

# The Phycologist

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The Newsletter of the British Phycological Society

Editor: Dr Jan Krokowski

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60



60 Years of the  
British Phycological Society

# 2012 British Phycological Society

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Welcome to the autumn edition of *The Phycologist*, continuing our celebration of 60 years of the BPS. I hope you enjoy the autumnal colours.

Firstly apologies and a correction. The Editorial in the spring edition incorrectly identified Mr Harry Powell as the first Treasurer of the Society – he was in fact the first Secretary, as I am sure many of you would have realised.

As detailed in the previous issue, included here are the abstracts of talks and posters, and AGM minutes from our Winter meeting back in January 2012. The Jubilee celebrations continue with articles from BPS past-presidents on 60 years of the BPS and Phycology, and of course we have details of the Celebratory Jubilee Meeting which was held at the Natural History Museum, London. We also have a list of reports following awards by the BPS, and research notes by members.

Very importantly, nominations are called for a number of Officers and for Ordinary Members of Council. Please ensure you follow guidelines and provide submissions by 9th November to the BPS Secretary (please see article on page 41).

So, let's take a deep breath, blow out those candles on the Jubilee cake, and while munching on the slice of cake and sipping tea, or something stronger, I hope you enjoy this issue.

Remember - do keep sending in your contributions. Write to us with your phycological views, news, work events, or any matter you wish to share with readers of *The Phycologist*. YOUR input is required; all relevant material will be considered (job adverts, science reports, book reviews, news items of topical interest, meeting announcements, research news, and suggestions for future articles are always welcome). Without YOU the newsletter would not exist

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

**\*\* Next BPS Meeting is on 8th – 10th July 2013, Belfast \*\***

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## 60 years of the BPS



Towards the end of my second year studying Marine Biology and Biochemistry in Bangor, I came to the realisation that it might be fun to learn a lot more about phytoplanktonic organisms and that I ought to be looking for someone working in this area who might be prepared to take me on as a PhD student. In those dark and distant times, 1976, getting information about potential PhD supervisors and their interests was not a question of a quick Google search, and it was this need that brought me into contact with the British Phycological Society. My tutor, Tony Walsby, advised me to arrange to see Christine Happy-Wood, who was the BPS Membership Secretary at the time, and she, being rather canny, was only prepared to go through the membership list with me on the condition that I became a member of the Society. This I did, and have remained a member ever since.

Although never regretting my membership of the BPS, it turned out that the investment necessary to gain access to the BPS membership list was not money well spent, as I ended up staying in Bangor to work with the first important Tony in my academic development, Tony Fogg. When I say “work with”, I should probably point out that Tony had a rather hands-off approach to PhD supervision, but he did have a NERC studentship, and the project involved a seven month cruise to the Southern Ocean with the British Antarctic Survey to study nutrient limitation in the phytoplankton communities on either side of oceanic fronts. It is surprisingly easy to describe the project, but it was infinitely more difficult to locate the frontal systems without access to any satellite imagery. It was, nonetheless, a wonderful experience, both because of the incredible beauty of the Antarctic, and also because it taught me how very difficult it was to study ecology at sea and how the best laid plans could be rendered useless by a sudden storm or a fire in the laboratory (fires at sea are something to avoid if at all possible!).

The second Tony in my story is Tony Walsby. In 1980 Tony took up a post as the Head of the Department of Botany at the University of Bristol. I went with him as a De-

monstrator in Botany and stayed there for 28 years, until my move to Portsmouth in 2008. Tony and I spent many years getting to grips with the structure of cyanobacterial gas vesicles and their evolution. These studies involved forays into the field of protein chemistry and introduced me to the emergent discipline of molecular genetics. It is perhaps difficult to imagine now, but finding and sequencing a gene in the 1980s was no trivial matter – there was no PCR, there were no kits for anything and you even had to synthesise your own oligonucleotides, but only after having spent a week or so redistilling key reagents to free them of any contaminating water. Two of the major findings to come from this work were that the main protein from which gas vesicles are assembled, GvpA, is very highly conserved across the Archaea and the Bacteria, and that there is an interesting relationship between the repeating structure of a second structural protein, GvpC, and the strength/diameter of gas vesicles: GvpC has a number of repeated sequence elements, each of about 33 amino acid residues, and the more of these there are, the wider and weaker are the gas vesicles. The width/strength of the gas vesicles, and hence GvpC, are under strong selective pressure in the environment, because organisms need gas vesicles that are as wide as possible to provide buoyancy at the minimum possible metabolic cost, but that are strong enough to survive both the turgor pressure within the cell and the hydrostatic pressure exerted by the water column.

Wanting to know more about the selective pressures acting on GvpC in nature ultimately resulted in a return to working at sea. Together with partners from across the EU, we took part in a number of projects focussed on obtaining an improved understanding of the blooms of *Nodularia* and *Aphanizomenon* in the Baltic Sea. Our initial aim here was really rather simple, i.e. to get some of these organisms into culture and to characterise both their gas vesicles and the genes responsible for their production. In the course of these studies we noticed that there was no consistent pattern to the phylogenetic relationships between the different *Nodularia* isolates revealed using a variety of standard genetic markers. This observation led us to develop techniques to determine multilocus genotypes from single *Nodularia* filaments, thereby bypassing the need to bring the organisms into culture, and allowing us to demonstrate that bloom populations were not clonal, but epidemic, in their population genetic structure. From our results, it seemed clear that horizontal gene exchange within the *Nodularia* population was rife, but we did not know how the genes were moving, and we did not know whether other phytoplankton populations were similarly diverse in terms of their genetic composition. Attempts to try and answer these questions led us to look at diatom and other phytoplankton population structures, and kickstarted my current and ongoing interest in cyanophages, the viruses that infect cyanobacteria, and their role as agents of gene exchange.

What I thought would be fun as an undergraduate has,

indeed, turned out to be the case. I feel blessed to have worked with some wonderful people (too many to list) on some fascinating projects, including some with Juliet Brodie on the molecular taxonomy of organisms that I find very difficult to tell apart. I now know with some certainty just how ignorant we remain about the complex interplay between microorganisms, the communities they form and the environments in which they exist, but at least the questions that need to be answered are becoming clear. What we have now is a whole suite of various “omic” and associated technologies that can help us to answer what were previously intractable questions, but it remains important

not to get too carried away with what these techniques seem to offer. All of the genome sequences, transcriptomes and metabolomes that money can buy are of rather limited value in the absence of supporting knowledge about the biology and ecology of the organisms that we study. This is where organisations like the BPS have so much to offer, acting as a vehicle to bring together individuals that share interests in all aspects of the study of algae. The Society has achieved a lot over its first 60 years, but I have a feeling that the next 60 are going to be so much more exciting.

**Paul Hayes**

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## *Happy Anniversary BPS*

My earliest recollections of seaweeds date back to immediate post-war holidays on the Kent coast, when building sandcastles and exploring rock pools were my major preoccupations. The smell of seaweed, DMS in current scientific parlance, is evocative to this day of those early seaside excursions. A more serious introduction to algae came in school biology when we had to study the morphology and life-history of *Fucus serratus*. This involved a field course with seaweed collections at Castle Rocks in Aberystwyth. However, my first professional introduction to algae came in 1964 when I was offered a PhD studentship at Birkbeck College, London under the supervision of John Dodge. A Zeiss electron microscope had just been purchased and I was selected as the ‘guinea pig’ to use this instrument. The three years I spent at Birkbeck were greatly rewarding. In sharp contrast to most PhD projects today, there was no master plan or Gantt chart to guide me on my way. I was given complete freedom to study what I wished and that suited me ideally.

After Birkbeck College, I moved north to Leeds University to work with Irene Manton and indirectly Mary Parke at Plymouth. Leeds Botany Department in the 1960s was a magnificent place to carry out research in phycology and electron microscopy. In addition to the home team, there was an extensive group of overseas postdocs and visitors. Many have remained lifelong friends and it is always a pleasure to meet them at international meetings. Irene Manton was a formidable but kindly mentor. From her, I experienced at first hand the need for rigour and quality in research and publication. We worked together in one context or another for the next twenty years. In 1969 I was appointed lecturer in botany at Birmingham University and there I had the opportunity, through lectures and field courses, to introduce generations of students to marine and freshwater phycology.

The first meeting of the British Phycological Society I attended was in January 1965 at University College, London. It reminded me of attending a family party. Everybody knew each other and although the meetings were profes-

sionally scientific there was a great sense of camaraderie. There were the family ‘elders’, mostly formidable ladies, many of whom had been founding members of the Society, who occupied the front rows of seats throughout the meeting. Meetings usually ended with an exhortation to return to our laboratories and continue with our research. During the 1960s the majority of universities had at least one resident phycologist and, of course, there were phycologists working in marine research laboratories such as Plymouth, Port Erin, Millport, The Gatty and Lowestoft as well as in government laboratories. Although the BPS was entitled ‘British’, it had a strong international following. In particular, colleagues from Europe and N. America were frequent attendees at our annual meetings and many eminent names today (and yesterday) ‘cut their teeth’ at BPS gatherings.

I congratulate the British Phycological Society on its 60th anniversary. I have enjoyed nearly 50 years of membership during which time I have served as treasurer and president. I have enormous admiration for the dedicated group of phycologists who were responsible for founding the Society in 1952. Their vision and commitment created a forum for the promotion of phycological studies that is still flourishing today. They recognized the need to welcome and encourage young phycologists, which at various times included myself and many other colleagues. This tradition remains stronger than ever and will ensure that the Society has a thriving future for many years to come. Happy Birthday BPS!

**Barry Leadbeater**



## 60 yrs of the BPS



At least in the eyes of a young PhD student, the British Psychological Society winter meetings in the early 1970s were much more formal events than they are now, dominated by a contingent of formidable women, who would sit at the front of the lecture theatre in their tweeds, twinsets and sensible shoes, ready to launch in at the end of a talk with questions and comments. It was clear that their contributions to the development of the society and phycology were significant, and they appeared somewhat intimidating to those of us who did not know them, reinforced by some of their transformations into sequined evening wear for the society dinner!

Having joined at our supervisor's (Frank Round) suggestion, as students we stuck very much together at those first meetings, only gradually learning to talk to the more senior members of the society. Meetings were held immediately after the new year, usually in London universities that had not been heated over the Christmas period, so it was important to be warmly dressed, even in a lecture theatre. There were no parallel sessions or poster presentations, so one listened to talks that ranged across the entire scope of the algae, often way beyond one's previous knowledge or experience. But this was invaluable in making one aware of the diversity of the algae, their structure, life histories and biochemistry, the 1970s seeing particularly the development and expansion of electron microscopy, many of the key microscopists being active in the society.

