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Algae take the stage in Genomics Special Session at the BPS winter meeting, Plymouth 4-7th January 2006

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2006
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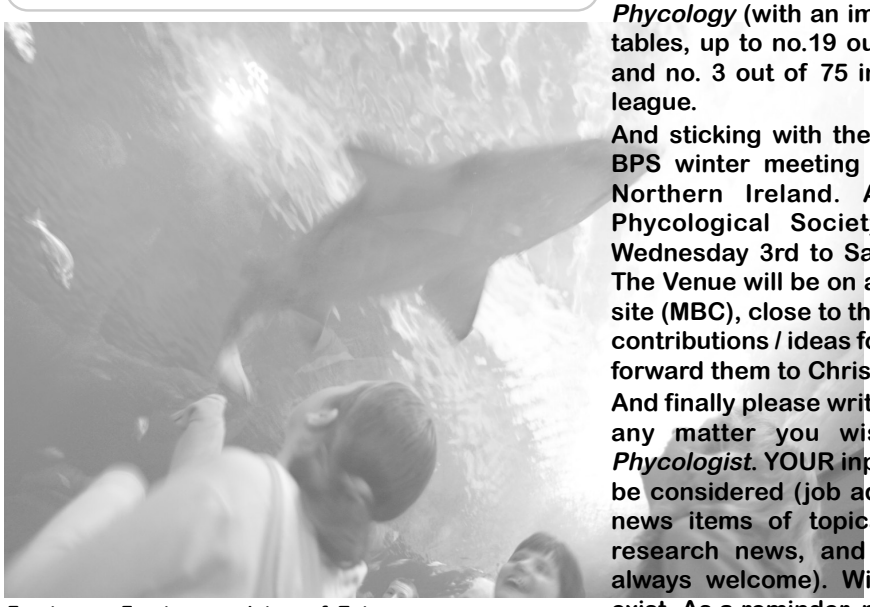


Front page: Front cover picture of *Ectocarpus siliculosus* : Akira Peters.

Photos of coral tank and shark - courtesy of NMA, Plymouth.

Editorial

What's New

Welcome to the first bumper edition of 2006 and a Happy New Year to all our readers!

Firstly, I hope you will all join me in thanking the past Editor, Dr Alison Taylor for all her hard work over the past 3 years of editing the newsletter, and for the generous support of the MBA and its staff. Also continuing thanks to Miss Agnès Marhadour for the layout. The newsletter has been well received by its members, and continues to be a rewarding and challenging experience - so I have been told - and I hope to fulfil this sentiment, and that I can maintain the high standard set by Alison & Co in future editions.

The BPS, like other Societies is concerned about its membership. BPS membership is open to all with an interest in all aspects of algae - academics and amateurs alike - please check out the membership details at http://www.brphycsoc.org/join.lasso, and please ensure your membership is up-to-date. New members are very welcome.

This issue details the past 54th annual winter meeting held in Plymouth, which was extremely well attended by 108 delegates from all corners of the globe. Two reports from our overseas visitors detail the attendees' experiences from the meeting. A number of contributions from the Sessions are also included, in particular on the main genomics special session, together with reports from the Manton and Poster prize winners. Particularly noteworthy were the conference dinner at the National Marine Aquarium, which proved to be an excellent venue for the food and sea-views (especially the baby seahorses), the Quiz Night at the amusingly named Ha! Ha! Bar and the return of 'the Auction'. The money raised from the Quiz and Auction go to support students, and as a reminder, awards and training bursaries details are available from http://www.brphycsoc.org/funding.lasso.

Applying a football analogy, the *European Journal of Phycology* (with an impact factor of 2.506) has risen up the tables, up to no.19 out of 138 in the 'Plant Science' league and no. 3 out of 75 in the 'Marine and Freshwater Biology' league.

And sticking with the football feel, the 'venue' for the next BPS winter meeting is to be Queen's University, Belfast, Northern Ireland. A first notice of the 55th British Phycological Society Winter Meeting, to be held on Wednesday 3rd to Saturday 6th January 2007 is provided. The Venue will be on and around the Medical Biology Centre site (MBC), close to the main University site. If YOU have any contributions / ideas for the symposia and workshops, please forward them to Christine Maggs, c.maggs@qub.ac.uk.

And finally please write to us with your 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.

Algae take the stage in genomics

Report from the Genomics Special Session

Jeanine L. Olsen, University of Groningen

The 2006 Winter Meeting in Plymouth kicked off with a 1.5-day symposium on *Genomics in Phycology* organized by Jeanine Olsen (University of Groningen) and Jim Callow (University of Birmingham); and jointly sponsored by the British Phycological Society, the Marine Biological Association and the FP6 Network of Excellence *Marine-Genomics-Europe*. The morning started with an overview lecture by Jeanine Olsen on genomics in general, some of its main branches, i.e. comparative, functional, and ecological and meta-genomics, and how genomics will integrate many sub-disciplines, thus enabling us to address more complex questions in ecology, physiology and evolution of the algae and the ecosystems which they support.

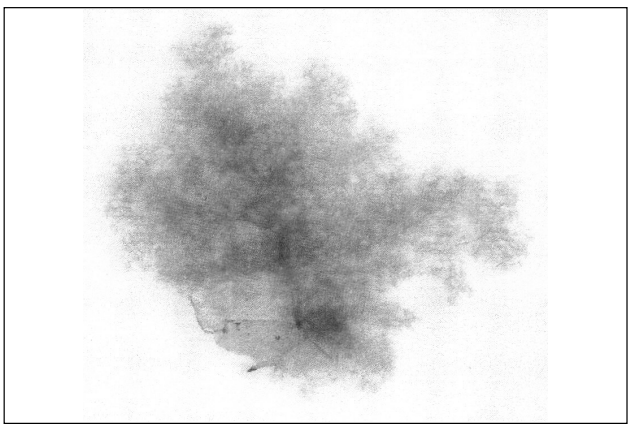
Of 276 eukaryotic genome projects currently underway or recently completed, 11 involve algae (*Thalassiosira pseudonana*, *Phaeodactylum tricornutum*, *Ectocarpus siliculosus*, *Chondrus crispus*, *Porphyra yezoensis*, *Cyanidioschyzon merolae*, *Chlamydomonas reinhardtii*, *Micromonas pupilla*, *Ostreococcus tauri*, *Volvox carteri* and *Emiliania huxleyii*). This may seem like a small number but as we all know, the phyletic breadth and depth of algae, along with their key roles in open ocean and coastal ecosystem function, has brought them to the front of the queue. At last, the criteria for qualifying as a "model system" are being expanded to include phylogenetic and ecological importance.

Ectocarpus siliculosus (~200 Mb) is the first multicellular heterokont being sequenced. Akira Peters (SB-Roscoff) reviewed the biology and "model aspects" of 'Esil', followed by Mark Cock (SB-Roscoff), who provided a detailed view of how genome sequencing projects are actually done. The first draft of *Ectocarpus* is expected by the summer of 2006. For those of us working in other browns—like *Fucus* and *Laminaria*—the opportunities to make heterologous comparisons on everything from the mating system to morphological development, to photosynthesis and speciation and everything in between are of keen interest. Other algal candidates are also being put forth for whole genome sequencing. The big one currently missing is a Florideophyte. Jonas Collén (SB-Roscoff) reported on preparatory studies being conducted for *Chondrus* and *Graciliara*.

For those with a systematics bent, phylogenomics is an exciting development. As full genome sequences accumulate, algal sequences will play an important role in disentangling the many deep and short internodes in the Tree of Life. This includes the comparison of genomic architectures, i.e. gene families, gene order, rearrangements and duplications; as well as the development and use of many concatenated gene sequences to establish better phylogenies at all levels. At the tips of the trees, opportunities to explore species radiations will come from the development of new classes of high throughput markers (like SNPs) with genome wide coverage.

Comparative genomic approaches in cyanobacteria (they have tiny genomes) are revealing the importance and prevalence of horizontal gene transfer. Paul Hayes (University of Bristol) discussed recent results that indicate blurred boundaries among gene pools forcing us to, again, rethink the concept of species. The role of gene transfer in eukaryotes awaits further exploration but will almost certainly prove to be important. Just think about algal viruses. Declan Schroeder (MBA-Plymouth) explained how microarrays are being used to address the prevalence, persistence and the ultimate roles of phaeoviruses in *Ectocarpus*; and Willie Wilson and Mike Allen (both from PML) reported on the role of viruses in bloom dynamics in *Emiliania huxleyi*, which in turn affect DMS production and putative feedback mechanisms involved in climate change.

Genomics, of course, relies on a lot of up-front tool development of one kind or another. Functional genomics is most advanced in the classic models like *Chlamydomonas* for which full genome information is available, but headway is being made in the groups for which genomic sequences are not available. Klaus Valentin (AWI-Bremerhaven) explained how to develop and use EST libraries for stress responses and their use in microarray transcripit profiling in ice-dwelling diatoms. Claire Gachon (Inst. Biotechnologie des Plantes, Paris-Sud) took a bioinformatics *in silico* approach showing how *Aribidopsis* microarray data bases can be mined for gene function in algae. Colin Brownlee (MBA-Plymouth) reported on RNAi (knockout methods) and imaging techniques that are currently under development for studying developmental pathways and physiological processes in, e.g. *Fucus* embryos. John Bothwell (MBA-Plymouth) presented a biolistic method for loading Ca^{2+} dyes (a master regulator cation in case you forgot) into algal cells which was elaborated upon by Ike Levine (University of Southern Maine, USA) in the case of low salinity aquaculture of *Porphyra*. Saul Purton (University College London) discussed new tools for nuclear



***Ectocarpus siliculosus* attached to *Ulva*. Photo by Akira Peters.**

transformation and ways to identify novel regulatory and structural components of the photosynthetic and respiratory pathways in *Chlamydomonas*. One of the most important take-home-lessons from the symposium was the need to develop partnerships around specific questions and "omics" technologies. This was illustrated by the EU *Diatomics* project reported on by Frederic Verret (MBA-Plymouth) in which 12 partners have joined forces to characterize diatom membrane biology. As the programme moved on to various contributed sessions in cell biology, chemical ecology and applied phycology, the hum of genomics remained in the background. These are exciting times to being working on algae.

Ecology and Applied Phycology Session

Frithjof C. Küpper (CCAP, Oban)

The session kicked off with Ricardo Otaíza's (Concepción, Chile) talk on the potential of unattached germlings of *Mazzaella laminarioides* and other Gigartinales, contrasting with spores, gametes, zygotes and vegetative fragments as the well-known types of propagules in other seaweeds. Such germlings would produce filaments and basal disks at a later stage, which might constitute an alternative survival strategy for spores that do not find a suitable substratum in the first place.

This was followed by a very illustrative presentation by Juliet Brodie from the Natural History Museum in London on recent additions to the seaweed flora of western Iceland, based on a recent field work. New records include *Acrothrix gracilis*, *Litosiphon laminariae*, *Ceramium pallidum* and *Sphacelaria rigidula*. As Juliet pointed out, the proportion of brown to red algae is relatively small (1 : 1.2), which appears typical for northern floras, and the total number of seaweed species recorded for Iceland (241) is smaller than those for neighbouring regions such as the Faroes and Shetland (260 and 342, respectively).

Gerald Boalch spoke of the 40 years of marine phytoplankton samples from the western English Channel, initiated by himself and which have since then been conducted by MBA researchers. The records, which are currently being transferred to a computerized database, also reveal the increased abundance e.g. of *Emiliania huxleyi*.

The next presentation by John G. Day (CCAP / SAMS, Oban; in fact, the talk had to be given by a CCAP colleague, Thomas Pröschold) dealt with the outcomes of a recently-completed EU project (COBRA - **CO**nservation of a Vital European Scientific & **B**iotechnological **R**esource: Micro**A**lgae & Cyanobacteria), comparing the efficiency of various cryopreservation methods between different laboratories, in particular with regard to genetic stability using molecular methods such as AFLP.

Finally, Charmaine Blake (Queen's University, Belfast) highlighted an exciting new, high-value application of coralline algae for the production of medical ceramics in bone or osteochondral tissue engineering. Coralline algae proved to provide a superior material than coral, due to their greater mechanical strength. Among the species tested, the European *Corallina officinalis* and the South African *Amphiroa bowerbankii* turned out to be the most promising due to their relatively high growth rates, calcifying structure and mechanical properties.

A Polish Perspective

Elżbieta Wilk-Woźniak, Institute of Nature Conservation, Polish Academy of Science, Poland.

I work at the Department of Freshwater Biology, Institute of Nature Conservation, PAS. I am interested in freshwater algae, phytoplankton in stagnant waters, and particularly in the study of algae in dam reservoirs, lakes and oxbow lakes. The most interesting algae for me are the green algae from the genus *Desmodesmus*. The most exciting thing for me is their phenotypic plasticity, understanding which factors affect their shape, how many species of *Desmodesmus* are really species, and how many morphs we can find in the different water systems. The work is in collaboration with Prof. Elliot Schubert from The Natural History Museum, London, who we have been in collaboration with for 7 years. We have taken a lot of interesting pictures which show the phenotypic plasticity (PP) and have made experiments which show how we can use PP to assess ecological conditions in aquatic ecosystems.

Other subjects which I am interested in are: the long-term investigation of phytoplankton dynamics in dam reservoirs, functional groups of algae, blooms created by cyanobacteria, and the relationships between phyto- and zooplankton.

The 54th annual meting was the first time I attended the British Phycological Society meeting. It was held between the 4th and 7th of January in Plymouth. I was surprised that in Plymouth was such nice weather. When I was leaving Poland, there was more than half a meter of snow, but in Plymouth there wasn't any mark of snow and low temperatures. Next what surprised me was the conference centre – Sherwell Centre which was a converted church. Inside I discovered such beautiful stain-glass windows!

Photo courtesy of Sławomir Ligeza. Touching history and feeling ghosts of the past.

The Meeting was very exciting. The main topic of the Meeting was 'Genomics – something for everybody'. However, there was also time for other algal topics. Even if I am not familiar with marine algae I found a lot of interesting oral and poster presentations. 'Genomics' is not an easy subject. In my country probably only a few people work on it. Genomics papers were given on Thursday and Friday. There was also a poster session on Thursday evening. Two sessions; Ecology and Applied Ecology, and Chemical Ecology were presented on Saturday.

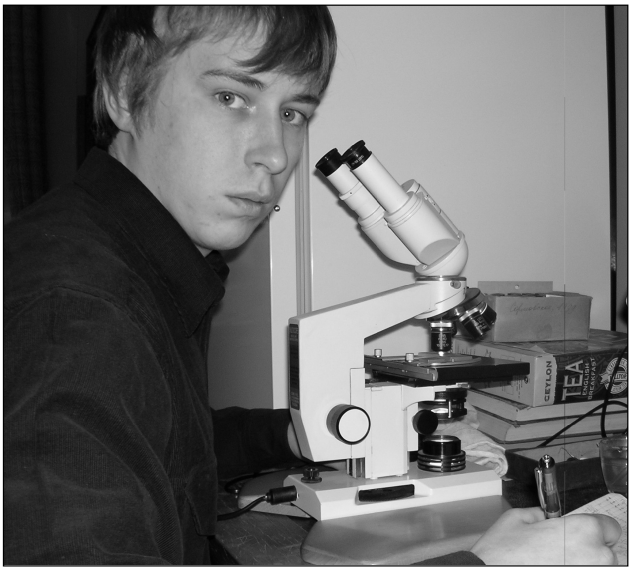
The social life was also very nice. The evening quiz and BPS auction at HA! HA! Bar was so funny. The Auction is a really great idea of how to obtain money to help students. Completely brilliant was the evening dinner at the National Marine Aquarium. It is a place which everybody who likes underwater life should see. The most exciting place for me was the aquaria with sea horses (they are so beautiful!) and the huge tank with different fish (and probably algae!).

Plymouth is a very nice city where you can touch history and feel the ghosts of the past. When you come to Poland during our winter, I recommend you take some Sloe Gin, which is made in the Plymouth distillery, then you will not be afraid of our low temperatures.

I am very happy that I could attend the BPS Meeting and hope that more British scientists will come to Poland to attend the Polish Phycological Society Meetings. Many thanks to the Organisers of the 54th BPS Meeting and to my friends for very nice days, and the possibility to broaden my point of view on algal studies.

Spoil before you spin

A Russian perspective of the Winter meeting



Alexey Khabibullin, Department of Botany, Nizhny Novgorod State University, Nizhny Novgorod, Russia.

I am a postgraduate student at the Botany Department of the Nizhniy Novgorod state university, where the phycology field is widely represented. The main sphere of our activity is the inventory of algae species of our region, the study of the change regularities of the algae communities in small urban reservoirs (rivers, lakes), and the floristic research in the reserve of the region and its reservoirs. In the past few years, in collaboration with other departments, scientific institutions and the government of our city, we have carried out a programme of compiling certificates for the reservoirs of the city and the region.

In 2006 I was lucky to take part in the 54th annual meeting of the British Phycology Society in Plymouth. This was my first visit to England.

In Russia we say: "you must spoil before you spin", and not everything went smoothly during my visit. It all began when I was still in Russia. I had to spend an extra 10 hours at the Moscow airport, as they sold more tickets for my flight than there were seats in the plane, and I had to wait for the next flight to London. As a consequence, I was late for the last bus from Heathrow to Plymouth and spent the night at the London airport. But that was not all. The "Aeroflot" company lost the poster I took with me for the conference, but these minor difficulties did not in the least influence my impressions of the meeting. I am deeply grateful to the people I met in England and whom I often asked for help. Unfortunately I did not have much time to get acquainted with Plymouth, but nevertheless I got only positive emotions from my experience in Plymouth and in England in general. Though I was one day late for the conference and my poster looked a bit untidy when compared to the others, I learnt much new and interesting information during the conference, and I do not at all regret my participation in it.

I express my sincere gratitude to the organisers of the convention and to the whole Society for the possibility to take part in such an event.

Department of Botany, Nizhny Novgorod State University, Nizhny Novgorod, Russia.

Student Representative report

Sara Marsham, University of Hull

My name is Sara Marsham and I am the BPS student representative for the current year. This is my second year in office and I am in the final year of my PhD at the Scarborough Centre for Coastal Studies, University of Hull. I am working on interactions between algal functional groups and intertidal grazers, under the supervision of Dr Graham Scott and Dr Michelle Tobin.

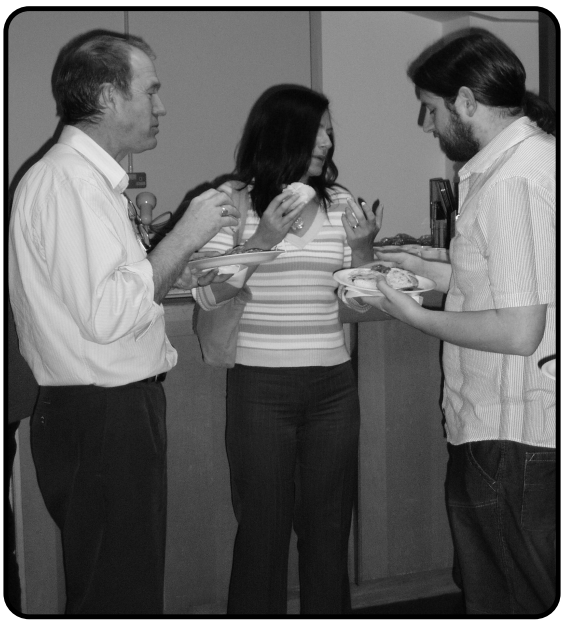
Research conducted over the last few years has indicated that student members would like a more informal session in which to present their work. Although the Manton Prize session is very valuable to student members, and to the society as a whole, in that it provides students with an excellent opportunity to present in front of established researchers in their field, students in the first couple of years of their research, or those wanting more experience, might benefit from a more informal session. I attended the MBA postgraduate workshop held at the University of Newcastle in April last year. Not only was it a very enjoyable few days, I came away feeling very positive after presenting to a postgraduate-only audience. The quality of both the oral and poster presentations was to a high standard, and the informal atmosphere allowed for fruitful discussions between delegates.

Part of my role as student representative involves sitting on the Communication and Education Committee, chaired by Michael Guiry. At this year's winter meeting in Plymouth, the committee agreed to hold an extra student session at the next meeting to be held in Belfast, 3rd - 6th January 2007. We aim to run a 2-hour evening programme comprising of 10 minute talks, followed by a wine reception, during which students will have the opportunity to discuss their work with other student members and new post-docs. We hope to provide student members with a positive presenting experience, along with chance to develop their networking skills. As yet we are undecided as to whether the audience should be student members only, or should include supervisors and other society members. I will be circulating an e-mail to all student members in the coming weeks to gauge opinion.

If members of the society have any students who are not currently members and feel that presenting during this session would be beneficial please encourage your students to apply for membership and to attend this session. Student membership is very reasonable at £5.00 per year (without the journal) and the Society offers financial support for student members to attend the Winter meeting (together with other conferences and field courses).

I would be delighted to receive any ideas, comments or suggestions regarding this proposal so that if you would like it to go ahead we can start with arrangements. If you think it is a good idea and would be interested in presenting do let me know!

Please feel free to contact me about this, or other BPS matters at s.marsham@hull.ac.uk. I look forward to hearing from you.



Participants to the 54th General Meeting in Plymouth.

2006 Manton Prize Winner

Barbara Rinkel, Natural History Museum, London.

