiophyceae. The aim of this study is to investigate species isolated from freshwater, or terrestrial habitats (some are symbionts in lichens) and were considered to be ulvophytes. Ultrastructural studies on some species have shown that the zoospores form the flagellar apparatus (counterclockwise basal body orientation), which is typical for the Ulvophyceae. In addition to ultrastructural features, the presence of a "*Codiolum*"-stage is characteristic for this algal class. Using a polyphasic approach we compared phylogenetic analyses of SSU and ITS rDNA sequences with morphology and life cycle of these species. Our preliminary phylogenetic analyses of SSU rDNA sequences have revealed that the terrestrial species studied, so far, belong to three independent lineages of the Ulvophyceae called here: *Chlorocystis*-, *Pirula*, and *Trichosarcina*-clades. The taxonomic revision of these species are in progress.

The challenge of conserving cryo-recalcitrant protists, is the use of vitrification the answer?

DAY, J.G., PRIBYL, P., ACHILLES-DAY, U.E.M., FIELD, J., MARTINEZ-MONTERO, M.E., MÜLLER, H., HARDING, K. & BENSON, E.E.

Many protists, particularly those with relatively small cell size (<20 μm) and "uncomplicated" morphology, can be successfully maintained in a cryopreserved state. For a large proportion of these, high post-thaw viability levels (70-100%) can be obtained, which effectively ensures phenotypic and genotypic stability of the conserved organisms. This is achieved using colligative cryopreservation, which is dependent on the application of penetrating cryoprotectants (commonly, DMSO or methanol) and slow cooling (e.g. -1°C min^{-1}), to an intermediate sub-zero temperature (usually the temperature of homogeneous ice nucleation -40°C) prior to plunging into liquid nitrogen (-196°C). Although, generally applicable, to many organisms, some remain freeze-recalcitrant including most euglenoids, ciliates as well as many diatoms and multi-cellular protists. These organisms may be preserved by vitrification, an alternative cryopreservation strategy, which is the conversion of an aqueous system to an amorphous, non-crystalline solid, termed the 'glassy state'. This is achieved by increasing cell viscosity to a critical point termed the glass transition (Tg) temperature. This obviates damage due to ice crystallisation as can occur during slow cooling. A variety of strategies have been applied to achieve the viscosity required for the vitrification of protistan cultures including the use of high concentration cocktails of cryoprotectants, alginate encapsulation and air-desiccation of cyst suspensions in soil. The successful application of the above approaches to marine diatoms, *Euglena gracilis*, and *Meseres corlissi* respectively will be discussed.

Disturbingly undesirable blooms

J. FODEN, M.J. DEVLIN, D.K. MILLS & S.J. MALCOLM

The OSPAR Comprehensive Procedure (CP) assesses the status of waters with regard to eutrophication, defined as 'the enrichment of water by nutrients causing an accelerated growth of algae and higher forms of plant life to produce an undesirable disturbance to the balance of organisms present in the water and to the quality of the water concerned'. One of the assessment criteria is 'the shift from long-lived macrophytes to short-lived nuisance species', interpreted as the existence of excessive blooms of opportunistic macroalgae (such as *Ulva* spp.). Macroalgal bloom abundance was used to help establish whether the UK's OSPAR marine (coastal or offshore) areas were being undesirable disturbed. Data were assessed using thresholds based on the metrics developed under the WFD, which were simplified for the OSPAR CP. Only one marine area failed the OSPAR thresholds. None of the areas were found to exhibit signs of undesirable disturbance.

Intertidal seaweed communities of microtidal seashores in the British Isles

ROSEMARY FOSTER, JOHN SPENCE & MARTIN WILKINSON

Microtidal shores have a low tidal range (< 1.0m mean spring tidal range). Although identified as a type for the EC Water Framework Directive in the British Isles, no distinctive reference conditions were defined as so little is known of these shores. In the British Isles they are restricted to a very small area: parts of Islay, Jura, Kintyre and Co. Antrim. Seaweed distribution could be affected because (1) tidal range is low in comparison with wave height, (2) there is only a small intertidal area for colonisation, (3) there is less subhabitat diversity owing to space limitation, (4) there is a disproportionately large effect of atmospheric pressure on sea level. Surveys of intertidal seaweed presence and zonation on 12 shores showed the following: (1) Zonation is present and extended upwards in the customary way with wave exposure. (2) Zonation is modified on less wave-exposed shores with fewer zones (the *Fucus vesiculosus* zone is rare or absent, the *Ascophyllum* zone extends into the sublittoral and the *Fucus spiralis* zone covers much of the intertidal). (3) Fewer species are present than on mesotidal and macrotidal shores except where gently-sloping wave cut platforms give a large intertidal extent (Ballycastle area). (4) Tides often did not appear to behave according to prediction on lowest tidal range shores (Islay) which might be explained by atmospheric pressure effects.

A long, long time ago…… What the older historic literature tells us about the distribution of toxic phytoplankton in Scottish coastal waters today

SHEILA FRASER & EILEEN BRESNAN

Phytoplankton monitoring programmes over the last ten years have revealed the widespread occurrence of the toxic genera *Pseudo-nitzschia* (Peragallo) and *Dinophysis* (Ehrenberg) in Scottish coastal waters. A century ago, a series of cruises were undertaken by two research scientists, Herdman and Riddell, from Port Erin Marine Laboratory on the Isle of Man. These cruises collected seawater samples along the west coast of Scotland and around the Shetland Isles with the aim of improving the knowledge of plankton in this region. The potential toxin producing dinoflagellate genus *Dinophysis*, was recorded during this time as well as the diatom *Nitzschia seriata*. *Nitzschia seriata* has since undergone a series of reclassifications but is now considered to be a member of the genus *Pseudo-nitzschia* (Peragallo). Mapping the phytoplankton results obtained during these cruises reveals the widespread distribution of both *Nitzschia seriata* and *Dinophysis* species along the Scottish west coast, Hebridean Islands and Shetland Islands. These results suggest that a century ago, potential toxin producing phytoplankton genera had a wide regional distribution in Scottish coastal waters similar to that observed in monitoring programmes today.

Effectiveness of *Asparagopsis* (Rhodophyta) extracts against a wide range of pathogens. (S)

G. GENOVESE, L. TEDONE, M. MORABITO, & M.T. HAMANN

Several marine algae produce bioactive metabolites in response to ecological pressures such as competition for space, deterrence of predation and epiphytism. These bioactive compounds have a rich pharmacological potential. There are numerous reports of macroalgae derived compounds that have a broad range of biological activities. About one century ago Harder observed antimicrobial substances secreted by algae. *Asparagopsis* (Bonnemaisoniales) is one of the species with the strongest activities against the broadest spectrum of target microorganisms, including pathogenic Gram-positive and Gram-negative bacteria and yeasts. The aim of the present work is to better typify the antibacterial and antifungal activity of *Asparagopsis* extracts. The bioactivity has been analysed from crude extracts of lyophilised samples using the agar diffusion technique and the extracts has been purified and chemically characterized.

Long term cryopreservation and vitality of *Porphyra* (Rhodophyta) gametophytes. (S)

G. GENOVESE, V. FIORE, M. MORABITO & G. TRIPODI

Cryopreservation method is commonly used in aquaculture and it is based on the ability of living cells to slow their metabolism in particular conditions. A cryopreservation method on *Porphyra* thalli has been developed about 30 years ago, in order to have a continuous production of thalli all year round and to reduce epiphytism. In

Japan a popular system (Ikada) is used for this process. Culture nets with thalli 2-3 mm long are initially air dried to reduce the water content to 20-40% and than stored to -20°C in polyethylene bags. The frozen nets can then be used to replace lost or damaged one. Thalli are reported to survive up to 10 months. Commonly samples are subjected to treatments with cryoprotectants (pre-freezing method). Aim of the present study is to verify the survival potential of *Porphyra* thalli collected in the Straits of Messina to cryopreservation during years 2005-2007. We verified that dried and frozen thalli of *Porphyra* are vital up to 31 months, even without any pretreatment. The present results are relevant in order to improve aquaculture and long term storage methods.

A genetic linkage map of the model brown alga *Ectocarpus siliculosus*, based on microsatellite markers

SVENJA HEESCH, GA YOUN CHO, AKIRA F. PETERS, J. MARK COCK

Ectocarpus siliculosus has recently been proposed as a genetic and genomic model for the brown algae. Its whole genome, the first-ever fully sequenced in a seaweed, comprises circa 200 Mbp, currently assembled in around 1900 scaffolds larger than 2 kbp. The aim of our project is to combine the longest scaffolds into linkage groups (putatively the approximately 25 chromosomes) in order to construct a genetic linkage map for *E. siliculosus*. For this, a segregating F2 population was generated from a cross between the sequenced strain (Ec32) from Peru and a strain from northern Chile. AFLP analysis indicated a significant level of polymorphism (41%) between the genomes of these two parental strains. In silico analyses, including virtual PCR amplifications run against the sequenced genome, were used to identify and test potential microsatellite markers for the 600 longest scaffolds, and to design oligonucleotid primers to amplify these markers. These were then tested in vitro against the parental strains. Among the 1152 microsatellite markers tested, 438 (38 %) were found to be polymorphic. Current work involves setting up the analysis of the segregation of these markers in the F2 progeny. Estimations of recombination frequencies from the linkage disequilibrium within the population will then allow to identify linkage groups and construction of the genetic map.

Diversity, biogeography and ecology of achnanthoid diatoms common in Himalayan streams

INGRID JÜTTNER, JAMES CHIMONIDES & EILEEN J. COX

Investigations of diatom assemblages in 209 streams of the Himalaya in Nepal and north-west India showed that as in other montane and alpine areas achnanthoid, naviculoid, fragilarioid and gomphonemoid species were the most common and abundant species groups in streams from the foothills (< 1000 m) to the high Himalaya (> 4000 m). Many of the species found also occur in other mountain areas of the world, but some taxa seem to have a more restricted distribution. Of the total 261 diatom taxa the achnanthoid taxa were the second most species rich group (47 species in total) with *Achnanthidium* (17), *Planothidium* (11), *Psammothidium* (8), *Achnanthes* (4), *Karayevia* (3), *Nupela* (2), *Eucocconeis* (1) and *Lemnicola* (1). Some achnanthoid species were abundant across the entire east-west and altitudinal range of the investigated area while others were restricted in their geographical range or with respect to certain stream types. We present the distribution and ecology of *Achnanthidium pyrenaicum* (Hustedt) Kobayasi and morphologically similar species such as *Achnanthidium crassum* (Hustedt) Potapova & Ponader and *Achnanthidium rivulare* Potapova & Ponader, and describe a new species similar to *Achnanthidium deflexum* (Reimer) Kingston.

The UK and Ireland diatom ring-test scheme

MARTYN KELLY

A ring-test scheme has been developed in order to ensure that diatom data collected by or for UK and Irish regulatory agencies is of a known and defendable quality. Five slides per year, drawn from a range of running and standing water types, are sent to all involved in diatom analyses. Each of these people analyse the slide using a standard method and return their results to the co-ordinator. The mean value of the Trophic Diatom Index of an 'expert panel', comprising six experienced analysts, provides both a target value against which participants are compared, and an expectation of the amount of variation that should be expected. A detailed report for each slide is also produced, containing images and notes about the main taxa present, so that participants can learn from their experiences. The expert panel's results so far have had standard deviations ranging from 0.63 TDI units to 4.16, the latter for a sample with a large number of chain-forming fragilarioid diatoms that did not separate fully on cleaning. These results suggest that the amount of inherent variation in diatom counts is partly a function of composition. However, another slide had high variability due to different approaches taken to splitting *Nitzschia palea* and *N. palea* var. *debilis*, an issue compounded by inexact descriptions in the taxonomic literature. A key role of the ring tests is identifying issues such as these and providing guidance to end-users on taxonomic best practice.

PLANKTON*NET: A versatile online database system for plankton related information

ALEXANDRA C. KRABERG & KAREN H. WILTSHIRE

While traditional biodiversity research projects remain of course of vital importance, the task of disseminating, searching for and analysing biodiversity information, both taxonomic and biogeographic, is increasingly carried out online. The online database system PLANKTON*NET (http://planktonnet.awi.de) is designed to facilitate the quick retrieval of information on a score of marine and freshwater plankton taxa and currently contains more than 6000 images of thousands of phytoplankton and zooplankton species. Originally conceived mainly as an image database, PLANKTON*NET is now much more comprehensive and can accommodate not only plankton images and glossaries (the database currently contains 850 annotated glossary terms) but also taxonomic information (authorities, taxonomic references, descriptions), biogeographic information and dynamic links to external resources all of which can be viewed simultaneously via the 'taxon details' generated for each taxon in the database. A facility for the upload of pdfs of original taxon descriptions is further enhancing the system. New data are constantly entered, by the PLANKTON*NET team but also remotely by a large number of external users via simple, easy to use online forms. In this way we are not only building a catalogue of taxonomic information for planktonic organisms but also detailed distribution records for these species.

New phytoplankton records for Scotland - a question of taxonomy, or a result of changes in phytoplankton flora affected by human influence and climate change?

JAN KROKOWSKI

The Scottish Environment Protection Agency (SEPA) are required under the Water Framework Directive (WFD) to assess the ecological quality of the water environment (surface waters, ground waters, transitional waters, and coastal waters). A number of biological monitoring tools have been developed to assess the ecological quality of surface waters, which have focussed on the responses of biological communities to environmental pressures. Draft 2007 results for lochs are detailed, based on the

'%cyanobacteria by biovolume' metric, a subsidiary of the phytoplankton taxonomic composition metric. Results highlight the geographic distribution of waterbodies sampled, and detail their ecological quality status based on the five classes: high, good, moderate, poor, and bad. The %cyanobacteria metric was used as it was intercalibrated across all EU Member States. The phytoplankton taxonomic composition metric is hoped to be intercalibrated with EU Member States in the future. Results also highlight 'new' phytoplankton records for Scotland - are these new records a result of differing taxonomy used by various 'counters', or are they a result of changes in the phytoplankton flora affected by human influence and climate?

A comparison of methods of protein extraction from *Chlamydomonas reinhardtii*

LAWRIE E, BRICKLEY M, COBB A, & HAWES, C

Extraction of algal cell protein lysates is important to facilitate proteomic and other biochemical analyses. A wide variety of extraction methods exist but comparative data on their effectiveness is lacking. Three different methods of protein sample preparation from the unicellular green alga, *Chlamydomonas reinhardtii* were compared in the current study: glass bead assisted disruption, repeated freeze thaw cycles and acetone precipitation based protein extraction. Lysates were subjected to both protein quantitation (Quantit, Invitrogen) and to denaturing SDS PAGE electrophoresis to determine any qualitative differences between the lysates. Acetone precipitation extraction resulted in significantly more protein than simple disruption whilst freeze thaw disruption yielded an intermediate amount. SDS PAGE of acetone precipitation lysates yielded several additional bands suggesting that it extracted several proteins that were lost using the other methods; these may be membrane bound proteins. The acetone extraction method was both more time consuming (160 minutes) and more labour intensive than the other methods. The optimal extraction method depends on purpose: Soluble proteins may be extracted rapidly by simple cell disruption or freeze thawing while proteomic based work would be best undertaken with acetone precipitation.