Over the following decade the society began to move outside London for its meetings, supported by members employed at universities across the country, poster sessions came to be recognised as key components of successful meetings accompanied by food and wine, and, with an increase in the number of contributions, parallel sessions were instigated. Student contributions were encouraged with the initiation of the Manton prize for the best student talk, followed by the introduction of the student poster prize. Together with the provision of support for students to attend meetings (and a student membership rate), the demographics of BPS meetings in the 21st century has undoubtedly changed; the average age has de-

creased, fewer members are in secure academic positions, their research areas are more diverse, and the atmosphere far more informal. But it is also easier to focus narrowly on those areas that one already knows, rather than being exposed to topics remote from one's own, except perhaps for Presidential and other invited lectures.

What has the society achieved in 60 years? It has certainly grown in membership and scope since the start, even if membership numbers are now below their historical maximum. The society's publication of phycological papers has expanded from the small "Bulletin of the British Phycological Society", via "The British Phycological Journal" to "The European Journal of Phycology", an established international, professionally produced, high quality journal that attracts contributions from members and non-members alike. Similarly, the newsletter has seen various incarnations, but continues (as *The Phycologist*) to be a vital source of information and news on the society and the activities of its members. The society has supported student attendance at meetings and strategic floristic projects and publications, algal mapping, field meetings, summer research projects and training courses, clearly fulfilling its aims to support the study of algae. It has seen (and embraced) the development of online communication and resources, but, thanks to many of the individuals involved with council over the years, has not lost its personal touch. Nor despite the retention of British in the name, is the society insular or inward-looking. The regular attendance and involvement of members from around the world is always a welcome aspect of the annual meeting.

Ten years ago, during my period as President, we celebrated our Jubilee in London and Trevor Norton edited "Out of the past", a collection of reviews which reflected some of the changes in algal research over the preceding 25 years. The last ten years have seen even more technological developments that allow new questions to be explored, but alongside these and the explosion of "omics" there has been a decline in the teaching of whole organismal biology. We have many more tools at our disposal, which open up all sorts of exciting possibilities, but we also need to preserve some of the traditional skills and knowledge and to ensure that we pass them on to succeeding generations. In continuing to focus on all aspects of the "algae", the society retains an important role of encouraging individuals to be aware of and seek to understand the diversity of these organisms, their structure, life histories, genetics, physiology, biochemistry and roles in ecosystems. However the society is not just about the acquisition of knowledge, but also about supporting its members to develop and achieve. Fostering informal conversations in which problems can be shared, new ideas raised and collaborations forged is a vital aspect of any successful learned society. I think our meetings provide a pretty good environment in which to do this, and I trust that they will long continue to do so.

**Eileen Cox**

# BPS Jubilee Celebrations

Jane Pottas

The 60th anniversary of the BPS was marked by a meeting held at the Natural History Museum in London on Wednesday 12<sup>th</sup> September and with remarkable symmetry 60 delegates arrived to celebrate the occasion.

Paul Hayes, in his capacity as President of the Society, welcomed everyone to the meeting and in his opening remarks commented on similarities between 1952 and 2012. There were Olympic Games then and now and the Royal family in the news for the coronation of the Queen then and her diamond Jubilee now. He also considered major events of the time. In the world of science Alfred Hershey and Martha Chase conducted a series of experiments that helped to confirm that DNA was the genetic material and Alan Turing proposed the reaction-diffusion model to explain how complex patterns in nature might emerge during development. I think Paul must have been trawling the internet for facts to dazzle us with but the most startling one to emerge was that the founding of the BPS was not mentioned on the 1952 page on Wikipedia. A ripple of astonishment ran around the room, but before we could consider this oversight further Paul spotted Linda Irvine in the audience, one of the first members of the society. In his concluding remarks he referred to the remaining grand challenge for phycologists – to get to the stage where an internet search for phycology does return the question “Do you mean psychology?” It just goes to show what serious errors result from a single letter substitution in orthography as in genetics.

In the early days of the Society the majority interest of the founder members was in seaweed but today phycology is a broad church which encompasses the study of macroalgae and microalgae, freshwater and marine algae as well as the development and application of techniques undreamt of in 1952. The daunting task of organising a meeting which would celebrate the many and varied achievements of the past 60 years whilst at the same time looking to the challenges of the future was undertaken by Juliet Brodie and of course she pulled it off. The programme included talks which were stimulating and inspiring, a debate on the contentious subject of biofuels from algae, an exploration of the cross disciplinary links between science and art, and a look back at the history of phycology and the lives of some of the people who first ventured in to the strange world of phycology.

Professor Paul Falkowski of Rutgers University flew in from the US to give us a whistle stop tour of the major role of phytoplankton in changing the redox state of the planet on geological time scales. Before our brains had time to cool down Professor John Allen from Queen Mary, University of London stepped up to the podium to talk about the role of cytoplasmic inheritance in the evolution of the algae and the consequent changes in the composition of the atmosphere. There was little time for questions, so animated and enthusiastic were the first two speakers for their subjects, but conversation buzzed over the buffet lunch as phycologists from varied disciplines gathered round the posters, admired an exhibition of the Hilda Canter-Lund photographs, and pored over a photograph of members who attended the 25<sup>th</sup> anniversary meeting. The NHM library mounted a display of historical books about algae and there was a display of phycological philately (try saying that after a couple of glasses of wine)

- stamps - depicting seaweeds collected by David Irvine and donated to the BPS by his family. The Seaweed Health Foundation brought along materials and information about their organisation which aims to promote the benefits of seaweed for human food and health. Delegates could purchase books and sign up for journals at the Taylor and Francis stand.

The afternoon session began with a thought provoking talk by Professor Joanna Verran from Manchester Metropolitan University in which she explained how art provides an opportunity for the visualisation and communication of science. This was followed by a debate about whether macroalgae or microalgae are the biofuels of the future. An initial show of hands favoured microalgae (25) to macroalgae (5) which changed to 25 to 15 after Professor Mike Cowling of the Crown Estates and Steve Skill from the Marine Biological Association had described the case for macroalgae and microalgae respectively. It seems that this debate will continue as there were quite a few abstentions. A break for tea provided another opportunity for discussion and the noise level indicated that there was plenty of talking going on. The last part of the day focused on the history of phycology. Ian Tittley gave a lively and informative talk entitled “Four Centuries of Seaweed Study in Kent” in which he described a number of people who predate the BPS who had worked on the seaweed of Kent. He really doesn't look that old. Juliet Brodie introduced the final session by summarising the foundation of the BPS at a meeting in September 1951 in Bangor. Interestingly in the first unofficial steering committee of nine, seven were women. The first annual meeting held in January 1952 was on Algal Taxonomy and Nomenclature, subjects which still exercise the lumpers and splitters who today have molecular techniques in their tool kit, unlike their predecessors who would have to wait until April 1953 for the publication of the discovery of the structure of DNA of which Crick and Watson said, with remarkable understatement, “This structure has novel features which are of considerable biological interest.” Eileen Cox, Martin Wilkinson and Barry Leadbeater gave personal reminiscences of some of the leading lights of the BPS from the early days – Kathleen Drew, Margaret Martin, Betty Percival, Elsie Burrows, Mairin de Valera, Mary Parke, Irene Manton, and Frank Round with personal contributions from the audience.

Juliet thanked everyone who had contributed to make the day a success. Paul rose to thank her for all her hard work in what was virtually a “one woman effort” and presented her with a lace scarf knitted from yarn made of silk and seaweed as a small token of our thanks.

Altogether it was a full and enjoyable day which ended with a wine reception sponsored by Taylor and Francis. An anniversary meeting is a time to look back to see how far the Society has come but is also an opportunity to look forward. The BPS was founded by a group of academics with purely academic purposes but outreach and education are increasingly on the agenda as well and there are moves afoot to reinstate field meetings again after a few years' absence. What will the secretary in 2072 be recording, I wonder?

PS: If you check the 1952 page on Wikipedia you will see that the founding of the BPS is now listed – the page having been updated during the anniversary meeting!

# British Phycological Society Diamond Jubilee 60th Annual Winter Meeting, Newcastle 4th - 6th January 2012

With thanks to



## *SPECIAL SESSION ONE: The Role of Phycology in Education and Outreach*

Chair: Dr Sara Marsham

### **The Big Seaweed Search: The first two years**

Juliet Brodie

Natural History Museum, London

The Big Seaweed Search is an outreach project developed by the British Phycological Society and the Open Air Laboratories (OPAL) to raise awareness of seaweeds. The aim of the project is to get people to undertake a seaweed survey to help monitor the effects of climate change and invasive seaweeds on our shores. This includes recording the presence of 12 different kinds of seaweeds along a stretch of shore with rocks, noting what the shore is like and counting the number of limpets found in a minute. Participants are then asked to send their results to the Natural History Museum seaweeds website. The seaweeds selected for the survey were chosen partly because of the relative ease with which they could be identified but also to build up a picture of the state of the conspicuous brown seaweeds (e.g. fucooids) that characterise the shores around Britain and which have been reported to be declining or disappearing in some places. Other seaweeds in the survey included a brown with a south-westerly distribution (*Bifurcaria bifurcata*), an alien (*Sargassum muticum*), red calcified *Corallina* species and green *Ulva* species. Since the survey was launched in July 2009, there have been over 7000 website hits, returns for at least 84 sites from England, Wales, Scotland and the Isle of Man plus excellent verbal feedback. In this talk, I will review progress of the project, and report on the data received so far. I will also consider how the project might be developed in the future.

### **Seaweed East '11 – On the road in search of weed**

Dawn Watson & Rob Spray

Seasearch

*Just typical philistines!*

We weren't seaweed people but really tried... we grasped just how accessible seaweed but were hungry for more seaweediness. The plan? To tempt some talented weed folk over to the East coast for a Seasearch road trip Dennis Hopper would envy? Seasearch is the recording project for amateur divers; it's very simple idea but a niche, within a niche. Niches can be a dead end but they do collect enthusiasts. If you harness that and connect enough niches eventually you're talking to the public.

### *Who would survey a coast like this?*

After inviting some fantastic people we were immensely lucky to have a hero (and sidekick) sign up from the outset. With the event secure we used our glamorous team to attract support. Algae celebrities gathered help from great and small alike: including The Wildlife Trusts, Norfolk Biodiversity Partnership, Environment Agency, Durham Heritage Coast, National Trust and Marine Conservation Society. The diversity of the East coast worked for us. Although it was daunting to whistle-stop seven counties in 12 days their sights and highlights kept the team enthusiastic. We covered the Blackwater, Orford Ness, Norfolk's chalk, Gibraltar Point, Flamborough, Boggle Hole, dived Seaham and surveyed Northumberland in spite of weather and defy exhaustion!

### *Not so weedy after all?*

The trip hugely boosted Seasearch East's recorded algae – from 20 to nearly 100 species in East Anglia alone. Invasives, unrecorded and species thought rare were common and over 225 pressings were gathered. We even found a sponge species new to science! Hear the tales of the trip; despair in Skegness, burn out in Boggle Hole and Karma Sutra biscuits. Was the positive publicity from TV coverage, radio interviews and newspapers enough to make us do it again and who came top of the weediest county league?