I have loved the world's oceans and seas since paddling off a slipway at Westgate-on-Sea in Kent at 8am one morning; I was about 10 years old and the water was freezing. It was some years later when I realised that the marine world should factor into my long-term career. The decision for a career change came when working as a computer services manager in Hong Kong. My passion for our environment, especially the ocean, took hold and I headed back to the UK and university. I graduated from Bath Spa University College with BSc. (Hons.) in Environmental Science in 2003. My undergraduate dissertation work, on estuarine foraminifera and tidal dynamics of the Severn estuary, has become part of a paper to be published later this year.

During my degree I was introduced to a huge variety of water-based disciplines and it was in my final semester, whilst studying marine biology, when marine algae caught my interest. My now supervisor, Dr Juliet Brodie, then one of my lecturers, approached me during the final part of my degree asking if I would consider applying for the proposed PhD project into green algal endophytes starting when she took up her new post at the Natural History Museum in London. The project presented a perfect opportunity to move into working with marine algae and in May 2003 I successfully applied for the studentship, which I started in October. The project is co-supervised by Prof. Paul Hayes, University of Bristol.

The aims of the project are to revise the taxonomy of the green algal endophyte genus *Acrochaete* and other associated species, to examine the UK biodiversity and to produce species-specific primers to aid in identification of endophytes *in situ*. To complete the project I have set up a culture collection numbering approximately 450 samples from around the UK as well as from several sites in Norway and Iceland. Wholly funded and based at the museum, I am currently in my final year of the project. Using the collection, I have now completed much of the necessary molecular work and am busy conducting morphological identification on the remaining samples. These fascinating microscopic greens with their wide variety of hosts have come to intrigue me far beyond the scope of this project.

Once I have completed my PhD I intend to continue with phycological research and, funding permitting, I would like to investigate other aspects of the microscopic green algal flora including host range, environmental influences and shore zonation. I would also like to extend my study to look at the southern hemisphere species. Other areas of interest include culture management, shore ecology and environmental factors and issues affecting coastal waters.

I would like to thank the British Phycological Society for the funding to attend the 2006 meeting (as well as in 2004) and to thank Plymouth for organising such an interesting and inspiring programme of talks.

Participants to the 54th General Meeting in Plymouth.

2006 Poster Prize Winner

Sarah Henkel, University of California, Ecology, Evolution and Marine Biology, Santa Barbara, California, USA.
henkel@lifesci.ucsb.edu

I was born (1978) and raised in Virginia, USA, where I decided in third grade that I wanted to be a marine biologist. Many people wonder how I came to that decision at such an early age since I lived about 5 hours inland. I have to thank my parents for providing many diverse experiences and encouraging all my interests.

I attended the College of William and Mary, where my formal training as a marine biologist began. While there, I assisted at the Virginia Institute of Marine Science with seagrass grazer population dynamics and feeding biology research. I was introduced to the wonderful world of phycology by my undergraduate advisor, Dr Joe Scott, working on electron microscopy projects on the ultrastructure of *Ectocarpus* and red unicellular algae.

I decided after my undergraduate experiences that I wanted to study kelps, so I moved to the west coast to attend California State University, Fullerton. I worked with Dr Steve Murray on a master's thesis studying seasonal patterns in the growth and reproduction of *Egregia menziesii*, including assessments of primary productivity and susceptibility to herbivores. In 2001, I was awarded a NOAA Sea Grant Traineeship studying long-term changes in the abundances of several species in the southern California rocky intertidal, corresponding with increasing urbanization and warmer sea temperatures. This involved monitoring and studies of intertidal productivity and food webs. I also participated in a grant entitled *A Regional Network for Monitoring Changes in Shoreline Populations*, funded by the Minerals Management Service.

I began my PhD work at the University of California, Santa Barbara in 2003 under the direction of Dr Gretchen Hofmann and Dr Allison Whitmer. I was employed by the Partnership for Interdisciplinary Studies of Coastal Oceans as the field coordinator for a project entitled, *Settlement, Growth and Survival of Intertidal Organisms across a Biogeographic Gradient*. In this study I led a team of students and technicians to monitor fecundity and recruitment of several invertebrate and algal species.

These studies set the stage for my doctoral research in which I work with the invasive kelp, *Undaria pinnatifida*, as compared to native kelp species looking at patterns of physiological tolerance throughout their ranges.

I would like to thank the BPS for the funding to attend this conference. I learned a great deal about genomics techniques being used to study algae and hope to incorporate a number of them in my current and future work. I am also greatly appreciative of this award and look forward to interacting with more phycologists from Europe in the future.

2005 summer bursary student award report

Mark Bradburn, Department of Ecology and Evolutionary Biology, University of Colorado, Boulder, Co 80309, USA

This past July (2005) I was fortunate enough to participate in the Advanced Course in Freshwater Algal Identification at the University of Durham, England, with assistance from the British Phycological Society. After a brief fishing holiday in Canada, I departed for Durham, England. Three different means of conveyance and 18 hours later I finally arrived. This was my first voyage to England, but I immediately became acquainted with the local microscopic flora. By arriving a day early, I had the opportunity to accompany the leaders of the course, Prof. Brian Whitton and Dr. David John, on a foray to Hell Kettles, where we collected fresh *Chara* specimens and some choice epiphyte squeezings. I also used the extra day to do a little exploring of Durham before the course began.

Luckily, I had the extra hours to be a tourist; because, once the course started, I was a full time phycologist. However, I had good company. Hailing from all parts of England and South Korea, my fellow participants offered a broad perspectives and specific interests. It is always refreshing to convene with a group of people whom share interest in algae, including our superb instructors and guest lecturers. For the next five days, we devoted long, productive days to collecting, identifying, and studying algae, as is appropriate for an intensive course. Despite often spending extended hours in the field and laboratory, we did manage to find a little time in the evening to arrive at the pub before last orders. During the field excursions, I was able to gain an appreciation for the regional landscape and environment and sample some unique habitats. I especially enjoyed the trip to the mine drainage site near the Pennines, where I was able to stand on the highest point in the country. It almost reminded me of the Rocky Mountains.

The most appreciated benefit of the course, besides the attentive instruction, was the Lucid Identification software. The keys are extremely practical and I continue to use the software in Colorado. The experience has also augmented my research. I have been working on planktonic blue-green algae, and received valuable information from the course. I learned new details about this group and its morphology, especially in the context of nutrients, which will be included in my thesis project. For this and many other reasons, I had a very fruitful experience.

First, I would like to express my gratitude to the British Phycological Society for subsidizing the cost of my tuition for this course and my home department at the University of Colorado for helping with my travel expense. I also would like to thank the instructors of the course: Brian Whitton, David John, Gordon Beakes, and Alan Donaldson.

Abstracts

Oral Presentations

THURSDAY 5TH JANUARY 2006: GENOMICS SYMPOSIUM

INTRODUCTION TO GENOMICS

Jeanine L. Olsen & Wytze T. Stam (**j.l.olsen@rug.nl** and **w.t.stam@rug.nl**)

The University of Groningen, Dept. of Marine Biology, Centre for Ecological & Evolutionary Studies, 9750 AA Haren, The Netherlands.

The unprecedented scope of genomic information—whether as the full genome sequence, expressed sequence tag (EST) databases, expression profiles, genome scans, or single nucleotide polymorphisms (SNPs)—is already allowing ecologists and evolutionary biologists to gain new perspectives on "the genes that matter" and their regulation in such varied *processes* as stress response (e.g., climate change, temperature, host-parasite interactions, virulence and predation) and the interactions of the genotype and phenotype in, e.g., early development, life histories, adaptive population divergence, ecotypic differentiation, and speciation.

At the moment, model species with small genomes have an advantage but imminent changes in sequencing and other high throughput (HT) technologies will remedy this limitation soon. Non-model and near-models species are on the lists with their selection based on phylogenetic or ecological importance. In both of these categories, algae play central roles because of their deep phyletic diversity and their key roles in community structure and/or ecosystem function.

But even without full genome sequences and a very deep purse, genomic tools are opening new or previously intractable areas of research in the way that PCR did 20 years ago. In this talk I will define and characterize key areas of comparative, functional and ecological genomics with examples taken from algal systems. I will also attempt to gaze a bit into the crystal ball of ecological genomics for phycology.

ECTOCARPUS (PHAEOPHYCEAE): CLASSICAL ALGAL MODEL GOES TO THE GENOSCOPE

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This talk will provide an introduction into the biology of *Ectocarpus siliculosus* and explain why it was chosen as a genetic/genomic model alga. The most important reasons why we selected *Ectocarpus* for genome sequencing were the comparatively small genome (214-240 Mbp), the body of knowledge on this species accumulated through previous research, and the ease of handling of all life-history stages in laboratory cultures. We were also attracted by the fact that controlled crosses can be performed in *Ectocarpus* which is required for forward genetics. Moreover, the alternation of independent generations and the development of non-fused gametes into partheno-sporophytes allows genetic analysis of mutants affected in either of the two generations. This latter aspect will be developed in detail using the mutant *immediate upright,* which shows an altered sporophyte development, as an example.

PROGRESS ON THE *ECTOCARPUS* GENOME PROJECT

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In June 2004, an international consortium headed by the Roscoff laboratory submitted a whole genome sequencing project for the model brown alga *Ectocarpus siliculosus* (Peters *et al*., J. Phycol. 2004) to the Genoscope sequencing centre in Paris. This project was accepted and library construction and sequencing was initiated in 2005. The presentation will describe the current status of this project and will detail the future work that will be required to complete and annotate the genome. Progress on complementary approaches, aimed at developing genetic tools for the functional analysis of *Ectocarpus* genes, will also be described. Finally, the presentation will also describe how the genome data is being used to dissect a specific biological problem, the genetic basis of the alternation between sporophyte and gametophyte during the *Ectocarpus* life cycle.

FUNCTIONAL GENOMICS APPROACHES FOR THE BROWN ALGAE

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Certain brown algal species such as *Fucus* provide classical models for the study of early polarization and fate development. While cell biological and biophysical approaches have provided a wealth of information into the physiological and structural changes underlying early development, understanding the underlying molecular mechanisms requires that these approaches are combined with genomics and molecular manipulations.

Our general aim is to provide genomics and molecular toolkits for the study of developmental and physiological processes in *Fucus* and *Ectocarpus*. The emerging *Ectocarpus* genome sequence and growing EST databases for both *Fucus* and *Ectocarpus* will provide a solid framework on which to develop functional protocols. These include introduction of nucleic acids into cells, transient and stable transformation and the

development of RNAi approaches for gene knock down combined with state of the art imaging and biophysical monitoring of cellular processes. Progress with each of these approaches will be presented.

WHAT CAN DNA MICROARRAYS TELL US ABOUT *ECTOCARPUS* AND ITS VIRUSES?

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Historically the taxonomic classification of species within the order Ectocarpales has been problematic. However, the use of molecular techniques has provided an independent set of data to clarify the order Ectocarpales at various taxonomic levels. The order Ectocarpales currently includes 5 families: Ectocarpaceae, Scytosiphonaceae, Chordariaceae, Adenocystaceae and Acinetosporaceae. These families are in turn composed of a number of genera and species, which are frequently infected by viruses with relatively large genomes composed of double-stranded DNA. Eight viruses have been described to date and are assigned to the genus *Phaeovirus* within the family *Phycodnaviridae*. In an attempt to address the fundamental question of prevalence, persistence and the ultimate role of these phaeoviruses in the life cycle of the Ectocarpales, we will evaluate the efficacy of using DNA Microarrays.

EST LIBRARIES – "THE POOR MANS GENOMICS"

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ESTs – "expressed sequence tags" – simply represent randomly sequenced cDNAs. These stem from mRNAs, isolated under (a) particular condition(s) of interest for the researcher, which are subsequently translated into a cDNA and cloned. Because every mRNA represents an active gene, every sequenced cDNA clone is a tag for an expressed sequence = an EST. An EST library is a representation of genes active at the time of mRNA isolation and thus its sequences allow conclusions on the transcriptional activity at this time.

The generation of an EST library is straightforward and modern sequencing technology allows for the rapid determination of thousands of sequences at moderate costs, compared to whole genome projects. A few thousand sequencing runs will result in perhaps half the number of individual partial gene sequences which typically will cover a wide range of metabolic pathways, ofering the researcher a wide choice of genes for further studies. The abundance of clones in the library gives an estimate of the transcriptional activity of the corresponding genes. Therefore a lot of conclusions can be drawn from simply analysing the genes and their abundances in an EST library, which has recently made EST library construction an effective and valuable tool also for phycologists.

In this presentation I will give an overview on the methods of EST library construction and on the conclusions which can be drawn from them. A few examples from our own research will highlight this. I will also discuss some problems inherent in this method, in particular the problem of reliable EST identification. Downstream applications, e.g. the construction of arrays for expression analyses and genome comparisons will also be addressed.

GENOMICS AND TRANSGENICS IN THE 'GREEN YEAST', *CHLAMYDOMONAS*

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The green unicellular alga *Chlamydomonas reinhardtii* is the most advanced of all model systems currently available for algal research. Traditional genetic, biochemical and physiological studies can be combined with modern molecular-genetic and genomic tools to investigate a wide range of eukaryotic cellular processes. Recently, the complete sequencing of the nuclear genome has been achieved by a US consortium (see: www.chlamy.org/), together with the generation of an Expressed Sequence Tag (EST) database of over 200,000 sequences. These data are allowing the molecular characterisation and annotation of the >10,000 genes of *Chlamydomonas*. In addition, routine transformation methods are now available for the nuclear, chloroplast and mitochondrial genomes, and a wide array of selectable molecular tools for genetic manipulation and transgene expression has been developed by the *Chlamydomonas* research community.

In our group, we are continuing to develop new tools for nuclear transformation, including new dominant markers and RNA interference techniques. We are employing these tools, in combination with biophysical analyses, to identify novel regulatory and structural components of the photosynthetic and respiratory electron transfer complexes. The talk will therefore provide an overview of the genomic and molecular-genetic resources available to the *Chlamydomonas* researcher, and illustrate how they can be used to understand bioenergetic processes in this 'photosynthetic yeast'.

BOUNDARIES OF SHARED GENE POOLS IN CYANOBACTERIA – A GENOMICS APPROACH

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An extremely reductionist view of success in life is that the biological fitness of an individual is determined by the interplay between patterns of gene expression and the environment (biotic and abiotic). Gene complement is an important component of this interplay, because no degree of sophistication at the level of regulation of gene expression can compensate for the absence of genes encoding a particular structural or metabolic function. The genetic repertoire available to organisms ultimately depends on the size of the gene pool to which they have access. In sexual organisms the barriers that define the boundaries of potentially interbreeding populations determine the size of this gene pool: the potential to interbreed is central to the biological species concept. In prokaryotic organisms, including cyanobacteria, where there is no sexual reproduction, there is a problem in defining the boundaries of shared gene pools. Analysis of whole genome sequences shows that genes have been transferred between very distant lineages (including trans-domain transfers), but these events are probably infrequent and relevant to survival only on evolutionary timescales. To identify shared gene pools at shorter timescales we need to take a population genetic approach. In the past, genetic fingerprinting techniques have been used to characterise population structures, but the results of such studies can be difficult to interpret. Whole genome sequences have a role in the development of more robust tools for the analysis of population structures, and may provide information about the mechanisms by which genes move between individuals.

BERRY-STONE VIRUSES: 30 YEARS OF CLIMATE CONTROL AND FACE CREAM

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The virus genus *Coccolithovirus* (*Cocco:* derived from Greek *kokkis,* meaning "berry" or "grain" referring to their shape and *Lith:* from Greek *Lithos*, meaning "stone") is a group of large, double stranded DNA viruses that infect the globally important marine coccolithophorid *Emiliania huxleyi*. The first observation of virus-like particles in *E. huxleyi* was reported back in 1974 though they are now known to be one of the causative agents of *E. huxleyi* bloom demise. We have developed diagnostic molecular tools to analyse the dynamics of coccolithoviruses and their hosts during natural blooms. Virus infection of *E. huxleyi* increases production of the biogenic gas dimethyl sulphide (DMS), which has implications for climate feedback mechanisms. We have recently sequenced the 407,339 bp genome of one coccolithovirus and revealed that only 14% of the predicted genes confer any significant database homology. The genome encodes a range of unexpected genes never previously observed in a virus. Most notably are those involved in biosynthesis of ceramide, a sphingolipid better known for it's role in face cream. Microarray analysis of potential genes on the virus genome will greatly enhance our understanding of the propagation of this unusual virus and why algal viruses have such large genomes.

FUNCTIONAL CHARACTERISATION OF DIATOM MEMBRANE TRANSPORTERS

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Diatoms are marine phytoplankton providing close to one quarter of global fixed carbon and one fifth of the oxygen we breathe. However, little is know about their basic biology and how it is affected by environmental change. The genome of the centric diatom *Thalassiosira pseudonana* (33 Mb) has been recently sequenced by the US Department of Energy and its annotated version is now publicly available (http://genome.jgi-psf.org/thaps1/thaps1.home.html). Moreover, the genome of the pennate diatom *Phaeodactylum tricornutum*, for which reverse genetic techniques becomes efficient, is now being sequenced. From this base, the European project Diatomics was established with 12 partners pooling their expertise in order to better understand diatom membrane biology using functional genomics. As a member of this consortium, our aim to determine the native transport properties of marine diatoms and functionally characterise key ion transport mechanisms at the molecular level. Using electrophysiology we have examined the biophysical properties of the *Odontella sinensis* plasma membrane which revealed that this marine diatom has the capacity to generate fast (ms) Na^+/Ca^{2+} based action potentials that are almost identical to those described for animal cardiac and skeletal muscle cells. The presence of such rapid membrane excitability has important implications not only for understanding the biology of the diatom but also for evolution of ion channels involved in signalling. We have identified a number of voltage activated channels including a Na^+ channel homologue in the *T. pseudonana* genome and verified the presence of putative Na^+ channel homologues in *P. tricornutum* and *Coccolithus pelagicus* genomes using Southern hybridisation. We are now cloning these transporters using a cDNA library approach in order to achieve full functional characterisation.

TRANSCRIPTIONAL PROFILING THE COCCOLITHOVIRUS INFECTION OF *EMILIANIA HUXLEYI*

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Microarrays have been used to study the transcriptional profile during the infection *of Emiliania huxleyi* by the coccolithovirus EhV-86. Due to the low database homology exhibited by the majority of EhV-86 CDSs, microarrays have been used to aid in the annotation of the EhV-86 genome using a direct labelling method.

Furthermore, transcriptional profiles generated using an amplification strategy during the first four hours of infection have allowed the assignment of EhV-86 genes into three broad groups: primary, secondary and tertiary genes. Primary genes are expressed within one hour of infection, are all localised to one region of the genome, are of unknown function and appear to have a unique promoter element associated with them. The use of an amplification strategy to generate labelled cRNA has also allowed the detection of transcripts for CDSs that were not previously annotated in the EhV-86 genome and were not detected using the direct labelling approach.

SPATIAL PATTERNS OF *PROCHLOROCOCCUS* DIVERSITY IN THE ATLANTIC OCEAN

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Prochlorococcus is the most abundant photosynthetic microorganism on earth. This project aims to study the micro-diversity of *Prochlorococcus* in the Atlantic Ocean. Samples were collected during an Atlantic Meridional Transect (AMT) cruise, at various latitudes. Depth profiles for each site were obtained by sampling at points corresponding to the depths to which 55%, 33%, 14% and 1% of surface irradiance could penetrate. The RNA polymerase core subunit gene *rpoC1* was chosen as a molecular marker because it provides greater genetic resolution than the universal bacterial marker 16S rRNA. Species specific PCR primers were developed that amplified a fragment of *Prochlorococcus*' *rpoC1* gene. Restriction Fragment Length Polymorphism (RFLP) analysis of the PCR products from a collection of cultured isolates proved this approach enables differentiation between most strains, and all *Prochlorococcus* phylogenetic clades; it also allows screening of large sample sets at high genetic resolution. This method was subsequently used to analyse the genetic diversity of *Prochlorococcus* populations in AMT samples. Clone libraries of the PCR products were produced through insertion of individual products into E.coli, via cloning vectors, where the *rpoC1* gene fragments were replicated. RFLP analysis of 100 clones from each clone library showed that the *Prochlorococcus* populations from the Northern and Southern Atlantic Gyres were dominated by genetically different clones. This was substantiated by phylogenetic analysis of the nucleotide sequences of each *rpoC1* RFLP type. Statistical analysis of environmental variables indicates there are spatial variations in the genetic composition of *Prochlorococcus*, between environmentally different regions in the Atlantic.

FRIDAY 6TH JANUARY: GENOMICS-CONTRIBUTED PAPERS

A RED MACROALGA- THE NEXT GENOMIC CHALLENGE

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The red seaweeds is the last unsequenced major group of multicellular organism. They are ecologically important in the coastal environment, of economic importance as a source of polysaccharides and of major evolutionary interest. However,

the selection of a species for sequencing is not trivial. The purpose of this presentation is to present criteria for selecting a suitable red alga and to get feedback from you on which species to chose. Criteria to consider are scientific (e.g. taxonomic position, ecological importance, and physiological relevance), based on feasibility (e.g. genome size, possibility of nucleic acid extraction, cultivation, and availability of literature data) and economic (e.g. economically important species or close relative). Since a primitive unicellular red alga, *Cyanidioschyzon merolae,* is already sequenced we suggest the selection of a florideophyte with an economically important cell wall. Another important part of this project is the construction of a consortium to support the application process and to be annotators and end-users of the sequence.