An antiviral product from *Dumontia contorta* (S)

MAGILL, C,L., GILMORE, B.F. & MAGGS, C.A.

Numerous investigations into the medicinal properties of algal metabolites and other compounds have been carried out over the years. The antiviral activities of polysaccharides from tropical Rhodophyta have been thoroughly investigated in the last 10 years. Polysaccharides with potent and specific antiviral effects in vitro on replication of Herpes Simplex Virus (HSV), Dengue Virus and other enveloped viruses with profound human impact have been found in many red algae including *Gracilaria corticata*, *Callophyllis variegata* and *Schizymenia binderi*. The antiviral compounds in red algae are the sulphated galactans (carrageenans, agarans) and their antiviral action is thought to be involved in blocking of virus adsorption to the host cell, preventing entry of the virion into the cell. The sulphated compounds have also been shown to have low cytotoxicity in vitro. This project, in collaboration with a company in Donegal, Ireland, which specialises in seaweed products, will be focusing on the temperate boreal red alga *Dumontia contorta* (Dumontiaceae, Gigartinales). The structure of the algal polysaccharides will be elucidated, the antiviral action assayed and the mechanism of action investigated. A phenological study will ascertain if the polysaccharide yield is constant throughout the life cycle. Samples from different locations will be compared for polysaccharide yield and using phylogeography the differences in geographical haplotypes and the related differences in polysaccharide yield, if any, will be investigated. As the project is linked to a commercial venture, the sustainability of harvesting *D. contorta* for the purposes of exploitation as an antiviral product will also be tested.

Observations of *Mediopyxis helysia* in Scottish waters. (S)

TRACY MCCOLLIN

In April 2005 a diatom, provisionally identified as *Mediopyxis helysia*, was observed in low abundances in samples from Stonehaven, in the north east of Scotland (56°57.8'N 02°06.2'W). This recently described diatom has previously been recorded as a species new to the Gulf of Maine, the German Bight and the Bay of Fundy in 1996, 2003, and 2002 respectively. This diatom has been observed in samples taken between April and September at the Stonehaven site. Although the diatom is large it may not have been detected previously as it has been observed in very low abundances. Historically it could also have been recorded as an unidentified diatom species. This diatom is currently included in the target list of species monitored at sites around the Scottish coast to improve our knowledge of the distribution of this species in Scottish waters.

***Porphyra* (Rhodophyta) species diversity in Iceland. (S)**

AGNES MOLS MORTENSEN, JULIET BRODIE, KARL GUNNARSSON, CHRISTOPHER D. NEEFUS & RUTH NIELSEN

Observations in the North Atlantic suggest that the red algal genus *Porphyra* challenges the generally accepted view that species diversity decreases with increasing latitude. Assessing the *Porphyra* flora of the most northerly regions of the North Atlantic is crucial in this context but currently not well understood. Iceland is by its central situation in the northern North Atlantic a key area that can provide important data on *Porphyra* diversity. By addressing the diversity of the *Porphyra* flora in Iceland we ask: i) How many *Porphyra* species are there in Iceland? ii) Does the *Porphyra* diversity in Iceland support the hypothesis that diversity increases with increasing latitudes? Comprehensive *Porphyra* collections made around Iceland in 1999 and between 2005 - 2007 together with historic and contemporary collections held at the Natural History Museum, London (BM) and the Botanical Museum, Copenhagen (C), provided the basis for this work. Species identification was based on morphology and molecular rbcL data and a phylogenetic analysis was carried out including available rbcL data from the Pacific and the Atlantic. *Porphyra amplissima*, *P. dioica*, *P.* "*leucosticta*", *P. linearis*, *P. miniata*, *P. purpurea* and *P. umbilicalis* which were recorded prior to this work are now molecularly verified and *P. birdiae*, *P.* "*brumalis*" and *Porphyra* sp. are new records for the area. *Porphyra* "*brumalis*" might be an undescribed sister taxon from the North Atlantic and *P.* "*leucosticta*" might represent more than one species. Including *Porphyra thulaea*, which earlier investigations have recorded and molecularly verified, eleven *Porphyra* species are currently listed for Iceland.

The effects of host and epiphytic algal architecture on epifaunal assemblages within rock pools - preliminary findings. (S)

DANIEL NEILSON, MICHELLE TOBIN & SUE HULL

The individual morphology of algal species has been shown to significantly affect the abundance and diversity of epifaunal species; branched macrophytes generally display a higher epifaunal abundance and biomass than unbranched macrophytes. The epiphytic algae found on many macroalgal species within the intertidal zone display evidence of a neutral interaction with their host algal species indicating that epiphytic species may act as an extension of the host plant in respect of habitat for fauna. This may raise the possibility that macroalgae with epiphytes show an overall increase in epifaunal abundance and diversity compared to those without. In an effort to quantify epifaunal abundance and diversity in relation to algal architecture, a combination of *Corallina officinalis* and three epiphytes of differing morphological complexity were collected from three rock pools from each of three separate sites

near Scarborough, North Yorkshire. Samples were collected in March and July of 2008. Algal species were washed clean of epifauna, dried at 60°C for 24 hours then weighed to quantify biomass. Epifauna were identified and counted to produce a total abundance per gram of dry algae. The implications of epifloral species on mobile epifaunal communities were investigated with respect to total epifaunal abundance and diversity across two seasons. This poster presents the findings of this study and outlines further work.

Characteristics and phylogeny of an acidophilic and halotolerant green alga, *Dunaliella* sp. LG-2

KAHOKO NISHIKAWA, KEIKO IIJIMA, SAORI HOSOMI, SATOSHI SHIMADA, HIDEAKI TSUMORI, EMI KINOSHITA, YUKIKO MIYATA, HIROYUKI TOMINAGA & NORIKO TOMINAGA

Salinity and acidity are major factors limiting the proliferation of plants and algae. We isolated a dual stress tolerant alga, an acidophilic and halotolerant green alga, from an acidic, highly saline lake in South Australia. This alga has wide tolerances to salinity (0.4-4.75 M NaCl) and acidity (pH 2.2-6.5), and requires both a minimum sodium chloride level and an osmotic pressure to live. It had a unique physiological characteristic, therefore it could be considered to be a model photosynthetic organism of dual stress (salinity and acidity). To clarify the family and physiological characteristics, physiological analysis, morphological observation, and phylogenetic analysis using 18S rDNA were carried out. Phylogenetic analysis showed that this alga comprised a robust clade with *Dunaliella* spp. Typical *Dunaliella* spp. don't have cell wall , but the presence of thick layer exterior covering looks like cell wall was confirmed by both electron and fluorescent microscopy in this strain. The exterior layer covering might develop in order to adapt for this hard dual stress environment.

Hypo-osmotic stress in developing fucoid embryos: How shore position correlates to tolerance

NIALL RAUH, ALISTAIR HETHERINGTON, STEVE HAWKINS & COLIN BROWNLEE

Many rocky shore habitats comprise complex interacting environmental gradients and temporal fluctuations. The varying levels of stress associated with these gradients potentially impose heavy costs on the organisms inhabiting this environment. Nevertheless, coastal environments often show biodiversity and biomass. The coastlines of N.W. Europe are often dominated by brown macroalgal members of the genus, *Fucus* (Phaeophyceae). Resistance to abiotic stress has previously been demonstrated through adaptive mechanisms within established, adult populations. However, gametes and embryos are potentially exposed to the same stresses as adults and are likely to be more vulnerable to stresses, such as changes in the external osmotic environment during emersion and immersion. This research aims to test the extent to which the distribution of fucoid algae is determined by recruitment and survival of early developmental stages (zygotes and embryos); in particular the influence of abiotic (osmotic) stresses at early developmental stages on subsequent growth and tolerance to biotic pressures such as grazing. Comparative physiological experiments have been carried out on three dominant fucoid species native to the U.K. We have shown that zygotes and embryos of these species display dramatically different physiological strategies for tolerating osmotic stress that relate to their respective normal distribution patterns on the shore. Field experiments are being carried out to interpret these physiological findings in an ecological context.

New insight into the reproductive strategy of stoneworts (Characeae, Chlorophyta) from the cool temperate climate (S)

PIOTR SKURZYNSKI & KATARZYNA BOCIAG

The reproductive mode of stoneworts has been still poorly recognized, especially in the case of species growing in the cool temperate climate, which thalli may overwinter in deeper parts of the littoral zone and retain an ability to further grow. The main role in the maintenance of the population's stability is often attributed to the oospore bank (i.e. bank of the resting zygotes) deposited in sediments. Therefore, vegetative propagation is usually neglected. The main objective of this study was to determine if thallus fragments may play the role of vegetative propagules in Eurasian stonewort species - *Chara rudis* A. Braun, and whether they are capable of creating the vegetative propagule bank and may produce new individuals (i.e. ramets). In situ and laboratory investigations were conducted. Fragments, collected from bottom's surface and obtaining by thalli cutting, were exposed in plastic trays filled with water for 7 weeks, in a long day conditions (D16h:N8h, 18ºC). It was shown that: 1/thallus fragments are capable of growing and producing new ramets, hence they may play the role of vegetative propagules; 2/fragments are not deposited in sediments, their bank is created only by fragments from the surface of bottom and their abundance changes along the water depth gradient; 3/ multi-node fragments from the apical part of thallus produce the highest number of ramets; 4/ the number of new ramets (including generative) produced by fragments rises along the water depth gradient. Therefore, it seems to be advantageous for stonewort to reproduce vegetatively by means of thalli fragments, especially in a deep part of population's area.

Growth inhibition of ecologically relevant bacterial species by the green alga, *Dictyosphaeria ocellata* (S)

JENNIFER SNEED & GEORG POHNERT

While interactions between microbes and sessile marine organisms such as sponges and corals have been well investigated, little is known about the interactions between macroalgae and the microbial community. Like sponges and corals, macroalgae are constantly exposed to large numbers of microorganisms, some of which are potentially pathogenic. Therefore, it is probable that macroalgae face selective pressure to regulate the surrounding microbial community. *Dictyosphaeria ocellata* is a green alga that grows in intertidal areas adjacent to mangrove forests and is therefore subject to heavy bacterial loads in the water. However, the surface of this alga remains relatively clean when compared to other co-existing abiotic and biotic surfaces. In this study we investigated the interaction between *D. ocellata*, and various strains of common marine bacteria in a laboratory culture. We found that the presence of the alga inhibits the growth of bacteria in culture. However, neither waterborne compounds exuded by the alga nor algal extracts produced similar effects. Our results suggest that *D. ocellata* does have a mechanism for regulating the surrounding microbial community, but that it may be related to factors other than constitutively released inhibitory chemicals.

Working the late shift: Novel virus dynamics in an *Emiliania huxleyi* bloom (S)

GEORGE SORENSEN, A. BAKER, M. HALL, C. MUNN & D.C. SCHROEDER

Denaturing gradient gel electrophoresis (DGGE), sequence analysis and analytical flow cytometry (AFC) were used to examine the population dynamics and genetic composition of *Emiliania huxleyi* isolates and co-occurring viruses during a mesocosm experiment in a Norwegian fjord in June 2008. We exploited variations in the calcium binding protein gene (GPA) and in the major capsid protein

(MCP) gene in order to assess the allelic and genotypic richness within *E. huxleyi* and *E. huxleyi* specific viruses (EhVs), respectively. The data were compared with that of two previous mesocosm experiments in 2000 and 2003 with the same virus and host genotypes being found to dominate in these studies; 8 years apart. Frequent sample collection over a series of 24 hour periods has given an insight into the timescale of changes in EhV community structure and, to our knowledge, shows for the first time variations in EhV genotypes over a scale of hours.

What is BIOMARA?

STANLEY, M.S., DAY, J.G. & KELLY, M.S.

Both macro- and microalgae are an important and diverse group of marine organisms. The microalgae comprise a vast group of oil-producing organisms with an immense range of genetic diversity. They exist as unicells, colonies and extended filaments, are ubiquitously distributed throughout the biosphere and grow under the widest possible variety of conditions. They can be cultivated under a range of conditions from freshwater to situations of extreme salinity meaning they can be grown under difficult agro-climatic conditions. The large brown macroalgae, or kelp, are perhaps the greatest potential source of marine biofuel. Immersed in seawater, these fast growing macroalgae have no need for internal transport systems for nutrients and water, which saves energy, hence they are naturally highly productive and have a high potential to fix carbon. Whilst there is evidence that large-scale biofuel production from algae is technically possible, further investigation is needed to find out which strains are likely to be the most productive and the optimal conditions for their growth before it can be produced on a commercial scale and brought to market. The key objective of this project therefore is to investigate the practicalities and underlying methodologies required to harness algal biomass as a biofuel source on a competitive and sustainable basis. This will include consideration of the underlying science and technology, as well as process control, engineering needs, supply chain issues, social and economic impacts.

Laser diffraction as a tool to investigate aggregate formation in planktonic diatoms

DANIEL C. O. THORNTON, CHARLES E. RZADKOWOLSKI & JENNIFER G. WILLIAMS

The termination of diatom blooms is often associated with the coagulation of the diatoms into aggregates. Diatom aggregates affect the biological carbon pump and provide microenvironments for organisms. Consequently, they are biogeochemically significant in the transport and transformation of organic carbon. We used the LISST-100X particle size analyzer (Sequoia Scientific Inc.) as a tool to investigate the aggregation of diatoms in culture and in situ. The LISST-100X (Type C model) uses laser diffraction to obtain the particle size distribution of particles in a water sample between 2.5 and 500 μm in diameter. The objective of this poster was twofold. Firstly, the particle size distributions of several unaggregated diatom species were presented and interpreted based on the size and shape of the diatoms. Secondly, data was presented from experiments in which the LISST-100X was used to test the hypothesis that the production of exopolymers (EPS) by diatoms increases with increasing temperature, resulting in increased diatom aggregation.