### **The Big Sea Survey: Volunteer Participation and Scientific Recording**

Heather Sugden

Big Sea Survey, Newcastle University



The Big Sea Survey is a volunteer led project aiming to engage local communities with their coastal marine environments throughout the north east of England. Volunteers are encouraged to take ownership of their local coastlines by recording the presence and abundance of rocky shore species. These records will help establish a baseline of species for the region and inform the future management of this coastal area. This talk will outline the structure of the project and how it works, what we have achieved and how we aim to progress in the future. Two case studies will be examined to show the benefits of volunteer participation in scientific surveys.

### Approaching algae from a different direction

Joanna Verran, James Redfern, Dariel Burdass & Peter Gilroy

School of Healthcare Science, Manchester Metropolitan University

At Manchester Metropolitan University, algae assume a low profile in the undergraduate curriculum, primarily as good examples of large microorganisms in first year laboratory classes. Microbiology research focuses on the interactions occurring between microorganisms and inert surfaces – but with dental/food/medical applications. An interest in biofilms provided some opportunity to explore the beauty of algae in this context, which fed into the development of novel cross-disciplinary activities linking microbiology and art. Other cross-disciplinary learning and public engagement activities have been developed as a result of this initial interest.

The Society for General Microbiology (SGM) invited MMU to work with them to produce new practical learning resources for schools. SGM identified phenomena in the school specification that could be illustrated in the laboratory using microorganisms, and we worked together to identify topics for the resource. Algae proved to be an excellent vehicle for many of these phenomena, including identification and taxonomy, eutrophication, phototaxis, bioluminescence, biofuels and element recycling, and 12 months ago a postgraduate student (James Redfern) took on the task. The development of the resource entailed considerable research of the literature and of relevant expertise, development of 'infallible' but interesting experiments, and repeated trialling and evaluation of the activities via students, teachers and the general public. The resource, intended for teachers at GCSE level will be launched at the Association for Schools Education (ASE) conference in January 2012, and, as a bonus, a new love has been found for algae at MMU.

This presentation will describe some of the novel cross-disciplinary teaching activities on-going at MMU, and the journey leading to the launch of the algal resource!

### Increasing awareness with macroalgae in the Eastern Aegean

Rupert Perkins<sup>1</sup>, Anastasia Miliou<sup>2</sup>, Chris Williamson<sup>1</sup> & Amy Trayler<sup>2</sup>

<sup>1</sup>School of Earth and Ocean Sciences, Cardiff University; <sup>2</sup>Archipelagos, Institute for Marine Conservation

Since 2006, Leonardo Mobility Initial Vocational training funding has enabled annual groups of Cardiff University Marine Geography undergraduate students to travel to the islands of Ikaria and

Samos to carry out coastal biodiversity survey work. The immediate educational benefits to these students (now numbering over 50) has been the experience of design, implementation, analysis and dissemination of a small research project. The wider outputs have included educational packages for local schools and community groups, increased awareness of the state of coastal fisheries amongst the local fishers, media outputs including TV and radio at local and national (Greek) levels and the use of project data in applications for conservation designations (e.g. extension to Natura 2000 sites, MPAs and voluntary NTZs). This presentation will summarise these activities, demonstrating how the coastal survey work on macroalgae has been utilised to facilitate this work, closely integrating the research of the host, Archipelagos Institute of Marine Conservation, with the local communities on Ikaria and Samos. This work has included the use of macroalgae in environmental impact assessment (including re-growth experiments and artificial reef work), the use of macroalgal biodiversity (concomitant with invertebrate biodiversity) as an indicator of coastal fish habitat quality and the study of the invasive *Caulerpa racemosa*.

### Open learning, professional development and reflective practice in applied phycology

Martyn Kelly

Bowburn Consultancy

The UK's environmental agencies have been using diatoms for freshwater monitoring since 1995. The emphasis throughout has been on embedding diatom analyses into the day-to-day activities of teams of multi-skilled biologists, rather than outsourcing to specialists. The organisations should, as a result, benefit from a more holistic view of environmental problems than would be possible if their staff were simply receiving distilled results with which they had little personal involvement. An open learning course was devised which enabled biologists from around the country to train at their own pace using their local streams. The course included tutorial materials supplemented by permanent slides, and exercises included sampling, slide preparation, analysis and interpretation of material associated with real operational issues. Graduates from this course are capable of routine analyses, but then spend an initial period working under close supervision, alongside "mentors", after which they work independently but within a quality management program. This requires them to fulfil three criteria:

- Exercise their skills on a regular basis (analyse at least 30 samples per year);
- Meet minimum criteria for on-going training; and,
- Meet minimum criteria for annual ring-test slides;

Analysts are expected to spend at least two days training each year. This can include attending specialist algae and diatom conferences as well taxonomic workshops organised in-house but with input from outside experts. The ring-tests involve five slides per year which are analysed both by a panel of experienced analysts as well as by all involved in routine diatom analyses (both in statutory agencies, universities and consultancies). The expert panel's results set a target and the standard deviation of their results, in turn, provides the limits that all analysts must achieve. A report on each slide, including notes and images of the main taxa is also prepared. Although originally conceived as an analytical quality control exercise, this ring test is now an example of "reflective practice", with participants expected to spend time reviewing

their results against the expert's results, in order to better understand reasons for any deviations. The formal "quality control" aspect is run with a soft touch, bearing in mind that an exercise based on a standard deviation from a small number of experts will, itself, throw up occasional "false negatives".

The watchword in the whole process is "professionalism" and is, in some respects, at variance with many other European countries. By introducing diatom analytical skills to "all-rounders" we develop good biologists rather than narrow specialists.

### *SPECIAL SESSION TWO: Algal Biotechnology*

Chair: Dr John Bothwell

#### **The AB SIG**

Michele Stanley

Scottish Association for Marine Science, Scottish Marine Institute, Oban

The Natural Environment Research Council (NERC) and the Technology Strategy Board (TSB) are jointly funding the Algal Bioenergy Special Interest Group (AB-SIG) to understand the opportunities and risks to the quality of freshwater and marine environments of using algal biomass as a source of renewable energy and chemicals. The network will scope commercial and environmental potential in this area, build research networks, promote appropriate research and secure key partnerships with industry. The Biosciences KTN is hosting the AB-SIG and will be working closely with the Environmental Sustainability KTN and Energy Generation and Supply KTN as the network progresses to ensure the wide-range of stakeholders relevant to the AB-SIG are aware of and engaged in activities.

This network has the high-level science goal of understanding the opportunities and risks to the quality of freshwater and marine environments of using algal biomass as a source of renewable energy and chemicals. The TSB is interested in better understanding how the UK science-base and industry can build upon their knowledge and expertise in algal research to establish new domestic and international market opportunities for algae-derived products and processes. The algae biofuel market alone is forecast to hit \$1.6bn in 2015. Algae-derived bioproducts are already a multi-billion dollar industry, with existing markets in the food and nutraceutical sectors, personal-care and pharmaceutical sectors, and significant growth opportunities are predicted in the biofuels industry. The network seeks through its activities to facilitate the direct application of this science by industry.

#### **IDEALG, a long term national integrative project to capitalize on the recent breakthroughs in algal genomics to develop seaweed agronomy and biotechnology**

Philippe Potin<sup>1</sup>, Pierre Boudry<sup>2</sup>, Catherine Boyen<sup>1</sup>, Jennifer Champenois<sup>3</sup>, Mirjam Czjzek<sup>1</sup>, Ludovic Delage<sup>1</sup>, Katia Frangouides<sup>4</sup>, Sophie Goulitquer<sup>1</sup>, Martial Laurans<sup>1</sup>, Catherine Leblanc<sup>1</sup>, Laurence Meslet-Cladière<sup>1</sup>, Myriam Valero<sup>1</sup>, Jean-François Sassi<sup>3</sup>, Anne Siegel<sup>5</sup>, Thierry Tonon<sup>1</sup> and the IDEALG consortium

<sup>1</sup>Centre National de la Recherche Scientifique, Station Biologique de Roscoff ; <sup>2</sup>Ifremer, STH, Centre de Brest ; <sup>3</sup> Centre d'Etudes et de Valorisation des Algues ; <sup>4</sup>Univ. de Bretagne Occidentale-Brest et Ifremer Brest, DEM, Centre de Brest ; <sup>5</sup>IRISA - Symbiose, CNRS - Univ. Rennes

One major challenge for the next five years in seaweed research is to make the best of genomics and post-genomic research to generate new tools and methods for improving algal bioresources and the domestication of seaweed species and to boost seaweed biotechnology (including by exploiting metagenomics of closely associated micro-organisms) both for improving seaweed crops and for developing white technologies based on the exploration of seaweed and microbial metabolism. In a context of an increasing demand of biomass worldwide, there is an urgent need to upscale or develop methods for mass or controlled production of native seaweeds in Europe. The French large integrated long-term research project IDEALG thus proposes to develop new culture methods to select novel seaweed varieties and to develop seaweed biotechnology. These approaches are expected to have a significant environmental benefit in the conservation of genetic resources, of algal-associated biodiversity and in the context of integrated aquaculture and bioremediation. This large project will also anticipate the economic, social and environmental impacts of such developments in the context of other maritime activities, the conservation and bio-safety issues and the context of competition for space and water in a larger frame.

Some examples of biotechnological approaches that will be developed in the frame of the project will be shown, including a strategy for medium throughput expression of recombinant proteins to elucidate the biochemical function of proteins annotated as unknown in genome mining. The expert analysis of the recently published genome of the brown alga *Ectocarpus siliculosus* has revealed a great deal both about the biology and about the evolutionary history of this organism. Features such as the metabolic routes for the synthesis of phlorotannins will be emphasized in this communication.

#### **Foam fractionation: an effective technology for harvesting microalgae biomass**

Thea C. Coward, Jonathan G.M. Lee & Gary S. Caldwell

School of Marine Science and Technology, Newcastle University

Harvesting and dewatering can account for up to 30% of the overall cost of production of usable microalgae biomass for the biotechnology and bioenergy sectors. Harvesting is particularly challenging due to the small amount of algal biomass produced, relative to water volume. This exacts high energy and cost demands and therefore limits further expansion in the microalgae biomass industry. Foam fractionation has potential to deliver a low cost, low energy harvesting solution. Microalgae cells adsorb to the surface of a stream of fine air bubbles, which rise up a closed column, discharging the concentrated product at the top. Foam fractionation significantly reduces construction, maintenance and energy costs compared to other harvesting technologies. Current work has demonstrated the efficacy of foam fractionation. Harvesting *Parachorella* sp. was optimized with the addition of the surfactant cetyl trimethylammonium bromide (CTAB) as an aid to flotation. Combining low levels of CTAB (10 mg/L) with slow air flow (100 L/h) allowed for long foam residence times within the column, optimizing water drainage. Harvesting concentration factors of 298 were achieved within 25 minutes. The surfactant had an additional benefit of significantly increasing the overall lipid recovery. Further, we show that foam fractionation has the potential to selectively harvest particular species from a mixed culture. These results indicate that foam fractionation offers considerable potential as an efficient, low cost and scalable microalgae biomass harvesting technology.