PREDICTING THE FUNCTION OF UNKNOWN GENES USING MICROARRAY DATA : A SUCCESS STORY FROM THE HIGHER PLANT *ARABIDOPSIS*

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In the plant community, the increased availability of microarray data over the last few years has raised many doubts on their usefulness because of technical difficulties generating biased results; and of the difficulty to extract relevant information from the wealth of data generated. Whilst the first point is progressively solved as microarray analysis is becoming routine in many laboratories, it is expectable that the second limitation will be even more acute in phycology, due to the relative scarcity of other physiological and molecular data. Clearly, methods to precisely pinpoint good candidates for a defined function will be the cornerstone for the successful exploitation of oncoming genomic data. In this talk, I will present a technique that was developed on *Arabidopsis* to predict the enzymatic activity of uncharacterized genes based on their transcriptional co-regulation with known enzymes of secondary metabolism pathways.

First, a detailed annotation of known genes encoding enzymes and transcription factors involved in relevant metabolic pathways (phenylpropanoids, indoles, flavonoids) was conducted. Then, we used publicly available sets of microarray data to demonstrate a wide-scale and robust co-expression of enzymes involved in a same pathway. Conversely, we assessed if the co-regulation of unknown genes with a particular pathway could be used to infer its involvement in it. Using this method, we predicted specifically the enzymatic activity of three glycosyltransferases, which belong to a multigenic family of 120 members. Since then, these findings have been experimentally confirmed for two of them, demonstrating the predictive value of our approach. This technique could be applied to algal models and contribute to the exploitation of microarray data in a functional perspective.

A BIOLISTIC METHOD FOR LOADING Ca^{2+} DYES INTO ALGAL CELLS

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In eukaryotes, changes in cytosolic Ca^{2+} concentrations ($[Ca^{2+}]_{cyt}$) are associated with a number of environmental and developmental stimuli. However, measuring $[Ca^{2+}]_{cyt}$ changes in single algal cells is often problematic. Although a wide range of Ca^{2+}-sensitive fluorescent dyes are available, they are often difficult to introduce into algal cells. Microinjection is the most robust method for dye loading, but is time-consuming, technically demanding, and unsuitable in many cell types. To overcome these problems, we have adapted biolistic techniques to load Ca^{2+}-sensitive dyes into cells of the green alga *Chlamydomonas reinhardtii*, and zygotes of the brown alga, *Fucus serratus*. Using this approach, we have been able to monitor $[Ca^{2+}]_{cyt}$ changes in response to various stimuli, including a novel $[Ca^{2+}]_{cyt}$ response in *C. reinhardtii*. Biolistic loading of differentiated algal cells is easier, quicker, and more widely applicable than microinjection, and should broaden the study of algal signal transduction.

PORPHYRA OSMOREGULATION AND THE ISOLATION OF A CA^{2+} SENSING RECEPTOR

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Establishment of land-based, seaweed:finfish hatchery intergraded polyculture systems are predicated on developing a commercial algal cultivar. The recent governmental restrictions on hatchery effluent discharges have resulted in expensive mechanical filtration installations. Potential alternative technologies include effluent sludge composting, worm:finfish polyculture, and algal:hatchery integrated bioremediation.

Modifying marine algae, e.g. *Porphyra* spp. to bioremediate effluents from a freshwater fish hatchery is the focus of a two-year USDA sponsored research effort because a commercial, cold freshwater alternative does not exist. The development of a zero salinity tolerant cultivar is the focus of both cultural and molecular investigations.

Extracellular calcium ions (Ca^{2+}) have been demonstrated to exert key regulatory effects on algae when exposed to low salinities. Previous reports suggest that: 1) calcium is a key element in determining algal survival at low salinities and 2) that genetic isolates of various seaweeds may possess alterations in distinct genes including Calcium Sensing Receptors (CaS) that provide them with the ability to maintain internal calcium ion concentration in response to shifting salinities. CaS have been shown to be the “master controller” of divalent calcium homeostasis in animals, flowering plants and green algae.

Preliminary results include the isolation and sequencing of 1/3 of the putative *Porphyra* CAS. Database searches indicate homologues in *Oryza sativa*, *Arabidopsis thaliana*, and *Chlamydomonas reinhardtii*. Future efforts include the complete isolation and sequencing of the CaS gene, determination of Ca^{2+} binding capacity, and subcellular localization.

FRIDAY 6TH JANUARY - SESSION A

GENOMICS-MOLECULAR PHYLOGENY

TAXONOMY OF MONADOID AND COCCOID GREEN ALGAE: CONFLICT OF CLASSIC AND MODERN APPROACHES

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Traditionally monadoid and coccoid green algae were classified in the orders Volvocales resp. Chlorococcales according to the morphological species concept. For example, in the genus *Chlamydomonas* (including *Chloromonas*), one of

the largest green algal genera, more than 800 species are described by using only morphological characters of vegetative cells. However, phylogenetic analyses of nuclear-encoded SSU and ITS rDNA sequences of more than 100 strains of both genera have shown that *Chlamydomonas* and *Chloromonas* consists to eight independent monophyletic lineages partly together with coccoid green algae (e. g. *Chlorococcum*, *Tetracystis*) with the CW (basal bodies displaced clockwise) subgroup of the Chlorophyceae. Using polyphasic approaches (e. g. secondary structures of SSU and ITS rDNA sequences, results of crossing experiments, sporangium autolysin data and studies of life cycles), a new generic and species concept within the CW-subgroup (traditionally designated as "Volvocales" and "Chlorococcales" s. str.) can be designed demonstrated here by "*Chlamydomonas* and its relatives".

NEW VIEWS ON THE PHYLOGENY OF THE SIPHONOCLADALES (CHLOROPHYTA) INFERRED FROM nrDNA GENE SEQUENCES

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The Siphonocladales, which includes about 17 genera, comprise a marine order of siphonocladous Chlorophyta with a tropical to warm-temperate distribution. Previous molecular phylogenetic studies have demonstrated that the siphonocladalean taxa form a monophyletic lineage, well separated from the paraphyletic Cladophorales. We examined the relationships within the Siphonocladales based on more than 100 newly derived partial LSU and 40 previously published complete SSU nrDNA gene sequences. An important aspect of rDNA genes is that the functional RNAs transcribed from these genes have a complex secondary structure consisting of base paired stem and unpaired loop regions. Because phylogenetic methods are known to perform better when the model of evolution is appropriate, we hoped to improve the reliability of the siphonocladalean tree by accounting for this secondary structure in the models of evolution. The partial LSU sequences, comprising about 600 bp, were found to be more informative than the complete SSU, consisting of 1700 bp. The present phylogenies reveal 6 well supported clades, echoing previous results based on SSU and LSU. The early divergences of the siphonocladalean lineages however remain largely unresolved. The present study further discloses non-monophyly of a number of well established tropical genera like *Anadyomene*, *Microdictyon*, *Chamaedoris* and *Valonia*. The enigmatic genus *Apjohnia*, whose systematic position has long been questioned, is found to be allied to the genera *Chamaedoris*, *Phyllodictyon* and *Struvea*. The traditional classification of the Siphonocladales, mainly based on thallus architecture and mode of cell division, differs considerably from the molecular phylogeny and is therefore in need of revision.

MOLECULAR PHYLOGENETICS OF THAMNOCLONIUM (HALYMENIALES, RHODOPHYTA), A REMARKABLE ALGAL-SPONGE CHIMERA

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Numerous algae form symbiotic or mutualistic associations with various animals. The best-known example is possibly represented by the various *Symbiodinium* species associated with coral polyps. In terrestrial environments the close association between fungi and a number of unicellular algae or cyanobacteria, better known as lichens, stands out. Next to these well-studied examples numerous other associations of algae with various metazoans have been reported, but most remain poorly understood. The types of relationships are highly diverse ranging from unspecific partnerships of microscopic pro- and eukaryotic photosynthetic algae infesting sponge tissue to densely integrated life forms of red or green macroalgae with specific sponge taxa. Next to the above cases, associations with macroalgae whereby a sponge covers the entire or part of the thallus surface have been reported for isolated species of several, distantly related genera of Rhodophyta, e.g. *Epiglossum*, *Osmundaria* and *Ptilophora*. An interesting case is represented by two genera of the red algal order Halymeniales, *Thamnoclonium* and *Codiophyllum*. Those two genera are unique in that all of their representatives are associated with a sponge partner and because the thallus morphology is heavily modified to accommodate sponge tissue. In our study the evolutionary relationships of the algal partner are studied in a molecular systematic context based on *rbc*L, partial LSU and 16S cpDNA sequences. Also the sponges were characterized by COI sequences and a comparison between the algal relationships and the sponge diversity is presented.

NEW ALGAL GROUP COMES TO LIGHT

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We report a novel class of picoplanktonic algae presently recognised from sequence data with additional observations from Fluorescent In Situ Hybridisation (FISH) on its morphology and pigmentation. This new algal group is sister to the lineage composed of Cryptophytes (nuclear host genome) and the Glaucocystophytes, which are an obscure and rare group in freshwater systems that is the third member of the consortium of the three primary endosymbiotic algae. The sister relationship between cryptophyte hosts and glaucocystophytes has been reported previously. These three groups form a well-supported lineage of phycobilin-pigmented algae separate from the red algae and cryptophyte nucleomorphs. From its basal position in its clade, it is likely that it is another marine primary endosymbiosis. The new lineage probably represents a marine counterpart of this ancient endosymbiosis, and from our observations from clone library distributions, it appears more common and successful than the Glaucocystophytes and contributes significantly to picoplankton diversity from coastal waters with predominance in cold temperate waters. We present evidence that in flow cytometric analysis of marine waters, the fluorescent signal of these novel algae has undoubtedly been recorded erroneously under the cryptophyte signal.

DNA-BARCODING – A NEW TOOL IN THE BOX FOR IDENTIFICATION OF RED ALGAE

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DNA barcoding involves sequencing a short, diagnostic segment to discriminate between species and has been advocated as a way to speed up the rate at which species on earth are identified and described in a world where life is disappearing at an unprecedented rate. It is a controversial approach with some fearing that it will replace traditional taxonomic practices. However, counter to that, there is evidence that it is a valuable tool in the identification of species. Following the proposal to use the mitochondrial cytochrome *c* oxidase, CO1 for DNA barcoding of animals, we assessed this gene region for use in the identification of red algae using species from four orders of red algae: the Bangiales, Gigartinales, Corallinales and Gracilariales. We found that it was generally possible to discriminate between species. Intra-specific variation was low at 0-4 bp over 541 bp analysed, except for *Mastocarpus stellatus* with 3-12 bp difference and may represent a species complex. Inter-specific variation was between 37 and 143 bp. A comparison of CO1 with the plastid Rubisco spacer for species in the Bangiales revealed that it was a more sensitive identification marker, with the capacity to pick up incipient speciation and cryptic diversity plus the potential for use in phylogenetic analysis. The results have revealed exciting areas for additional research and suggest that CO1 has the potential to be used for DNA barcoding of red algae.

CELL BIOLOGY

INORGANIC CARBON FIXATION PATHWAY IN *EMILIANIA HUXLEYI*

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Reinfelder and colleagues have interpreted work on the marine planktonic diatom *Thalassiosira weissflogii* as indicating the occurrence of C_4 photosynthetic metabolism, at least when grown under inorganic carbon and/or zinc limitation. Earlier observations by Bowes and colleagues had indicated C_4 photosynthesis in the acellular marine green macroalga *Udotea flabellum*. These results reopen the more general question of the biochemical pathway of inorganic carbon assimilation in photosynthesis by other algae. The outcome of C_4 biochemistry in supplying CO_2 to Rubisco at higher steady-state concentrations than could be provided by diffusion from the medium (i.e. a carbon concentrating mechanism or CCM) is the same as that achieved by CCMs based on active transport of HCO_3^-, CO_2 and/or H^+. One feature of a C_4 pathway based on HCO_3^- entry followed by phosphoenolpyruvate carboxylase activity in the cytosol, and then decarboxylation by phosphoenolpyruvate carboxykinase in the stroma, is that it comprises a CCM which does not need carbonic anhydrase. This could have selective significance in zinc- or cobalt- limited parts of the ocean, and could permit photosynthesis and calcification independent of the need for carbonic anhydrase in coccolithophores. We know of no data on the initial photosynthetic inorganic carbon fixation product in the Haptophyta, and hence of whether these very important members of the marine phytoplankton are, biochemically, C_3 or C_4. Short-term ^{14}C inorganic carbon fixation products in coccolithophorid *Emiliania huxleyi* are being investigated, and their implications for CCMs, photosynthesis and coccolithogenesis will be discussed.

CHEMOATTRACTION TO BACTERIAL QUORUM SENSING SIGNALS MODULATES THE SETTLEMENT OF ZOOSPORES OF THE MARINE ALGA, *ULVA INTESTINALIS*

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Quorum sensing is used by bacteria to regulate gene expression in a cell density-dependant manner. Zoospores of the marine alga, *Ulva intestinalis*, exploit the acyl-homoserine lactone (AHL) quorum sensing system to identify bacterial biofilms for preferential settlement. We have found that chemoattraction to AHLs does not involve a chemotactic orientation towards the AHL source. Instead, chemoattraction occurs via a chemokinetic effect, in which zoospore swimming speed is rapidly decreased in the presence of AHLs. *N*-(3-oxododecanoyl)-homoserine lactone (3O-C12-HSL) was the most effective signal molecule suggesting there is specificity in the chemoresponse. In addition, we found mean zoospore swimming speed decreased more rapidly over wild type biofilms of the marine bacteria, *Vibrio anguillarum,* relative to biofilms of the *vanM* mutant, in which AHL synthesis is disrupted. We are now investigating the chemoresponse at the cellular level and we will present data suggesting a role for calcium signalling in mediating the chemokinesis.

THE WOUND REPAIR MECHANISM IN THE GIANT UNICELLULAR CHLOROPHYTE *DASYCLADUS VERMICULARIS* IS A TWO-STAGE PROCESS

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Upon injury, coenocytic algae like *Dasycladus vermicularis* are capable of forming temporary wound plugs to prevent detrimental cytoplasmic loss. The operative strategy in *Dasycladus* to prevent ‘‘cytoplasmic hemorrhage’’ is a two-stage process. Early events after cellular injury in D. vermicularis include retraction of the cytoplasm and the assembly of a soft, adhesive, gel-like plug, which is then subsequently hardened to add mechanical resistance.

Typically, formation of the initial plug in *Dasycladus* occurs within 1 min of injury, requiring the availability of sequestered carbohydrate and lectin precursor components throughout the thallus for plug assembly. Once the initial assembly has commenced, additional biochemical interactions are initiated (as a function of time) to promote structural integrity. In a second major step, the activation of an oxidative burst (producing millimolar H_2O_2 levels) plays a key role. Our results show peroxidase activity in the wound plug, real-time *in situ* measurements of an oxidative burst, as well as coumarin localization in wound plugs. This study provides strong evidence that the biochemical machinery exists to drive the oxidative crosslinking of coumarin molecules during the wound healing process of *Dasycladus vermicularis*.

TO WHAT EXTENT IS CELL WALL SYMMETRY (OR ASYMMETRY) IN PENNATE DIATOMS UNDER CYTOPLASMIC CONTROL?

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Valve symmetry or asymmetry has long been a significant

taxonomic distinction, and a basis for delimiting many genera within the pennate diatoms. Thus, heteropolarity remains a key character for allocation to genera such as *Gomphonema*, *Gomphoneis*, *Didymosphenia*, *Licmophora* and *Meridion*, and dorsiventrality to *Cymbella*, *Encyonema*, *Amphora*, *Seminavis*, *Eunotia* and *Hannaea*. However, in a few cases, bilaterally symmetrical and dorsiventral taxa are now included within a single genus, e.g. *Climaconeis*, *Biremis*, genera that have either been relatively recently described (using LM and SEM), or revised.

Because of the mode of raphe formation, raphid diatom valves are inherently asymmetrical although their outlines may appear symmetrical. Mann showed that, as a result, cells exhibit mirror or diagonal symmetry with respect to the primary sides of their component valves. Diagonally symmetrical cells are invariably bilaterally symmetrical, only those with mirror symmetry can (but not invariably) become dorsiventral. He related this to the oscillation or non-oscillation of the nucleus with subsequent mitoses.

How cells become heteropolar is unknown, but evidence suggests that heteropolarity is established by an intrinsic mechanism after auxosporulation. This contrasts with the development of heteropolarity in other unicells, where an extrinsic trigger is often responsible. Initial cells of heteropolar diatoms are often more or less isopolar, and apical pore fields are not found in the first initial valve.

This paper will review the evidence that cytoplasmic activity determines valve and wall asymmetry and the establishment of heteropolarity.

FLOW CYTOMETRIC ASSESSMENT OF TWO GREEN ALGAE (*CHLORELLA VULGARIS* AND *CHLAMYDOMONAS REINHARDTII*) FOLLOWING PROLONGED EXPOSURE TO DARKNESS UNDER CONDITIONS OF LOW AND AMBIENT DISSOLVED OXYGEN

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Cellular viability of two unicellular freshwater green algae (*Chlorella vulgaris* and *Chlamydomonas reinhardtii*) was assessed following 65-day exposure to darkness under conditions of low and ambient dissolved oxygen. Various techniques for assessing cellular fitness during the two-month incubation were periodically performed. Analytical flow cytometry was recruited in order to monitor cellular density, metabolic activity and membrane integrity over the experimental duration. In addition, cellular chlorophyll *a* and *in vivo* chlorophyll fluorescence were analysed to further clarify the effect of darkness on cellular viability.

CALCIUM SIGNALLING DURING THE CELL CYCLE IN *FUCUS* EMBRYOS

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One-cell zygotes of the brown alga, *Fucus serratus*, polarize in response to incident light. Optimal zygotic growth requires polarization to be co-ordinated with the first cell division. It is unclear how the polarization apparatus communicates with the cell cycle machinery and we are investigating this interdependence. In particular the roles of cytosolic Ca^{2+} signals ($[Ca^{2+}]_{cyt}$) and cytoskeletal organization are being studied using a variety of single cell approaches, including confocal and 2-photon microscopy, manipulation of $[Ca^{2+}]_{cyt}$ signalling and the development of single cell markers for specific stages of cell cycle progression.

FRIDAY 6TH JANUARY – SESSION B

MANTON PRIZE

THE CELL BIOLOGY OF *ULVA* ZOOSPORE SETTLEMENT

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The recruitment processes of many marine algae involve the settlement of motile zoospores onto a substratum via the secretion of vesicles containing adhesive. Our aim is to determine the cellular mechanisms underlying the mass exocytosis that occurs at settlement in *Ulva* (syn. *Enteromorpha*) zoospores. The plasma membrane labelling fluorescent dye FM 1-43 and fluorescent Ca^{2+} indicators were used to follow membrane recycling and cytosolic Ca^{2+} ($[Ca^{2+}]_{cyt}$) at settlement. When swimming zoospores were continuously exposed to FM 1-43 only the plasma membrane appeared to be labelled. At settlement FM 1-43 was rapidly internalised (within one minute) reflecting high membrane turnover. The internalised membrane was focused into a spot indicating that targeting of membrane to an endosomal-like compartment may occur at settlement. Pulse-labelling of FM 1-43 led to perinuclear accumulation of dye implying a constitutive membrane recycling pathway where it is proposed that plasma membrane is recycled to Golgi and/or endoplasmic reticulum surrounding the nucleus. Various AM-ester Ca^{2+} indicators were evaluated and sequestration of the dye into cellular compartments was a common problem. Oregon Green BAPTA-5N was used to follow settlement as it showed minimal compartmentalisation and responded to inducers of $[Ca^{2+}]_{cyt}$. Zoospores exploring surfaces had higher $[Ca^{2+}]_{cyt}$ than settled zoospores and settling zoospores were seen to undergo transient elevations of $[Ca^{2+}]_{cyt}$. Indirect evidence for the involvement of Ca^{2+} in zoospore settlement was found as Ca^{2+} channel inhibitors reduced the proportion of cells settling. Future work will focus on investigating the presence of Ca^{2+} channels in the plasma membrane through patch clamping.

BIOLOGICAL CONTROL OF BIOFOULING ON ARTIFICIAL MARINE STRUCTURES

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Increased pressure on coastal resources has highlighted the world-wide problem of biofouling. Copper sulphate and other harmful biocides are commonly used to deal with this. In our study an ecologically sound method to control seaweed fouling will be tested on coastal structures An assessment of the biofouling problem on slipways was carried out in Northern Ireland. Slipway users were asked several key questions related to the problem of biofouling. The possibility of using grazers to reduce the amount of seaweed on coastal structures was investigated. Percentage seaweed cover and numbers of limpets were compared on the sides and upper surfaces of the

slipways. Experimental blocks were designed using different concrete mixes (normal, micro-silica and rapid hardening) and surface textures. Settlement of algal spores on these blocks is recorded by SEM. In the concrete mix that is least susceptible to biofouling, artificial refuges for grazers are provided (designed on the basis of those observed in natural environments) and monitored over a six month period. Data collected so far show that 70% of slipway users questioned have a serious problem with biofouling. On the slipways examined, limpet densities were highest on the sides of the slipways and lowest on the upper surfaces. Inversely, seaweed cover was lowest on the sides and highest on the surfaces. This highlights the grazing potential of limpets on slipway surfaces, which we are enhancing through using suitable concrete mixes, surface textures and built-in refuges.

MOLECULAR CHARACTERISTICS OF INVASIVE AND NATIVE KELP SPECIES

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To date, much research has been conducted at the organism level on non-native species; however, little physiological work has been done on invasive seaweeds. I have employed molecular techniques to identify physiological characters that may facilitate the invasion of a particular species. In physiological ecology, an established index of thermotolerance is the up-regulation of heat shock genes (termed the heat shock response) by which heat shock proteins (Hsps) are rapidly synthesized. The goal of this study was to examine the up-regulation of Hsps as a means to assess the physiological plasticity and tolerances of the Eastern Pacific invasive kelp, *Undaria pinnatifida*, as compared to a potentially competing native kelp: *Egregia menziesii*. I hypothesized that the invasive would exhibit broader temperature tolerance than the native kelp species at sites where they co-exist. This work is to be carried out on both sporophyte and gametophyte tissue to assess tolerance levels at different life history stages that may be important for competition between native and invasive species. Temperature is thought to be one of the primary factors determining the geographic boundaries of seaweeds; thus, this study will elucidate a possible mechanism for how seaweeds cope with temperature stress and what affects their ability to expand their range. Knowledge of the potential for *Undaria pinnatifida* to expand beyond its current level of invasion is important for assessing where to focus prevention efforts as well as for establishing methods to control transmission.