Dihydroxycoumarin sulfate biosynthesis and biopolymer wound plug formation in *Dasycladus vermicularis*

MATTHEW A. WELLING, C. ROSS & GEORG POHNERT

Unlike most other fossil organisms, the Dasyclads have modern analogues and are thus often referred to as "living fossils" which exhibit primitive morphological characteristics having undergone little evolutionary change [1]. The geologically ancient unicellular macroalgae *Dasycladus vermicularis* exhibits an extraordinary wound response mechanism. The rapid assimilation of cellular contents into an insoluble wound plug prevents detrimental cytoplasmic loss and limits the intrusion of extracellular components, such as pathogens or minerals, which could otherwise prove fatal. Here we revise the structure of the organism's major secondary metabolites, dihydroxycoumarin sulfate, suggest a biosynthetic pathway for its production, and elucidate its role in the assembly of the wound plug.

1) 3-hydroxycoumarins are rare in nature and little is know about their biosynthetic origins. Using biotransformations we suggest that caffeic acid undergoes alpha hydroxylation, giving rise to α-hydroxycaffeic acid. Subsequent oxidation followed by ring closure results in the 3,6,7-trihydroxycoumarin. Sulfotransferases then perform a site specific transfer of a sulfate group to the hydroxycoumarin, increasing its hydrophilicity.

2) Mechanical disruption of the cell results in the decompartmentalisation of cellular sulfatases which subsequently come into contact with dihydroxycoumarin sulfate rapidly transforming it into 3,6,7-trihydroxycoumarin. Chemical oxidation of the catechol functionality, mediated by an oxidative burst, produces reactive quinone intermediates. These quinones undergo nucleophilic attack from thiol and amino-bearing functionalities resulting in the formation of a protein crosslinked biopolymer. This would act to compliment the lectin-carbohydrate interaction in the rapid assimilation of an insoluble wound plug [2].

Literature: [1] J. L. Olsen, *J. Phycol.* 1994, 30, 729-744. [2] C. Ross, *J. Phycol.* 2005, 41, 46-54.

Discovering the Algal Herbarium at the Natural History Museum

JO WILBRAHAM & JULIET BRODIE

The algal herbarium in the Department of Botany at the Natural History Museum is a treasure trove of marine and freshwater algal specimens, including over 370,000 red, green and brown seaweeds, freshwater algae including stoneworts, blue-green algae and dinoflagellates. Collections date back to the 17th century and include some of the earliest specimens held in the museum from Britain and abroad and probably represent the start of modern marine algal study. It is the second largest type-rich collection of algae in the world (Leiden is the richest), with c. 10,000 types (c. 3300 brown, c. 6000 red and c.1000 green algae) from 74 countries. The largest collections of NHM algal types are from Australia, New Zealand and Polynesia, followed by the UK and Ireland, although France, Guadeloupe, Sri Lanka, Falkland Islands, Chile and Japan are well represented. The potential for the use of these collections is immense with scope at the local, regional, national and international level. In addition, they are supported by a comprehensive algal library which includes economic uses of these organisms. Here we report on the collections. This includes how they are currently being used, including in the production of floras, providing data for Important Plant Areas, as a source of molecular data, digitisation projects, and our aims for the future.

Water Framework Directive monitoring on intertidal, rocky seashores of naturally low seaweed species richness in the British Isles

MARTIN WILKINSON, ROSEMARY FOSTER, HOLLY BROWN & EMMA WELLS

Quality assessment of rocky intertidal seashores for the United Kingdom and Republic of Ireland for the EC Water Framework Directive is based partly on seaweed species richness under closely defined conditions of sampling and normalised to take account of subhabitat diversity. In addition to species richness there are

supporting elements which represent the composition of the flora: % green species; % red species; % problem opportunist species and ratio of two Ecological Status Groups. To facilitate identification by non-phycologists in the water industry a reduced species list (RSL) of about 70 species is used rather than the full c. 650 species in Britain. Good or high quality shores will have a high number of RSL species (c. 50 spp.). The tool and the RSL were developed with species lists form surveys of high reliability and thoroughness. These were nearly all open coastal macrotidal and mesotidal shores. A problem can arise with tool application to shores which are of good quality but have a naturally low species number. On these shores it only takes a small variation of a few species in the supporting elements of floral composition to have a disproportionately large effect on shore classification. Surveys described in this presentation have shown that these situations are of three possible types: (1) fucoid dominated near the mouths of estuaries, (2) microtidal shores where then intertidal extent is low, and (3) some Scottish sea loch shores where intertidal extent and intertidal subhabitat diversity is low (despite sublittoral richness).

The micro-algal biodiversity of Maltese hypogea

GABRIELLE ZAMMIT, L. ELLIOT SHUBERT, EILEEN J. COX & PATRIZIA ALBERTANO

The growth of biofilms on artworks in Maltese hypogea is prolific. These biofilms have been documented and characterised in separate studies, being composed predominantly of cyanobacteria and microalgae that develop in proximity to entrances and artificial lamps, and which become associated with heterotrophic microorganisms. The main aim of this study was to characterise a number of phototrophic biofilms present on ochre-decorations and wall paintings in Maltese underground sanctuaries, crypts and catacombs and to investigate the phenotypic diversity of photosynthetic species in situ and in culture using a variety of microscopy techniques. Predominant biofilms were collected using methods that are non-invasive to the substratum, through the use of adhesive tape strips and damp sterile filter paper. Isolates were grown under controlled laboratory conditions. Direct fluorescent microscopic observation of the most extensive biofilms confirmed that the predominant groups of phototrophs were cyanobacteria and micro-algae, including diatoms, through the autofluorescence of photosynthetic pigments and fluorescent labels for nucleic acids. SEM observations evidenced biomineralisation processes and different bacterial populations associated to phototrophs. TEM observation of cyanobacteria and microalgae allowed the description of (i) the structure of exopolymeric capsules and sheaths involved in adhesion processes to the substrata and in cohesion between microorganisms, and (b) the nutritional status of cells, in which an unbalanced storage of different types of cell inclusions may be due to nutrient or light limitation. The genetic diversity of these phototrophic communities is being studied further through the application of molecular methods.

Poster presentation

President past and present

BPS dinner

Manton Prize Winner

Thomas Silberfeld, Muséum National d' Histoire Naturelle, France, silberfeld@mnhn.fr

Since I was a child, I have always shown a voracious curiosity for natural things, always scanning the ground, diving or lifting rocks to collect and observe flowering plants, mosses, slugs, bugs, beetles, marine critters, and so on. Even though I've almost always been living in the urbanized outskirts of Paris, my naturalist tendencies kept on growing up on holidays in the countryside near Clermont-Ferrand, as well as at my grandmother's by the sea, near Marseilles. It took me several years to figure out that what was hidden underneath my compulsive collecting behaviour was nothing but a deep desire to organize and understand the evolutionary processes underlying the huge biodiversity I observed. In other words, I came out quite early as a systematist…! During my four-year scholarship at the biology department of the 'École Normale Supérieure' in Paris (a graduate institution which specifically prepares its students to research and teaching in a wide range of topics, including literature, humanities and sciences), I chose to attend a Masters degree in Systematics, Evolution and Paleontology, organised at the Muséum National d'Histoire Naturelle (MNHN) and the Pierre-et-Marie-Curie University, both in Paris.

In March 2005, I attended a field course in Phycology at the 'Station Biologique de Roscoff", in western Brittany - and what I experienced there for seaweeds was kind of a revelation. I remember feeling astonished by their huge diversity, but not in an at-first-sight way, depending on the tides, the exposure, and your acceptance to get wet, slip on kelp, and duck in ice-cold, deep tidal pools to explore shaded habitats.

Two years later, I was offered a three-year research grant for a PhD at the MNHN, under supervision of Prof. Bruno de Reviers and Dr Florence Rousseau, which aimed at unravelling phylogenetic relationships within the brown algae (Phaeophyceae), at the whole class level. To date I generated and analyzed a multi-marker data set of ca 10,000 base pairs, which resulted in an almost fully resolved phaeophycean phylogeny. From now on, I am planning to focus my work on the phylogenetic relationships and biogeographical affinities within some worldwide-spread brown algal genera. Furthermore, from May to October 2009, I will move out to Roscoff, western Brittany, for a six-month collaboration within the Algal Genetics Group of the Station Biologique. I will initiate there a comparative study of the early developmental stages of the sporophyte of several brown algal taxa, in order to reveal morphological homologies hidden in the adult morphs, due to high rates of homoplasy.

Once I have completed my PhD, I would like to explore further the evolutionary history of seaweeds in a variety of frameworks. Since I had the exceptional opportunity to go and collect seaweeds along the coasts of Eastern Antarctica last year, I would be particularly interested in studying processes underlying endemicity as well as biogeographical affinities of a variety of Antarctic algal taxa.

I would like to express my gratitude toward the British Phycological Society for creating such a warm, inspiring… and most of all, very comforting atmosphere, which allowed me to overcome hyperventilation and stress caused by the perspective of giving my first talk in front of an English-speaking audience!

Poster Prize Winner

Hella Behrend, University of Potsdam, Hella.Behrend@gmail.com

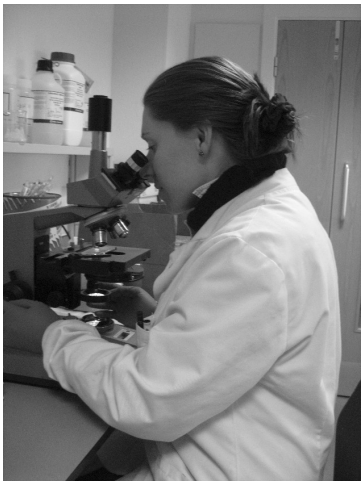
I started my studies in biology in Mainz, a small city close to Frankfurt am Main in Germany. I soon realised that I wanted to specialise in ecology, as I was interested in the interconnection of the biological aspects I got to know so far. For this reason I moved to Berlin after finishing my "Vordiplom", to continue my studies at the University of Potsdam, which offers a lot of ecological lectures and research. I had never heard about limnology before, but I was fascinated by aquatic ecology from the first instance. One thing I like about limnology is that aquatic systems can develop much faster than terrestrial ones, and therefore, ecological models and mechanisms can be investigated within relative little space and time. Aside from research in biodiversity and aquatic food webs, the Department of Ecology & Ecosystem Modelling at the University of Potsdam is studying acidic mining lakes in eastern Germany. Those lakes are extreme environments with a pH <3 and high concentrations of heavy metals.

My diploma thesis, which is presented on my poster, is embedded into this project. I am analysing the influence of high iron concentrations on growth and photosynthesis of *Chlamydomonas acidophila*, one of the main primary producers in these lakes. The results until now show that growth and photosynthesis of *C. acidophila* are nearly not negatively influenced even at high iron concentrations up to 1200 mg Fe/l. I think it is fascinating to see and understand the way organisms can survive in habitats that seem uninhabitable and I like the combination of physiology and ecology in my work.

I want to thank the BPS for the Poster Prize. The Winter Meeting in London was my first scientific conference and it was a quite important experience for me. I learned a lot and I really enjoyed the friendly and inspiring atmosphere at the Natural History Museum. Surrounded by skeletons of dinosaurs and the big Darwin exhibition, the museum was the perfect place to think and discuss about science.

The Water Quality and Technology Conference,

Duke Convention Center, Cincinnati, Ohio, U.S., November, 2008



The temperature dropped rapidly as we landed in Cincinnati, Ohio, it was November admittedly but the U.K. was still enjoying pretty mild weather when I left. This conference was heavily advertised as the taxi arrived at the hotel, thankfully the conference center was right next door, so as the snow started falling on the first day I wasn't too troubled. This was the largest international conference I had ever attended, full to the brim with Water and Technology experts from all corners of the globe.

Subjects varied widely from water quality and supply, environmental protection policy, contamination warning system design, advancements in alternative technologies; to using software tools to manage water quality. I was extremely fortunate to receive funding from the British Phycological Society to allow me to attend this conference. I presented my 25 minute platform presentation on the third day of the conference which outlined the results from the first half of my PhD research on using ultrasound to treat harmful algal blooming species. It surprised me how much interest there was in this area as numerous water professionals from different water municipalities across the U.S were curious about my findings and in general about algal interaction with their environment. The dearth in knowledge of algae in general meant that my research was received well. Water engineers in general, it appeared, view algae as a nuisance and will do whatever it takes to remove them from the water body. This is very much a different view to that which I hold even taking into account the subject of my PhD. I was informed that with knowledge on algae I would always have a job in the U.S. - this was of course pre-credit crunch!

The deputy Mayor of Cincinnati gave a speech on the very first morning reminding us of the importance of water to Cincinnati (Cincinnati sits in a prime location on the Ohio river bordering Kentucky and Ohio). The success of the city is based firmly on it's location on the river and the trade it carried inland. A local historian then gave us an enthralling talk on the history of the city, including talking about a monument which was erect in 1871 called the Tyler Davidson Fountain, depicting a woman with water pouring out from her hands standing above several other figures. This is also called the Genius of Water and is the symbol of the city which Cincinnati is very proud of. We had an opportunity to see the history of the city too by attending a dinner at the Cincinnati Museum Center at Union terminal, an old railway station now cataloguing the historical significance of the city and it's links to industrialisation of middle America, it's role during the second world war, and on the opposite side of the same building it's natural history, including the flora and fauna that inhabited this area before the arrival of settlers.

As a member of the British Phycological Society for several few years I am extremely grateful to the funding committee for allowing me have this opportunity to attend this conference. This field of water treatment is very new to me which I have only joined during my PhD and has been extremely insightful regarding how my work fits into the overall extremely important job of supplying clean and safe drinking water in the U.K. The contacts I have made through this meeting and in general through the years of attending BPS meetings has proved invaluable to my career I can't wait for the next one.

Diane Purcell, PhD student at the Centre for Water Science, Cranfield University, Cranfield, U.K. d.purcell@cranfield.ac.uk

15th Workshop of the International Association of Phytoplankton Taxonomy and Ecology

Ramot, Israel

Paula de Tezanos Pinto, University of Buenos Aires. paulatezanos@yahoo.com

Last November 2008 I participated in the 15th Workshop of the International Association of Phytoplankton Taxonomy and Ecology (IAP) in Ramot, Israel. The workshop's ecological topic was: "Phytoplankton in the physical environment" and one of the taxonomic topics was "Filamentous cyanoprokaryotes." The workshop program included keynote lectures by leading scientists, introductory presentations followed by informal discussions, field sampling, and sessions on microscopy to which people brought their samples from home for identification by experts. The IAP workshop was an excellent opportunity for daily personal contact with the world best references in phytoplankton taxonomy and ecology. The workshop was held in an isolated spot and all participants stayed in the same hotel and shared breakfast, lunch and dinner together. This generated multiple opportunities for discussing diverse scientific questions in an informal atmosphere and also for building personal relationships, both with young and established scientists.