## Microalgae for renewable energy generation

Christopher Howe

Department of Biochemistry, University of Cambridge

The last few years have seen a dramatic growth in interest in microalgae, both eukaryotic and prokaryotic (cyanobacteria), as possible sources for renewable energy generation. There are many reasons for this interest, including the great diversity of strains to be exploited, the availability of genetic tools for some taxa, and in some cases the high yields of algal material that can be obtained under appropriate conditions. Much of the work on harnessing algae for energy generation has concentrated on using them to produce fuel molecules, such as triacylglycerides and hydrocarbons. However, it is also possible to harvest electrical energy directly from algal cells, using 'biophotovoltaic' (BPV) devices. These are similar to microbial fuel cells (MFCs), in which heterotrophic organisms metabolise organic substrates provided to them and dispose of excess reducing power by excreting electrons that are harvested by an electrode. In BPVs, the heterotrophs are replaced by photosynthetic micro-organisms which can be grown either as planktonic cultures or as biofilms. They produce electrons both in the dark (presumably by respiration of stored metabolites) and in the light. Although the efficiency of BPVs is very low compared to silicon photovoltaic devices, BPVs have possible advantages in the sustainability of the materials for their production.

### PRESIDENTIAL ADDRESS

#### Contributions of the University of Malaya towards the development of a sustainable algal industry in Malaysia

Prof. Siew-Moi Phang, Overseas Vice President

Institute of Biological Sciences and Institute of Ocean and Earth Sciences, University of Malaya

Phycological Research in Malaysia started in the 1900s with the documentation of both freshwater and marine microalgae and seaweeds, especially those with economic importance. Phycological research grew from diversity and ecological studies to DNA-based research which allowed us to venture into the world of phylogenetics, genomics and strain improvement. After more than 70 years, phycology in the form of algae biotechnology, has become of great relevance in today's world of energy and food crises amidst a changing climate. This is especially relevant to the development of our seaweed industry and the opportunities for establishment of an algal biofuel industry in Malaysia. Seaweed farming is one of three priority development areas for the agriculture sector in Malaysia. Microalgae are now seen as potential sources of biofuel with great interest in the application of local macroalgal strains for biodiesel production. This presentation shall take us through a brief historical account of phycology in Malaysia, to be followed by the contributions of the Algae Research Group, University of Malaya, to the development of a sustainable algal industry. Our research is supported by two very important collections: (i) the University of Malaya Algae Culture Collection (UMMAC) which contains about 150 isolates of microalgae; (ii) the University of Malaya Seaweeds and Seagrasses Herbarium; which houses more than 10,000 specimens.

SESSION A: Ecology and distribution of rhodophyta

Chair: Dr Gordon Beakes

#### Ecology of the freshwater red alga *Chroothoece* in the highly calcareous Rio Chicamo, S-E. Spain

Marina Aboal<sup>1</sup> & Brian A. Whitton<sup>2</sup>

<sup>1</sup>Departamento Biología Vegetal, Universidad de Murcia; <sup>2</sup>School of Biological and Biomedical Sciences, Durham University

The red alga *Chroothoece* has been reported from less than twenty sites worldwide, but these include diverse habitats ranging from springs to the surface of peat. Most records have few environmental data and most refer to groups of unicells, but in Rio Chicamo, Spain, it can form distinct colonies up to 2 cm across. The colonies often occur mixed with colonies of the cyanobacterium *Rivularia*. Our study set out to explain why this river favours its success. The Chicamo, which is fed by groundwater, is highly calcareous and slightly saline; nutrient analyses at various times during the year show a high aqueous N:P ratio, with the phosphate almost entirely organic. *Chroothoece* also occurs as single cells and colonies on submerged rock and consolidated silt, mostly in full sun, but also moderate shade. Individual cells can move and it seems probable that colonies originate by cell aggregation. Macroscopically the colonies start with a blue colour, but become green and then brown-orange, the last being due to numerous carotenoid globules surrounding the pyrenoid of the chloroplast. Cells inside the colony have long stalks, many of which reach down to the region where the colony is attached; cells and stalks are embedded in mucilage and the colony has a distinct outer layer. The colonies show high surface phosphatase activity and staining of the stalks indicates that these are an important site for this. While both *Chroothoece* and *Rivularia* are favoured in the Chicamo by their ability to use organic P, it still needs an explanation as why *Chroothoece* does not entirely outcompete *Rivularia*, which is a N<sub>2</sub>-fixer living in an environment with relatively high combined nitrogen.

#### Ecology of the red alga *Chroothoece* on a wet cliff in upper Swaledale, West Yorkshire

Allan Pentecost<sup>1</sup> & Brian A. Whitton<sup>2</sup>

<sup>1</sup>Freshwater Biological Association; <sup>2</sup>School of Biological and Biomedical Sciences, Durham University

A small form of *Chroothoece richteriana* was reported by G.S. West and F.E. Fritsch in *A Treatise on the British Freshwater Algae* (1927) on wet limestone rocks in W. Yorks, but without details of the exact location. Apart from a record in Port Erin, there have been no subsequent records for the British Isles, in spite of many detailed surveys of calcareous streams and rocks, until its recent discovery in Boggle Hole Gorge on Whitsundale Beck, W. Yorks. Here it occurs on the wet travertine-covered face of the cliff bordering one side of the stream. Much of the surface is wetted by constant drips from the soil under clumps of moorland vegetation projecting beyond the upper edge of the cliff. Environmental features and the floristic composition of the phototroph communities were studied on three dates during autumn 2011. Features of the drip water include high conductivity and the fact that the phosphate is mostly organic. *Chroothoece* is widespread on the cliff and, although it never formed distinct colonies, it was the dominant in several regions with orange-brown soft gelatinous mats. The reasons for the success of the alga at this site are discussed and a brief comparison made with its occurrence in Rio Chicamo, Spain.

## Foraging for Freshwater Red Algae in Australia (and New Zealand), 1980-2010

Timothy J. Entwisle

Royal Botanic Gardens Kew

*Batrachospermum* is an attractive, addictive and sometimes allusive freshwater red alga. It grows in some of the most beautiful locations on Earth; many in Australia, and New Zealand. Between 1980 and 2010 the number of freshwater red algal species known from these two countries rose from 7 to 34, most of them endemic species of *Batrachospermum* described by myself and Helen Foard. The south-west corner of Tasmania is my favourite Phycological foraging area – it is particularly rich in species as well as a spectacular place to walk. One of the new taxa was first collected by Peter Tyler from the edge of Lake Pedder a few years before it was flooded in 1969, and sent to the brilliant Heinrichs Skuja in Uppsala shortly before he died. For this reason I named it *B. diatyches*, the twice unfortunate batrachospermum. The intriguing genus *Psilosiphon*, embedded within a paraphyletic *Batrachospermum*, occurs just south of Sydney - where I lived last – as well as the northern tip of New Zealand and south-west Tasmania. A colleague Morgan Vis (Ohio University) and I found the Tasmanian and New Zealand populations to be more similar to each other than they are to the New South Wales population, and postulated a Gondwanic origin for this genus. Australia is a fascinating place to study algae, with plenty to discover and strong endemism in the groups I fancied. Now living and working at Royal Botanic Gardens Kew, not far from the type locality of *Batrachospermum*, I have the opportunity to tie down the identities of the first described species, study a little phenology, and perhaps even embark on a broader phycological project – ‘From Fritsch to Metagenomics’ – in the ponds of Kew.

### Occurrence of *Mesophyllum* sp. along the Atlantic Iberian coast

Viviana Peña<sup>1,2</sup>, I. Bárbara<sup>1</sup>, R. Barreiro<sup>1</sup>, C. Pardo<sup>1</sup>, O. De Clerck<sup>3</sup> & L. Le Gall<sup>2</sup>

<sup>1</sup>BIOCOST Research Group, Universidade da Coruña; <sup>2</sup>Muséum National d’Histoire Naturelle, France; <sup>3</sup>Phycology research group, Ghent University

Along the Atlantic European coasts, the genus *Mesophyllum* is represented by three species: *M. lichenoides*, *M. sphaericum* and *M. alternans*. The type of the genus, *M. lichenoides*, is widely distributed and it is commonly found epiphytic on *Corallina* species in the lower intertidal zone. By contrast, the recently described *M. sphaericum* was recorded as maërl from a single Galician locality only, and *M. alternans* (type locality: Tanger, Morocco) has only been reported from southern Atlantic France (Biarritz). The latter species, however, is frequently cited from Mediterranean coral-ligenous assemblages together with *M. expansum* (type locality: Sicily). The latter species is also known from the Macaronesian region and Morocco. In our recent surveys of intertidal and subtidal non-geniculate corallines in the Atlantic Iberian Peninsula (Basque Country to North Portugal), we have detected the occurrence of large encrusting specimens of *Mesophyllum*. Specimens are commonly found epilithic on stable rocky substrate in the lower intertidal and sciaphilous mid-littoral. Specimens with reproductive structures (uniporate sexual and multiporate asexual conceptacles) were found, and two types of multiporate conceptacles were observed: i) presence of peripheral raised rim and

flattened to concave roof, and ii) absence of peripheral rim and flattened to convex roof. The latter type was the most common in our collections. Based on these features, our material could correspond to *M. alternans* and *M. expansum*, respectively. We carried out a morphological examination of the collected samples, with a particular attention to the anatomy of multiporate asexual conceptacles which is regarded as the main diagnostic feature for the identification of *Mesophyllum* species. Molecular data (COI-5P sequences) were obtained to support the morphological observations. In addition, Mediterranean material of *M. expansum* and *M. alternans* was also studied for comparison with their Atlantic counterparts.

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### BOLD project “MAERL”: Assessing biodiversity of these key species in the OSPAR maritime area using DNA barcodes

Viviana Peña<sup>1,2</sup>, C. Pardo<sup>1</sup>, J. Hernández-Kantún<sup>3</sup>, L. Le Gall<sup>2</sup>, I. Bárbara<sup>1</sup> & R. Barreiro<sup>1</sup>

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Maërl beds are relevant coastal habitats with worldwide distribution. In the European Atlantic, maërl beds are formed by various species. However, only *Phymatolithon calcareum* and *Lithothamnion corallioides* are listed in the EC Habitats Directive, in agreement with the fact that these two species are widely cited in the literature as the main maërl-forming algae. Yet, many of these previous studies generally suffer from the lack of thorough anatomical studies needed for accurate identification, as maërl-forming species are prone to high phenotypic plasticity. The present study aims to assess maërl species diversity using DNA barcodes (COI-5P sequences). Samples of maërl beds from OSPAR area and adjacent regions (Madeira Archipelago and Canary Islands) were investigated. Specimens used in our analyses included the various shapes and morphologies found in each maërl bed. They also comprised the neotype of *P. calcareum* (BM), specimens from the neotype locality (Falmouth) and from the Galician site (Ría de Vigo) used by Adey & McKibbin (1970) to propose the combination, and specimens of *L. corallioides* from the type locality (Rade de Brest). Barcodes for maërl taxa (as OTUs) were uploaded to the on-going BOLD project “MAERL” (Barcode Of Life Data Systems). Results obtained so far reflect the occurrence of 13 OTU’s in European Atlantic waters. Some maërl species display a wide distribution whereas others occurred in small areas. From a biogeographic perspective, species composition in the southern boundary of the OSPAR area (Iberian Peninsula) shows similarities with neighbouring regions (Canary Islands and Madeira) while Galicia (northwest Iberian Peninsula) appears as the limit of distribution for several OTUs. Future efforts will be devoted to assign specimens to existing names or propose new ones and to infer phylogenetic relationships of the detected OTUs. Our results suggest that current protection legislation may need to be updated.