THE INFLUENCE OF CURRENT VELOCITY AND WAVE EXPOSURE ON THE MORPHOLOGY OF *LAMINARIA DIGITATA*

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The morphology of *Laminaria digitata* collected from 5 sites exhibiting varying wave and current velocity conditions around the Ards Peninsula, Northern Ireland, was investigated. Fourteen characteristics of each plant were measured in samples of 50 plants from each site. Differences in significance were based on the 95% probability level. *L. digitata* from the site exposed to greatest wave activity but low mean current velocities exhibited both the thickest and most branched blades. Plants from the site with strong current flows but low wave activity possessed the longest blades and longest and thickest stipes. Holdfasts of maximal basal surface area and maximum mass were associated with plants from the high current site while the widest blades were found in plants from the calmest site. The thicker blades associated with the high wave exposure site appear adapted to withstand the abrasive effect of rocks while the thickness also adds mechanical strength to the blades in a dynamic environment. The larger holdfasts from the plants in the high current, low wave activity environment provide greater substrate anchorage while the longer stipes and blades enable enhanced photosynthesis, even when plants are subject to strongly turbulent regimes. Under benign physical conditions, the larger surface area of the plants associated with the reduced drag conditions, allows greater nutrient and light absorption rates per unit biomass of plant.

USING SEAWEEDS AS INTEGRATING BIOMONITORS OF NITRATE AND PHOSPHATE POLLUTION IN COASTAL WATERS.

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The potential for using seaweeds to monitor the extent and development of eutrophication by nitrate and phosphate in the coastal waters of Northern Ireland is being studied. Initial work shows significant variation in internal nutrient concentration within and between *Ascophyllum nodosum* and *Fucus serratus* plants sampled randomly from the same area. Nutrient analysis of different areas of thallus showed that samples taken 1-2 cm behind the tip of the plant had the least variation. Restricting sampling to this region of thallus has reduced variation between samples from the same shore.

The effect of plant position on the shore was also studied. Phosphate content of samples taken 1-2 cm behind tips of *F. serratus* plants decreased in with increasing height above low water. No such pattern was seen in *A. nodosum* samples.

A monthly monitoring programme at two sites, one inside Strangford Lough and one on the Irish Sea coast of the Ards Peninsula shows the seasonal variation in internal nutrient content. Samples of *F. serratus* and *A. nodosum* from 14 sites where sewage discharge has either been through waste water treatment works or from retention tanks allow comparison of sites with different nutrient loads.

CONTRIBUTION TO THE SYSTEMATICS OF THE ECTOCARPALES (PHAEOPHYCEAE): MOLECULAR PHYLOGENY OF SMALL BROWN ALGAL EPIPHYTES

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The classification of the large order Ectocarpales (Phaeophyceae) has remained controversial, mainly because it is based on few morphological/anatomical features. Based on molecular characters, Peters and Ramírez (2001) have divided the Ectocarpales into five families, but their phylogeny was limited to 17 taxa. In order to better understand the relationships amongst the Ectocarpales, and to test the monophyly of their five families, the rubisco large subunit has been sequenced on 15 North Atlantic species, distributed into 11 genera of which 10 are investigated for the first time at a molecular level.

Phylogenetic analyses were performed on a dataset of 85 taxa. In our trees, the five families proposed by Peters and Ramírez (2001) appeared monophyletic. However, in the early divergence of the Chordariaceae, a monophyletic group supported by very high bootstrap values was revealed in our analyses, which perhaps suggests the need to consider a sixth family within the order Ectocarpales. Also, the genus *Petrospongium* was clearly not clustering with any of these

families. Moreover, the species *Compsonema microspongium* and *Myriactula areschougii* were included into the Ectocarpaceae clade. Finally, the genera *Myriactula*, *Myrionema*, and *Elachista* were shown to be polyphyletic. These results upset the present classification and raise the question of the taxonomic relevance of non-molecular characters used within the Ectocarpales.

NODULARIN-BASED ELISA FOR THE IMMUNOASSAY OF THE CYANOBACTERIAL HEPATOTOXIN, NODULARIN, IN WATER AND ANIMAL SAMPLES

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Parts of the world e.g. the Baltic Sea and parts of Australasia, suffer from regular blooms of the nodularin-producing cyanobacterium *Nodularia spumigena*. Nodularin (NOD) is a protein phosphatase inhibitor and a tumour promoter, as is the cyanotoxin microcystin (MC). However, in contrast to MC, NOD is also carcinogen. Several animal species have been shown to accumulate the toxin with a potential ecological impact and a human health concern as exposed animals are a dietary component in these regions. Additionally, *N. spumigena* is found in sources of drinking water, e.g. Lake Alexandrina, Australia and in recreational waters. Whilst there is currently no maximum exposure guideline it has been suggested that the WHO value of 1 mg/l MC-LR per day is applied for the biochemically related NOD. Therefore, there is a need for accurate and sensitive assays of NOD.

To date the ELISA used for quantifying nodularin has been based on a MC-LR microtitre well-coating and commonly a MC-LR standard curve. The antibodies raised against MC-LR show good cross-reactivity with NOD, but they have approximately half the affinity, which may lead to inaccuracy. A nodularin-based indirect competitive ELISA (NOD-ELISA) was developed and tested against the MC-LR-based ELISA (MC-ELISA) and HPLC with cultured *N. spumigena*, and toxin-spiked water and *Mytilus edulis* tissue samples. The NOD-ELISA was significantly more sensitive with a broader detection range and showed an improved correlation with HPLC readings. Tissue-matrix, increasing methanol and salinity can all give false positive results as has previously been shown with MC-based ELISAs.

CELL EXTRACTS FROM DIFFERENT MORPHS OF THE MARINE DIATOM, *PHAEODACTYLUM TRICORNUTUM*, VARY IN THEIR LEVEL OF ANTIBACTERIAL ACTIVITY

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Single-celled eukaryotic microalgae have been identified as a potential source of useful pharmaceutical compounds. Of particular interest is the discovery of novel antibacterial compounds, which is one strategy employed to address the problem of increasing bacterial antibiotic resistance. Such compounds are made by microalgae, possibly to provide an advantage against bacteria competing for space and resources. We have been investigating the character of antibacterials made by the marine diatom, *Phaeodactylum tricornutum*, a robust species found in coastal and estuarine waters. This organism appears to synthesize several antibacterial compounds, including fatty acids, an unusual sugar molecule, and a tetrabutyl ammonium phenolate. Curiously, the level of antibacterial activity in methanol cell extracts of *P. tricornutum* seems to vary depending on the morph of this diatom. Of the four known morphs (triradiate, oval, fusiform and an oval-fusiform intermediate), strongest antibacterial activity is present in extracts from cultures in which the fusiform morph dominates. Various environmental factors, such as availability of a surface, medium composition, light regime, and temperature, are known to influence the morphology of *P. tricornutum*, although it remains unclear why the diatom responds to environmental change by altering shape. Our studies have revealed that pH may also influence the morphology of *P. tricornutum*. It is possible that the morphological change and associated alteration of antibacterial compound production might be a defence response caused by environmental stress, perhaps aiding the diatom in out-competing surrounding prokaryotes.

PHYLOGENETIC RELATIONSHIPS AMONG SPOROCHNALEAN TAXA INFERRED FROM RUBISCO SEQUENCES AND MORPHOLOGY

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The Sporochnales is a morphologically well-defined group of algae due to their conspicuous tufts of trichothallic filaments, which are a result of their subapical intercalary growth. In their diplohaplontic life history with a heteromorphic alternation of generations, and particularly in their sexually dimorphic microscopic gametophytes which show pheromone-induced sperm release, they resemble the Laminariales and Desmarestiales. It is generally assumed that Desmarestiales is the sister taxon. As it currently stands, the Sporochnales comprises a single family (Sporochnaceae) of 10 genera and 27 species. The group is distributed worldwide, although disjunct, in cool temperate to tropical waters. Australasia including Australia, New Zealand and New Caledonia currently accounts for a disproportionate share (approximately 65%) of total world species diversity and also hosts the greatest number of endemic taxa.

This research project has utilised an analysis of DNA sequence data (from the plastid-encoded *rbc*L gene and the RuBisCo spacer) and morphological characters to provide the first inference of phylogenetic relationships within Sporochnales and to revise the taxonomy of the group. The results confirm the Sporochnales are monophyletic, belonging to the 'brown algal crown' clade but no clear sister-order relationship could be established. *Rbc*L sequence data alone does not resolve or support a close relationship between the Sporochnales and Desmarestiales.

However, our results suggest that for a taxonomy reflecting evolutionary relationships the most recent treatment of the Sporochnales (Womersley 1987) which recognises 10 genera (*Austronereia, Bellotia, Carpomitra, Encyothalia, Nereia, Perisporochnus, Perithalia, Sporochnema, Sporochnus* and *Tomaculopsis*), requires several changes at genus rank to better reflect the evolutionary relationships.

THE GENUS *ACROCHAETE* (CHLOROPHYTA): TAXONOMY, SPECIES DIVERSITY AND DISTRIBUTION AROUND THE UK

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Species assigned to the green algal genus *Acrochaete* are filamentous epi-endophytes found in association with a variety of macroalgal hosts and endozoites typically occurring in shelled organisms. Attention was first drawn to the need for revision of the taxonomy of the genus from rDNA ITS sequence data, which showed that the species *A. heteroclada* fell outside the main *Acrochaete* lineage. The aim of our study is to use a combination of molecular and morphological techniques to resolve the taxonomy of the genus and to gain a better understanding of the species diversity and distribution around the UK. Sequence results for two molecular markers, rDNA ITS2 and *tuf*A, show that most species assigned to *Acrochaete* form a sister clade to the genus *Ulva* and that species diversity appears to be greater than previously described. Analyses based on both rDNA ITS and *tuf*A sequences support the exclusion of *A. heteroclada* from the main *Acrochaete* clade and *Ulva*, its sister group. Our data suggest that some *Acrochaete* species are much more widely distributed than previously recorded and confirms that they can occur within a variety of host macroalgal species.

MOLECULAR EVOLUTION OF ACTIN GENES IN GREEN ALGAL LINEAGES

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Actin represents one of the most ubiquitous proteins common to all living organisms. It is a key cytoskeletal protein responsible for mechanical support for the cell, determining the cell shape, and enabling cell movements. The presence of multiple copies of Actin genes has often been linked to morphological complexity. Streptophytes are known to possess multiple copies, whereas the presumed ancestors of the higher plant lineages (e.g. *Mesostigma viride*) contain a single copy only. Little, however, is known about Actin gene evolution in the green algal lineages (Chlorophyta), the sistergroup of the Streptophytes. The green algae exhibit a remarkable diversity of cell forms ranging from unicellular microscopic algae with a single nucleus, over multicellular filaments and foliose blades, to coenocytic and even siphonous life forms that are essentially composed of a single giant cell containing thousands of nuclei. There are scattered reports of multiple copies of Actin in the Ulvophyceae (*Acetabularia* and *Cladophora*) and Trebouxiophyceae (*Nannochloris* and *Chlorella*), but a broad picture on Actin evolution in the Chlorophytes is lacking. Our principal aim is to investigate the molecular evolution and copy number of the Actin gene in the Chlorophyta and link this information to the evolution of thallus complexity. Secondly, the presence of multiple copies in certain taxa could relate to ancient gene duplications and/or be potentially indicative for the role of hybridisation as a driving force of speciation. Genes were amplified using Reverse Transcriptase PCR and copy number assessed by Southern hybridizations.

OOMYCETE MARINE ALGAL ENDOPARASITES: THEIR BIOLOGY, EVOLUTION, AND PHYLOGENY.

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It is well-established that the members of the oomycetes belong to the chromists with the heterokont algae, bicosoecid flagellates etc. They also have important roles in marine, freshwater, and terrestrial ecosystems such as eukaryotic decomposer and important pathogens. Recent phylogenetic studies suggest that marine algal endoparasites appear to be located at the base of the oomycete tree, which suggests these parasites may hold the key to make clear both the phylogenetic origin and evolutionally development of the oomycetes. In this study, light and electron microscopic studies of *Olpidiopsis* sp., a unicellular endoparasite of *Porphyra*, and *Eurychasma dicksonii*, a unicellular endoparasite of brown algae, were carried out to compare with other oomycetes based on their morphology. The characteristic feature of the close perinuclear association of mitochondria in the zoospore initials was observed in *Olpidiopsis* sp. This feature has never been observed in "advanced" oomycetes, which suggests it might be primitive phylogenetic character of oomycetes. On the other hand, characteristic empty sporangium structure, which called as "net" sporangium, was observed in *E. dicksonii*. This feature has been known only in this species in the oomycetes. Our morphological comparative analyses in the oomycetes showed that almost none all of the structural features have not beenare shared within oomycete endoparasites, which suggests they may beare a polyphyletic group. It would beis clear that more structural and molecular data from other oomycete endoparasite species are needed to fully elucidate the phylogenetic origin and evolutionally development of oomycetes.

FRIDAY 6TH JANUARY – FOUNDERS LECTURE

GRAZING INTERACTIONS AND THE STRUCTURE AND FUNCTIONING OF ROCKY SHORE COMMUNITIES

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A review will be given of field experimental investigations of the role of grazing in determining the composition of intertidal assemblages. The importance of limpet grazing in controlling macroalgae including events in microbial films will be illustrated drawing on work done over the last three decades including european scale approaches. Consequences of climate change for outcomes of interactions and hence ecosystem functioning will be discussed

SATURDAY 7TH JANUARY

ECOLOGY AND APPLIED

REPRODUCTIVE ECOLOGY AND GENETIC STRUCTURE OF FUCOIDS IN THE INNER BALTIC SEA, INCLUDING *FUCUS RADICANS* (sp. nov.)

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Brown seaweeds of the genus *Fucus* occupy a wide variety

of temperate coastal habitats, and are recognised as an evolutionary dynamic group with many recent radiations. Fucoids are the only perennial canopy-forming algae in the inner Baltic Sea, where low salinity imposes strong physiological restrictions on their reproduction. The northernmost populations of *Fucus* in the Baltic Sea (salinity 3-5) have recently been described as *Fucus radicans* (Bergström & Kautsky), based on their unique morphological, ecological and genetic characteristics. Remarkably, *F. radicans* is clonal to a large extent, a feature not previously observed in the genus. Clonality is likely to play an important role for the persistence and differentiation of *F. radicans* in its marginal marine environment. At the same time, the extremely low genetic variation signals strong vulnerability to environmental changes.

GAMETOPHYTIC DOMINANCE IN *MAZZAELLA LAMINARIOIDES* (RHODOPHYTA, GIGARTINALES): DIFFERENTIAL SURVIVAL OF BASAL DISKS IN RELATION TO ENVIRONMENTAL STRESS

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In red seaweeds, relative abundance of life-history stages usually favours sporophytes or show no difference with gametophytes, but in some Gigartinales with obligate, isomorphic life-cycles and reduced or nil vegetative reproduction the haploid gametophytes are more abundant. Explanations have usually invoked differential survival or reproductive output of haploid and diploid stages or differences in phenology, although the mere fact of having non-spore producing male gametophytes has also recently been suggested. We sampled the red intertidal seaweeds, *Mazzaella laminarioides*, and evaluated the density of blades and the density and size of the basal disks along the vertical intertidal gradient. Compared to seasonal blades, perennial basal disks are a better indicator of long term survival at the level of the individual. Gametophytic dominance was greater higher on the shore, and was also greater among larger disks, and given that disk growth rates did not differ between phases, these results indicate that differential survival of disks is the most likely explanation. Unexpectedly, female gametophytes were also more abundant than male gametophytes (3:1), indicating that the haploid condition does not explain this phase dominance. We propose that female gametophytes are stronger because, apart of their own growth, they must bear the development of carposporophytes resulting from an unpredictable arrival of male gametes, whereas sporophytes and males support a single maturation process. Then, gametophytic dominance results from differences in life-history features related to sexual reproduction and the maintenance of the third life-history phase typical of many red seaweeds. (Funded by FONDECYT, Grant 1020855).

THE BENTHIC MARINE ALGAL FLORA OF WESTERN ICELAND: ADDITIONS AND AMENDMENTS

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Systematic studies of the benthic marine algae of Iceland were started by Strömfelt in the late 19th century and continued in the early 20th century by Jónsson. In the second half of the 20th century, Caram & S. Jónsson and Munda studied algae at many localities around Iceland. A recent checklist compiled by Gunnarsson and Jónsson recorded 238 species of green, brown and red algae for the country. The western coastline of Iceland is characterised by a series of fjords and open rocky coasts and at its northern point almost reaches the Arctic Circle. The most westerly point lies only 300 km east of Greenland. As part of a general survey of the marine flora of Iceland, started in 1999, a study was undertaken of the intertidal and subtidal benthic algae of the west coast in July 2005. In this survey, 200 species (78 red, 62 brown and 60 green) were found, representing approximately 85 % of the Icelandic seaweed flora. New records for Iceland included *Acrothrix gracilis*, *Sphacelaria rigidula*, *Ceramium pallidum* and *Litosiphon laminariae*. As elsewhere, there are several groups where further taxonomic study is required, e.g. Cladophorales, Acrosiphoniales, Bangiales and filamentous brown algae. The north-west differed in species composition from the south-west of this region, most notably in the absence of southern species, e.g. *Pelvetia canaliculata*, *Fucus serratus* and *Chondrus crispus*, from the far north. Northern cold water species in the Icelandic flora included *Coelocladia arctica*, *Phyllaria dermatodea*, *Polysiphonia arctica* and *Coilodesme bulligera*. Although the results broadly confirm those of previous studies, they provide a more comprehensive distributional data set of algal biodiversity for the 21st century.

40 YEARS OF MARINE PHYTOPLANKTON SAMPLES FROM A COASTAL SITE NEAR PLYMOUTH

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In the early 1960s Gerald Boalch started listing the species of phytoplankton in samples taken frequently form a station about 10 miles south of Plymouth. Sampling has continued in the same way and at fairly regular intervals ever since. The records from this series have now been transferred to a computer data-base and are beginning to be analysed. They show not only the seasonal changes in the phytoplankton but longer termed changes including the arrival of immigrant species.

INTER-LABORATORY POST-CRYOPRESERVATION STABILITY TESTING

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The concept of validating methodologies is debatably as old as civilisation, as man has always needed to be confident that his methods/systems of work/protocols etc are “fit for purpose” and reproducible. In this paper we outline the basic principles of protocol validation and present our efforts to validate/standardise cryopreservation protocols, as well as phenotypic and genotypic stability testing in a pan-European project (COBRA). This project, based on a consortium of European algal culture collections, had the central aim to apply cryopreservation methodologies to microalgae and cyanobacteria, organisms that, to date, have proved difficult to conserve using cryogenic methods. In addition, molecular and biochemical stability tests have been developed to ensure that the equivalent strains of microorganisms supplied by the culture collections are of equal quality. One of the key objectives of the

COBRA project was to ascertain the robustness and repeatability of the methods employed/developed. This validation process was undertaken by engaging laboratories of varied experience, both within and outside the collaborative COBRA framework. An important aspect of this process was that it was not simply a process of distributing protocols and awaiting results from participants. The participants were encouraged to own the process and many were actively involved in establishing the protocol for the validation process including how the results were collated, evaluated and published. This was achieved by using the project website (www.cobra.ac.uk), a discrete discussion forum and appropriate discussion threads.

USE OF CORALLINE ALGAE IN MEDICAL CERAMICS

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Queen's University Belfast are supplying coralline algae for use in medical ceramics under the EU funded Hippocrates program. We select various species of geniculate and non-geniculate (maerl forming) coralline algae and transform them into hydroxyapatite/tricalcium phosphate (HA/TCP). These ceramics (bi-phasic calcium-phosphate) are converted into a scaffold, which is then used for bone or osteochondral tissue engineering. The HA/TCP retains the highly porous and interconnected structure of the original algal material, which is compatible with bone.

An example application for these implants is use in reconstructive facial surgery. Algal species from temperate and sub-tropical localities are being investigated for their suitability. Growth rate, porosity, heavy metal content and internal structure of source algal material, cultured material and HA/TCP product are examined. Our results to date indicate that *Corallina officinalis* is the most suitable species for use in these implants, due to its growth rate in cultivation and internal morphology. We are developing sustainable aquaculture techniques for *C. officinalis* using long line cultivation.

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CHEMICAL ECOLOGY

HEALTH GUIDELINES AND LEGISLATION IN THE RISK MANAGEMENT OF CYANOBACTERIA AND CYANOTOXINS IN WATER RESOURCES

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International awareness is increasing of the occurrence, abundance and toxicity of cyanotoxins in water resources required for drinking and recreational purposes, and of the health risks which these toxins can present. This increase is due in part to: greater application of research effort on cyanotoxin toxicity; improved recognition of cyanotoxin-associated health incidents; and increased capability to anticipate, detect and quantify cyanotoxins. Progress on the detection of potential and actual production of microcystins, nodularin, anatoxin-a and cylindrospermopsin is summarized.