During the workshop I presented the results of three sets of laboratory experiments assessing the physio-ecological responses of filamentous cyanoprokaryotes to either nitrogen:phosphorus (N:P) ratios, light, or their interaction both at the population and community level. These studies were performed by Dr. Elena Litchman and myself at the Kellogg Biological Station, Michigan State University during summers 2006 and 2007 when I was a visiting PhD student from the laboratory of limnology, University of Buenos Aires, Argentina.

In a nutshell, our results showed at the community level (eleven species assemblage) that low N:P ratios promote the dominance of the nitrogen fixing filamentous cyanoprokaryote (N-fixers), but only under high light. N fixation occurred at low N:P only and increased with increasing light. Also, competition hierarchies between a N-fixer and a non nitrogen fixer (non-N-fixer) (two species assemblage) varied at different N:P ratios: the N-fixer dominated at low N:P, both coexisted at intermediate N:Ps and the non-N-fixer dominated at the highest N:P. Intriguingly, mutual invasibility experiments suggest that blooms of N-fixers may occur at very high N values, depending on the initial densities. Furthermore, the N-fixer (one species, population level) altered its physiology, depending on the N:P ratio applied: it behaved as a N fixer from 0 to 32 N:P, whereas above 32N:P it behaved as a non fixer. Finally, the ecological traits related to light use (μmax, α, I*k*) of three N-fixers isolated from a natural bloom suggest good competitive abilities under low light and sufficient nutrients, yet no N- fixer blooms would be expected at irradiances ≤17 μmol photon m^{-2} s^{-1}. Also, prolonged darkness resulted in akinete degradation, thus in with permanently dark sediments, the prevalence of N-fixers should not be favoured. We believe our results will contribute to a better understanding on how environmental factors shape the success of N-fixers, which recurrently bloom in waterbodies worldwide.

It was exciting to discuss our research results in such stimulating environment and receiving enriching comments. As in my first IAP experience (Sapanca, Turkey, 2005), this meeting was an eye opening experience! I am very thankful to the British Phycological Society for their financial help towards attending this workshop and for believing in me! Also many thanks to Tamar Zohary, the Kellogg Biological Station, CONICET and NSF; together with the BPS, their joint help made all this possible.

Participants at the 15th Workshop of the International Association of Phytoplankton Taxonomy and Ecology

Hurricane Bertha briefly threatened to delay me on the island for a few more days but turned North at the last minute. With a heavy heart and an equally heavy bag of duty free rum, I made my way onto the plane and headed back to the UK, my microbiological knowledge much the richer for the experience.

Tropical Field Phycology Course (Panama)

Kevin Miklasz, PhD Candidate, Hopkins Marine Biology Station, Stanford University, kmiklasz@gmail.com
Botany Department
University of Hawaii at Manoa

This past summer, I participated in the short course in Tropical Field Phycology, just outside the town of Bocas Del Toro on the Isla Colon, Panama. The course was instructed by Dr. Brian Wysor, Dr. Suzanne Fredericq, and Dr. Wilson Freshwater. The course was held at the gorgeous waterside research facilities of the Smithsonian Tropical Research Institute (STRI) with the help of Dr. Rachel Collin.

My interest in algae is relatively recent, and has only grown as a participant in this course. My previous experience has been restricted to the northern part of the pacific coast of America. I was very excited to see not only a different climate, but a different coastline entirely. My PhD research at Hopkins Marine Station (Monterey, California) is about the capacity of coralline algae to withstand physical stressors, such as temperature, desiccation, and water motion. I am particularly impressed by the coralline's ability to live in virtually every marine environment on the planet, and so was especially interested to examine corallines in this new part of the world.

The course featured a diversity of students, 13 in total, from 6 countries, 4 languages, and 3 algae phyla. A typical day started with a lecture in the morning, followed by a collecting trip. The entire afternoon was usually set aside for identification of algae we had collected, though even an entire afternoon never seemed like enough time to dedicate to this task. Although we were encouraged to work on different groups of algae to broaden our understanding, we were also given the freedom to pursue algae that interested us or was related to our research.

After dinner, the students gave presentations about their research, completing a very full day.

There were several projects that the students participated in as part of the course. We worked with Dr. Amy Driskell of the Smithsonian's Barcode of Life project to link genetic barcodes to identifications we had made. All course participants, including the professors and students, compiled their identifications into one list to add to the taxonomic diversity previously found in Panama. We pressed and preserved our identifications to be put into a new herbarium at STRI. Under the guidance of Dr. Fredericq, we conducted a genetic identification project on the genus *Gracilaria*.

The last project of the course was in my opinion the most rewarding. Each student created an illustrated guide for several species of their selection. Each of these one-page illustrations was collected, bound, and given to each student as a very satisfying reward for their work in the course. The resulting collection is quite impressive, featuring over 50 species of algae!

I would like to sincerely thank the BPS for their funding and the course organisers for putting together such an amazing experience. This opportunity both furthered my interest in and broadened my understanding of phycology.

Student Representative - The British Phycological Society: an invaluable network for students

Phycologists are a rare breed and the British Phycological Society (BPS) offers an invaluable network of like minded people. Therefore, while studying algae for my master's degree, I decided to become a member of the society.

At the BPS winter meeting in London this January, I became the student representative of the BPS council. I feel excited by this challenge and I see it as an important task. A student member of Council gives the students a voice and an opportunity to be heard. My role in the Council will be to communicate ideas and wishes from the student BPS members and to report back what goes on in the Council to the stude nts. From a student's point of view membership and participation in activities of the BPS provide opportunities to get to know phycologists from different parts of the world. The BPS is also a forum where a student network can be established.

Representing the students on the BPS Council, I would like to work for, and encourage student members to become more visible within the society. I believe that the BPS as a network and academic forum can be strengthened if the individual members and especially the students become more visible. Communication and potential collaboration is easier to establish when people know about each others work and ideas.

My fascination of the algal world started in the Faroe Islands where I grew up. I did my undergraduate studies at the University of Faroe Islands and at the University of Copenhagen, Denmark. I continued at the University of Copenhagen and completed my master thesis on *Porphyra* diversity in the Faroe Islands in 2007. I fell in love with *Porphyra* and currently I am doing my PhD at the University of New Hampshire, USA, on *Porphyra* taxonomy. Through my educational journey I have been inspired and advised by talented phycologists such as Ruth Nielsen, Dr Poul Møller Pedersen, Dr Susse Wegeberg, Prof. Juliet Brodie and Dr Chris Neefus and they are all invaluable to me.

As students of phycology we are the next generation to develop and carry on this field of knowledge and research. It is important that we contribute to the field with new ideas as well taking the opportunity to learn from our predecessors and more experienced colleagues. Currently there are sixty nine student members in the BPS and as a great pool of resources I wish to encourage you all to bring forward ideas, thoughts and possible questions that can be beneficial to you as well as to the society. You are most welcome to contact me on my e-mail.

Agnes Mols Mortensen - agnes.mols@unh.edu

First winners of the Hilda Canter-Lund Photomicrograph Award

In *The Phycologist* 75 (autumn 2008), the British Phycological Society announced a new prize, the **Hilda Canter-Lund Photomicrograph Award**, to commemorate the superb photographic images that Dr Canter-Lund produced over many years, which grace journal articles as well as the book "Freshwater algae: their microscopic world explored". The first award was for the micrograph published in the *European Journal of Phycology* in the years 2007 and 2008 (excluding part 4) that was judged best with respect to a combination of scientific, technical and aesthetic merit. The judges on this occasion were Professor David G. Mann (Royal Botanic Garden Edinburgh) and Dr Martyn Kelly (Bowburn Consultancy).

The Council of the British Phycological Society is delighted to announce that the first Hilda Canter-Lund Photomicrograph Award has been won by **Drs Conxi Rodríguez-Prieto, D. Wilson Freshwater** and **Noemí Sánchez** for Fig. 25 in their paper on the "Vegetative and reproductive morphology of *Gloiocladia repens* (C. Agardh) Sánchez et Rodríguez-Prieto comb. nov. (Rhodymeniales, Rhodophyta), with a taxonomic re-assessment of the genera *Fauchea* and *Gloiocladia*. *European Journal of Phycology* 42 (2): 145-162 (2007). Congratulations! They share a prize of £150.

Competition rules for the next Hilda Canter-Lund Award will be announced later in 2009.

Membership Secretary

Sara Marsham, s.marsham@newcastle.ac.uk

It was good to see so many of you at the Annual Winter meeting at the Natural History Museum in January and especially pleasing to see so many student members in attendance. The meeting was very successful with a wide range of interesting talks and posters. Now that we have all returned to work/studying I would like to take this opportunity to remind you about your BPS membership. As reported at the AGM, our membership at the end of 2008 remained relatively constant at around 450 members, including 84 student members and 37 retired members. However, of these 450 members, over a hundred members were in arrears for 2008. The Society generously allows members to be one year behind on subscriptions, during which time you continue to receive The Phycologist, but not the *European Journal of Phycology*. I began alerting you via e-mail that renewals were being taken for 2009 back in November 2008. I followed this up with a reminder at the end of January, again by e-mail. For those of you who do not have an e-mail address listed in the database, I wrote to you all personally.

As technology moves on, so must we and so it is very important that you keep your contact details up-to-date, especially your e-mail addresses. Recent e-mails sent to you via BPS-L returned many error or out-of-date addresses to us. It is very easy for you to now check your details using our online database. Go to http://www.brphycsoc.org/ and click on the 'Membership' link on the left-hand side then click on 'Your membership account: view and modify personal details'. This will take you to a page where you enter your log in details. The first time you access the page you will need to enter your e-mail address in the box under 'Forgot your password'. A password will then be sent to your e-mail address. If you return to the page and log in using your e-mail address and password you will be able to view your account details where you can see your address, telephone number and e-mail address. To amend any of these, please change them in the appropriate box and click on the 'Save' button at the bottom of the page. You can also check when you lasted renewed by looking at the 'Renewal Date' under Membership Details. If your membership is due for renewal there will be a 'renew now!' link next to the renewal date.

Subscription rates for the Society have not increased over the last few years and remain excellent value for money. The current rates are:

	With journal	Without journal
Ordinary Member	£35.00 (£36.50 online)	£10.00 (£10.50 online)
Retired/Student Member	£30.00 (£31.00 online)	£5.00 (£5.50 online)

Renewing online will cost you slightly more as we are charged by the bank to process your credit/debit card payment. Unfortunately the Society cannot afford to absorb this cost and so we must pass it on to you. Though, if you compare it to the price of a first class stamp, it is not that much more expensive and you do not have to queue at the post office!

So far, 250 members have renewed for 2009, including 32 student members and 33 retired members. Thank you to all of you who have renewed for this year, I hope you are finding the online system easy to use. Can I please remind the rest of you to renew now so that you continue to receive the benefits the Society offers. Also, the first issue of the *European Journal of Phycology* is soon to be published and if you wish to receive the journal you will miss the first issue of volume 44.

If you do not wish to renew online you can still complete a renewal form (available inside the back cover). You can either fill in your credit/debit card details and we will debit your bank account, or you can send a cheque made payable to the British Phycological Society. Can I please ask any member paying by standing order to cancel this arrangement with your bank? Standing orders are very difficult for us to manage and many of you continuing to pay this way are paying obsolete membership fees. As a Society we are unable to cancel them on your behalf. It is up to you to contact your bank. We are currently investigating direct debits as a more convenient payment method and will update you as to the progress of this.

It is important that the Society continues to grow and attract new members to support phycological activity both now and in the future. If any of you have friends, colleagues, postgraduate students or undergraduate students who are interested in an area of phycology and are not yet members - sign them up! Please feel free to pass on my contact details and I will be more than happy to answer any questions they have, or point them in the direction of our website. As of January we have a new Student Representative, Agnes Mols Mortensen. Myself and Agnes are hoping to work closely together to increase student participation in the Society (please see Agnes' report for more details).

If any of you have any questions about your membership status, the database or subscription to the journal, please do not hesitate to contact me. I would finally like to thank you all for your comments about the new database over the last couple of years, and also for the continued support of the Council. Here is to another year of successful phycological study!

Minutes of the 57th Annual Meeting of the British Phycological Society,

National History Museum, London, Wednesday 7th January 2008, 4.20pm

Present: 44 members were present

1. Apologies

Jackie Parry, John Anderson.

2. Minutes of the 56th AGM held on the 5th January 2008

The minutes were approved: proposed by David Mann and seconded by Elizabeth Haworth.

3. Matters arising

None

4. Reports from Officers

a) Secretary

In Jackie Parry's absence Geoff Codd spoke on her behalf. Jackie sent her apologies and said that she had carried out her normal secretarial duties over the previous year and there was nothing out of the ordinary to report. As this was her last AGM as Secretary she thanked Council members of the last six years with whom she had worked and also the three presidents under whom she had served (Barry Leadbeater, Mike Guiry and Geoff Codd). Jackie will contact the incoming secretary (Jane Pottas) regarding handing over Council documentation.

b) Treasurer

Michelle Tobin reported that the society's financial situation remains good and is in a slightly better position than in the previous year with funds ca. £108 000. Income from membership is less than last year (currently standing at £6000) but figures will be updated once the accountant can be contacted after the holiday period (8/1/09). Payment can now be made on line via the Treasurer but in future Taylor & Francis will oversee this. The Journal has again performed well financially and the balance to the Society from Volume 42 was £31,588.33 (£26,714.19 for Volume 41) due to the current guaranteed annual income of at least £20,000 from the publishers, Taylor and Francis. 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. However, during this financial year the society has only supported one student to attend an overseas conference and six students to attend field courses and workshops. Despite advertising, no summer studentships had been applied for and Michelle encouraged members to take advantage of this source of funding to introduce students to phycological research. All surplus money from the Bristol meeting (£3888.36) was being used to fund the 2009 meeting at the Natural History Museum, London. Council has agreed for the Society to change bank accounts within Bank of Scotland to provide the Society with a higher rate of interest on short term deposits and to facilitate a more flexible current account. These changes will take effect during the 08/09 financial year. Michelle thanked all Council and Society members for their co-operation and support during the year and recommended approval of the Treasurer's report with the proviso that details will be updated once information has been received from the accountants.

Geoff Codd thanked Michelle for her work as Treasurer. The Treasurer's report was accepted: proposed by Mike Guiry and seconded by Juliet Brodie.

c) Membership Secretary

Sara Marsham reported that the on-line data base continues to work well and most members are renewing membership on line with few problems. The current active membership of the Society is 447 (318 fully paid up, 117 paid to end of 2007 and 12 Honorary Life Members), which is down by 27 fully paid up members from the end of 2007. 60 new members have joined the Society in 2008, compared to 51 new members over 2007 and there are more student members than last year. Recruitment to the Society appears to be maintained; though the renewal level has dropped slightly. 117 members are in arrears and they will be contacted and those still in arrears after one year will be removed from the data base. Of the 318 fully paid up members 208 receive EJP. Taylor and Francis have been very helpful in issuing the journal to members when they join. There is an ongoing problem with a few members who continue to pay with standing orders and they have again been urged to cancel them. As Sara is unable to cancel the instruction on their behalf the BPS has to continue to accept their payments (often at an incorrect subscription rate). The seven Special Session speakers from the Winter Meeting in January 2008 who received Complimentary Membership for 2008 have been contacted by letter from Geoff. So far only one member has responded to the letter and renewed for 2009. There are two corporate members - SEPA and AORI (Algae Orphanage Research Initiative) in India. Sara thanked Michelle Tobin, Mike Guiry and Pier Kuiper for help with processing paymen ts and maintaining the database.