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#### SESSION B: Algal impact on environment and human health

Chair: Dr Eileen Cox

#### MIDTAL: Microarrays for Toxic Algae, close to a final report

Linda K. Medlin<sup>1</sup>, Jixin Chen<sup>1</sup>, Lucia Barra<sup>2</sup>, Johannes Hagström<sup>3</sup>, Francisco Rodríguez<sup>4</sup>, Laura Escalera<sup>4</sup>, Lourdes Velo-Suárez<sup>4</sup>, Gary McCoy<sup>5</sup>, Simon Dittami<sup>6</sup>, Joe Taylor<sup>7</sup>, Katrina Campbell<sup>8</sup>, Yolanda Pazos<sup>9</sup> & Lucie Maranda<sup>10</sup>

<sup>1</sup>Marine Biological Association of the UK; <sup>2</sup>Laboratory of Ecology and Evolution of Plankton, Stazione Zoologica Anton Dohrn; <sup>3</sup>Linnaeus University, Marine Ecology Department; <sup>4</sup>Instituto Español de Oceanografía. Centro Oceanográfico de Vigo; <sup>5</sup>Martin Ryan Institute, National University of Ireland; <sup>6</sup>University of Oslo, Department of Biology; <sup>7</sup>School of Life Sciences, University of Westminster; <sup>8</sup>Institute of Agri-Food and Land Use, Queens University of Belfast; <sup>9</sup>Instituto Tecnológico Para O Control Domestico Marino De Galicia; <sup>10</sup> University of Rhode Island, Graduate School of Oceanography

Microalgae in marine and brackish waters of Europe regularly cause harmful effects, considered from the human perspective, in that they cause economic damage to fisheries and tourism. Cyanobacteria cause similar problems in freshwaters. These episodes encompass a broad range of phenomena collectively referred to as «harmful algal blooms» (HABs). For adequate management of these phenomena, monitoring of microalgae is required. However, effective monitoring is time consuming because morphology as determined by light microscopy may be insufficient to give definitive species and toxin attribution. In the EU FP7 project MIDTAL (microarrays for the detection of toxic algae) we achieved rapid species identification using rRNA genes as the target. These regions can be targeted for probe design to recognize species or even strains. We also included antibody reactions to specific toxins produced by these microalgae because even when cell numbers are low, toxins can be present and can accumulate in the shellfish. Microarrays are the state of the art technology in molecular biology for the processing of bulk samples for detection of target RNA/DNA sequence. After 36 months we have completed RNA-cell number-signal intensity calibration curves for 18 HAB species, and the analysis of monthly field samples from five locations from year one, and are partway through the analysis of year two samples. Results from all partners will be presented.

#### Cyanobacteria responses to phosphorus: identifying risks to recreational use

Laurence Carvalho & Claire McDonald

CEH Edinburgh

A safe, clean water supply is critical for sustaining many important ecosystem services provided by freshwaters. The development of cyanobacterial blooms in lakes and reservoirs has a major impact on the provision of these services, particularly limiting their use

for recreation and water supply for drinking and spray irrigation. Using a dataset from over 1500 European lakes, we highlight the use of quantile regression modelling for understanding the maximum potential capacity of cyanobacteria in relation to phosphorus and the use of a range of quantile responses, alongside World Health Organisation (WHO) thresholds for recreational waters, for setting robust phosphorus targets for lake management in relation to water use. The analysis shows that cyanobacteria exhibit a non-linear response to phosphorus with the sharpest increase in cyanobacterial abundance occurring in the TP range from about 20 µg L<sup>-1</sup> up to about 100 µg L<sup>-1</sup>. The likelihood of exceeding the WHO 'low health alert' threshold increases from about 5% exceedance at 16 µg L<sup>-1</sup> to 40% exceedance at 54 µg L<sup>-1</sup>. About 50% of lakes remain below the WHO low threshold, irrespective of increasing TP concentrations, highlighting the importance of other limiting factors affecting cyanobacteria populations, such as high flushing rates. Our results can be used to set nutrient targets to sustain recreational services and provide different levels of precaution that can be chosen dependent on the importance of recreation at the site.

#### Magnetic Particle Induction and its Importance in Biofilm Research

Amy Anderson, Bryan Spears & David Paterson

The Technopole Centre, Edinburgh Technopole

In recent years awareness of antibiotics as common contaminants of aquatic systems has increased significantly. They reportedly occur in wastewater treatment plant (WWTP) effluent and surface waters at concentrations ranging from ng l<sup>-1</sup> to several µg l<sup>-1</sup>. Antibiotics released into aquatic environments are a concern for several reasons, including their potential to negatively impact important ecosystem services regulated by microorganisms. One such ecosystem service which may be adversely affected is biostabilisation whereby, microbial consortia living in biofilms at the sediment surface mediate the response of the sediment to erosive forces. Understanding the biostabilisation capacity of biofilms and its impairment by pollutants is important for successful sediment management in waterways and coastal zones. We will present the findings of an investigation into the biostabilisation potential of natural biofilms when exposed to environmentally relevant concentrations of antibiotics. Over the course of the experiment the MagPI System was used to measure the adhesive capacity of the substratum, a proxy for sediment stability. The MagPI System is a relatively new device developed to evaluate biofilm formation and state of development. The results of this experiment successfully demonstrate its ability to determine subtle changes in surface adhesion as a result of biofilm formation. This presentation will also encompass a brief review of previous investigations in which the MagPI System has been used and detail other potential uses for this device.

#### Large-Scale Cultivation of *Spirulina* in Saudi Arabia

Ali A. Al-Homaidan

Department of Botany and Microbiology, King Saud University

The unique chemical composition of *Spirulina* makes it a good food supplement in human and animal nutrition. A strain of *Spirulina platensis* (Nordstedt) geitler (UTEX No. LB 2340) was acquired from the University of Texas at Austin, U.S.A. and it was adapted to grow under the harsh environment which prevails

in the central region of Saudi Arabia. It was grown in covered and opened rectangular raceway ponds. Softened ground water was enriched with a commercial compound fertilizer (N:P:K = 20:20:20), NaHCO<sub>3</sub> and micronutrients. The average yield of the biomass during production periods was very high and ranged from 10.5 to 12.2 g (dry weight)/m<sup>2</sup>/day. The protein percentage in the final product ranged from 52 to 70% with an average of 65.25%. The amino acid content in the fine powder was 62.10%. The concentrations of the heavy metals As, Cd, Cu, Fe, Hg, Mn, Pb and Zn were measured in the final dry powder and they were within the recommended range established by major producers. The results of this work showed a great potential for the cultivation of *Spirulina* in the Kingdom of Saudi Arabia.

### **Desmodesmus: a model organism for investigating cancer and elucidating the origin of multicellularity**

Scott Lawton, Paul Hayes & [Elliot Shubert](#)

Natural History Museum, London

*Desmodesmus* exhibits phenotypic plasticity and can switch between colonial and unicellular forms under controlled nutritional and environmental conditions in a 24-hour period. Differential gene expression analysis revealed up-regulated and down-regulated genes. In-depth similarity searches were performed on the sequenced expressed genes. BLAST searches using BLASTn, tBLASTn and tBLASTx were used to identify sequences and to predict any potential functional similarities between differentially expressed genes in both unicellular and colonial forms of *Desmodesmus* and other multicellular organisms. Genes were identified that were not only involved in photosynthesis, but also in cellular aggregation and signalling pathways found only in multicellular organisms. However, the most significant BLAST hit was similarity to a tumour cellular adhesion protein expressed on the surface of cancerous cells. This is indicative that the fundamental gene types involved in multicellularity are either highly conserved or are under exceptional convergent selective constraints. Equally, based on this preliminary gene identification exercise, *Desmodesmus* could have the potential to be utilised as an ethical model in cancer and stem cell research and elucidating the origin of multicellularity.

### *SESSION C: Evolution and phylogeny*

Chair: Prof. Juliet Brodie

### **Intense exon shuffling in the *Ectocarpus* ROCO-LRR and NB-ARC-TPR genes: are brown algae capable of adaptive immunity?**

Antonios Zambounis, Marek Elias, Lieven Sterck, Florian Maus & [Claire Gachon](#)

Scottish Association for Marine Science, Scottish Marine Institute

Our lab is interested in the physiology of disease resistance in marine brown algae. In order to identify candidates potentially involved in algal defence, we mined the genome of the brown alga *Ectocarpus siliculosus* for homologues of animal and plant defence genes. Whilst homologues of plant resistance genes are absent from the genome, we identified two families of candidate pathogen receptors (LRR-ROCO and NB-ARC-TPR proteins) that apparently evolve new ligand-binding specificities by a highly original, controlled, and dynamic exon shuffling mechanism. Moreover, hypervariable solvent-exposed amino acid residues are subject to positive selection, an unusual feature reflecting strong evolutionary pressures, such as the ones imposed by a host-

pathogen arms race. The genomic organization, structural and evolutionary features of these candidate pathogen receptors are strikingly similar to the pathogen recognition systems described in plants and animals. In conclusion, we hypothesize that brown algae might generate their immune repertoire *via* controlled somatic recombination. We will discuss these findings in the context of the evolution of adaptive immunity in early eukaryotes.

### **All at sea: Oomycete parasites of marine algae and what they tell us about the evolutionary phylogeny of the lineage and their relationship to other "Chromistans"**

[Gordon William Beakes](#)

School of Biology, Newcastle University

The oomycetes are best known as devastating parasites of plants, trees and fish and were long considered to be of terrestrial origin. However, recent studies on obligate holocarpic parasites of seaweeds such as *Olpidiopsis* spp. and *Eurychasma* have shown these marine genera diverge early within the oomycete lineage, before the two main predominantly terrestrial clades the Saprolegniomycetes and Peronosporomycetes. *Eurychasma* appears to be the most basal-known genus forming a clade with the nematode parasite, *Haptoglossa*. The general morphology and ultrastructure of these little studied marine oomycetes will be described as well as their effects on their seaweed hosts. It also seems likely that other marine parasitic species such as *Ectrogella* and *Lagenisma*, both of which infect centric marine diatoms, will also be in this basal group of oomycetes. It is now clear that the oomycetes have their evolutionary roots firmly in the sea and have long been adapted to the parasitic life style. Indeed all early diverging genera appear to be obligate parasites. The oomycetes belong to a monophyletic line within the Chromista/Heterokonta which also includes the unflagellate Hyphochytrids and their parasitoid cousin *Pirsonia*, as well as the photosynthetic Ochrophyta line. It seems quite likely that oomycetes co-evolved along with their diatom and phaeophyte hosts.