Risk management has been applied to cyanobacterial blooms and cyanotoxins in some countries for some years (e.g. UK, Australia) and cyanobacterial cells and some toxins are now included in World Health Organisation (WHO) Guidelines for Recreational Water (2003) and Drinking Water (2004). However, a dichotomy in policy at national level is now apparent. As summarized here, some countries (since 2002) have introduced national legislation to regulate cyanotoxins (mainly microcystin-LR, or "microcystin"), whereas others are continuing to use guidelines (i.e. for policy guidance), either as recommended by the WHO, or after national modification. Problems of appropriateness, and interpretation of guidelines and legislation are identified. These include: lack of guidelines for some cyanotoxins due to no/ or inadequate toxicity data; reliance on microcystin-LR as a "worst case scenario" indicator; existence of multiple variants of different toxicities within toxin families, with the options of estimating "concentration equivalents " or "toxicity equivalents"; continuing lack of quantitative analytical standards for cyanotoxins. Under these circumstances, differences in approach between regulation and guidance seem set to continue.

DETECTION OF MICROCYSTIN AND NON-MICROCYSTIN CYANOPEPTIDES IN ARCHIVED RESCOBIE LOCH BLOOM SAMPLES (1983-2004)

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Cyanobacteria are capable of producing a large number of bioactive compounds, of which peptides are one of largest studied groups. In addition to the well characterised hepatotoxic microcystins, cyanobacteria produce other cyanopeptides that may also contribute to the biological activity of a cyanobacterial bloom. Non-microcystin cyanoeptides include the aeruginosins, anabaenopeptins, cyanopeptolins, microginins and microviridins and although members of these peptide families have not been described as acutely toxic, their biological activities include enzyme inhibition (serine protease, protein phosphatase and angiotensin-converting enzyme).Until recently, information has been lacking on the environmental concentrations of these cyanopeptides and so it has not been possible to assess their ecological impacts and potential risks at relevant concentrations.

Cyanobacterial bloom samples collected and lyophilised from a single waterbody over a 21-year period were extracted and analysed for microcystins plus 3 non-microcystin cyanopeptides for which quantitated standards had been produced. In this particular waterbody, the maximal concentration of one of the non-microcystin peptides was 6 times higher than the maximal microcystin concentration over the 21-year period, however the concentrations of all the investigated peptides varied considerably. No non-microcystin peptides were detected until samples taken in 1992 and on 2 further dates none of the investigated peptides were detected in the extracted bloom samples. Possible explanations include instability of non-microcystin cyanopeptides in archived material, but more likely is that differences are due to alterations in the cyanopeptide pool due to heterogeneity and succession of the cyanobacterial bloom composition.

SIGNIFICANCE OF THE NEUROTOXIN BMAA AS A PRODUCT OF CYANOBACTERIA

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β-*N*-methylamino-L-alanine (BMAA), a neurotoxin originally

isolated from cycad seeds, is produced by a symbiotic cyanobacterium (*Nostoc* sp.) from the coralloid roots of *Cycas micronesia* (Cox *et al.* PNAS 100: 13880 (2003)). The cyanobiont appears to be a source of dietary exposure to BMAA among the native Chamorro people of Guam via biomagnification (*Nostoc* – cycad tissues – cycad seeds – flying foxes – Chamorro). The association between dietary exposure to BMAA and an amyotrophic lateral sclerosis/ Parkinsonism dementia complex among the Chamorro, and the presence of BMAA in the brains of Canadian Alzheimer's disease patients, have stimulated interest in the environmental origin(s) of BMAA and of other potential exposure routes. Recent findings that BMAA is produced by laboratory strains of symbiotic and free-living, aquatic and terrestrial cyanobacteria (Cox *et al.* PNAS 102: 5074 (2004)), indicate that human exposure to cyanobacterial BMAA may be more widespread than immediately apparent in the Guam investigations.

Archived, cyanobacterial bloom samples from 12 UK waterbodies, collected between 1990 and 2004, contain BMAA at concentrations similar to those in laboratory cultures per unit dry weight. The environmental blooms, including spp. of *Microcystis, Anabaena, Planktothrix, Aphanizomenon* and *Nodularia,* were from high resource waterbodies (drinking water reservoirs, recreational lakes and a marina), where human and animal exposure to cyanobacterial mass populations and/or cyanotoxins has already occurred. Research is needed on the environmental concentrations and likely multiple fates of BMAA in aquatic environments and aquatic biota. Comparisons between potential human exposure levels from cyanobacteria versus toxicity of BMAA, are also required.

UV LIGHT INDUCTION OF VOLATILE ORGANIC HALOCARBON COMPOUNDS, EMISSION BY: *ULVA RIGIDA*, MAZZAELLA *LAMINARIOIDES AND LESSONIA NIGRESCENS*.

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The inductive effect of 0 to 160 h of exposure periods to PAR and UV+PAR radiations on the emission of volatile halocarbon compounds (VOHC's) was studied for *Ulva rigida*, *Mazzaella laminarioides* and *Lessonia nigrescens* from central Chile. Automated sampling coupled to a GC-MS system was used to determine VOHC's from one gram fresh tissue samples incubated in 20 mL head space vials under 150 µmol m^{-2} s^{-1} at 20 ±1°C. Progressive production of VOHC's were done in triplicate every 40 minutes for 160 minutes for both light conditions. The three species produced equivalent molecular diversity of VOHC's under PAR and UV+PAR *U. rigida*: $CHBrCl_2$, CH_3Br, CH_2I_2 and CH_3I, *M. laminarioides*: produced CH_2Cl_2, $CHBrCl_2$, CH_3Br, CH_2I_2 and CH_3I, and *L. nigrescens*: $CHBrCl_2$, CH_3Br, CH_2I_2 and CH_3I. Whereas, under UV+PAR a smaller diversity but more complex VOHC's were produced *U. rigida*: $CHBrCl_2$, CH_3Br, CH_2I_2 and CH_3I, *M. laminarioides*: produced CH_2Cl_2, $CHBrCl_2$, CH_3Br, CH_2I_2 and CH_3I, and *L. nigrescens*: released: $CHBrCl_2$, CH_3Br, CH_2I_2 and CH_3I. Also, under PAR the three seaweeds released an average of 300 µg g^{-1} fresh tissue weight. While an average concentration three times greater (1010 µg g^{-1} fresh tissue weight) was produced under UV+PAR. These results indicate that UV can be a powerful inductor of VOHC's for intertidal seaweeds. This work was financially supported by the Ministry of Education through Grant MECESUP USC9901.

VOLATILE ORGANIC HALOCARBON COMPOUNDS, PRODUCED BY *DUNALIELLA SALINA* (TEODORESCO) IRRADIATED WITH UV LIGHT AT DIFFERENT STAGES OF CULTURE PERIOD.

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The production of volatile halocarbon compounds (VOHC's) was studied in axenic cultures of *Dunaliella salina* (Teodoresco) strain Conc.006. Cultures were maintained in standard conditions (150 µmol m^{-2} s^{-1} at 20 ± 1 °C) and in Johnson (J/1) culture medium. At two stages of growth, day 4 (log phase) and day 8 (stationary phase), 12 samples were taken and placed in 20 mL head space vials. Three samples were analysed immediately, and the remaining 3 groups of three vials were exposed to PAR for 4, 8 and 12 h respectively. An identical procedure was done with another 12 samples but were exposed to UV+PAR (120-280 nm). Automated sampling c oupled to a GC-MS system was used to determine VOHC's. At day 4 both algal species under PAR and UV+PAR produced the same 7 VOHC's molecules for all the incubation periods; CH_3Br, $CHBr_2Cl_2$, CH_2I_2, CH_2BrCl, CH_2ClI, CH_2Br_2 and $CHCl_3$. VOHC's. The average production PAR was 0. ng^{-1} 10^6 cell mL^{-1} and UV+PAR average was 2.51 ng^{-1} 10^6 cell mL^{-1}. This is a 2.7 times greater. At day 8, cells produced 7 VOHC's under PAR for all the incubation periods; CH_3Br, $CHBr_2Cl_2$, CH_2I_2, CH_2BrCl, CH_2ClI, CH_2Br_2 and $CHCl_3$. Whereas under UV+PAR 5 VOHC's produced; CH_2I_2, CH_2BrCl, CH_2Br_2 and $CHCl_3$. Furthermore, under PAR, VOHC's production averaged 3. ng^{-1} 10^6 cell mL^{-1}, whereas under UV+PAR production averaged 8.8 ng^{-1} 10^6 cell mL^{-1}, this is 2.7 times greater. These results indicate that UV reduces diversity, but increases the production of VOHC's. This indicated that the ozone layer will continue its depletion process with the synergic effect anthropogenic and biogenic VOHC's production. This work was financially supported by the Ministry of Education through Grant MECESUP USC9901.

Abstracts

Poster Presentations

1) THE EFFECT OF DIFFERENT ENVIRONMENTAL CONDITIONS ON GROWTH RATES IN *ALEXANDRIUM* SPECIES (Poster Prize)

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The AlgaDec project is being undertaken by a European consortium for the development of an RNA biosensor to enable quick and easy identification and quantification of algal species in productive waters. Probes have been designed that can identify individual species of *Alexandrium* (and other nuisance species of algae). In order to validate the quantitative use of these probes in waters with different environmental conditions, experiments are being carried out under laboratory conditions. These are intended to determine the effects of various environmental factors (e.g. different salinities, temperatures and nutrient concentrations) upon the growth rates and RNA content of different species/strains of *Alexandrium*. Three cultures, *Alexandrium minutum*, a North American strain of *A. tamarense,* and a Temperate Asian strain of *A. tamarense* have been studied under various conditions, including salinities ranging from 20‰ to 40‰ and temperatures from 15°C to 19°C, and growth curves have been produced. Using these growth curves the specific growth rate has been calculated for these strains/species under each environmental condition and thus the optimal, maximal and minimum growth rates for each have been determined. The next stage of this work is to harvest cells at different growth phases, under differing growth conditions to measure whether these factors have any effect on the RNA concentration.

2) PHAGE-MEDIATED GENE TRANSFER WITHIN FRESHWATER CYANOBACTERIA (Poster Prize)

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Cyanobacteria are important members of phytoplankton communities both in marine and freshwater environments. They are a significant source of primary production, forming the base of the food chain. Viruses are consistently the most abundant biological entities in aquatic systems, about 10^9 viruses per litre. Over the past two decades, it has been shown that viruses are important in controlling bacterial composition: some work has shown this to be true for cyanobacterial communities that are infected with cyanophage. There is increasing evidence that lateral gene transfer within cyanobacterial communities and populations has a role in generating novel phenotypes. Very little is known about phage-mediated gene transfer within freshwater species of cyanobacteria. There is also very little known about the role of cyanophage in regulating cyanobacterial population development and structure. The aims of this project are to isolate cyanophage able to infect strains of the freshwater cyanobacteria *Anabaena, Microcystis* and *Planktothrix*, to quantify diversity and dynamics within phage communities and to investigate the potential for phage mediated gene transfer within cyanobacterial populations.

3) COMPOSITION AND STRUCTURAL CHARACTERISTICS OF THE PHYTOPLANKTON IN SMALL URBAN RIVERS WITH DIFFERENT ANTHROPOGENIC LOAD (Poster Prize)

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The subjects of the study are the compositions and structural characteristics of phytoplankton of two small urban rivers, which are included in the basins of the rivers Oka and Volga with the same hydrological and hydrophysical characteristics. The river-bed of one of them (the river Gnilichka) is embank by two earth dams.

The species composition of phytoplankton represented in the river Gnilichka and Chernaya is 324 species, 22 orders and 8 departments. In vernal season the phytoplankton association's basis was formed by Diatomea, and in the Chernaya – Chrysophyta alga. In the summer time chlorophyta and euglenophyta predominated in the phytoplankton of the river Gnilichka while in the river Chernaya – Diatomea, Chlorophyta and Chrysophyta in its low current. In the autumn Cyanophyta alga prevailed in the river Chernaya. High Snennon's and Pielou's indexes meant polydominance of phytoplankton communities. The predominating species, the nature of area and seasonal dynamics of the quantitative characteristics of the phytoplankton in the river Chernaya were greatly enhanced by the river Volga and this impact increased while approaching the creek. The most noticeable impact was during the autumn. The same impact on the cenosis of phytoplankton of the river Gnilichka be alga communities of the river Oka was not observed because of the earth dams at the bed of the river Gnilichka.

4) COMPARISON OF NUTRITIVE CHEMISTRY OF A RANGE OF TEMPERATE SEAWEEDS (Poster Prize)

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Eleven species of macroalgae (including four species from commercially important genera) were analysed for moisture, ash, fat, protein, neutral detergent fibre, crude fibre, calorific value, and calcium content. At the extremes of the nutritional values, *Corallina officinalis* had low calorific value (2.7±0.3 MJ Kg^{-1}), high ash content (77.8±0.2% dw), low protein (6.89±0.1 % dw) and high calcium content (182.2 ppm); whereas the exploited *Porphyra* sp. had high calorific value (18.3±1.8 MJ·Kg^{-1}), low ash content (9.3±0.2% dw), high protein (44.0±1.2 % dw) and low calcium content (19.9 ppm). The other species considered had intermediate values, but tended to be more similar to *Porphyra* than to *Corallina*.

5) GENERATION OF EXTRA-CELLULAR REACTIVE OXYGEN BY MARINE DIATOMS; THE DEVELOPMENT OF REAL-TIME IN VIVO ASSAYS TO REVEAL PHYSIOLOGICAL FUNCTION (Poster Prize)

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Hydrogen peroxide (H_2O_2) is ubiquitous in seawater where it plays a major role in many marine chemical processes. As a key chemical species in redox reactions, it has the potential to affect the cycling of trace metals and organic compounds. Phytoplankton are known to generate reactive oxygen species such as superoxide (O_2) and H_2O_2 with several potential functions including cell defence and stress response. In addition, this may also affect the organism's ability to access nutrients such as iron.

Novel techniques have been developed to determine H_2O_2 and superoxide production by marine phytoplankton species in laboratory based incubations. In addition to understanding the physiological function of ROS production by cells our aim is to ascertain the magnitude of the biological contribution to the concentration of reactive oxygen species in surface waters

6) COMPARING CARBON FIXATION BETWEEN TWO SPECIES OF THE MARINE DIATOM *THALASSIOSIRA*

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Marine diatoms are considered to be responsible for fixing the same amount of carbon per year as all the terrestrial rainforests, and over a quarter of the total carbon fixed by the oceans. Dissolved CO_2 is also a potentially limiting factor for marine primary productivity, and a great deal of research has been conducted on marine phytoplankton into carbon-concentrating mechanisms (CCMs) which are thought to involve active transport of inorganic carbon. However. Reinfelder and co-workers demonstrated that, at least under conditions of zinc and CO_2 limitation, the marine diatom *Thalassiosira weissflogii* shows short-term carbon fixation products consistent with a functional C_4 photosynthetic pathway, i.e. another kind of CCM. The recently published whole genome sequence of the closely-related *Thalassiosira pseudonana* also highlighted the presence of key enzymes in the C_4 pathway. However, short-term ^{14}C carbon fixation studies have not previously been conducted on *T. pseudonana*, so the presence of a functional C_4 pathway in this species is still unknown. The ability to use two separate, but potentially complementary, carbon-acquisition pathways may enable *Thalassiosira* to out-compete other phytoplankton in areas of the ocean subject to zinc- (or cobalt-) limitation. In this work, we have used an HPLC method to determine the short-term ^{14}C carbon fixation products formed by both *T. weissflogii* and *T. pseudonana* under ambient (400ppm) and low (100ppm) CO_2 conditions.

7) EVALUATION OF RED ALGAL PHYLOGENETIC MARKERS THROUGH META-ANALYSIS OF PUBLISHED DATA SETS

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Red algal phylogenetics mainly relies on two DNA markers: the large subunit of the plastid RUBISCO gene (rbcL) and nuclear ribosomal DNA (nrDNA: 18S, 28S, ITS regions). The use of both markers in phylogenetic research has been criticized. Whereas rbcL is mainly criticized because of third codon saturation, the use of nrDNA is most commonly dispraised because of alignment difficulties and its mode of inheritance. Despite these criticisms, there have been very few studies analyzing and comparing topological accuracy and resolution provided by different phylogenetic markers. We present a meta-analysis of red algal phylogenetic data extracted from more than 70 studies. Bare sequence data were aligned using various algorithms. Bayesian methods were used for inference of topology and branch support. The first focus of the study is on evaluation and comparison of phylogenetic resolution provided by different markers at different taxonomic levels and of the utility of markers as barcoding genes. The second focus is on the impact of third codon saturation of protein-coding markers, alignment issues in RNA-coding markers, and the impact of substitution model choice. The final focus is on correspondence among topologies obtained from different markers and marker combination.

8) MOLECULAR SURVEY OF GENERA *GELIDIUM* AND *CAULACANTHUS* ON EUROPEAN SHORES: UPDATE ON ALIEN INTRODUCTIONS.

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Gelidium is a very common genus on all European rocky shores. Its high tolerance of salinity and temperature changes, as well as its presence on vectors of anthropogenic transport such as oyster shells, make it a good candidate for non-indigenous introductions. However, no alien *Gelidium* has ever been recorded in Europe, despite the high number of introduced species in the area. Apart from ecological considerations, one potential reason could be the difficulties in identifying specimens of this "genre diabolique" at the species level. In our study, we undertook a molecular survey (using *rbc*L as a marker) of all the forms of *Gelidium* we have been able to find on selected shores in Europe. The results indicated the presence of several species not presently recognized as occurring in Europe, and we will discuss whether these may include new aliens or undescribed species, or whether older literature includes descriptions of these taxa. Specimens of the genus *Caulacanthus* were also sampled in the same areas. We detected the range extension of an introduced strain across the English Channel (to Plymouth!) and we will discuss some taxonomic issues in the Mediterranean Sea.

9) MOLECULAR DIVERSITY OF EUKARYOTIC PICOPLANKTON FROM PRIEST POT, A PRODUCTIVE POND IN THE ENGLISH LAKE DISTRICT

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Picoplankton, defined by its size between 0.2 and 2 µm, plays a significant role in microbial food webs and biogeochemical cycles. The small size and lack of obvious morphological features make picoplankton difficult to identify by 'classical' methods, like light microscopy. Molecular techniques, such as sequence comparison, provide the tools to identify and quantify the diversity of these organisms. This has been done in the oceans: molecular analyses confirmed the abundance and importance of eukaryotic picoplankton and showed its huge diversity with picoplanktonic representatives from nearly every algal lineage, including classes that had not previously been described. In contrast, few molecular analyses have yet been made on freshwater picoplankton and virtually no information is available for picoeukaryotes. Therefore, the real species richness of picoplankton in lakes is unknown, even though it has been suggested to be high and to exceed that in the oceans.

In this preliminary study, the biodiversity of picoeukaryotes in Priest Pot, a productive pond in the English Lake District, has been analysed. An environmental clone library was established and restriction analysis and sequence analysis showed a broad diversity of operational taxonomic units (OTUs) from a variety of classes. Comparisons with sequences from Genbank identified those OTUs as mainly belonging to the ciliates, alveolates, cryptophytes, and chytrids. Some sequences from Priest Pot were only weakly homologous to known organisms or to picoplanktonic OTUs from other environmental genomic libraries made from marine and freshwater samples.

10) ESTIMATION OF GENETIC DIVERSITY IN THE COLONY FORMING POLAR PRYMNESIOPHYTE SPECIES *PHAEOCYSTIS ANTARCTICA* - PRELIMINARY RESULTS

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The prymnesiophyte *Phaeocystis* is a cosmopolitian, ecologically important genus that contains also two colony-forming cold water species, *Ph. pouchetii* in the Arctic and *Ph. antarctica* in the Antarctic ocean. First results about their genetic diversity have been obtained by molecular biological analyses using ribosomal RNA (rRNA) and ITS (Internal Transcribed Spacer) sequences, showing substential inter- and intraspecific diversity and first attempts have been made to trace the biogeographical history of strains in Antarctic coastal waters. A more detailed analysis of the population structure of *Ph. antarctica* just started to study the genetic diversity inside populations from different locations and the gene flow between them. For this analysis, microsatellite markers shall be developed and used to analyse the genetic diversity in a large number of clones from different locations at Antarctic coastal waters. The results from these experiments will be analysed by statistical tests to estimate the genetic diversity inside this species.

11) BIOINFORMATIC TOOLS FOR ALGAL GENOMICS: GENELYNX AND PHYLOGENA

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The poster introduces two bioinformatic tools for algal genomic research. The frist, GeneLynx is a meta-database dedicated to algal genes, making the retrieval of algal sequences easier than it is when using the more and more overloaded public sequence databases. A web interface is available at http://www.awi-bremerhaven.de/Genelynx. The second tool, Phylogena, is a software pipeline for automatically performing similarity searches, selecting a representative subset of them, aligning them and calculating and displaying a phylogenetic tree from their alignment. It is designed to speed up and improve the quality of phylogenetic and functional annotation of sequences becoming available at an increasing pace from genome and EST sequencing projects. The tool has proven to be a useful complement to “traditional” approaches to the annotation of unknown ORFs, which are based on simple similarity searches and motif searches.

12) SEED: LIFE CYCLE TRANSFORMATIONS AMONG HARMFUL ALGAL BLOOM SPECIES, AND THE ENVIRONMENTAL AND PHYSIOLOGICAL FACTORS THAT REGULATE THEM

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SEED aims to understand how environmental and physiological factors may influence non-vegetative stages of the life cycles of harmful algal bloom species contributing to the increase in harmful algal blooms (HABs) in European marine, freshwater, and brackish waters. SEED will focus on the life histories of some inportant HAB species in Europe. The overall objectives are to improve and extend our knowledge of the transitions between life history stages, to identify the environmental and physiological factors that regulate those transitions, and hence the relative importance of anthropogenic vs. natural causes, and to integrate that knowledge in the development of a new simulation model or refinement of existing ones. This will allow improved prediction, mitigation and management strategies for HABs.