There followed a discussion on payment by standing order and direct debit. Michelle Tobin is to enquire about the possibility of payment by direct debit.

Geoff Codd thanked Sara Marsham and Mike Guiry for their work. The Membership Secretary's report was accepted: proposed by Michelle Tobin and seconded by Eileen Cox.

d) Student representative report

No report received.

Geoff Codd commented on the need for a student page on the website.

e) Joint Editors-in-Chief of the European Journal of Phycology

Eileen Cox reported on behalf of herself and John Day. The page allocation for 2008 was 448 pages. All four issues of volume 43 were printed on time. Issue 1 had 4 papers, including a major review; issue 2, 10 papers; issue 3, 8 papers, including a mini-review and issue 4, 9 papers occupying a total of 438 pages. Issue 2 was reprinted and distributed at no cost to the BPS, as the print quality was unsatisfactory, because of an error at the printers that reduced the contrast. Volume 44 (1 & 2) are currently at the proof stage and should appear on time. Approximately half the manuscripts for 44 (3) are already at the proof stage and the remainder with the copy editor. In addition, there are sufficient manuscripts accepted, or close to acceptance, to completely fill Volume 44. There has been a good spread of subjects with submissions from established authors and young researchers. The impact factor has increased to 1.507 and it is hoped that this will continue. The increasing speed of papers on to iFirst has led to a higher percentage of papers in the journal being cited. All submissions are going through the electronic system. Rejection rates are running at 40-75% with physiology and ecology papers having a higher rejection rate than molecular/taxonomic manuscripts. In 2008 the production of EJP was put out to tender and following presentations by four publishing companies the tendering committee (Eileen Cox, John Day, Geoff Codd, Wytze Stam and Michelle Tobin) agreed unanimously that Taylor & Francis Group be awarded a five-year contract commencing 2009. Taylor & Francis are increasing the guaranteed income to the BPS from £20K to £32K and also raising the profile of the journal. The editors have been considering the options available to manage the issue of the length of time from submission to hard copy - still 8 months - and have prepared an additional submission to Council suggesting a way forward. Members were encouraged to sign up with Taylor & Francis for journal alerts. Taylor & Francis are planning to make access free to reviews which should increase citation rates. Chris Maggs strongly supported this.

Geoff Codd thanked Eileen and John. The Editors-in-Chiefs' report was accepted: proposed by Chris Maggs and seconded by Liz Haworth.

f) Editor of The Phycologist

Jan Krokowski reported that *The Phycologist* continues to go from strength to strength as reflected by a steady increase in the number of pages per spring and autumn issues. Each edition has interesting and varied articles, from students, from those who have received bursaries from the BPS, and since last year book reviews have been moved from the *European Journal of Phycology* to *The Phycologist*. There has been a steady increase in cost of production associated with increasing content and an increase in postage. Jan appealed for articles from members and expressed the hope that the new student representative will encourage submissions from student members. There followed a discussion about the format of *The Phycologist*. Elliot Shubert enquired about the possibility of going to pdf format only but Mike Guiry explained that it is obligatory to produce a certain number of hard copies because *The Phycologist* is an ISSN publication.

Geoff Codd thanked Jan for his work in editing The Phycologist. The editor's report was accepted: proposed by John Day and seconded by Michelle Tobin.

g) Webmaster

Mike Guiry reported that the website is up 99.9% of the time because of having a Mac site (not Microsoft). He pointed out that Pier Kuiper maintains the website as a friend. Mike proposed that in future he would like to run BPS-L from the site in Galway rather than Dublin and assured all that there were no security issues.

Geoff Codd thanked Mike for his work and prompt response to enquiries and asked that the thanks of the BPS be passed on to Pier. The Webmaster's report was accepted: proposed by Jan Krokowski and seconded by Juliet Brodie.

h) Student Awards and Training Committee

Barry Leadbeater reported that all awards made this year were bursaries for students to attend conferences. There were several expressions of interest in Summer Research Projects in 2008 but in spite of encouragement to apply no final applications were received. The total sum awarded this year (£6835) compares with £6532 for 2006 and £5140 for 2007. A relatively modest sum had been spent in 2008 to support students but funds were available to support more. Barry pointed out that the application form has been modified and simplified and asked for electronic submissions only, to aid circulation to committee members. He thanked Martyn Kelly and Gill Malin for processing applications.

Geoff Codd thanked Barry for his work on the committee for the past four years as his term of office ended. The report was accepted: proposed by Mike Guiry and seconded by Sara Marsham.

i) Biodiversity and Conservation Committee

Juliet Brodie reported that three species have been put forward for the 5th quinquennial review of Schedules 5 and 8 of the Wildlife and Countryside Act as being of concern but there has been no response to date. Field meetings have been well attended and Juliet encouraged the planning and organisation of more meetings which the BPS will endeavour to support. She reported that the green flora is selling well and a freshwater flora is well underway. Bob Fletcher has contacted Juliet with news that the second volume of the brown flora is in the draft stage. Some of the editions which are out of print may be reprinted - Juliet is to consult with the

Natural History Museum. The Algal Conservation Project - discussed with OPAL (Open Air Lab) - will go ahead this year funded by a grant. Juliet received an award from Plantlife for her work with Important Plant Areas for Algae and this was reported in *The Phycologist*. Juliet reported that she is stepping down as chair of the BCC to be replaced by Martin Wilkinson.

John Raven commented that in Plantlife no expert phycologist was mentioned. Juliet replied that she had given a speech at the award ceremony at which she had commented strongly on the lack of mention of the algae.

Geoff Codd thanked Juliet for chairing the committee for six years. The report was accepted: proposed by John Day and seconded by Linda Medlin.

j) Communication and Education Committee

Geoff Codd reported on behalf of Jackie Parry who sent her apologies. BPS is on the books of the books of the Science Media Centre - a one stop shop based in London which will liaise with all branches of the media. GAC encouraged members both as individuals and as groups to contact the SMC to raise the profile of phycology. Geoff thanked Jackie and the committee members for their work.

5. Federation reports

a) The Federation of European Phycological Societies (FEPS)

Geoff Codd informed the membership that the council of The Federation of European Phycological Societies met in January and the summer of 2008 to establish the society and its activities (http://www.feps-algae.eu/cms/). The constitution is available via the BPS website and a hard copy has been lodged with the secretary for archiving. Geoff Codd was elected as president, Elliot Shubert as Secretary/Treasurer. The council of FEPS is keen to produce a journal which will focus entirely on reviews and which will complement all other phycological journals. The website is built and developing. The 5th European Phycological Congress (EPV V) will take place on the Island of Rhodes, Greece in 2011. Geoff will report back to future AGMs about progress.

b) The Federation of European Microbiological Societies (FEMS)

Geoff Codd informed members that the BPS (currently a probationary member) has to decide by the end of January 2009 whether or not to apply for full membership. FEMS is an association of over 40 societies and the BPS would be the only phycological society in the federation. Members can apply for research fellowships, visiting scientist grants, young scientist meeting grants and/or support when organizing a meeting. Geoff encouraged BPS members to take advantage of the funds. Frithjof Küpper pointed out that members should be aware that the application procedure is lengthy. The BPS has been invited to become a member. Council recommends acceptance and the membership was asked to vote on the proposal. The vote was carried. Geoff will write a report for *The Phycologist* to include website details.

c) The Biosciences Federation (PH reported in GJCU's absence)

Paul Hayes reported on behalf of Graham Underwood who sent his apologies. The Biosciences Federation and the Institute of Biology will merge to become the Royal Society of Biology - a single voice for biology - by summer 2009. Paul will keep BPS informed of developments.

6. Future Meetings

John Day is to investigate the feasibility of holding the 2010 winter meeting in Oban. Eileen Cox asked that a venue for 2011 also be discussed. Rupert Perkins offered to enquire about holding the 2011 meeting in Cardiff.

7. Changes in Council Structure.

The term of office of four Ordinary Members of Council and the Student Representative has come to an end. Geoff Codd thanked retiring council members Gill Malin, Barry Leadbeater, Graham Underwood, John Anderson and Sam Fielding and also the outgoing Overseas Vice President Professor Antonio Quesada for their contributions. Nominations were received for three Ordinary Members for three years and these were Dr James Metcalf (proposed by Jan Krokowski and seconded by Jackie Parry), Dr Marian Yallop (proposed by Paul Hayes and seconded by Geoff Codd) and Prof. Christine Maggs (proposed by Juliet Brodie and seconded by Paul Hayes); for one Ordinary Member for two years and this was Martin Wilkinson (proposed by Juliet Brodie and seconded by Paul Hayes) and for a Student Representative and this was Agnes Mortensen (proposed by Juliet Brodie and seconded by Geoff Codd). The Overseas Vice President proposed by Paul Hayes will be Prof. Patrizia Albertano (University of Rome). Paul Hayes becomes President Elect. Geoff Codd will become chair of the Student Awards and Training Committee. The membership approved the nominations. All accepted their nomination and were welcomed to their posts. The services of the current auditor Flannigan, Edmonds and Bannon will be retained (proposed by Elliot Shubert and seconded by Michelle Tobin).

8. Any other business

Geoff Codd thanked Eileen Cox and Elliot Shubert for organising and hosting the winter meeting at the Natural History Museum, London and Taylor and Francis for sponsoring the reception. He thanked members for their support during his term as President and handed over to the incoming President, Juliet Brodie. Juliet thanked Geoff for all his hard work in office.

The meeting ended at 5.30pm.

Annual Report for the year ended 30 September 2008

The British Phycological 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 Phycology*.

Membership of the Council of the Society:

Executive Members

President:	Professor G.A. Codd	Treasurer:	Dr M.L. Tobin
Vice President:	Dr J. Brodie	Eds (*Eur. J. Phyc.*):	Dr E.J. Cox
Overseas Vice President:	Professor A. Quesada de Corral		Dr J. Day
Immediate Past President:	Professor M.D. Guiry	Ed. (*The Phycologist*):	Dr J. Krokowski
Secretary:	Dr J.D. Parry	Webmaster:	Professor M.D. Guiry
Membership Sec:	Dr S. Marsham		

Ordinary Members

Prof P. Hayes	Dr M. Clokie	Dr D. Mann	Dr B.S.C. Leadbeater
Professor R. Perkins	Dr G. Malin	Dr M. Kelly	Dr T. Proeschold
Professor G. Underwood	Professor J. Anderson	Mr S. Fielding	

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 fifth 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 phycological research, disseminate phycological knowledge and assist young phycologists to present their findings at scientific meetings. The 2008 annual winter meeting and AGM were hosted by the University of Bristol and thanks go to Prof. Paul Hayes and his team for organising a highly successful meeting. The range and standard of presentations was excellent as usual and congratulations go to Li Deng and Katharine Crawford whose contributions earned them the 2008 Manton Prize and Poster Prize respectively. Eleven students received support to attend this meeting from the Scientific Meetings Fund (SMF) (ten in 2007). The auction and quiz raised £240, with thanks going to the quiz organisers and Elliot Shubert for their efforts. The meeting returned a surplus of £3888.36 and this money has been used to support the 2009 meeting.

During this financial year the society has supported one student to attend an overseas conference and six students to attend field courses and workshops. Unfortunately despite advertising no summer studentships were awarded in 2008. Members are encouraged to consider this source of funding for introducing students to phycological research.

During 2008 honoraria were awarded to the following council members: the Membership Secretary, Secretary and the Editor of The Phycologist each received £750, the Treasurer received £1000 and the Editors of the European Journal of Phycology received a total of £1500. The Society is now managing the funds provided annually by Taylor and Francis to support the EJP editorial assistant.

The Journal has again performed well financially and the balance to the Society from Volume 42 was £31,588.33 (£26,714.19 for Volume 41) due to the current guaranteed annual income of at least £20,000 from the publishers, Taylor and Francis. We look forward to continuing our successful relationship with T&F following the renewal of our publishing contract.

The Society's financial situation remains good. Council has agreed for the Society to change bank accounts within Bank of Scotland to provide the Society with a higher rate of interest on short term deposits and to facilitate a more flexible current account. These changes will take effect during the 08/09 financial year. 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 Phycological Society

Registered Charity No. 246707

Statement of Financial Activities for the Year ended 30th September 2008

	Note	Unrestricted General	Designated S.M.F.	Restricted Manton	Total 2008	Total 2007
		£	£	£	£	£
Income and Expenditure						
Incoming Resources						
Subscriptions 2006						143.00
Subscriptions 2007		2,125.00			2,125.00	9,273.00
Subscriptions 2008		5,999.00			5,999.00	
Journal profit share		31,588.33			31,588.33	26,724.19
Auction proceeds			240.00		240.00	55.00
FW Atlas		397.91			397.91	597.87
Interest		359.83			359.83	2,836.93
Winter Meeting 2007 surplus					-	1,975.00
Winter Meeting 2008 surplus		4,388.36			4,388.36	
EJPMC		5,418.00			5,418.00	
Miscellaneous (auction 05))					-	220.00
Total Incoming Resources		**50,276.43**	**240.00**		**50,516.43**	**41,824.99**
Resources Expended						
Grants, studentships & awards	**2**	8,161.14	2,560.00	250.00	10,971.14	4,345.00
Publications expenditure	**3**	14,861.61			14,861.61	11,234.81
Meetings & Committee Expenses	**4**	7,852.75			7,852.75	8,392.31
Administration Costs	**5**	7,490.76			7,490.76	6,452.00
		38,366.26	**2,560.00**	**250.00**	**41,176.26**	**30,424.12**
Net Incoming (Outgoing) Resources for the Year		**11,910.17**	**-2,320.00**	**-250.00**	**9,340.17**	**11,400.87**
Fund at 1 October 2007		69,582.74	25,000.00	4,944.09	99,526.83	88,125.96
Transfer (General to SMF)		**-2,320.00**	2,320.00			
Fund at 30 September 2008		**79,172.91**	**25,000.00**	**4,694.09**	**108,867.00**	**99,526.83**