### **Genetic diversity and ecology of *Phaeocystis antarctica* and *P. pouchetii* – a bipolar approach**

[Steffi Gaebler-Schwarz](#)<sup>1</sup>, [Manuela Goers](#)<sup>2</sup>, [Lydia Gustavs](#)<sup>2</sup>, [Florian Leese](#)<sup>3,4</sup>, [Linda K. Medlin](#)<sup>5,6</sup> & [Ulf Karsten](#)<sup>2</sup>

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The two cold water colony-forming species of the prymnesiophyte genus *Phaeocystis*: *Phaeocystis pouchetii* in the Arctic and *P. antarctica* in the Southern Ocean, are known to be key species within their habitats. Many ecological and biogeochemical aspects of *Phaeocystis* spp. have already been studied, but less is known about their basic ecophysiological performance. Molecular techniques have become a valuable additional tool in the past decades to study planktonic microalgae by providing the possibility to identify phytoplankton and its diversity down to species level or even below (infra-specific differentiation), regardless of their sizes and developmental stages. Genetic diversity is the key factor for a species to adapt to ecological conditions and is always changing, reflecting evolution. Only a species that continuously adapts is able to survive in any environment but more especially in harsh conditions, such as the Arctic or Southern Ocean. The combination of traditional molecular methods with physiological growth experiments could lead to a detailed analysis of the population structure of both polar species and it is intended to link genetic data to environmental parameters and to ecophysiological

cal response patterns. *'Ecophysiological genetics'* is a novel approach to investigate *Phaeocystis* and may offer new insights into ecological questions and the reaction of key species to predicted climatic changes in both Polar Regions. First results will be showed.

### O father, where art thou? Paternity analyses in a natural population of the red seaweed, *Chondrus crispus*

Stacy A. Krueger-Hadfield, Stéphane Mauger, Denis Roze, Christophe Destombe & Myriam Valero

Marine Biological Association of the UK

*Chondrus crispus* is an ecologically and economically important intertidal red seaweed of which little is known about its population biology. This species follows an isomorphic haploid–diploid life history in which dioecious haploid gametophytes alternate with a diploid tetrasporophyte. Male gametophytes release non-motile spermatia that fertilize the carpogonium. Fertilization results in the formation of a cystocarp, a swelling on the haploid female thallus housing the diploid zygote and the subsequent mitotically-produced diploid daughter spores (carpospores). The objective of this study was to understand the impacts of haploid-diploidy, male gamete dispersal and the intertidal landscape on fine-scale genetic structure in *C. crispus*. Individual fronds were sampled every 25 cm in two 5 m x 5 m grids located at the upper and lower edge of the *C. crispus*–range at one intertidal site. Fronds and cystocarps (excised from female gametophytes) were genotyped using polymorphic microsatellite loci. The maternal allele at each locus can be determined from the genotyped haploid female gametophytic thallus. Therefore, the paternal genetic contribution is the remaining allele. In contrast to diploid organisms, the paternal multilocus genotype can be reconstructed without inference and directly compared to the gametophytic genotypes sampled within the population. Very large levels of inbreeding, specifically intergametophytic selfing, were detected within populations using indirect methods (e.g.  $F_{is}$ ). This was supported by the paternity analyses in which larger kinship coefficients were detected between males siring cystocarps on the same female in comparison to males in the entire population. However, only one putative sire was identified in the sampled population, the remaining 424 sires were not sampled. The location of putative sires is discussed in light of the novel model of population structure detected in this species in which large levels of inbreeding are associated with low levels of genetic differentiation.

### The North Atlantic colonization of *Fucus* and its diversification

Jeanine Olsen, Wytze Stam & Jim Coyer

MarBEE-CEES, University of Groningen

The genus *Fucus* arose around 3-5 mya in the Pacific and radiated into the Atlantic on at least two occasions <500-800K years ago. Once reaching the Atlantic, repeated glacial and interglacial periods have shaped the genus resulting in numerous species and ecotypes for which the phylogeography is well known. Studies by our lab and others over the past 15 years have demonstrated inter- and intra-specific hybridization, as well as habitat selection leading to further ecotypic differentiation. *Fucus* species now dominate intertidal zones over 45 degrees of latitude along the European Atlantic yet reproductive isolation is, at best, partial. Is this because the timeframe is too shallow for reproductive isolation to become complete or are other processes at work? With the possibility of acquiring whole genome sequences in the very near future, opportunities to explore genome architecture will help to unravel some of the reasons for *Fucus*' enormous success.

### Does the *Laminaria digitata* gametophyte bank act as a genetic diversity repository?

Lucía Couceiro, Marine Robuchon, Akira F. Peters & Myriam Valero

ÉQUIPE BEDIM, Station Biologique de Roscoff

Shallow nearshore waters in temperate and high latitudes are dominated by large brown algae, primarily kelps –Order Laminariales–, which form dense stands on rocky substrates and alternate macro- and microscopic life-history stages. It is generally assumed that the microscopic forms of some of these species are able to delay their development and persist periods unfavourable to the larger morphologies. However, since they are small and difficult to observe in the field, their relative contribution to the population recruitment/persistence has remained relatively unexplored. The main objective of this work is to obtain a complete understanding of the *Laminaria digitata* life history and the ecological/evolutionary importance of its microscopic stages. In particular, it is expected to establish (i) if the recovery of its populations after potential perturbations – e.g. increasing temperature, harvesting, or pollution– depends on the arrival of new individuals from neighbour locations or, by the contrary, it is determined by the presence of local microscopic stages that may act as a “seed bank” and, (ii) if this bank of microscopic forms might function as a “genetic memory” accumulating and storing gametophytes formed during different years and, therefore, increasing effective population size.

### SESSION D: Applied algal monitoring

Chair: Dr Maeve Edwards

### Potential Important Plant Areas (IPA's in Wales)

Francis Bunker

MarineSeen

Several sites have been highlighted by the Countryside Council for Wales (CCW) as being of interest for their marine algae, either as species rich sites or for supporting rare/scarce/BAP species. Many of these sites were designated in 2007 as provisional Important Plant Areas (pIPA) and all the sites are situated within marine Special Areas of Conservation (SACs) or Sites of Scientific Interest (SSSIs).

It was decided that further survey work was needed to provide an inventory of species and a baseline methodology against which future monitoring might be undertaken. CCW commissioned MarineSeen to study 6 sites between 2009 and 2011.

The six sites studied included:

1. Rhosneigr intertidal reefs (Anglesey). A total of 83 species (including species groups) were recorded from selected habitats during the present survey.
2. Llanbedrog low water lagoon (Llyn Peninsula). The general species richness of the lagoon reflects that of the surrounding area and with species of interest *Spyridia filamentosa* and *Dudresnaya verticillata*
3. Oyster Bank sublittoral Site (Pwllheli). This site is a not only very rich in seaweeds, some of which are rare and two of which are designated as UK BAP species (*Anotrichium barbatum* and *Grateloupia montagnei*).

4. Glanllynau shore and shallow subtidal (Tremadog Bay). The shore was a rather scoured habitat poor in species and the shallow subtidal had been ravaged by recent storms. A resurvey is recommended here.
5. Sarn Badrig sublittoral monitoring site (Tremadog Bay). A series of times searches were undertaken in this seaweed rich habitat as part of established long term monitoring.
6. West Angle (Pembrokeshire). A total of 68 species of macroalgae were recorded from the 7 habitats studied. This survey has only covered a small number of example habitats at the site. Included in the species recorded was *Gracilaria dura* at its northern distribution limit.

#### Monitoring changes in the only bed of living maerl (unattached coralline algae) in Wales

Francis Bunker<sup>1</sup>, [Christine A. Maggs](#)<sup>2</sup>, Mike Camplin<sup>3</sup> & Aethne Cooke<sup>3</sup>

<sup>1</sup>MarineSeen; <sup>2</sup>School of Biological Sciences, Queen's University of Belfast; <sup>3</sup>Countryside Council for Wales

Maerl habitats comprise loose-lying non-jointed coralline red algae (Corallinales, Rhodophyta) that can build up over millennia to create habitats of high benthic biodiversity. The European Union's Habitats Directive gives legislative protection to maerl with *Phymatolithon calcareum* and *Lithothamnion corallioides* included in Annex V. Throughout Europe maerl beds have been impacted by a range of anthropogenic factors such as commercial extraction (now stopped in the UK), eutrophication and fish and mussel farming. In the UK, there are extensive beds in Scotland and Ireland and one area of live maerl in Milford Haven, South Wales. The Milford Haven maerl bed is listed as a component of particular conservation importance in the Pembrokeshire Marine Special Area of Conservation. In 2005, just prior to the renovation of the old Esso jetty, which involved construction work over the area of the maerl bed, baseline monitoring data for maerl extent and status (live/dead/fossil), algal epibiota and infauna were collected at 6 sites. The endemic maerl epiphytes *Gelidiella calcicola* and *Cruoria cruoriaeformis* were recorded, and a new species *Cladophora rhodolithica* was described.

Following construction work, the maerl was re-evaluated in 2010. Between 2005 and 2010 there was a significant decline in live maerl cover at two of the sites, alongside a conspicuous increase in the invasive slipper limpet *Crepidula fornicata*. Various factors may account for a decline of live maerl since 2005 with the most likely being: (1) The intensive industrial activity during the renovation of the old Esso jetty trestle and the construction of the South Hook LNG jetty terminal between 2005 and 2008. (2) Scallop dredging, although now banned, was known to have taken place in the maerl bed since 2005. (3) A rise in abundance of the slipper limpet, *Crepidula fornicata*, taking space previously available to live maerl.

#### *Caulerpa racemosa* var. *cylindracea* invasion around Arki Island, Eastern Aegean Sea: spatial distribution and impacts

[Christopher Williamson](#)<sup>1,2</sup>, Mark Jenner<sup>2</sup>, Anastasia Miliou<sup>3</sup> & Rupert Perkins<sup>2</sup>

<sup>1</sup>Natural History Museum, London; <sup>2</sup> School of Earth and Ocean Sciences, Cardiff University; <sup>3</sup>Archipelagos, Institute for Marine Conservation

An examination of the extent and impacts of *Caulerpa racemosa* var. *cylindracea* invasion was performed around Arki Island, Eastern Aegean Sea, Greece, in comparison to exposure and substratum type. *C. racemosa* is regarded as one of the most serious invaders to impact Mediterranean ecosystems, yet research examining the alga's distribution and impacts is relatively sparse in comparison to more well-known invaders, e.g. *C. taxifolia*. In particular, monitoring of invasive species and assemblage distributions is poorly developed and coordinated within Greek waters. Underwater Visual Census (UVC) techniques were therefore employed to examine *C. racemosa*'s shallow (0 – 5m) spatial distribution, morphology and effects to native macroalgae and invertebrate assemblages in 10 sites around Arki Island. Sites were assigned to one of three exposure ratings (sheltered, moderately exposed and exposed) and within each site, 3 substratum types were examined (rock, sand and *Posidonia oceanica* seagrass bed). *C. racemosa* was present in sites of all exposures and across all substratum types, although at lower percent covers than recorded from other invaded Mediterranean regions (average  $12 \pm 2.13$  % cover). Low abundances likely reflect a recent range expansion into the area, rather than abundance limitation via abiotic or biotic controls. Higher abundances recorded within sheltered sites highlight such conditions as favourable for invasion. Increased frond sizes were observed on *P. oceanica* seagrass bed substratum, independent of exposure or abundance, perhaps as a result of competitive interactions between *C. racemosa* and the seagrass. Negative impacts to native macroalgae assemblage species richness (S), diversity (D) and evenness (J') were observed despite low *C. racemosa* abundance, although these were not sufficient to cause changes in native invertebrate assemblages.