Our approach is comparative, from species to ecosystem level, using field studies and laboratory experiments because life history transitions are complex and processes occur over a range of scales. Areas to be studied comprise regions bordering coastal sites of the Western Mediterranean Sea, Atlantic Ocean, North Sea, Baltic Sea, and Swedish lakes where ongoing monitoring programs and baseline information about species distribution and physical-chemical data already exists. All have heavy anthropogenic influences and are subject to frequent HABs, with a variety of detrimental impacts including human intoxications, closure of shellfish farms and water discolorations.

The innovation is to implement the most appropriate research strategies to non-vegetative phases, which determine the success of HABs and their expansion. Moreover, a mitigation strategy, analogous to sterile insect releases that are an effective element of agricultural pest control will be investigated.

13) EPIPHYTIC ABUNDANCE AND TOXICITY OF *PROROCENTRUM LIMA* POPULATIONS IN THE FLEET LAGOON, UK

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Planktonic *Dinophysis* spp. and epiphytic *Prorocentrum lima* (Ehrenberg) Dodge are known dinoflagellate producers of okadaic acid (OA) and dinophysistoxins (DTX); causative phycotoxins of diarrhetic shellfish poisoning (DSP). Underestimation of toxic dinoflagellates associated with a toxic event may be due to the lack of sampling of species with epiphytic and epibenthic strategies, such as *P. lima*. As *Dinophysis* spp. are not found in the Fleet Lagoon, Dorset, but previous DSP events have closed the *Crassostrea gigas* oyster farm, *P. lima* is the most likely causative organism. A field assay for separating microalgal epiphytes and concentrating wild cells on to filters was successfully applied to sub-samples of a variety of macroalgae and macrophytes (seagrass) collected from the Fleet during summer 2002. *P. lima* was present in increasing cell densities on most substratum species, over the sampling period; from 10^2 to 10^3 cells g^{-1} fresh weight (FW) plant biomass. LC-MS analysis detected OA and DTX-1 in extracts of wild *P. lima* cells, in ratios characteristic of *P. lima* strains previously isolated from the Fleet. No toxins, however, were detected in oyster flesh.

14) CYTOTOXIC COMPOUNDS FROM BRITISH MARINE ALGAE

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Seaweed species have been collected from the United Kingdom (Bembridge, Isle of Wight and Kimmeridge, Dorset) and the Republic of Ireland (Finavarra, County Clare). To date, 33 species have been screened for cytotoxicity against DLD-1 cells (human colon adenocarcinoma) using the MTT colorimetric assay. Of the species tested to date, the chloroform fraction of the methanol extract of *Polysiphonia lanosa* had the most potent cytotoxic activity. Activity was also shown by the chloroform fractions of the methanol extracts of *Plocamium cartilagineum*, *Cystoseira baccata*, *Codium fragile* ssp. *tomentosoides* and *Saccorhiza polyschides.*

Fractionation of the cytotoxic chloroform fraction of the methanol extract of *Codium fragile* subsp. *tomentosoides* led to the isolation of the known sterol, clerosterol (IC50=13.5 ?M) and two pigments (IC50=4.4 and 5.6 ?g/ml against DLD-1 cells).

The major cytotoxic compounds found in *Polysiphonia lanosa* were the bromophenols, lanosol, the aldehyde of lanosol, the *n*-propyl ether of lanosol and the methyl ether of lanosol, all previously reported for the species. Synthetic derivatives of these compounds have been prepared and shown to be more potent than the parent compounds in the test system used.

15) THE INFLUENCE OF DIATOMS ON COPEPOD REPRODUCTION: FIELD AND LABORATORY INVESTIGATIONS

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Certain diatom diets cause adverse effects on the reproductive success of copepods. Diatom-derived polyunsaturated aldehydes, formed upon cell damage, were made responsible for these effects. An enzymatic cascade of lipase/lipoxygenase and lyase activities, which can even be initialized in the copepod gut, can provide for diverse structurally related aldehydes. Nevertheless most exciting studies focus on laboratory experiments and only few diatom-species were examined for their deleterious potential. It is thus difficult to get a reliable picture of the potential ecological impact of unsaturated aldehydes. To overcome these limitations an *in situ* derivatisation protocol of unsaturated aldehydes was elaborated for monitoring the chemical defence potential of phytoplankton in coastal waters of Roscoff (Bretagne, NW Atlantic) and of cultivated strains. We have developed a sensitive approach based on the reaction of aldehydes with *O*-(2,3,4,5,6-pentafluorobenzyl) hydroxylamine hydrochloride (PFBHA·HCl) to the oxime-derivates. The approach is useful for quantification and was applied for field investigations. In parallel the effect of phytoplankton on the reproductive success of copepod was investigated (Marine Biological Station in Roscoff). Egg production rates and hatching success by *Calanus helgolandicus* females have been determined with specimens sampled weekly, from April to November 2003 and from March to October 2004. Our findings suggest that the diatom-derived production of unsaturated aldehydes cannot exclusively account the reduction of reproductive success observed. Moreover we found that only 36% of the investigated diatom species release unsaturated aldehydes upon cell disruption.

16) DIVERSITY OF *PSEUDO-NITZSCHIA* SPECIES IN THE SHETLAND ISLANDS

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Members of the genus *Pseudo-nitzschia* (H. Pergallo) have been associated with extensive closures of Scottish Scallop fishing grounds due to high concentrations of domoic acid (DA) detected in the gonad of King Scallops (*Pecten maximus*). During August 2005 a research cruise to the Shetland Isles surveying the phytoplankton in this region revealed high numbers of *Pseudo-nitzschia* spp. (> 500,000 cells.l^{-1}) to be present. Analysis of integrated water samples using light microscopy showed *Pseudo-nitzschia* populations to be diverse with cells of both the *P. delicatissima* 'type' (diameter < 5µm) and the *P. seriata* 'type' (diameter > 5 µm) present. This may affect the toxicity of the phytoplankton populations in this region as *P. seriata* and *P. australis* from Scottish waters have been confirmed as DA producers while no DA production has been observed in *P. delicatissima* from Scottish waters. A more detailed study of these *Pseudo-nitzschia* populations using Transmission Electron Microscopy (TEM) will be presented.

17) THE TAXONOMY OF *KLEBSORMIDIUM* (KLEBSORMIDIALES, CHAROPHYTA) IN URBAN HABITATS IN EUROPE

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Species of *Klebsormidium* are common green algae, widely distributed in all geographic areas of the world. The genus includes uniseriate filamentous forms with a parietal chloroplast and a distinct pyrenoid, reproducing by release of zoospores and widespread in terrestrial and freshwater habitats. Due to the poverty of characters useful for a reliable morphological identification, the taxonomic relationships of many species are

uncertain. Collections of *Klebsormidium* were obtained from 15 European cities (Bergen, Bordeaux, Copenhagen, Galway, Hamburg, Konstanz, Koper, La Valletta, London, Manchester, Marseille, Pisa, Porto, Prague, Siena). For each collection, morphological analyses were made on the field material and unialgal cultures were isolated. The morphology of each strain was examined in a series of culture experiments carried out with two media (Bold's Basal Medium and Jaworski's Medium), three temperatures (10, 15 and 20°C) and two photon irradiances (15-20 and 45-50 µmol/m²/s). On the basis of the main taxonomic treatments for the genus, all field collections were identified as *K. flaccidum*; the morphology in culture, however, showed a large variation in the growth form. Only the strains from Bergen, Galway, Hamburg and Konstanz produced a well-developed superficial layer, as considered typical of *K. flaccidum*. Strains from southern Europe (Marseille, Pisa, Siena, La Valletta) showed a high tendency to fragmentation into short fragments, whereas other strains (Bordeaux, Copenhagen, London, Manchester, Prague) maintained a filamentous habit on the long term. The results indicate a high hidden diversity and suitable molecular data are considered almost mandatory to elucidate the low-level taxonomy of the genus.

18) ONE HUNDRED YEARS OF ALGAL CULTURING IN PLYMOUTH

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The Plymouth Algal Culture Collection forms one of the oldest collections of marine microalgae in the world. E. J. Allen (later FRS) began experiments on generating pure algal cultures in 1905 and together with E.W. Nelson published his findings in 1910. These early studies formed the basis of the Collection which developed greatly under the guidance of Dr Mary Parke (later FRS), who was transferred to the Plymouth Laboratory in 1941 to work on alginate production from kelps and brown rockweeds. Plymouth clones have been distributed to all the major international algal culture collections; including 46 cultures sent in 1962 to the American Collection of Type Cultures of Algae at Indiana University. The Plymouth Collection, together with the Butcher and Pringsheim Collections, also formed the basis of the marine section of the Culture Collection of Algae and Protozoa when it was originally established in Cambridge before transferring to the Dunstaffnage Marine Laboratory near Oban. Today the Collection consists of ~300 strains from over 80 genera and includes 40 Type Cultures. In addition it holds some 150 *Emiliania huxleyi* clones. The Collection distributes approximately 300 culture strains per year to researchers throughout the world. The isolation of new strains is ongoing in Plymouth, with the emphasis on diatoms (for studies on membrane physiology and characterisation of membrane transporters) and bloom-forming species (for studies on calcification, nutrient acquisition and viral infection processes). The Collection also acts as a repository for strains isolated and characterised by other researchers.

19) MORPHOLOGICAL AND MOLECULAR IDENTIFICATION OF RECENT POLAR ISOLATES ACCESSED INTO THE CULTURE COLLECTION OF ALGAE AND PROTOZOA

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Climate change is threatening to destabilise the polar ice caps with the potential to alter environmental parameters such as sea temperature, pH and salinity. The initial and most dramatic changes will occur in the ecosystems of the Arctic and Southern oceans. In order to survive in these areas phytoplankton communities may require rapid adaptation. Other threats, including succession of polar species by more cosmopolitan phytoplankton, may occur as sea temperature begins to rise in these oceans.

In the Culture Collection of Algae and Protozoa (CCAP) we aim to make the isolation and maintenance of polar strains a priority. To this effect, water samples were obtained from two Antarctic and an Arctic research cruises in 2005. Samples were kept at a cool temperature, returned to the CCAP laboratory at SAMS in Scotland and pure algal cultures were isolated. Strains were identified using a combination of traditional morphological examination and also DNA extraction and 18S rRNA gene analysis. The accession of such strains into CCAP will allow for future research into their ability to survive under differing environmental conditions, their suitability for long-term storage using cryopreservation techniques, and may act as a "living archive" if environmental change has a devastating effect on polar phytoplankton biodiversity.

20) WILL ESTABLISHMENT OF AN INTRODUCED RED ALGA RESULT IN LOCAL BIODIVERSITY CHANGES?

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The Pacific red alga *Heterosiphonia japonica* was first observed in Europe in 1994, and has since then had a rapid dispersal along European shores. Due to its high abundance in many habitats along the southwestern coast of Norway an impact on local macroalgal communities might be expected. Sublittoral algal communities at 14 localities on the southwest coast of Norway, investigated in 1994 before the establishment of *H. japonica*, were reinvestigated in 2003 by using the same sampling methods. The total number of recorded macroalgae in the area was approximately the same in 2003 as in the first study. A multidimentional scaling ordination showed that the macroalgal species composition was not much different in 2003 compared to the first study. Our main conclusion is that *H. japonica* has not had a negative impact on algal species richness in the relative short time span since its introduction The results of a similarity analysis (SIMPER) showed some temporal changes in composition of the algal communities, mainly caused by increased frequency of recordings of 'southern species' (species with a northern limit on the Norwegian coast) in 2003 compared to the first study. Also, the percentage share of 'southern species' of recorded species at the localities was higher in 2003 than in the first study. The temporal differences observed are most likely to be caused by several warm summers/autumns and mild winters since the first investigation, which may favour a higher abundance of algal species which have their main area of distribution south of Norway.

21) UNATTACHED GERMLINGS AS POTENTIAL PROPAGULES IN FIVE SPECIES OF GIGARTINALES (RHODOPHYTA)

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Spores, gametes, zygotes, and vegetative fragments are the most common types of seaweed propagules. Spores have short

viability, loosing their ability to attach to the substratum after a few days. Also, some species show low percentage of adhesion. Therefore, attachment of spores seems a difficult process. Preliminary observations indicated that spores that did not attach in a short period laid a cell wall and initiated cell divisions, growing into free-floating germlings. Experimentally, we evaluated the frequency with which unattached germlings were produced in some species of Gigartinales. Tetraspores and carpospores of *Mazzaella laminarioides*, *M. membranacea*, *Chondracanthus chamissoi*, *Sarcothalia crispata* and carpospores of *Mastocarpus papillatus* were incubated in several trials. Results showed that a small percentage of spores of both life-history phases attached and developed directly into "normal" disks, whereas most developed into unattached germlings, which later produced filaments with which they adhered to the substratum and formed a basal disks. These results indicate that spores that are not successful in arriving to a suitable substratum and attaching within a few days after being released may not be lost. Instead they may follow a different pathway in the life cycle. Producing attachment filaments facilitates crossing the barrier imposed by biological films that usually cover natural substrata. Given the high frequency of formation of free-floating germlings and their ability to attach they should be considered as propagules in these species of Gigartinales. Dispersal distances of these propagules may be much greater than that of spores. (Funded by DIN-UCSC, Grant 01/2001).

22) IS WESTERN IRELAND A CENTRE OF DESMID DIVERSITY IN THE BRITISH ISLES?

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The 'desmids' (Zygnemoidiinae *pro parte*, Closteriinae, Desmidiineae) are the largest group of green algae in the British Isles. Of about 750 species (over 1330 taxa) recorded in Great Britain and Ireland, almost two-thirds are only known from relatively nutrient-poor waters with an acid pH. Of the remainder the large majority occur in circumneutral and/or alkaline waters with very few confined to alkaline waters where nutrient levels are sometimes relatively high. The diversity and abundance of desmids is greatest in the high rainfall areas of the north and west of the British Isles where nutrient-poor waters abound. When selecting the most Important Plant Areas (IPAs) in Britain, it became evident that northwest Scotland and the English Lake District are centres of desmid diversity ('hotspots'). In these areas are some of the most desmid diverse sites known (often >100 taxa at a site) and present are many rare desmids unknown from elsewhere in Britain. Selection of IPAs was on the basis of the 'best available' site-specific information collected over the last 50 years. Ireland was outside the scope of the IPA project and yet western Ireland far surpasses most other parts of the British Isles for its richness of lakes, bogs and other habitats whose waters are soft and non-alkaline. New information on the desmid flora of western Ireland is presented, and compared to more and less intensively sampled parts of the British Isles.

23) CAN ALGAL STRUCTURAL COMPLEXITY BE USED TO PREDICT INVERTEBRATE ABUNDANCE?

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Six established methods to quantify algal structural complexity were examined using replicates of 12 algal species from each of two rock pools to determine if they could be used to predict invertebrate abundance. Fractal dimension and order of branching showed no significant correlation with invertebrate abundance. Bifurcation ratio and number of tips/order of branching only showed significant correlations with macrofauna. Interstitial volume showed significant negative correlations with total, macrofaunal, and meiofaunal abundance whilst frond density showed significant positive correlations. When used as a predictive measure of faunal abundance for a given algal structural complexity, frond density and interstitial volume produced significant regressions for which there was no significant difference between slope and elevation of actual versus predicted regression lines. R^2 showed that regression of abundance against frond density accounted for a greater proportion of the variability in invertebrate abundance than did interstitial volume. Measures such as frond density, and to a lesser extent interstitial volume, as well as being the most convenient to measure, are good indicators of algal use as a habitat by invertebrates.

24) PATTERN OF PERIPHYTIC ALGAE AND THE EFFECTS OF AN ARID YEAR ON THE RIVER DANUBE AT GÖD

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Periphyton sampling was carried out on a monthly basis in the River Danube at Göd (riv. km 1669) in the period 1984-86. This work has continued from 2003. The ratio of different algal groups was observed by light microscopy, periphytic diatom composition was determined by light and scanning electron microscopy, furthermore, the abundance of picoalgae was calculated by fluorescent microscopy. In addition, some physicochemical parameters of the water were measured. The scope of these studies was to compare the monthly and longer-term patterns of the periphytic algal composition and to analyse the water quality with the aid of diatom indices. An unexpected aspect of the studies was an uncommonly dry period in 2003. In August 2003 unusually low phytoplankton abundances were found at Göd, which did not correspond to the low water discharge. At the same time benthic diatoms showed exceptionally vigorous multiplication and produced large masses of gelatinous matrix. The diatom-based water quality was subsequently found to be poor (polluted). In order to find the possible causes of these phenomena, toxicity tests (with *Sinopis alba* and *Scenedesmus capricornutum*) were carried out, and the heavy metal content of the periphyton was measured using TXRF method. On the poster, the pattern of the periphytic algal composition, water quality analysis and the possible causes and consequences of the 2003 phenomenon are discussed.

25) THE USE OF PHENOTYPIC PLASTICITY TO ASSESS ECOLOGICAL CONDITIONS IN POLISH AQUATIC ECOSYSTEMS

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Desmodesmus was tested as a bioindicator of nutrient conditions in several freshwater reservoirs in Poland.

Desmodesmus produces a variety of morphs such as spiny colonies (low nutrients), unicells (elevated phosphorus or nitrogen) and spineless colonies or unicells (low iron). *Desmodesmus* was collected from the Vistula River and isolated into axenic culture (strain V-3). V-3 produced spiny and spineless morphs in defined media. Water samples were collected from three different reservoirs during four seasons (pre-filtered, sterile-filtered and stored in sterile bottles at 4C). A bioassay experiment was set up using 4-well sterile-titre plates. Each water sample was inoculated into duplicate wells and inoculated with 1 x 10^5 cells ml^{-1} of the V-3 strain. Control cultures (medium 7 and additions) were also inoculated. The cultures were maintained at 24C and 16 h L: 8 h D. The cultures were counted after 72 hours for percentage of spiny and/or spineless colonies and unicells. Our results gave an indication that there was a differential phenotypic response to the concentration of nutrients of the three reservoirs (R1>R2>R3). R1 had a higher percentage of spiny unicells (up to 40%) than R2 and R3. R2 and R3 were dominated by spiny colonies (R2: 90% 4-celled and R3: 50% 2- and 50% 4-celled). The only seasonal difference was the spring sample of R2 (90% colonies with short spines). The phenotypic plasticity response from the titre plate experiments was compared to the actual chemical analyses of the water samples. The results suggest that the morphs of *Desmodesmus* V-3 may be used as general indicators of nutrient availability in natural ecosystems.

26) ALGAEVISION – WEBSITE OF FRESHWATER ALGAL IMAGES

'***A VIRTUAL COLLECTION AND IDENTIFICATION TOOL***'

Peter V.York and David M.John

Department of Botany, The Natural History Museum, London, UK.

We are pleased to announce '*AlgaeVision*' a new and revised website of images and habitats of UK freshwater algae. It enables users to readily compare algae, viewed under the microscope, with over 1000 high quality colour images of more than 150 genera and 300 species in all major phyla other than diatoms. The large majority are of living algae since crucially important diagnostic features are not always visible or become lost when an alga is preserved. To give added value to the database included are many images of harmful and nuisance algae. Many images are of specimens collected on fieldwork visits to various parts of the UK where algal habitats, waterblooms and macroscopic algal growths have been photographed. A variety of microscopic techniques have been used to produce completely in-focus images from electronically processed series of optical slices. Accompanying each algal image is its currently accepted binomial authority, unique 8-digit code, magnification, collection date, site details and pages where the species taxon is described and illustrated in 'The Freshwater Algal Flora of the British Isles' (John et al., 2002, reprinted May 2003).

27) BRITISH ISLES SEAWEED IMAGES

F. StP. D. Bunker[1], C.M. Maggs[2], J.M. Perrins[3] & A.R. Bunker[4]

[1]*MarineSeen, Estuary Cottage, Bentlass, Hundleton, Pembrokeshire, SA71 5RN, Wales, UK;*

[2]*Queens University of Belfast, MBC Centre, 97, Lisburn Road, Belfast, Northern Ireland BT9 7BL, UK;*

[3]*exeGesIS SDM Limited,Great House Barn, New Street, Talgath, Powys, LD3 0AH, UK;*

[4]*Countryside Council for Wales, Llanion House, Llanion Park, Pembroke Dock, Pembrokeshire, Wales, SA72 6DY, UK.*

This project is creating an interactive colour photographic guide to the marine algae of the British Isles on the Internet (http://www.weedseen.co.uk) and in .pdf format. The images supplement and complement available keys and guides to marine algae and are linked to the British Museum Flora series, providing an additional tool for confirming identifications. Most available guides (including the British Museum Flora series) are based on either line drawings or black and white photographs and this colour guide will serve as an additional resource. In addition to photographs obtained in the field, microscope and laboratory based images are used. Working in collaboration with the Joint Nature Conservation Committee, over 80% of the Marine Nature Conservation Review littoral and sublittoral species lists are currently illustrated. The project has been financed by the Joint Nature Conservation Committee (JNCC), Countryside Council for Wales (CCW), British Phycological Society and carried out in association with MarLIN.

28) TESTING FOR HIDDEN DIVERSITY IN RED ALGAE IN THE UK

Lavinia Robba and Barbara Rinkel (J.Brodie@nhm.ac.uk)

Natural History Museum, Department of Botany, Cromwell Road, London SW7 5BD, UK.