Balance Sheet as at 30 September 2008

	Note	2008 £	2007 £
Current Assets			
Debtors	**7**	5,888.36	4,330.97
Short term deposits		92,043.30	82,043.30
Cash at bank		25,366.34	24,915.47
		123,298.00	111,289.74
Liabilities: amounts falling due within one year	**8**	14,431.00	11,762.91
Net Assets		**108,867.00**	**99,526.83**
Funds	**9**		
Unrestricted		79,172.91	69,582.74
Restricted		4,694.09	4,944.09
Designated		25,000.00	25,000.00
		108,867.00	**99,526.83**

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

The British Phycological Society
Notes to the Account for the Year ended 30 September 2008

1 Accounting Policies

The accounts have been prepared in accordance with applicable Accounting Standards and the SORP - Accounting and Reporting by Charities issued in March 2005. 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 2008, 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 2008, 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 2008 £	Total 2007 £
2 Grants, Studentships & Awards					
Travel awards for Winter Meeting		2,560.00		2,560.00	1,990.00
Awards for courses, travel, Summer Bursary	5,261.14			5,261.14	1,955.00
Manton Prize			250.00	250.00	250.00
Poster prize at Winter Meeting	150.00			150.00	150.00
Special Project Grants	2,750.00			2,750.00	-
	8,161.14	**2,560.00**	**250.00**	**10,971.14**	**4,345.00**
3 Publication expenditure					
Journal	6,669.00			6,669.00	6,905.25
Hon. Editor's Honorarium (2008)	1,500.00			1,500.00	-
Hon. Editor's Honorarium (2007)				-	1,500.00
Editor's Honorarium (2007)				-	750.00
E.J.P. Management Committee	1,028.97			1,028.97	179.18
The Phycologist	3,704.72			3,704.72	1,900.38
EJP Editorial Assistant Expenses	1,958.92			1,958.92	-
	14,861.61	**-**	**-**	**14,861.61**	**11,234.81**
Meetings & Committee Expenses					
4 Council Meeting 2006					172.20
Council Meeting 2007					2,716.32
Council Meeting 2008	2,678.19			2,678.19	
Biodiversity Committee Expenses	377.80			377.80	163.88
Winter Meeting 2007					4,323.00
Winter Meeting 2008	3,952.54			3,952.54	
Federation of European Phycologists	844.22			844.22	1,016.91
	7,852.75	**-**	**-**	**7,852.75**	**8,392.31**
5 Administration Costs					
Public liability insurance	367.50			367.50	367.50
Independent Examiner's Fee	1,082.50			1,082.50	1,019.38
Credit Card Charges	748.30			748.30	614.39
Bank Charges	165.00			165.00	75.00
Executive Honoraria (2007)	-			-	3,250.00
Executive Honoraria (2008)	3,250.00			3,250.00	
Federation of Bioscience Federation Subcription	566.00			566.00	552.00
Attendance at Biosicence Federation	-			-	79.60
Miscellaneous (membership refund)	36.50			36.50	35.00

The British Phycological Society
Notes to the Account for the Year ended 30 September 2008 (cont.)

	Unrestricted General	Designated S.M.F.	Restricted Manton	Total 2008	Total 2007
	£	£	£	£	£
5 Administration Costs (cont.)					
General Expenses	-			-	387.91
FEMS subscription	152.43			152.43	71.22
DEPS subscription	341.53			341.53	
Website Maintenance	781.00			781.00	
	7,490.76			**7,490.76**	**6,452.00**

6 Reimbursment of Council members' expenses

Twelve (2007: Seventeen) Council members received £2,678.19 (2007: £2,716.32) as reimbursment of travel and overnight accommodation for expenditures incurred during the year on Society business. No monies were paid to any Council member in respect of subsistence.

7 Debtors	2008	2007
	£	£
Interest receivable	2,000	1,959.97
Membership receivable	-	2,371.00
Prepayments	3,888.36	4,330.97
	5,888.36	**4,330.97**

8 Liabilities: Amounts falling due within one year	3,931.00	1,262.91
Accruals	10,500.00	10,500.00
Provision for the *Journal* and *The Phycologist*	**14,431.001**	**11,762.91**

9 Analysis of Net Assets between Funds

	Unrestricted Funds	Restricted Funds	Designated Funds	Total Funds
	£	£	£	£
Fund balances as at 30 September 2008 are represented by				
Current assets	93,603.91	4,944.09	25,000.00	123,548.00
Current liabilities	-14,431.00	-250.00		-14,681.00
Total Net Assets	**79,172.91**	**4,694.09**	**25,000.00**	**108.867.00**

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

We report on the accounts of the Society for the year ended 30 September 2008, which are set out on pages 32 to 34.

Respective responsiblities 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 responsibiliy 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

Note on a 'Red Tide' of *Spermothamnion repens*

Clare Scanlan and Sarah Holt, Scottish Environment Protection Agency.
clare.scanlan@sepa.org.uk, sarah.holt@sepa.org.uk

A "red tide" on the shore at the Castletown beach near Thurso in Caithness (NGR 203 683) on the north coast of Scotland was reported to the Scottish Environment Protection Agency (SEPA) in October 2007. A rather spectacular swath of red seaweed was cast up on the beach (Fig.1). This was formed of small balls of a filamentous red alga. A sample made its way to our lab in Aberdeen, where we identified it as a *Spermothamnion*. As an apparently loose-living form of spherical balls it didn't fit the normal descriptions, but a quick internet search revealed occurrences in the U.S.A. of occurrences of masses of *S. repens* being washed up annually on beaches (e.g. R.Salit, 2005). Confirmation of our alga as *S. repens* was kindly made by Prof. Christine Maggs of Queen's University, Belfast. She has herself found similar blooms, but much further south and west than the eastern end of the Pentland Firth. The species itself has a fairly ubiquitous distribution, and could easily occur in this area, but the form and quantities were surprising.

While visiting Caithness last summer on other field work, a small diversion to Castletown showed that the alga was still washing up. This phenomenon has apparently been occurring for an unspecified number of years here, but not normally on the scale of 2007. Then there was a particularly vivid bloom with no obvious cause. Balls were mostly of the order of 1 to 2 cm in diameter and become brownish in colour when pigment was lost (Fig. 2).

The phenomenon of normally attached algae forming detached balls under certain calm environmental conditions is well-known - e.g. *Ascophyllum nodosum* ecad *mackii* or *Cladophora/Aegagropila* - but seemed surprising on a coast better known for surfing due to its good waves; the Pentland Firth is one of the roughest stretches of water in Britain. However, the local bay has a degree of shelter from Dunnet Head, and plants were probably attached initially and became detached. This seems to be the case in Rhode Island, U.S.A., where *Spermothamnion repens* has occurred in nuisance quantities over a prolonged period (e.g. R. Salit, 2005). There it was linked with sewage inputs, but we have no such clear linkage in this case. It would be interesting to know of other such occurrences.

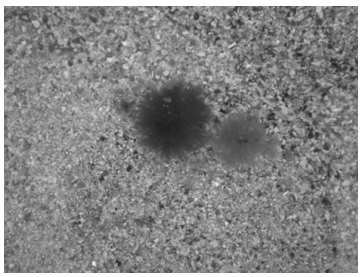


Figure 1. (top) 'Red tide' in Caithness, October 2007.
Figure 2. (bottom) *Spermothamnion repens* 'balls' *in situ.*

Acknowledgements

Thanks to Prof. Christine Maggs for confirmation of the taxon and our colleagues Angus Spirit and Mhairi Wilson for field photographs and specimens.

References

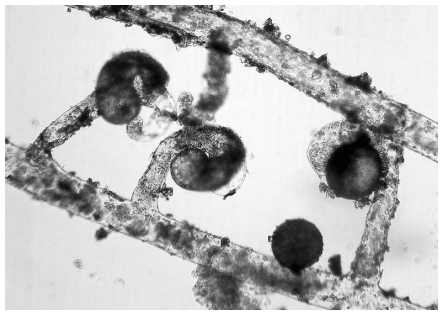
Salit, R. 2005. Algae taking aesthetic, financial toll on Easton's beach. *Providence Journal East Bay*.

New faces, New altitude, New species

Roy Merritt, Roymerritt2@aol.com

The sadly missed Hilda Canter-Lund had told me that the rotifer galls that I was finding on *Vaucheria* would be of interest to our rotifer collectors and that was how I met Eric Hollowday and through him, Fred Longrigg, an amateur rotifer enthusiast already studying, amongst others, the rotifer that lives in Volvox.

Fred now became fascinated with the gall causing rotifer *Proales wernecki* and he and his wife Sarah who live in Scotland began to find *Vaucheria* everywhere. Until now I had rather unhappily accepted that we in the UK had an upper limit of about 350m for our *Vaucheria* population, whereas Tim Entwisle had found a highest collection site of 1,560m in South-eastern mainland Australia. Alfred Rieth had written in his book on the *Vaucheria* of Central Europe that three *Vaucheria* spp, occurred at over 2,000m with a fourth *V. aversa* occurring at up to 3,625m. Sarah soon found a *Vaucheria* site at 570m whilst botanising for alpines at the head of Kirkton Glen, Balquhidder and not satisfied with that they went on to find a new *V.* sp, for the UK that of *Vaucheria uncinata* near Aberfoyle.



Vaucheria uncinata

John M. Huisman, *Algae of Australia: Nemaliales*. ABRS, Canberra: CSIRO Publishing, Melbourne (2006). AU$90. ISBN: 0643093788.

T.J. Entwisle, S. Skinner, S.H. Lewis, H.J. Foard, *Algae of Australia: Batrachospermales, Thoreales, Oedogoniales and Zygnemaceae*. ABRS, Canberra: CSIRO Publishing, Melbourne (2007). AU$90. ISBN: 9780643094314.

There are many things I like about *Algae of Australia: Nemaliales*. This book, which, covers the Liagoraceae, Galaxauraceae and Scinaceae and the 20 genera and 55 species of these families that are found in Australia, forms a part of the *Algae of Australia* (McCarthy & Orchard, 2007). The text of Nemaliales starts with a highly informative introduction on the history of the order and gives an account of present day concepts including controversies at the various levels of classification. The introduction continues with a discourse on the diagnostic characters of the Nemaliales and rounds up by explaining how to prepare specimens for microscopical examination. Anyone who has worked with species in this group of algae will know how tricky it can be to make preparations and interpret what is seen under the microscope. Thus background information on features including calcification, branching patterns, life history and reproduction and how to distinguish epiphytes and endophytes - which can be tricky - coupled with the illustrations that accompany this part, are especially welcome. The descriptions follow on from the introduction. After the description for the Nemaliales and a dichotomous key to the families, each family continues with keys to the genera and species in a typical flora format. There are also distribution maps for each species after the main flora.

It is worth noting that this book also includes three papers in a series of Appendices at the end of the book. The first of these usefully covers the typification of species that are included in this book based on specimens in the herbarium of WH Harvey at Trinity College, Dublin (TCD). As for many taxa in the red algae, the Nemaliales is undergoing major revision as a result of the application of molecular analysis and this is reflected in the two papers that follow. The second paper describes a new genus, *Titanophycus*, in the Liagoraceae, based on morphological and molecular analysis. Similarly, the third paper also uses morphological and molecular analysis to explore the *Dichotoma marginata* complex in Australia. It is good to see the inclusion of molecular treatments increasingly incorporated into modern floras and I hope that this trend will continue.

While this book has contributions from several scientists, including Gerry Kraft, Akira Kurihara, John Parnell, Gary Saunders, Alison Sherwood and Brian Womersley, all credit has to go to John Huisman for the enormous progress he has made towards understanding the species of the Nemaliales and for his superb art work. The book is beautifully illustrated throughout, with both black and white and colour photographs plus superb drawings. The illustrations alone make this an inspiring volume and it is a pleasure just to look at these visually striking and amazingly intricate organisms. This is a good book.

One of the values of a flora is that a great deal of knowledge can be brought together under a single cover and I feel that this is a major plus point of *Algae of Australia: Batrachospermales, Thoreales, Oedogoniales and Zygnemaceae*. This flora covers the red algae and filamentous green algae that are found in Australian freshwater habitats. However, there is no introduction to explain to the reader the concept of the content and no overview of the classification, which suggests that this book is aimed at specialists. The closest I could find to an explanation was the blurb on the back cover. This is informative and, unlike inside the book itself where you have to search for clues, it becomes clear which of the orders covered are red algal groups and which green. Along with the *Nemaliales*, the book is part of *Algae of Australia*, which I assume aims to eventually produce floras on all the algal groups, although I have not seen this stated in the *Introduction* (McCarthy & Orchard, 2007).

Batrachospermales, Thoreales, Oedogoniales and Zygnemaceae follows the same format as the *Nemaliales*. As with the latter book, I like the inclusion of distribution maps at the back of this work. A striking observation one can make when glancing through the maps, is the sparseness of the records of many individual species, suggesting endemism and/or possibly that much recording needs to be done and perhaps this book will help to encourage that. Although there are notes for each species under the species entry, it would have been interesting to have had a commentary on the maps by the authors. This left me wondering whether the maps reflect the true extent of each species in Australia or merely where the phycologists have been and I was also curious as to the impact of recent advances in understanding species on distributions.

The book is illustrated with a mixture of line drawings and black and white photographs. While they serve their purpose well, I did rather crave at least a few colour illustrations and possibly even some habitat shots. However, as someone who studies marine algae, I feel inspired to go and hunt for some of these freshwater organisms.

The inclusion in this book of the Thoreales, a new order of algae, set me thinking about just what there is out there in the natural world to discover and about the dedication of the authors in bringing so much information together. While all the people who have contributed to this work deserve praise, as with John Huisman in the *Nemaliales*, I sense the spirit of Tim Entwisle and the impact he has had on the understanding of freshwater algae in Australia.

In conclusion, both these floras contain a wealth of useful information. I hope that these books will inspire people to keep on studying these groups of fascinating algae and in doing so help to increase knowledge and understanding of species diversity and the distribution of these intriguing organisms in both marine and freshwater habitats.

Reference

McCarthy, P.M. & Orchard, A.E. [Eds], 2007. *Algae of Australia: Introduction*. ABRS, Canberra; CSIRO Publishing, Melbourne, Australia, 744 pp.

Juliet Brodie

GERALD T. KRAFT. *Algae of Australia: Marine Benthic Algae of Lord Howe Island and the Southern Great Barrier Reef, 1. Green Algae*. ABRAS, Canberra, CSIRO Publishing, Melbourne, Australia, 2007: vi + 347 pp. ISBN 9780643094321 (hbk). Price AU$125.