#### What has the coal-mining industry done to British intertidal seaweed communities?

[Martin Wilkinson](#), Sharon Woolsey & Caitriona Buggle

Centre for Marine Biodiversity and Biotechnology, School of Life Sciences, Heriot-Watt University

In three areas of Britain, where coal-mining has taken place on the coast, there have been considerable effects on the intertidal seaweed communities. These areas are County Durham, west Cumbria and the Fife coast of the Firth of Forth. Adverse effects result from both solid and liquid wastes. The solid waste is coal spoil or minestone which has been dumped directly onto intertidal seashores in all three areas. This exerts a physical rather than a chemical polluting effect, smothering solid bedrock substrata and their biota and inhibiting species attachment, increasing turbidity in the water column, and creating new shingle shores. The liquid effluent is mainly mine drainage water but this does not become a serious problem until mines have been abandoned so that the water has not been pumped out of the mine. The water that accumulates in the mine eventually bursts out after a period of ageing in the mine which can make it acid, deoxygenated and iron-rich, resulting in precipitation of ferric solids when the water oxidises at the surface. Both types of waste can eliminate seaweed species to a greater degree than that due to more traditional pollutants such as sewage, sometimes resulting in almost algal-bare shores. With the cessation of coastal minestone dumping in the last 30 years there has been erosion of accumulated spoil, aided in Co. Durham by deliberate clean up measures, but only partial seaweed recolonisation of shores has occurred. In some areas the delayed outburst of minewater could set back some recovery.

#### Education: The roles of phycological Biological Research Centres (BRCs)



Christine N. Campbell & John G. Day

Culture Collection of Algae and Protozoa, Scottish Association for Marine Science, Scottish Marine Institute

In the 21<sup>st</sup> century phycology has come of age. The rapid developments in molecular biology, (genomics, proteomics *etc.*), have ensured that fundamental and applied algal research is at the cutting edge of science. In parallel, potent economic and political drivers, such as fuel & food security and global warming, have stimulated interest in the biotechnological exploitation of algae. Such an upsurge in interest necessitates the accessibility of education, delivered as living material with accompanying bioinformatic data, as training courses for PhD students and researchers in the biotechnology and biofuel industries, and, as outreach activities to educate school pupils and the general public about the wonders and uses of algae. Biological Resource Centres (BRCs) such as the CCAP Collection are ideally positioned to fulfil this requirement. They contribute both as resource and service infrastructures and repositories of gathered expert knowledge on identifying, isolating, culturing and *ex situ* conservation of algal material. In the past five years there has been a rapid increase in demand for services and materials from culture collections. Cultures are available for use in teaching at school, undergraduate and post graduate levels. SAMS has recently developed a series of continuous professional development (CPD) courses and CCAP now regularly delivers short practical courses on topics such as 'Algal Culturing for Biotechnology' and 'Long term conservation of marine microbial resources'. CCAP has also witnessed a novel interest in using algae, such as bioluminescent species, for art installations – a 'left-field' method of educating the public about the fascinating world of algae!

#### MANTON SESSION ONE

Chair: Prof. Paul Hayes

#### **The dynamics of toxic and non-toxic strains of the harmful dinoflagellate *Alexandrium tamarensis* from Scottish Waters**

Lisa Eckford-Soper<sup>1</sup>; Keith Davidson<sup>1</sup>; David Green<sup>1</sup>; Eileen Bresnan<sup>2</sup> & Jean-Pierre Lacaze<sup>2</sup>

<sup>1</sup>Scottish Association for Marine Science, Scottish Marine Institute; <sup>2</sup>Marine Scotland Science

Harmful algal blooms pose a threat to human health worldwide. In Scottish waters this is most commonly through the production of bio-toxins that are concentrated and then vectored to humans by filter feeding shellfish. One of the most prominent harmful species is the dinoflagellate *Alexandrium tamarensis* that produces bio-toxins associated with paralytic shellfish poisoning (PSP). *A. tamarensis* can be highly toxic with the presence of relatively low cell densities (<1000 cells l<sup>-1</sup>) potentially resulting in shellfish fishery closures. Historically Scottish waters were thought to be dominated by the toxic group I 'North American' Strain but in recent years there has been a shift towards the non-toxic group III 'Western European' Strain with both strains potentially co-occurring at the same location. I shall present some initial findings from a set of a set of laboratory batch culture, time course growth experiments where both toxic and non-toxic strains of *A. tamarensis* were co-cultured at different temperatures (12, 15 and 18°C). Cells were grown in low phosphate media (5µM) so cells experienced the phosphate limitation that is thought to promote toxicity. A Fluorescence In Situ Hybridization-Flow Cytometry-Cell (FISH/FC) Sorting-Based Method was developed for the separation and enumeration of these morphologically indistinguishable ribotypes. Differences in growth rates were noted between toxic and non-toxic strains. Early results appear to suggest that there is a difference in growth dynamics between toxic and non-toxic strains as well as some allelopathic interactions in co-culture.

#### **Monitoring the physiological and behavioural responses of rocky shore benthic biofilms to varying temperatures**

Naomi Ginnever & Rupert Perkins

School of Earth and Ocean Sciences, Cardiff University

Compared to soft sediment microalgal communities, very little research has been undertaken focussing on rocky shore microalgal biofilms. In particular little is known regarding their photophysiology and capacity to regulate their primary productivity. This is despite Britain's rocky shores being important areas of high biodiversity which is in part supported by these phototrophic communities.

Benthic biofilms were collected from Dunraven Bay in Bridgend. This is an exposed rocky shore with the phototrophic community dominated by high density diatom and cyanobacterial biofilms. The tolerance to heat and light stress of this community was investigated *ex situ* using environmental computer controlled chambers, which maintain and monitor the temperatures within tidal simulation tanks. The biofilm samples were exposed to 5, 10, 15, 20, 25 and 30 °C for 48 and 60 hours. Measurements were taken using a Walz Water PAM fluorometer every 4 hours during the daylight hours. Samples which were exposed to temperatures above 15°C all experienced very rapid reductions in the capacity to induce non-photochemical quenching (NPQ) which is the major photosynthetic regulatory mechanism for rocky shore biofilms. Thermal microscopy was used to observe cell behaviour at changing temperatures. Above 14°C the cells began to move within their tubes. Findings suggest that tube forming diatoms in this community may have an additional behavioural regulatory mechanism to compensate for reduced NPQ capacity during periods of high temperature and high light exposure.

#### **Impact of herbicides on river biofilms: a multifaceted approach**

Helen Rosenkranz<sup>1</sup>, A.M. Anesio<sup>2</sup>, M.G. Kelly<sup>3</sup>, M.L. Yallop<sup>1</sup>

<sup>1</sup>School of Biological Sciences, University of Bristol; <sup>2</sup>School of Geographical Sciences, University of Bristol; <sup>3</sup>Bowburn Consultancy

A wide range of techniques have been published in the literature to assess the impact of herbicides on river biofilms. These studies conducted field and laboratory experiments primarily on isolated single species (like in standardised growth inhibition tests), or worked on whole biofilms. Each of the used methods focused on different components and functioning of the complex benthic communities.

During my PhD several different approaches were applied to determine the impact of herbicides on biofilms. Experiments were performed on natural biofilm communities both in the laboratory and field. Clonal species were isolated from the field samples and growth inhibition tests were performed under standardised laboratory conditions. Various parameters were selected to quantify impacts including: community biomass measurements (ashfree-, dry weight and chlorophyll *a*), assessment of the function of the community (photosynthesis and respiration, bacteria and virus biomass) as well as species biovolume and diversity identification to class, genera and species level using microscopy. Comparisons were then made between techniques used to study selected structural and functional parameters. In this talk I present insights into the impact of selected herbicides on the biofilm community and individual taxonomic groups and evaluate the various methodological approaches applied.

## Development of bioassays for assessing antifouling activity of biogenic compounds extracted from marine microalgae

Ghezlane Id Daoud<sup>1</sup>, M. Devonshire<sup>1</sup>, P. Gurung<sup>1</sup>, B. Véron<sup>2</sup>, A.V. Patel<sup>3</sup>, J. Pope<sup>1</sup>, P.K. Hayes<sup>1</sup> & C. Hellio<sup>1</sup>

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Biofouling, defined as the undesirable colonisation of natural and man-made submerged surfaces by micro and macroorganisms, can have major economic and environmental impacts, which justifies the development and deployment of novel preventive treatments. Biocides and heavy metal-based antifouling paints are still widely used, but their toxicity against non-target-organisms is problematic and is driving the search for more specific and environmentally friendly antifouling (AF) compounds.

There is growing interest in screening marine organisms for the production of biogenic compounds (marine natural products, MNPs) that have potential for use in AF applications. Microalgae as a source for MNPs are attractive because they have a high growth rate and can be cultivated sustainably on a large scale under controlled conditions.

Assessing the AF activity of new eco-friendly MNPs in the laboratory can be very challenging, as it is difficult to recreate conditions that mimic those in the environment. The majority of the bioassays used presently are monospecific and only assess growth inhibition.

In this project new MNPs have been screened for their biofilm formation inhibition activity using bioassays that are more relevant for AF purposes. In combination, biostatic and biocidal activity is assessed through toxicity testing to confirm the eco-friendly properties of the MNPs. The biological activities of promising MNPs are tested through multispecific bioassays before taking them to field-testing trials, which are time and material consuming. Five concentrations of MNPs (from 0.01 to 100 µg mL<sup>-1</sup>) extracted from microalgae have been screened for their AF activity against bacterial and microalgal biofilm forming species: six biofilm forming bacteria - *Pseudoalteromonas elyakovii*, *Polaribacter irgensii*, *Vibrio aestuarians*, *Vibrio natrigens*, *Shewanella putrefaciens* and *Halomonas aquamarina*; six microphytobenthic algal species - *Exanthemachrysis gayraliae*, *Pleurochrysis roscoffensis*, *Cylindrotheca closterium*, *Porphyridium purpureum*, *Amphora coffeaeformis* and *Lotharella globosa*. The results of these studies will be presented and discussed.