The seaweed flora of the UK is well documented, yet evidence suggests that there is hidden diversity still to be discovered. The aim of this project is to use molecular markers to look for hidden diversity in red algae that are widespread in the UK and to see if there is any difference in genetic variation within and between individuals collected from different regions of the coast. We are initially concentrating on a few, morphologically highly variable, widespread species including *Mastocarpus stellatus*, *Calliblepharis ciliata* and *C. jubata*. Molecular markers used include the mitochondrial cytochrome c oxidase (CO1) and the plastid URP1 genes. Preliminary results of sequence data indicate that *Mastocarpus stellatus* may represent a species complex, or at least the possibility that incipient speciation is taking place and this confirms previous results by other workers for this species. Generally we know very little about the genetic variation in species of red algae on UK shores so this work will increase our knowledge in this respect. The results will contribute towards the development of a DNA-barcoding system for the red algae.

Activities of the Biodiversity and Conservation Committee of the British Phycological Society 2005

Juliet Brodie, Natural History Museum, London.

It has been a very active and positive year for the Biodiversity and Conservation Committee. Members of the committee have met twice over the last year, once in May 2005 in London at the Natural History Museum and again in January 2006 in Plymouth during the British Phycological Society winter meeting. Below is a summary of the main activities of the committee. If you would like further information on any of the topics then please contact Juliet Brodie at J.Brodie@nhm.ac.uk, or write to her at The Natural History Museum, Department of Botany, Cromwell Road, London SW7 5BD.

Important Plant Areas and related topics

A major achievement was that the first list of important algal sites was sent off for consultation to Plantlife as potential Important Plant Areas (IPAs). Eleven sites were submitted for the marine algae, covering locations in England, Wales, Scotland and Northern Ireland. Fourteen freshwater sites were also submitted and these were based on data relating to desmids. The committee is very grateful to the members of the British Phycological Society who have nominated potential sites and who have also provided much valuable information. All the sites that have been nominated will form part of a document *Important Freshwater and Marine Algal Sites in the UK* that will be completed in the next few months. Another part of this work has been the generation of a list of 'rare' marine algal species published in *The Phycologist* (Brodie *et al.* 2005). It is anticipated that a refined version of the list will enable an assessment of these species as to whether they are genuinely rare and/or if they are at potential risk. Primarily as a result of data generated for the IPA project, member of the Biodiversity and Conservation Committee have been able to put forward twelve possible marine species and over two hundred freshwater desmids as possible BAP species as part of the UK BAP revision process that is currently underway.

Members of the committee have also been active in their input to the Lower plant strategy for Scotland which has now been launched, and to report on algal progress in relation to the Plant Diversity Challenge with information being supplied to DEFRA.

Field meetings

2005 was a good year for field meetings, including the well established freshwater algal identification courses based at Kindrogan (run by Eileen Cox and Elliot Shubert) and Durham (run by Brian Whitton and David John) as well as the highly successful Marine algal identification course in Southampton (run by Francis Bunker and Christine Maggs) which is rapidly becoming a regular fixture. A seaweed identification day in Cornwall (Juliet Brodie) attracted considerable interest and a large number of participants. 2006 promises to be another good year for courses with all of the above courses planned, plus one on the identification of freshwater and subaerial algae of Ireland (Fabio Rindi and David John) in Galway and an advanced course on blue-green and green algae in Durham in addition to the introductory course. This interest in the identification of the algae is very welcome news and it is one of the aims of the committee to try to ensure that this is encouraged and nurtured in the years to come.

Flora volumes

Freshwater algae: The Freshwater Algal Flora of the British Isles (John *et al.* 2002) has sold almost 1,300 copies since publication with £700 of royalties going to the British Phycological Society. A further 500 were printed in 2005, indicating the success of this project. The CD of algal images that accompanies the volume is now available on the worldwide web ('AlgaeVision').

Green seaweeds: A new, fully illustrated flora of the green seaweeds of the British Isles, incorporating all the latest information is now underway with an expected publication date of early 2007. It is a multi-author project with an international team edited by Juliet Brodie, David John and Christine Maggs and with contributions from Martin Wilkinson, Jaanika Blomster, Lynne McIvor, Fabio Rindi, Frederik Laeliert, Ruth Nielsen, Thomas Pröschold, John Kelly and Barbara Rinkel.

Brown seaweeds: The second part of the brown seaweeds of the British Isles is nearing completion. Bob Fletcher made several visits to the Natural History Museum (London) in the latter part of 2005 to examine and extract data from material of species that he was unable to find in the field. He proposes to have the manuscript ready for submission by June 2006.

References

Brodie J., Tittley I., John D. & Holmes M. (2005). Important Plant Areas for the marine algae: determining which species are rare. *The Phycologist* 68: 3-5.

John, D.M., Whitton, B. A. & Brook, A.J. (2002). *The Freshwater Algal Flora of the British Isles*. Cambridge University Press.

The British Phycological Society

Registered Charity No. 246707

Annual Report for the year ended 30th September 2005

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 M.D. Guiry	Hon. Treasurer:	Dr M.L. Tobin
Vice President:	Professor G.A. Codd	Hon. Eds (*Eur. J. Phyc*):	Professor M.J. Dring
Overseas President	Dr S. Fredericq		Dr E.J. Cox
Immediate Past President:	Dr B.S.C. Leadbeater	Hon. Ed. (*The Phycologist*):	Dr A.R. Taylor
Hon. Secretary:	Dr J.D. Parry	Webmaster:	Professor M.D. Guiry
Hon. Membership Sec:	Dr G.W. Scott		

Ordinary Members

Dr F. Küpper	Dr D.M. John	Professor E. Shubert	Dr L. King
Dr M. Wilkinson	Dr S.C. Maberly	Dr J. Brodie	Dr J. Krokowski
Dr D. Stengel	Miss S. Marsham		

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

This is the second Annual Report presented by the current Hon. 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 annual winter meeting and AGM were held at the University of Birmingham. The standard of presentations was as usual very high and congratulations go to Fiona Young and Eva Novak who shared the Manton Prize this year, and Stephanie Thompson, who received the annual Poster Prize. Nine students received support to attend this meeting from the Scientific Meetings Fund (SMF) (nine in 2004). The auction raised £242 and thanks must go to Prof. Elliot Shubert for his continuing enthusiasm and efforts. Please note that due to a banking error the proceeds for the auction will appear in next year's financial report. The meeting returned a surplus of £1,253 (primarily due to a 10% refund on the accommodation) and this money has been used to support the 2006 meeting.

Ten students were supported to attend algal identification workshops organised by the Society and two students received support to attend international meetings to present their research findings. No applications were received for summer research projects this year.

Honoraria were paid to some officers for whom it was felt the time commitment of the positions was exceptional. Honoraria for 2004 not processed before the end of the last financial year appear in this year's financial report. For the current year, the Hon. Membership Secretary, Hon. Secretary and the Hon. Editor of *The Phycologist* each received £750, the Hon. Treasurer received £1,000 and the Hon. Editors of the *European Journal of Phycology* received a total of £1,500. The archivist received an Honorarium of £150 in recognition of his contribution to the maintenance of the Society's archive material.

Members should note that the status of the bank account and high publications expenditure this year reflects the fact that Taylor and Francis billed us for the 2003 and 2004 EJP issues together (due to an error on their part). It was necessary to use the short term deposit account to pay the invoice as at the time the current account did not contain sufficient funds. Since this payment the Society has received the 2005 membership subscriptions and the Journal profits from Taylor and Francis. It is envisaged that money will be transferred to the short term deposit account during the next financial year.

The Journal has performed well financially and the balance to the Society from Volume 39 was £25,979.93 (£20,000 for Volume 38) due to the current guaranteed annual income of at least £20,000 from the publishers, Taylor and Francis.

The Society's financial situation remains good. The Scientific Meetings Fund was topped up to a total of £25,000 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 patience and support during this financial year.

The British Phycological Society

Registered Charity No. 246707

Statement of Financial Activities for the Year ended 30th September 2005

	Note	Unrestricted General £	Designated S.M.F. £	Restricted Manton £	Total 2005 £	Total 2004 £
Income and Expenditure						
Incoming Resources						
Subscriptions 2004		2,158.50			2,158.50	7,523.00
Subscriptions 2005		8,254.63			8,254.63	0.00
Surplus from Journal		25,979.93			25,979.93	20,000.00
Atlas Book		0.00			0.00	1,704.50
Auction proceeds		0.00			0.00	0.00
FW Atlas		1,111.03			1,111.03	0.00
Interest		3,314.80			3,314.80	2,144.62
Winter Meeting 2005 surplus		1,253.66			1,253.66	
Miscellaneous (Jubilee A/C Transfer)		0.00			0.00	7.82
Miscellaneous (cash return)		300.00			300.00	0.00
Total Incoming Resources		**42,372.55**	**0.00**	**0.00**	**42,372.55**	**31,675.78**
Resources Expended						
Grants, studentships & awards	**2**	2,700.00	1,186.07	250.00	4,136.07	6,597.65
Publications expenditure	**3**	23,756.02			23,756.02	6,464.51
Meetings & Committee Expenses	**4**	3,372.35			3,372.35	558.01
Administration Costs	**5**	9,380.71			9,380.71	8,737.89
Reduction in provision for newsletters						-8,214.68
		39,209.08	**1,186.07**	**250.00**	**40,645.15**	**14,143.38**
Net Incoming (Outgoing) Resources for the Year		**3,163.47**	**-1,186.07**	**-250.00**	**1,727.40**	**17,532.40**
Fund at 1 October 2004		42,111.02	25,000.00	5,694.09	72,805.11	55,272.71
Transfer (General to SMF)		**-1,186.07**	1,186.07		0.00	0.00
Fund at 30 September 2005		**44,088.42**	**25,000.00**	**5,444.09**	**74,532.51**	**72,805.11**

Balance Sheet as at 30 September 2005

	Note	2005 £	2004 £
Current Assets			
Debtors	**7**	2,001.58	1,652.25
Short term deposits		57,149.21	71,853.24
Cash at bank		29,028.69	11,690.26
		88,179.48	85,195.75
Liabilities: amounts falling due within one year	**8**	13,646.97	12,390.64
Net Assets		74,532.51	**72,805.11**
Funds	**9**		
Unrestricted		44,088.42	42,111.02
Restricted		5,444.09	5,694.09
Designated		25,000.00	25,000.00
		74,532.51	**72,805.11**

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

The British Phycological Society

Registered Charity No. 246707

Notes to the Account for the Year ended 30th September 2005

1 Accounting Policies

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

Basis of Accounting

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

Subscriptions

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

Funds

Restricted funds comprise unexpended balances of donations and interest to be applied for specific purposes. At 30 September 2005, the Society's only restricted fund was the Manton Fund. Designated funds are those set aside out of unrestricted funds for specific purposes. At 30 September 2005, 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 2005 £	Total 2004 £
2 Grants, Studentships & Awards					
Travel awards for 2005 Winter Meeting		1,036.07		1,036.07	1,347.65
Awards for courses, travel, Summer Bursary	2,700.00			2,700.00	1,850.00
Manton Prize			250.00	250.00	250.00
Poster prize at Winter Meeting		150.00		150.00	150.00
Special Project Grants				0.00	3,000.00
	2,700.00	**1,186.07**	**250.00**	**4,136.07**	**6,597.65**
3 Publication expenditure					
Journal	17,313.75			17,313.75	0.00
Hon. Editor's Honorarium (2004)	1,500.00			1,500.00	750.00
Hon. Editor's Honorarium (2005)	1,500.00			1,500.00	0.00
E.J.P. Management Committee	1,136.74			1,136.74	116.93
The Phycologist	2,305.53			2,305.53	3,505.33
Algal Atlas	0.00			0.00	1,704.50
Miscellaneous (ID Book)	0.00			0.00	387.75
	23,756.02	**0.00**	**0.00**	**23,756.02**	**6,464.51**
4 Meetings & Committee Expenses					
Council Meeting 2004	813.50			813.50	278.95
Council Meeting 2005	2,558.85			2,558.85	0.00
Biodiversity Committee Expenses	0.00			0.00	279.06
	3,372.35	**0.00**	**0.00**	**3,372.35**	**558.01**
5 Administration Costs					
Executive expenses	100.00			100.00	594.47
Public liability insurance	367.50			367.50	367.50
Independent Examiner's Fee	802.50			802.50	746.25
Credit Card Charges	460.80			460.80	391.80
Bank Charges	252.01			252.01	101.00
Executive Honoraria (2004)	1,400.00			1,400.00	6,000.00
Executive Honoraria (2005)	3,250.00			3,250.00	0.00
Archivist Expenses	37.50			37.50	31.90
Web page maintenance (2003-05)	1,500.00			1,500.00	0.00
Miscellaneous (cc refund)	36.50			36.50	504.97
Federation of Bioscience Federation Subscription	398.00			398.00	0.00

The British Phycological Society

Registered Charity No. 246707

Notes to the Account for the Year ended 30th September 2005 cont.

	Unrestricted General £	Designated S.M.F. £	Restricted Manton £	Total 2005 £	Total 2004 £
5 Administration Costs (cont.)					
Hon. Secretary Expenses	75.74			75.74	0.00
Attendance at Bioscience Federation	700.16			700.16	0.00
	9,380.71	**0.00**	**0.00**	**9,380.71**	**8,737.89**

6 Reimbursment of Council Members' expenses

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

7 Debtors	2005 £	2004 £
Interest receivable	2001.58	1652.25
	2001.58	**1652.25**

8 Liabilities: Amounts falling due within one year		
Accruals	3146.97	746.25
Provision for the Journal and The Phycologist	10500	11644.39
	13646.97	**12390.64**

9 Analysis of Net Assets between Funds

	Unrestricted Funds £	Restricted Funds £	Designated Funds £	Total Funds £
Fund balances as at 30 September 2005 are represented by				
Current assets	57,735.39	5,444.09	25,000.00	88,179.48
Current liabilities	-13,646.97			-13,646.97
Total Net Assets	**44,088.42**	**5,444.09**	**25,000.00**	**74,532.51**

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 2005, 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 unsual 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 consquently 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
23 December 2005

Announcements

For further information on Algal training courses courses, see the British Phycological Society website: www.brphysoc.org/courses.lasso

Identification of the Freshwater and Subaerial Algae of Ireland

This introductory course runs from Monday 12 to Friday 16 June 2006 at the Martin Ryan Institute, National University of Ireland, Galway. The fee of 150 Euro covers tuition, documentation, field excursion, lunch and minor refreshments.

The course aims to provide a broad training in identifying all groups of freshwater/subaerial algae and is designed for those with little previous knowledge on non-marine algae. The focus will be on those algae used for monitoring environmental change, assessing the 'ecological status' of sites/habitats and/or the cause of nuisance problems. Several different types of recently developed identification aids will be used, including multi-access keys on CD-ROMS, image database web sites and 'The Freshwater Algal Flora of the British Isles'.

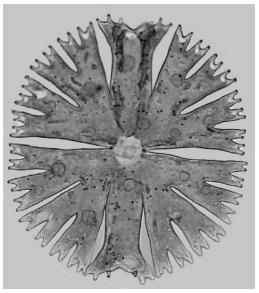
Lectures and practicals will usually run from 0900 to 1800 and there will be a half-day field visit to demonstrate sampling methods.

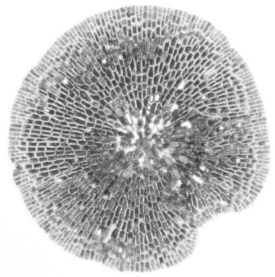
The organisers, Drs David John (Marie Curie Fellow, MRI) and Fabio Rindi (MRI), deal with all algal groups other than diatoms; diatoms will be dealt with by Dr Bernadette Ni Chatháin.

For further information, contact the organisers:

david.john@nuigalway.ie, phone 091493210 (office) /0872553909 (mobile) or fabio.rindi@nuigalway.ie, phone 091493200 (office). If phoning from outside Ireland use 0035 and drop the first '0' in the Irish regional code.

Photos: *Micrasterias* and *Phycopeltis*.





Introduction to Freshwater Algal Identification

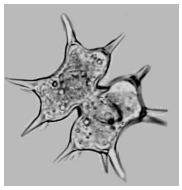
The course runs from Sunday 2 July to Friday 7 July 2006 at Hild-Bede College and School of Education, University of Durham, UK. The inclusive cost for all participants other than full-time research students is £850 (no VAT charge). The discounted price for full-time students or people from countries outside Europe is £750. More than 220 people have attended the Introductory course since it began in 1992.

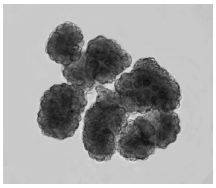
The course aims to train staff from the Environment Agency, Scottish Environment Protection Agency, water plcs and other companies, research students and overseas visitors in the identification of freshwater algae. Related topics, such as aspects of monitoring and implications of the EU Water Framework Directive, will be introduced.

Lectures/practicals run until 2115 each evening, including the Sunday. Most study is in the laboratory, but there is at least one field visit.

The organisers, Prof. Brian Whitton (Durham) and Dr David John (Marie Curie Fellow, Martin Ryan Institute, National University of Ireland, Galway), give the majority of the lectures. Dr Gordon Beakes assists at the beginning of course; Dr Alan Donaldson (special expertise blue-green algae) helps on several days; Dr Martyn Kelly gives lectures and practicals on diatoms.

Anyone wanting further information is welcome to email or phone Brian Whitton: b.a.whitton@durham.ac.uk, phone 0191-386-7504 (home) or 0191-334-1347 (university). People in Ireland may prefer to contact David John directly: Dr D.M. John, Martin Ryan Institute, National University of Ireland, Galway; email david.john@nuigalway.ie, phone 091-493210 (NUI, Galway) or 0872553909 (mobile).





Photos: *Xanthidium* and *Botryoccoccus*.

Advanced Course on Blue-green and Green Algae

The course runs from Friday 7 July to Sunday 9 July 2006 at Hild-Bede College and School of Education, University of Durham, UK. The inclusive cost is £275 (no VAT charge).

The aim is to provide training on identification of blue-green algae (cyanobacteria) and green algae at a more advanced level than the 'Introductory Course on Freshwater Algae'. This short course is planned for anyone who has attended one of the introductory courses, but also for those who have considerable experience of field material. Participants on previous advanced courses have included biological staff from Environment Agency, Scottish Environment Protection Agency, water plcs and overseas visitors. The course will focus on identification, especially modern methods, such as the use of various CDs and information available from websites.

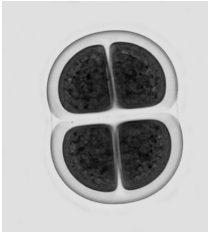
Lectures/ practicals run until 2100 on Friday and Saturday. Because the course is short, the only opportunities for field visits will be very local.

The course leaders are Dr David John (Marie Curie Fellow, MRI) and Prof. Brian Whitton (University of Durham). Dr Alan Donaldson (consultant) will also contribute to it.

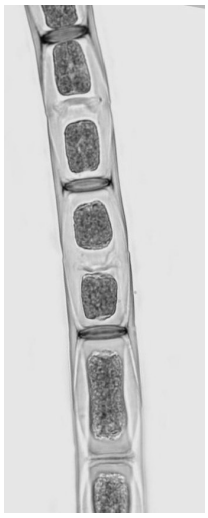
Anyone wanting further information is welcome to email or phone Brian Whitton: **b.a.whitton@durham.ac.uk** phone 0191-386-7504 (home) or 0191-334-1347 (university). People in Ireland may prefer to contact David John directly: Dr D.M. John, Martin Ryan Institute, National University of Ireland, Galway.

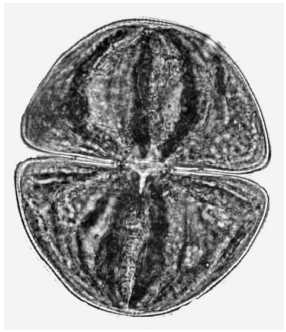
david.john@nuigalway.ie
phone (in Ireland), 091-493210 (office), 0872553909 (mobile)

Photo: *Chroococcus*.



FRESHWATER ALGAE COURSE 2006





Photos: ***Microspora*** **and** ***Cosmarium.***

Where and when?

Kindrogan Field Centre, Enochdhu, Blairgowrie, Perthshire, Scotland (near the tourist area of Pitlochry), 24 - 31 July, 2006.

What is the course about?

The course takes full advantage of the excellent range of aquatic and terrestrial habitats in this beautiful area of the Scottish Highlands in Perthshire to provide a sound introduction to the recognition, identification and ecology of freshwater algae. Emphasis will be placed on the use of the microscope and taxonomic keys (print and electronic) for the identification to generic and species level and the ecological importance of algae.

For those with some prior knowledge of the algae, we hope that the opportunity to study samples from a range of habitats will broaden their knowledge and/or allow them to focus on particular groups.

Field trips, on foot or by vehicle, will be varied, but not strenuous and will be complemented by laboratory work, illustrated talks and class discussion.

The course focuses on how to get to grips with identification, and the broader aspects of algal morphology, structure, reproduction, and systematics (morphological and molecular).

Who are the participants?

The course is open to individuals with different backgrounds ranging from beginners to those who would like to refresh their knowledge of particular groups of algae or broaden their experience collecting in a different region of the world.

What is the full cost of the course?

The course costs £410 per person (approx € 599 or $724), which includes excellent on-site accommodation, all meals (please notify if you have any special dietary needs) and tuition. This is excellent value for money and costs *significantly less* than other algal courses on offer.

Who are the course tutors?

The course tutors, Dr Eileen Cox and Professor Elliot Shubert, have taught this course for the past nine years and have a wide ranging expertise on freshwater algae. Eileen and Elliot conduct research at The Natural History Museum, London, specialising in diatoms and green algae respectively. Eileen has published a key to live diatoms and Elliot has published a key to the non-motile coccoid and colonial green algae.