This volume represents the fourth in the *Algae of Australia* series and targets the green algae from the tropical-subtropical coral reef settings of Australia. The previous volumes comprise the marine red algal order Nemaliales by J. M. Huisman (164 pages) published in October 2006, Introduction by 35 authors and edited by P. M. McCarthy and A. E. Orchard (744 pages) published in March 2007, and the macroscopic freshwater algal orders Batrachospermales, Thoreales, Oedogoniales and family Zygnemaceae by T. J. Entwisle, S. Skinner, S. H. Lewis and H. J. Foard (191 pages) published in April 2007.

The uniqueness of the endemic marine flora is showcased from the world's southernmost consolidated coral reefs of Lord Howe Island, an oceanic volcanic outcrop located between Australia and New Zealand, and the Capricorn Group of the southern Great Barrier Reef consisting of patch reefs and coral cays. Many of the marine green algal species described in this attractive green hard-cover book are also found in other coral reef areas in the western and central Pacific. A two-page Content with the listing of orders, families and genera simplifies the finding of a specific genus.

The book begins with an Introduction which details the history of phycological research and descriptions of Lord Howe Island and the Capricorn Group, supported by maps and 18 colour photographs (see pp. 134 and 135). The Systematic Arrangement of orders, families and genera is then summarized in outline form with explanations of the particular taxa used in the book. Habitats of selected green algae and affinities of the green algae from the subject area are briefly discussed. A dichotomous Key to Genera, consisting of 41 couplets, is provided to all 41 genera of green algae. The text page to the particular genus and citing of the preceding couplet makes the key easier to use. Most importantly, the key really works based on my progressing through the key targeting different morphological shaped genera.

The systematic sections comprise 83 percent of the book and include workable identification keys to the species within each genus, and descriptions of 41 genera and 135 species and infraspecific taxa of marine benthic green algae. Species are discussed in the order of their position in the species key. Reference citations are provided for each species and synonyms in the text which makes it easy for the reader to immediately identify the applicable reference. The collection site of the type specimen is also provided.

The black and white photographs and microphotographs, two to 13 photos per species, of the habit, morphology and anatomy of the species are clear and complement the detailed descriptions of the genera and species. There is, however, one glaring editorial error in my copy, where the identical plate of 11 photos (Figure 72, p. 200) of *Halimeda micronesica* Yamada and *H. discoidea* Decaisne is replicated and labelled Figure 73 (p. 207) with the caption *Halimeda gracilis* Harvey ex J. Agardh. Where's the plate for *H. gracilis*? Such an error is surprising when one considers the rarity of typographical errors in the text.

The 33-page section on the genus *Halimeda* covers 16 species, with one newly described species, and is co-authored by Joanne M. Noble and Gerald T. Kraft who update its taxonomy based on past molecular findings conducted over the past six years. This co-authorship is fitting since J. M. Noble did her M. Sc. Thesis in 1987 in the Heron Island region of the Capricorn Group, and described the new species *H. magnidisca* J. M. Noble in 1986 from the Capricorn Group and participated in the description of H. howensis Kraft & J. M. Noble in 2000 from Lord Howe Island. The *Halimeda* section contains a few line drawings of surface patterns and shapes of utricles, and medullary siphons which are most appropriate.

My favourite section is the discussion after the listing of examined specimens where the author provides his taxonomic insights of the species under discussion. I was elated to read that I was not alone in believing that *Pseudochlorodesmis furcellata* (Zanardini) Børgesen may still be a distinct species and not a life stage of *Halimeda tuna* (J. Ellis & Solander) Lamouroux. A bonus section of this book is the additional 57 colour photos of the green algae in their natural habitats. An extensive Bibliography of 412 references is provided which represents the past and current nomenclatural, molecular and taxonomic treatments on Pacific tropical and subtropical green algae, and other references applicable to the geographic sites.

The Bibliography is followed by an Appendix which compiles and reintroduces the descriptions of one new genus *Botryodesmis*, 11 new species (*Boergesenia magna*, *Botryodesmis exocarpa*, *Bryopsis profunda* Kraft & K.R. Dixon, *Cladophoropsis herpa*, *Cladophoropsis planiuscula*, *Codium gongylocephalum*, *Codium reversum*, *Halimeda cereidesmis*, *Pseudochlorodesmis monopodialis*, *Ulva polyclada*, *Ulvella perfurcata*), one new form (*Halimeda gracilis* Harvey ex J. Agardh f. *triloba* J.M. Noble & Kraft), three new combinations (*Ulva flexuosa* Wulfen subsp. *paradoxa* (C. Agardh) Kraft, *Ulva howensis* (A.H.S. Lucas) Kraft, *Valonia nutrix* (Kraft & A. Millar) Kraft), and one new name (*Chaetomorpha ochlophobians*). A Glossary of 338 words and an insightful section on explanations of Abbreviations and Contractions follow the Appendix. I, especially, like the Index which displays the accepted taxa in roman letters, and the synonyms and doubtful names in italics. The Index also includes the authors of all genera and species mentioned in the text.

I found this book helpful during my floristic study of the septate green algae, e.g., Cladophorales and Siphonocladales, from the central Pacific islands just north of the equator. Aside from the usefulness of this book to Pacific tropical-subtropical phycologists, this volume will be an important reference to coral reef scientists working in the Great Barrier Reef area as well as on Lord Howe Island. Gerald Kraft should be proud of this book and I, personally, look forward to seeing the companion volumes on the browns and reds in book form but at a user-friendlier price.

ROY T. TSUDA

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Natural Sciences
Bishop Museum
1525 Bernice Street
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Unravelling the algae: the past, present and future of algal systematics **eds Brodie, J. and Lewis J. The Systematics Association Special Volume Series 75.CRC Press. Boca Raton Florida ISBN 13-978-0-8493-7989-5. Hdbk. £65.99**

This is a remarkable book, ambitious in concept and wide in scope, reflecting the intellectual ferment aroused in the science of systematics by the avalanche of new genomic information. The book is the result of a symposium held in the Natural History Museum in London in 2006 when phycologists from around the world met to review the state of algal systematics. It is now obvious that much of our classical thinking about what constitutes the phylogeny of an organism greatly underestimated the anatomizing path of development with sometimes multiple gains and losses of cell inclusions before arriving at the organisms we see today. Little can be taken for granted, which is what makes the subject so exciting. Virtually all known algal groups are treated to a greater or lesser extent. Each has a critical assessment, with a clear statement of the challenges faced in trying to make a coherent story out of the almost overwhelming complexities which have come to light in the past twenty years.

After a brief introduction and setting of the scene by Jane Lewis, the book begins with some overview chapters. The first, by Delwiche, is entitled 'Algae in the warp and weave of life: bound by plastids' and plunges in at the deep end treating some of the central questions of the rest of the book: how often and how many plastid acquisitions can be perceived in the known genetic inheritance and how might these have come about? The closing line of the chapter "to draw too bright a line between predation, cultivation, and symbiosis would be to oversimplify the profound complexity of the natural world" encapsulates much of the uncertainty of the status of "host" and "slave/prey/endosymbiont/parasite" and the limitation of language and even of graphics to deal in simple terms with such complex events. The second chapter is by Cavalier-Smith who discusses the position of algae on the tree of life, distinguishing proalgae (cyanobacteria and prochlorophytes) from eualgae and also of course from meta-algae - euglenoids and chlorarachneans - which arose from cells that enslaved chlorophyte green algae. There is much food for thought here and summary diagrams showing the major innovations in the tree of life as well as much more detailed diagrams of the possible history of protein targeting, and the evolution of photosynthetic reaction centres. "Algae are not a taxon" says Cavalier-Smith "but an important ecologically distinctive functional group of organisms". Next is an overview chapter on diatom classification by Williams which although treating only one group of organisms, nevertheless deals with fundamental questions arising from the philosophy of classification. As in many of the succeeding chapters, due reference is made to the work of previous authors. In this chapter particular care is taken to document the milestones posted by such well known historical names as Agardh, Kützing, Smith, Merezhkowsky as well as Round and Simonsen in our own era. Williams tackles such questions as why classify? And what do we mean by the 'right' data to reveal 'true' relationships? His final conclusion is that progress comes "from the elimination of paraphyly...understood by some as synonymous with discovering natural classification". Otherwise, we may be like the reported words of the baseball legend Yogi Berra lost, but making good time.

There then follows an impressive series of twelve chapters dealing in turn with the cyanobacteria, red algae, green algae, charophytes, chlorarachniophytes, haptophytes, cryptomonads, dinoflagellates, diatoms, phaeophytes, Chrysophyceae and Synurophyceae and euglenoids. Each author or group of authors has risen to the challenge and presented a chapter of a high standard worthy of the book's lofty aims. Space does not permit a detailed review of each chapter, which they fully deserve. Progress is obviously uneven in the different groups but each chapter has much to interest and stimulate and it is fitting that the last two chapters are again overviews. Bowler and Andrews review the contribution of genomics to the understanding of algal evolution and finally Medlin *et al.* review the past and look at the prospects for the future of algal molecular systematics. Apart from the detailed work on classification, there is naturally an emphasis on the importance of genome sequencing, which is a remarkable milestone in biological science, providing a rich source of new information that will continue to yield deep insights. Perhaps almost as remarkable is the cultural revolution the sequencing projects have engendered, which is evident in the long list of authors in the new publications. For example, the citation for the paper reporting on sequencing *Thalassiosira pseudonana* headed by Armbrust comprises forty five authors' names, testament to the level of interdisciplinary cooperation required. This is not to neglect the fact that advances will continue to be made by original thinkers working in isolation, if allowed space to do so.

Finally it is perhaps a relief to members of the British and other phycological societies that the term 'algae' has survived intense scrutiny. This is as it should be, because the meeting together of scientists studying very diverse groups of organisms continues to be stimulating and constructive.

Chris Gibson

POSA A. SKELTON and G. ROBIN SOUTH. *The Benthic Marine Algae of the Samoan Archipelago, South Pacific, with Emphasis on the Apia District*. Nova Hedwigia, Beihefte132: iii + 350 pp., 2007. ISBN 978-3-443-51054-1. Price EUR109.

This soft-cover supplemental issue of Nova Hedwigia represents a slightly revised version of P. A. Skelton's Ph.D. dissertation to the University of the South Pacific originally entitled A survey of the benthic marine algae of the Apia District, Samoa, South Pacific and treats123 genera and 205 species of red, brown and green benthic marine algae from this district on the north coast of Upolu in Samoa. The issue also consolidates under one cover many of the taxonomic and nomenclatural findings made in previous studies on Samoan algae, as well as algae from other south Pacific islands, by P. S. Skelton and his advisor G. Robin South. This issue covers 57 percent of the 360 species of red, brown and green benthic marine algae now documented from the entire Samoan Archipelago which encompasses the independent nation of Samoa (formerly British Samoa and later Western Samoa) and the United States unincorporated territory of American Samoa.

An informative Abstract precedes the Introduction where the past phycological history and description, with maps, of the Apia District are discussed. The Materials and Methods section summarizes the field collection and laboratory methods, and describes the eight sites within the Apia District where collections were made. The red algae is organized in accordance with a revised classification of the supraordinal level proposed by Saunders & Hommersand (2004) which is briefly discussed in the section Taxonomic Treatment of the Rhodophyta.

The Catalogue of species comprises 289 of this 350-page issue and provides information on 83 genera and 134 species of red algae, 15 genera and 23 species of brown algae, and 25 genera and 48 species of green algae. Descriptions and reference citations are provided for each order, family and genus. Type reference, locality, depository and other reference citations are included for each species. A workable dichotomous key to the species within each genus aids in the identification of the appropriate species or will indicate quickly that your specimen is another species. Descriptions are complemented by an iconography of 757 black and white digital images. Most photos are clear and show the intended morphological and anatomical characteristics.

The subheading "Representative specimens" is reserved for those specimens collected from the Apia District, while the subheading "Other specimens examined" covers specimens from American Samoa and other geographic sites, e.g., Hawaii and various Pacific island groups, Australia, Canary Islands, South Africa. I did see a few spelling errors in Hawaiian place names, but should assume some responsibility since I served as an outside reader for the dissertation version; otherwise, I encountered few typographical errors in the text. The final two sections cover "Habitat and remarks" and geographic "Distribution" of the species around Pacific and Indian Ocean islands. The taxonomic views of phycologists who have spent long periods observing specimens in the field of a particular island group are extremely informative.

I was pleasantly surprised to see the brown algal genus *Sargassum* represented in the Apia District of Upolu by the same three species, i.e., *S. crassifolium* J. Agardh, *S. cristaefolium* C. Agardh and *S. polycystum* C. Agardh, found on western Pacific reefs of Palau and Yap in Micronesia. The finding of only four species of *Caulerpa* in the Apia District of Upolu was, likewise, surprising when one considers the species diversity of this genus around other south Pacific island groups. The use of the binomial *Halimeda incrassata* (Ellis) Lamouroux for Samoan specimens is the authors' prerogative; however, a remark should be included as to why the name of an Atlantic species based on molecular evidence is retained for a Pacific alga.

The Discussion covers several topics relative to the marine flora in the Apia District, i.e., taxonomic appraisal of the Apia flora, description of mangrove algal flora and two species of seagrasses, invasive species, failure of deliberate introduction of *Kappaphycus alvarezii* (Doty) Doty ex P. Silva and *Eucheuma denticulatum* (Burman) Collins & Hervey for mariculture, species richness of the Apia flora as compared to the rest of the Samoan Archipelago and other Pacific island groups, and affinities of the Samoan flora with its extremely low endemism of 1.3 percent. A section on future taxonomic studies targets the ecological important blue-green algae (cyanophytes or cyanobacteria) and crustose corallines which represent a void in our overall floristic knowledge of benthic marine algae throughout the Pacific islands.

The Reference section contains 888 literature citations, including current nomenclatural and taxonomic treatments of tropical and subtropical algae. The 36 excellent colour images of benthic marine algae in their habitat settings include photos of six red algae, 15 brown algae, 13 green algae and two seagrasses. The alphabetized Index to Genera and Species is in large boldface print and easily read.

The descriptions and figures in this supplemental issue were extremely helpful during my examination of approximately 1,000 slides of benthic marine algae collected from the Manu'a Islands of American Samoa in 2002, 2004 and 2006 by United States National Oceanographic and Atmospheric Administration research vessels. This reference source on Samoan algae will be useful to phycologists and coral reef scientists, not only working in the south Pacific, but to those working in the western and central Pacific, since 95 percent of the benthic marine algae described here will be encountered in these areas. Posa Skelton, a local Samoan, and Robin South are to be commended for their extensive studies on the benthic marine algae in the south Pacific and the publishing of this excellent reference which expands our knowledge of the biodiversity and biogeography of Pacific benthic marine algae. Perhaps, we may see a future supplement which will cover the remaining 155 species now known from the Samoan Archipelago. Libraries will, no doubt, purchase this reference for their shelves; however, the price may deter individuals from purchasing this reference for their personal library.

Reference

Saunders, G.W. & Hommersand, M.H. (2004). Assessing red algal supraordinal diversity and taxonomy in the context of contemporary systematic data. *American Journal of Botany*, **91**: 1494-1507.

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Obituary

Ralph Arnold Lewin (1921-2008)

Phycologists have something in common with the objects of their study: they are a heterogeneous collection of beings. Once in a while one comes across a new example that is particularly difficult to classify. Ralph Lewin, who died on 4 December 2008, was a prime example.

Ralph Lewin was born in London in 1921. In the early 1940s he read Botany at Cambridge and was then drafted by the Ministry of Supply into a team of biologists - V. J. Chapman, G. E. Fogg and R. H. Richens - to survey the coast of Great Britain and to report on the nation's seaweed resources, principally red algae and kelps for production of agar and silk. Richens's diary notes, later edited by Fogg into Strictly Marginal, contained a pen portrait of Ralph still recognisable years later:

> "Ralph sat in front ... and kept a running commentary on the journey from beginning to end. Not only did he point out objects of interest on the way, but he discoursed on the significance of these in the light of a scientific outlook directed to the progress of humanity. His many questions were answered shortly by [Chapman], at length by Dick, and left unanswered by Gordon."

This is how one encountered Ralph. Immediately on opening his door to you, he would have a question that needed an immediate response, perhaps about the pigmentation of a green spider that he held between finger and thumb, or the cause of an actinomorphic flower on an *Antirrhinum* in his garden. If he seemed easily satisfied by one's reply that was because he had a queue of other questions needing answers and a list of scarcely credible facts that he wanted to impart; we should start with a few facts on Ralph.

After the war Ralph Lewin moved to Yale University, Connecticut, where he started his celebrated studies on *Chlamydomonas*. He completed his PhD in 1950 but stayed until 1952 as a Special Lecturer and Instructor in Botany. From there he moved to Halifax, Nova Scotia for three years as a researcher on algae at the NRC Maritime Laboratory and for part of this time also as a special lecturer at Dalhousie University. Between 1956 and 1959 he worked at the Marine Biology Laboratory at Woods Hole, Massachusetts. In 1960 he moved to Scripps Institution of Oceanography in San Diego, California as Associate Professor. He was Professor of Biology there from 1967 until his retirement in 1991 and remained very active as Professor Emeritus.

Lewin's studies on the reproduction of *Chlamydomonas* established his reputation in phycology. In the burgeoning field of genetics there was a need for good experimental organisms: the genetics of *Drosophila* and *Neurospora* was well established but there was no model organism for the genetic dissection of photosynthesis. Provasoli had isolated complementary plus and minus mating types of the unicellular *Chlamydomonas* but its sexual cycle was unreliable. In a series of the briefest notes to Nature, Lewin reported that 100% germination of *Chlamydomonas* zygotes could be obtained by manipulating the light-dark regime provided for the gametes and resulting zygotes. He made beautiful observations on gamete mating, showing that those of different mating types first clasped each other by their paired flagella, became motionless and then only one of the two cells - the *plus* partner - resumed flagella motility. *Minus* partners failed to resume activity even when mated with non-motile but flagellate 'paralysed' mutants of *plus* mating type. Lewin established many mutants by ultraviolet radiation in characters including motility, flagellar production and photosynthesis. He obtained clonal cultures from single zygotes by plating on agar and by analysing the progeny he established that the changes were attributable to single genes, which segregated independently in a regular Mendelian fashion. He demonstrated and measured linkage between genes for different characters and established that *Chlamydomonas* possessed all of the features required for the role of a genetic workhorse.

By solving these reproductive problems in *Chlamydomonas* Lewin provided the biochemical geneticist with a model photosynthetic organism. While others might have exploited these findings exclusively in their own research, Lewin made them freely available to the scientific community. He was not about to shut himself away for years mapping the *Chlamydomonas* chromosomes, when this would be done by others.

Lewin went on to investigate algae from a number of different classes - other green algae, diatoms, browns and cryptophytes. One line that developed from his *Chlamydomonas* studies was the controversial concept of obligate autotrophy in algae. Most species of *Chlamydomonas* were autotrophic but he showed that *C. dysosmos* could grow heterotrophically on acetate. He isolated a mutant that could oxidise acetate but not grow on it in the dark; the alga had become an obligate photoautotroph.

From these studies he developed interests in heterotrophy and in the so-called 'apochlorotic' microorganisms, which at that time were regarded as the colourless cousins of various algae. He became particularly interested in gliding filamentous organisms such as *Saprospira* spp. that showed a close morphological resemblance to cyanobacteria, though they lacked chlorophyll and phycobiliproteins. He discovered two new genera - *Herpetosiphon* and *Flexithrix* - and a number of new species. Lewin was the most cited author in the standard work on this group of organisms, the Cytophagales, (Reichenbach & Dworkin, 1981).

In a number of publications Lewin discussed the possibility that these gliding organisms might be members of the 'blue-green algae' or Cyanophyta. For a long time he rejected Stanier's term 'cyanobacteria': "Just because he's bigger than me doesn't mean to say that I have to do what he says." (Roger Stanier stood a head and shoulders taller than Ralph). Of course, Ralph argued the case more properly in the scientific

literature but it was a vain attempt to hold back the tide of molecular phylogeny. In due course a new orthodoxy was established which revealed that these apochlorotic forms were true bacteria and that they were more closely related to the flavobacteria than to the cyanobacteria. I think that it is possible, however, that Ralph Lewin's heterodoxy played a part in his greatest discovery - *Prochloron*: someone who could accept there were cyanophytes that had lost all of their photosynthetic pigments would have no difficulty in accepting that there might be other cyanophytes that had replaced their phycobiliproteins with an another chlorophyll.

Lewin reported the discovery of *Prochloron* in two papers: in the first, with his wife Lanna Cheng, he described the association of microscopic algae with a didemnid ascidian; in the second paper he described the prokaryotic structure of the algal cells, the presence of chlorophylls a and b and absence of phycobiliproteins. Although uncertain of the correct generic assignment he named the organism *Synechocystis didemni*, and clearly established its possible phylogenetic significance:

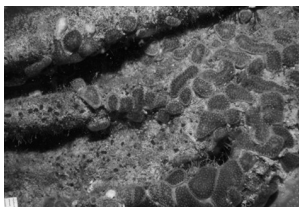
> "The existence of a green cyanophyte with chlorophylls a and b would lend support to the theory (Mereschkowsky, 1905) for the symbiotic origin of green algal chloroplasts."

Lewin formally renamed the organism *Prochloron didemni* in 1977. There was tremendous interest in the organism and Ralph did what he had done with *Chlamydomonas* twenty years earlier: he made it freely available to the scientific community. At the 1976 Photosynthetic Prokaryotes meeting in Dundee he positively promoted the organism and actively enlisted experts in different scientific disciplines to investigate its ribosomal rRNA, G+C ratio, genome size, its biochemistry, pigmentation and photosynthetic activity. The main problem for these investigations was that Prochloron was unculturable and Ralph Lewin and Lana Cheng were therefore obliged to make frequent visits to tropical island paradises to secure enough material for their laboratory-bound collaborators.

Ralph Lewin and Lanna Cheng maintained the research momentum on *Prochloron* over three decades. Its star waned as molecular phylogeny revealed that *Prochloron* belonged firmly in the cyanobacterial clade and that there were other unicellular cyanobacteria more closely related to green chloroplasts. The spirit of *Prochloron* lived on, however, with the discoveries of *Prochlorothrix* and *Prochlorococcus*, both free-living and culturable organisms.

Ralph Lewin continued to delight his scientific audience with other discoveries: a *Spirulina* that became unscrewed; an *Aphanocapsa* that entered the split ends of guard hairs of polar bears, turning them a bluish shade of green. His contributions were by no means restricted to algae: they include wonderful articles in the Massachusetts Review on a childhood summer in Paris and on a winter excursion across the frozen sea at Wood's Hole, an object-lesson in observation. There are letters to editors on the stupidity of renaming the flagella of eukaryotes 'undulipodia' - just because they were not homologous with bacterial flagella - and asking if we must now talk of birds' 'flapopodia' because 'wings' are reserved for insects. And there are tirades against microbiologists who frustrate the aim of the Linnaean binomial - simply to give an identifying name - by turning it into a polysyllabic Latin diagnosis.

Ralph Lewin sampling



Prochloron

I first met Ralph Lewin when he was visiting his old colleague, G. E. Fogg, my research supervisor, at Westfield College in 1970. Ralph was already venerated as the editor of the first multi-author tome on algae. When I demonstrated to him the collapse of isolated gas vesicles, he asked if they could be resurrected under a tension. Knowing that gas vesicles were broken on collapse, it had not occurred to me to try, but I held my breath as Ralph went red in the face sucking on a sample of gas vesicles in a capillary tube. To my relief, none reappeared.

Over the succeeding years, my wife Fausta and I often met up with Ralph and Lanna during their annual trips to their house near Oxford. In short countryside walks I watched as he observed the minutiae of his surroundings. When I mentioned that the yew berries were poisonous he immediately picked and swallowed a dozen - and only then explained that he had eaten the edible pink fleshy arils but not the toxic seeds. Anything unusual could become the subject of a poem, sometimes finished before breakfast the next day. On one occasion, visiting my garden together with Tony Fogg and Arthur Bell, the Director of Kew Gardens, Ralph composed a poem about the Director who had to watch his Peas and Kews. I saw him compose In the Beginning, one of the opening poems in The Biology of Algae, sitting on a garden bench in the hour before the final dinner of the Photosynthetic Prokaryotes meeting in Dundee. Ralph gave me copies of his books of poetry and reprints of his various writings. Browsing through this wonderful collection I feel that I have just spent the day with him.

Anthony E. Walsby. Bristol, 25 February 2009

Ralph Lewin (1921-2008)
Personal Reflections

It was around 7am on a Sunday morning in 1978. I (Jeanine) was a graduate student at the University of Guam Marine Laboratory and just pouring my first cup of coffee when a knock came on the office door. Then a head poked in and said, "Helloooo, my name is Ralph Lewin…may I come in?" …and so was the beginning of a 30-year friendship spanning the globe. He and Lanna Cheng (his wife) had just flown in from Honolulu and were planning to spend a few days on the island before continuing on to Palau for fieldwork. He wanted to know if we could go collecting (immediately) and what were my interests…and did I know anything about tunicates and where could he obtain a glass of juice. It was quite a weekend.

Over the years our paths crossed at least every couple of years - Moorea, Seattle, Leiden, Oxford, La Jolla, Groningen, Thessaloniki and so on….I think he was just about the most well-travelled person I've ever met with a social and professional network bordering on that of Google.

Though he and Lanna had (and still have) homes in La Jolla and Oxford, their lifestyle was simple and their generosity great. There was always food, drink, a warm bed and shower to go with conversational opportunities that might cover anything. The guest books held the names of Nobel laureates as well as several thousand of the rest of us - and this is not an exaggeration.

Ralph was a polyglot and Esperanto guru (translating *Winnie the Pooh* into Esperanto) as well as a task master of English (as the editors of *Nature* learned on an intermittent basis). One of his favourite stories was about a trip he and Lanna made with some colleagues in which the group collectively spoke some 18 languages and yet they ended up linguistically helpless somewhere in Outer Mongolia. He was also a fan of Gilbert and Sullivan, and Medieval music; he played and acted in various groups throughout his lifetime. He was also a poet and published several books on algae (*Poems about Animals and Plants*, *The Biology of Algae* and *Diverse other Verses*). He also wrote a book on coprology. Ralph was also an avid gardener although I did catch him once putting plastic flowers into his camellia bush to plump it up a bit. This was part of his wicked humour.

Ralph once told me that he had truly had an atrocious university education and that it had always been amazing to him that he ended up a professor. It was during and just after the Second World War and conditions at Cambridge were dismal. Most of what he learned was self-taught and when not in the university library browsing through whatever interested him (and that could be virtually anything), he spent vast amounts of time wandering in the country and along the coasts. During this period he was also asked to survey algae for agar and laminarian silk as part of the war effort. This natural curiosity would serve him well when he later discovered those little green balls in didemnids that would turn out to be *Prochloron*. But that came later.

In the early 1950s he spent three years in Nova Scotia, first as an algal biologist with the National Research Council of Canada and subsequently including a dual position with Dalhousie University. He then switched to Wood's Hole on Cape Cod from 1956-1959. In 1960 he accepted an associate professorship at Scripps, where he remained for the next 30 years, retiring in 1991. Besides *Prochloron*, he is considered the father of green algal genetics (and maybe of algal biofuels too), with many publications on *Chlamydomonas* but also on prokaryotic flexibacteria. All in all he published >250 papers and articles and a number of books: Physiology and Biochemistry of Algae, The Genetics of Algae, Origins of Plastids and, with Lanna, *Prochloron*: a Microbial Enigma.

Botanizing with Ralph was an experience. Much of it was done fully clothed to protect against the sun. He looked like a 19th century explorer complete with shorts and pith helmet. He would spend hours in the mangroves and the shallows of the inner reef. His kit included the usual plastic bags and nets but he also carried scissors and other tools tethered to his clothes. These almost inevitably became entangled requiring the rescue skills of Lanna (herself a marine entomologist and keen naturalist). One also had to have considerable stamina…as I learned in a dawn to dusk foray around the island of Moorea in my rental car. We finally stopped for dinner at a small Chinese restaurant where I learned that he didn't like garlic - so he did have at least one major fault after all.

Scientifically, he will probably be most remembered for the discovery of *Prochloron* and his tireless pursuit of its evolution and ecological significance. He collaborated with electron microscopists, physiologists, taxonomists, invertebrate zoologists, chemists…you name it…and as he was proud to say, "the best grant is a postage stamp". Wytze, an unsuspecting molecular biologist working on "blue-greens", met Ralph at the 1976 Symposium on Photosynthetic Prokaryotes in Dundee. A little while later he received his samples of *Prochloron* in the mail with the instructions: for single-copy DNA-DNA hybridization (no DNA sequencing back in those days)…and so began Wytze's long friendship as well.

We last visited with Ralph and Lanna in March 2008 at their home in La Jolla. The diagnosis of oesophageal cancer has been made and the prospects were not good. Even so, he was delighted to have visitors. Though visibly tired, he wanted to know what our lab was up to, what were our new questions and so forth. He did not want to talk about his health and we respected that.

As I think back about how to describe Ralph, there are many facets: idiosyncratic, sometimes a bit weird, original, generous, opinionated, energetic. If it has to be one word though, it's integrity.

Ralph we shall all miss you but your memory will live on. Take care old friend.

More details about Ralph can be found on the Scripps Institute of Oceanography website:
http://scrippsnews.ucsd.edu/releases/?releaseID=943

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