Is there support for students?

Yes, support for a student stipend is available from:

The British Phycological Society**,**
http://www.brphycsoc.org/funding.lasso

Student members of the British Phycological Society are eligible for stipend support. **The deadline for applications is 1 June 2006.**

Phycological Society of America**,**
http://www.psaalgae.org/ops/grants.shtm#croasdale

Graduate students who are members of the Phycological Society of America are eligible for financial support to attend a phycology course at a field station from the Hannah T. Croasdale Fellowship. **The deadline for applications is 1 March 2006.**

British Ecological Society**,**
http://www.britishecologicalsociety.org/grants/attendmeetings/index.php#specialist_course

Student members of the British Ecological Society may be eligible for a 'specialist course' British Ecological Society stipend. **Applications open on 16 February 2006.**

How do you get to Kindrogan?

Edinburgh and Glasgow have international airports. The nearest mainline railway station is Pitlochry, which is on the London Kings Cross-Edinburgh-Inverness route. Coaches leave from London and Edinburgh. Participants will be met at Pitlochry by Kindrogan staff.

Where can I find more information?

For detailed information about the Kindrogan Field Centre go to: http://www.field-studies-council.org/kindrogan/

For specific information on the course, go to:

http://www.field-studies-council.org/professional/2006/courseinfo.aspx?id=521

For a booking form go to:

http://www.field-studies-council.org/documents/leisurelearning/2006/bookingform.pdf

A £50 (approx € 71 or $94) non-refundable deposit is required (credit cards are accepted).

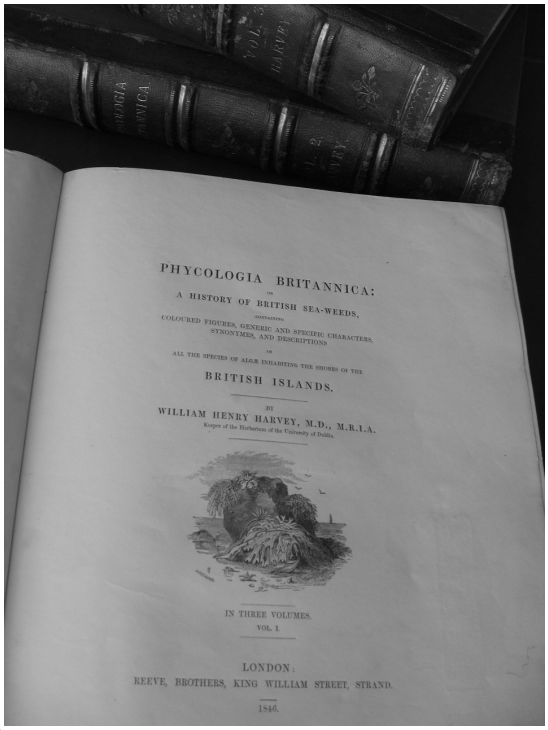
Prospective applicants may be interested in reading the experiences of two students who participated in the 2005 course in the Autumn 2005 issue of *The Phycologist* 69: page 6. http://www.brphycsoc.org/phycologist.lasso

If you have any other queries, please contact:
e.shubert@nhm.ac.uk

Professor Elliot Shubert, Department of Botany, The Natural History Museum, Cromwell Road, London SW7 5BD, UK.

FOR SALE

Phycologia Britannica by W.H. Harvey 1846-51, Reeve Brothers



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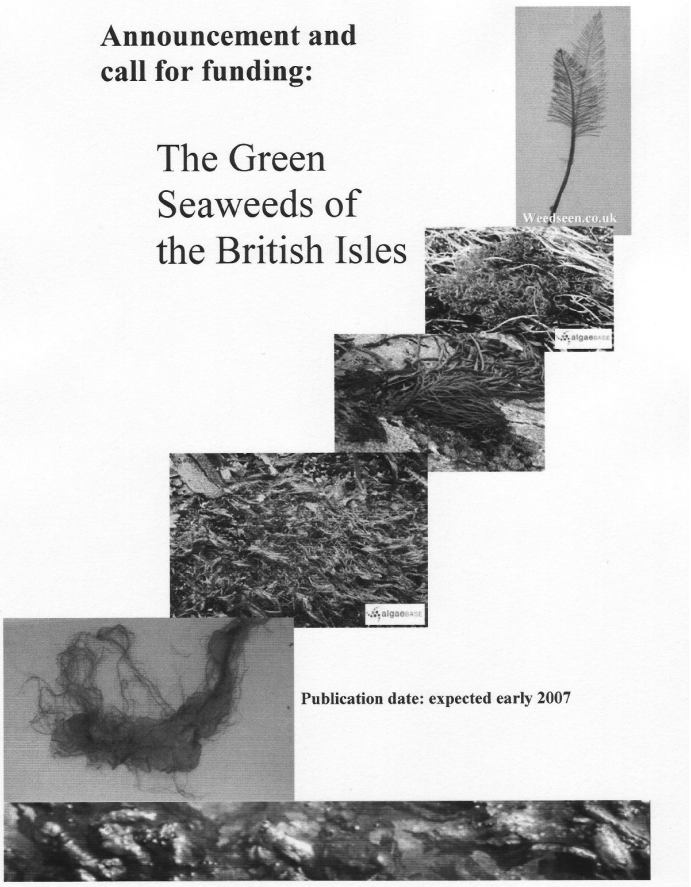
Announcement and call for funding:

The Green Seaweeds of the British Isles



Publication date: expected early 2007

Background

The last book to be published on the green seaweeds of the British Isles was by Elsie Burrows. Published in 1991, it was the *Chlorophyta* volume in the series *Seaweeds of the British Isles*, a collaborative project of the British Phycological Society and the Natural History Museum in London.

Dr Burrows' book remains the only authoritative guide and yet was always out of date since it was published four years after she passed away. Only about two-thirds of the species were illustrated, by line drawings, although a small collection of black and white plates of nine species was included at the end.

Over the past 25 years, considerable advances have been made in our understanding of the taxonomy and morphology of green seaweeds. Most progress has been in morphologically difficult groups, owing much to the ready availability of molecular tools. As a result, there have been many taxonomic changes in the green seaweeds including the merging of well-known genera.

NEW BOOK *The Green Seaweeds of the British Isles*

We are seeking funding to prepare a multi-authored, authoritatively written book incorporating all the latest information on the green seaweeds of the British Isles. It will be fully illustrated and is intended to enable the ready identification of all the green seaweeds known from the British Isles (about 100 species). Included will be user-friendly keys, diagnostic descriptions, ecological information, notes for the taxonomic specialist, line-drawings, monotone and colour photographs.

Who is involved?

Lead: Juliet Brodie **Consultant:** Linda Irvine

Editors: Juliet Brodie, David John, Christine Maggs

Authors: Juliet Brodie, David John, Christine Maggs, Martin Wilkinson, Jaanika Blomster, Lynne McIvor, Fabio Rindi, Frederik Laeliert, Ruth Nielsen, Thomas Pröschold, John Kelly, Barbara Rinkel.

Families included in volume

Prasiolaceae	Acrosiphonaceae	Bryopsidaceae
Chlorococcaceae	Ulvaceae	Codiaceae
Ulotrichaceae	Chaetophoraceae	Chaetosiphonaceae
Monostromataceae	Cladophoraceae	

Estimated cover price

It is important to keep the cover price to below £20 to ensure the volume has as wide a distribution as possible. This will encourage not only professional scientists but others with an interest in the marine environment to purchase their own copies.

Why we need funding

All species will be illustrated by line drawings and monotone photographs. Ideally we would also have colour photographs of most species since these are invaluable aids to identification. Funding will go towards subsidising the cost of production, with the number of colour photographs dependent on the level of support and sponsorship we receive. Each colour plate costs approximately £60 and a page of black text and black line drawings £20 to print. Our target for the project is to raise £15k in sponsorship.

WHY YOU SHOULD SUPPORT THIS PUBLICATION

- There is an overwhelming need by the water industry, the Environment Agency, SEPA, Marine Institute, countryside agencies, conservation bodies, contract agencies, professional scientists and others for a modern, authoritative and well-illustrated guide to the green seaweeds of the British Isles.
- There is a need to accurately identify those green seaweeds causing undesirable biological changes when they are present in large and nuisance quantities on nutrient-impacted shores, e.g. polluted shores.
- All agencies involved with assessing 'ecological status' of shores under the EU Water Framework Directive need an authoritative guide to enable them identify environmentally sensitive and opportunistic seaweeds including the green algae.
- Important Plant Areas in Europe for seaweeds will require accurate inventories of all those marine algae present of which the green algal flora is an important component.
- Many green seaweeds have a wide geographical distribution, therefore this volume will be used by workers outside Britain and Ireland for identification and be an important source of modern information on the group.

All those who sponsor the green seaweed volume will be prominently acknowledged.

If you wish to sponsor the book, please contact Christine Maggs (c.maggs@qub.ac.uk) or telephone +44 (0) 28 90972265

Interested in an accompanying CD?

A CD supplement to the volume may also be produced depending on interest and costs involved (estimated at £5,000). This would contain more colour photos of each species and their habitats and possibly an interactive species key.

Please express your interest and thoughts on this to John Kelly: j.kelly@qub.ac.uk

First notice

British Phycological Society Winter Meeting, Belfast

Wednesday 3rd to Saturday 6th January 2007

Venue: Queen's University, Belfast, Northern Ireland, on and around Medical Biology Centre site (MBC), Lisburn Road/Elmwood Avenue junction (close to the main University site).

Travel to Belfast is easy and cheap if booked early. Belfast City airport is about 15 min taxi/bus ride; the International Airport is about 30 min away by bus. Another possibility is Dublin airport, with hourly buses to Belfast (trip takes about 2.5 hours).

Costs: conference fee is expected to be around £60 for BPS members, including lunches.

Outline programme:

Wednesday January 3

1500 Council meeting (MBC, Lisburn Road)
1900 Buffet and poster session (MBC, Lisburn Road)

Thursday January 4

(MBC, Lisburn Road)

0900 Symposia (Genomics update; Water Framework Directive and/or Aquaculture)
1100 Coffee
1130 Symposia
1300 Buffet lunch in MBC
1400 Contributed papers including Manton sessions
1530 Tea
1600 Contributed papers including Manton sessions
1730 AGM
1900 Dinner, table quiz, auction (Varsity restaurant/bar, College Gardens)

Friday January 5

(MBC, Lisburn Road)

0900 Contributed papers including Manton sessions
1100 Coffee
1130 Contributed papers including Manton sessions
1300 Buffet lunch in MBC
1400 Contributed papers
1630 Tea
1700 Presidential lecture
1930 Dinner and céilidh (Great Hall, Lanyon Building).

Saturday January 6

(MBC, Lisburn Road)

Workshops could be arranged if there is sufficient interest.
Possibilities include:
Use of PAM (with Walz)
Consult the experts (bring your problem specimens!)
Microarrays
If YOU have any contributions/ideas for the symposia and workshops, please forward them to Christine Maggs, c.maggs@qub.ac.uk.

Accommodation: There is a lot in the vicinity including hotels, B&Bs and backpackers' hostels. For information on getting to Belfast: http://www.gotobelfast.com/

This is a guide to the accommodation available for the 2007 BPS meeting in Belfast. You will have to make your own bookings but group rates have been obtained. To get these group rates, you need to book by October 2006, but obviously the earlier you make your reservations the more certain of getting the place you choose.

Various types of accommodation at various prices are available within a few blocks of the MBC. Maps can be seen at http://www.qub.ac.uk/home/TheUniversity/Location/Maps/

All the streets mentioned here are on either the campus map (MBC is building no. 57) or the Belfast map (Eglantine Avenue; Shaftesbury Square)

For hotel accommodation we recommend:
The Malone Lodge Hotel & Apartments, Eglantine Avenue
http://www.malonelodgehotelbelfast.com/
maps at
http://www.malonelodgehotelbelfast.com/findus/index.asp
phone: 028 9038 8000
This hotel is quiet.
The BPS meeting has a special discounted rate of:
- B&B single room £65
- B&B double room £85
- 3-bed apartment £129 per night

Madisons Hotel
59-63 Botanic Avenue (about 10 mins walk from MBC)
www.madisonshotel.com
028 9050 9808
The BPS meeting has a special discounted rate of:
- B&B single room £60
- B&B double/twin room £70

This includes entry to their club at weekends! The area is not quiet but we have not heard complaints from previous visitors about the rooms being noisy.

There are many **other hotels** including luxury ones such as Radisson (the Belfast Hilton was voted by customers best Hilton in the world!!)
http:// www.gotobelfast.com/
"Visit Belfast"
"Where to stay"

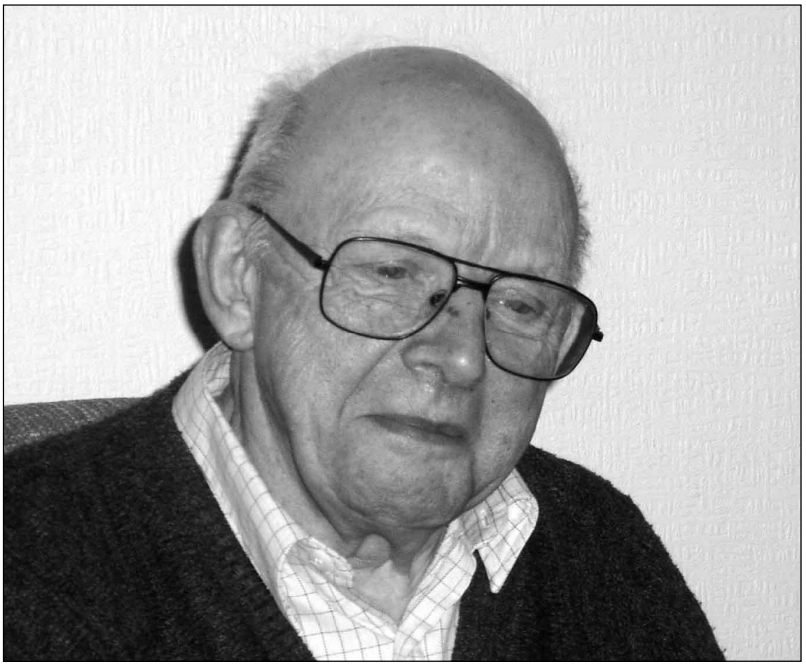
Very good B&Bs:
Marine Guest House, Eglantine Avenue, near Lisburn Road
- B&B single room £40
- B&B double room £55
- B&B triple room £75

Kate's B&B (opposite Holiday Inn Express)
127 University Street
Tel : 028 9028 2091
Email : katesbb127@hotmail.com
- B&B £25 per person (most rooms sharing).

Very cheap accommodation:
Arnie's Backpackers (Australian-run)
63 Fitzwilliam Street, almost opposite MBC
arniesbackpackers.co.uk
028 9024 6810
- B&B £11 per person in rooms of 4.

Belfast International Youth Hostel
22-32 Donegal Road, near Shaftesbury Square (about 10 mins walk from MBC)
Very respectable, good facilities
028 9032 4733
- B&B from £8.50 per person

Obituary
Bryan Clarke (1926-2006)



Occasionally a name is known only as an author on a paper never to be remembered as an individual. Bryan Clarke was one such person. His fate was to be the second author on the classic publications that emanated from Irene Manton on the 9+2 flagellar axoneme in algal and fern zoids (Manton and Clarke, 1951a, b, c, 1952 et seq.), and to be third author on the now celebrated series of papers on algal nanoflagellates published by Parke, Manton and Clarke (1955 et seq.). Thereafter he disappeared from biology to spend the rest of his working life employed in the paper industry. Bryan also had the good fortune to work at a time when it was possible for a technician of excellence to make a major personal contribution to 'cutting edge' research.

Bryan was born in 1926 in Reddish, a suburb of Manchester. He attended North Reddish Council School and at the age of eleven moved to Stockport School. The privations of the Second World War were disruptive to Bryan's education and in 1942, during the school holidays, he decided to look for work. He presented himself unannounced at the botany department of Manchester University and was duly employed as a trainee technician for a week with an offer that if he enjoyed the work he could take the job permanently. This he did and so he became 'apprenticed' to the senior technician with the task of setting up practical classes, preparing reagents and sectioning plant material.

One day in 1944 when Bryan was using a Cambridge rocker microtome, Irene Manton heard the clattering noise whilst in the teaching laboratory next door. She went to find out what was happening and saw Bryan cutting sections. Noting his skill with the instrument, Irene invited Bryan to become her personal technician. So began a remarkable working relationship between Irene Manton and Bryan Clarke, which was to span 15 years and generate 16 publications.

Bryan's skills at this time included his meticulous ability to work with microscopical material and his knowledge and practice of photography. He had superlative eye-hand coordination and no specimen was too small for him to handle. During the war years Irene had become interested in UV microscopy, which at that time was still at the prototype stage. It became Bryan's job to familiarise himself with the preparative techniques for UV microscopy and on this basis Irene invited Bryan to accompany her to Leeds University when she was appointed to the chair of botany in 1946.

Bryan's first task on arriving in Leeds was to collaborate with engineers at Cooke, Troughton and Sims, a York firm of scientific instrument makers, in the construction of a 'horizontal' UV microscope. Eventually five such microscopes were manufactured and in 1948 one was delivered to the Leeds botany department. Early techniques, developed at the National Institute of Medical Research (NIMR) in Hampstead, for the preparation and staining of material for UV microscopy had to be modified for visualising chromosomes in plant material. Bryan's skills now came into their own for he could prepare individual cells or even chromosomes, firstly for light microscopy and then transfer them for observation with UV microscopy. Using this microscope and Bryan's techniques, Irene observed for the first time the longitudinal splitting of flagella on the spermatozoids of the fern *Dryopteris villarsii*. However, within a year of the delivery of the UV microscope, the Leeds botany department acquired a Philips EM 100 electron microscope, which not only superseded the UV microscope in terms of specimen resolution but also set in motion a completely new line of research in which Bryan was to play a key role.

The connecting thread between light, UV and electron microscopy was to be the morphology of fern spermatozoids (1951a). The spirally twisted rod-shaped cells each with many flagella not only provided photogenic material but also, more

importantly, demonstrated a flagellar substructure of 11 longitudinal 'fibres'. Whilst the longitudinal splitting of flagella, sometimes into 11 fibres, had been observed before; the details of how the longitudinal fibres compacted together to form the now familiar '9+2' axoneme was the seminal contribution of the papers authored by Manton and Clarke (1951a, b, c, 1952 et seq.).

In 1956 Mary Parke, working at the Marine Biological Association, Plymouth, invited Manton and Clarke to collaborate with her in the description of the marine nanoflagellates that she had in culture. Bryan soon found that the techniques that he had devised for plant spermatozoids were eminently suitable for algal flagellates, in particular species of *Chrysochromulina* (Prymnesiophyceae). Their cell preparations showed that the cells were covered with scales and that the 'third filiform appendage' was not a flagellum at all but a narrower microtubule-containing structure, which they called the haptonema (Parke, Manton and Clarke, 1955).

With the purchase of a new EM in Leeds, Manton expanded and diversified her studies to include ultrathin sectioning of fixed and embedded algal material which opened up an 'Aladdin's cave' of new findings (see Leadbeater, 2004). By 1959 Bryan felt he had given of his best and decided to move to a job with the Reed Paper Group in Kent. Here, as a senior microscopist, he was to be involved with research and development, with particular responsibility for problem solving in relation to new products. In this role he authored articles on paper quality and travelled extensively giving lectures on paper production. In the early 1970s he returned to the city of his birth to become an experimental officer in the Paper Science Department of UMIST (University of Manchester Institute of Science and Technology).

This might have been the end of the story except that Irene Manton's loyalty to her former colleagues and collaborators never faltered. Having lost contact with Bryan for nearly 20 years, she wrote in an article for the Proceedings of The Royal Microscopical Society (Manton, 1978): "He (Bryan Clarke) remained with me for over twelve years, and if he happens to read these lines I would like him to know how much I valued, and value, the part he played as a founder member, as it were, of a very skilled and loyal team of non-graduates. Without them, as a full-time professor and not neglecting the essential duties of that post, I might not have survived as a scientist". Amazingly, Bryan read these lines and made contact with Irene again a year before she died in 1988.

Barry Leadbeater

Leadbeater, B.S.C. (2004). Irene Manton: A Biography. *The Linnean* Special Issue: 5, 1-96.

Manton, I., 1978. Recollections in the history of electron microscopy. *Proceedings of the Royal Microscopical Society*, 13: 45-56.

Manton, I., Clarke, B., 1951a, Demonstration of compound cilia in a fern spermatozoid with the electron microscope. *Journal of Experimental Botany*, 2: 125-128.

Manton, I., Clarke, B., 1951b. Electron microscope observations on the zoospores of Pylaiella and Laminaria. *Journal of Experimental Botany*, 2: 242-246.

Manton, I., Clarke, B., 1951c. An electron microscope study of the spermatozoid of *Fucus serratus*. *Annals of Botany*, 15: 261-471.

Manton, I., Clarke, B., 1952 An electron microscope study of the spermatozoids of Sphagnum. *Journal of Experimental Botany*, 9: 265-275

Parke, M., Manton, I., Clarke, B., 1955. Studies on marine flagellates. II. Three new species of Chrysochromulina. *Journal of the Marine Biological Association of the UK*, 34: 579-609.

Instructions for Contributors

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

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

Submission of Copy and Deadlines

Copy should be submitted to:

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Redwood Crescent, Peel Park, East Kilbride,
Glasgow G74 5PP
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Fax. +44 (0)1355 574688,
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