## Adhesion preferences for ectocarpoid algae in relation to surface wettability, polarity and charge

Emmanuelle Evariste, Maureen Callow & James Callow

University of Birmingham, School of Biosciences

Species of filamentous brown algae in the family Ectocarpaceae are significant members of fouling communities on ship hulls and other underwater structures. However, there are few systematic studies on the influence of surface physico-chemical properties on their adhesion. In the present study, the development of a laboratory-based adhesion bioassay for ectocarpoid algae, at an appropriate scale for the screening of sets of experimental samples in well-replicated and controlled experiments is described. The assay is based on the colonization of surfaces from a starting inoculum consisting of small multicellular filaments obtained by blending the cultured alga *Ectocarpus crouaniorum*. After 14 days growth, the adhesion strength of the resulting biomass is assessed by applying a known hydrodynamic shear stress. To

understand which surface properties of coatings affect adhesion, the bioassay was applied to a range of experimental siloxane-based, elastomeric coatings varying systematically in surface energy, wettability and polarity. In general, the results show that adhesion is weakest on those coatings with a high wettability (i.e. high total surface energy) and a high polar contribution to surface energy. Such coatings also show low fouling by ectocarpoid species in field tests. However, results with a range of cross-linked, organosilica xerogel coatings in which polarity is contributed through aminopropyl groups, show that this trend is reversed if the polar coatings also bear a net positive surface charge. The response of *E. crouaniorum* to the surfaces was also compared to that for the green alga, *Ulva*.

## Small things, plasticity, adaptation and climate change

Elisa Schaum<sup>1</sup>, Sinead Collins<sup>2</sup>, John Raven<sup>3</sup>, Andrew Millar<sup>4</sup> & Bjoern Rost<sup>5</sup>

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Evolutionary Biology; <sup>3</sup>University of Dundee, Oceanography; <sup>4</sup>University of Edinburgh, Centre for Systems Biology; <sup>5</sup>Alfred Wegener Institute for Marine and Polar Research

There is more to marine phytoplankton than meets the eye: despite being microscopic, they are responsible for about half of the global primary production. They also contribute to the global carbon cycle and the food web. Marine phytoplankton are taxonomically diverse, occurring in coastal and open-ocean environments and are found throughout the water column as long as there is sufficient irradiance and sufficient nutrients. The oceans, however, are bound to change. The Intergovernmental Panel on Climate Change (IPCC) scenarios predict further increases in atmospheric CO<sub>2</sub> pressure and increases in sea surface temperature. This will be - and has been - accompanied by a drop in pH and an intensification of stratification. When confronted with drastic changes to their environment, organisms can track the desired conditions, adapt, or go extinct. We can rule out moving and global extinction for most marine picoplankton, and focus on adaptation and processes favouring or constraining adaptation, in particular phenotypic plasticity and phenotypic integration. Whether and how phenotypic plasticity affects genetic adaptation in large populations is still an open question in evolutionary biology. However, as most oceanographic research focuses on short-term plastic responses and it would be useful to know how plastic responses relate to adaptive responses. Here we use one widely-distributed genus of picoplankton, *Ostreococcus*, as a model organism. We demonstrate that phenotypic plasticity in *Ostreococcus* is ecotype specific. We also show that plasticity is adaptive for the conditions tested here. Next, we will determine how likely lineages are to adapt in a long-term selection experiment, which may allow us to predict composition and carbon fixation properties of future algae communities better. To increase our ability to account for ecological factors that may influence evolution in natural populations, I will either model the impact of horizontal gene transfer on adaptation or focus on carbon budget models.

## Responses of the macroalgal key Species *Fucus serratus*: Driving the impact of climate change on North Atlantic rocky shores

Alexander Jueterbock, J.A. Coyer, L. Tyberghein, J.L. Olsen & G. Hoarau

Marine Ecology Research Group, Faculty of Biosciences and Aquaculture, University of Nordland

Climate change is likely to have a profound impact on the marine intertidal, where ecosystem resilience already suffers from additional human stressors. Its impact largely depends on how the key species of this ecosystem respond to increasing temperature. Basically, they are confined to three possible strategies: to (1) move, (2) be plastic or (3) evolve. Our overall objective was to uncover responses of the habitat provisioning key species *Fucus serratus* that have the potential to provoke changes throughout the entire North Atlantic intertidal ecosystem. More specifically, we aimed to (1) predict distributional changes of this macroalgae under three IPCC scenarios with ecological niche models using the program Maxent and (2) identify genetic changes and putatively selected loci in four populations that we had sampled at the beginning and end of the previous decade and genotyped for 31 microsatellite loci. Our niche models predict that the fundamental niche of *F. serratus* shifts up to 1000 km north within the coming two centuries. At the southern limit of distribution, in Spain, the allelic richness had already significantly declined by 14% over the past decade. Although each of the four genotyped populations revealed significant genetic changes over the past decade, outlier loci coincided only partly between them. If the southern populations are despite high genetic diversity unable to evolve tolerance to increasing temperature, they will become extinct under the predicted northward niche shift. The presence of outlier loci however suggests adaptive responses of *F. serratus* to climate change that might mitigate the predicted extent of northward retreat. Otherwise, the affected coastal regions may undergo substantial ecosystem restructuring with an unpredictable impact on human society and economy.

#### Role of the engineering species *Laminaria digitata* on the associated algal community

Marine Robuchon, L. Couceiro, M. Valero & L. Le Gall

Station Biologique de Roscoff

Kelp forests are emblematic marine ecosystems in temperate waters. Their removal profoundly disturbs the whole ecosystem and modifies community structure. Therefore they have been described as ecosystem engineers. However, their exact role in the associated community remains unclear. In Brittany, *Laminaria digitata* is the dominant kelp species of the low intertidal rocky seashore. This species has been harvested for decades, constituting an interesting model not only from a scientific but also from a cultural and economic point of view. The main goal of this study is to address the role of *Laminaria digitata* on the associated algal community as an engineering species. Specifically, we aim to answer the following questions: i) Does the presence of *L. digitata* facilitate the recruitment of other algal species? ii) Is the alpha diversity of algae higher when *L. digitata* is present? iii) Is the species composition more stable over time in presence of *L. digitata*? To fulfil our objective, a field survey was set up at low tide within a 1400 m<sup>2</sup> area where *L. digitata* formed a dense forest. Forty five quadrats (0.25 m<sup>2</sup>) were realized: 15 burnt quadrats, 15 burnt quadrats with *L. digitata* transplants and 15 control quadrats. The aim of this experimental design is to compare the recruitment kinetic of macroalgae during two years between burnt quadrats containing kelp transplants and those without transplants at different times after the beginning of the experiment. Preliminary results (one month and six months after the beginning of the experiment) on alpha diversity and abundance of new recruits are presented here.

#### Tracing hybrid speciation in the green seaweed *Halimeda*

Marie Pažoutová & Heroen Verbruggen

Department of Botany, Faculty of Science, University of South Bohemia

Although hybrid speciation is common in land plants, it has not been identified with certainty in green algae. Here we explore the possibility of hybrid speciation in the genus *Halimeda*. Phylogenetic trees of several nuclear (EF1a, HSP90, SSU-ITS) and plastid-encoded (*tufA*, *rbcl*, UCP3, UCP7) loci are reconstructed, showing conflicts between plastid and nuclear gene trees. We attempt to test for hybrid speciation likelihood by means of relative gene trees divergence estimates and phylogenetic networks analyses.

#### Polyphasic approach in systematics and delimitation of the Oocystaceae family

Lenka Štenclová & Marie Pažoutová

Department of Botany, Faculty of Science, University of South Bohemia

The family Oocystaceae comprises a group of microscopical green algae and has been relatively well-defined on the basis of morphological and subsequently ultrastructural data. Several phylogenetic studies based on ribosomal SSU rRNA sequences confirmed its monophyly inside the class Trebouxiophyceae. In addition these studies demonstrated the polyphyly of the type genus *Oocystis* and several morphologically close species from the families Scenedesmaceae, Chlorellaceae and Radiococcaeae are embedded within the Oocystaceae. As an attempt towards a major revision of the systematics of Oocystaceae, we are applying a polyphasic approach using multigene molecular phylogenies combined with morphological observations and TEM. We use the nuclear ITS region and plastid *rbcl* gene in addition to the ribosomal SSU rRNA data because of poor resolution of some lineages in the SSU phylogenies and the occurrence of long branches which may cause topological artefacts. In addition to previous ultrastructural observations of the genera *Oocystis*, *Eremosphaera*, *Neglectella* and *Makinoella*, we confirmed the specific cell-wall structure for the taxa formerly placed in the Scenedesmaceae (e.g. *Tetrachlorella alternans* and *Willea* sp.).

#### Systematic studies of the genus *Halymenia* (Halymeniales; Rhodophyta) in Pacific basin

Jazmin Hernandez-Kantun, A. Sherwood, J. Huisman, O. De Clerck & R. Riosmena-Rodriguez

Irish Seaweed Research Group, National University of Ireland

Species of the genus *Halymenia* are distributed from temperate to tropical regions. Ecologically they are associated to rhodolith beds, rocky shores and coral reefs. Traditionally, gross morphology and anatomical features have been used to characterize the various species in the genus. But since morphology is increasingly regarded as an inadequate estimator of species diversity, we applied a molecular approach to *Halymenia* diversity in two regions of the world, the Indo-Pacific and the Gulf of California. Twenty-two species of the genus *Halymenia* are known from the Indian Ocean; many are reported with a repeatedly branched thallus, toothed margins, spinose proliferations on the blade and firm gelatinous texture. The *H. durvilleii* complex in the Indo-Pacific needs re-examination because the conclusions of previous authors now seem unlikely after uncovering cryptic diversity with molecular data and increased taxon sampling based on our preliminary results. The descriptions of a new species from the Hawaiian Islands and the Philippines are presented and compared with previous descriptions of branched *Halymenia* species. Mor-

phological data were uninformative for delineating some of these species in this region. In the Gulf of California, traditionally the genus *Halymenia* has been described based on soft and mucilaginous texture and anticlinal filaments running from cortex to cortex in a transversal view, however, these characteristics are shared with some other genera as *Grateloupia* and *Cryptonemia*, bringing uncertainty on how many species belong to the genus in the region. After including samples from around the Gulf of California, two species were identified for the genus *Halymenia* contrasting with nine traditionally reported. A new species of *Cryptonemia* is described in this study, but initially included in the original description of *Halymenia actinophysa*. These results bring many questions on the number of species for the entire order Halymeniales in the Gulf of California.

### **Investigation of gene expression in lipid synthesis pathways in *Phaeodactylum tricornutum***

Carole Shellcock, Michele Stanley, David Green & John Day

Scottish Marine Institute

Many micro-algal species are able to store high percentages of triacylglycerols (TAGs). These neutral lipids can be chemically processed to produce biofuel. However, molecular level knowledge of oil biosynthesis and its regulation, in micro-algae, is limited. Using the model organism, *P. tricornutum*, the expression of selected target genes, within the glycerolipid metabolic pathway, is being examined. The aim is to determine "key" genes in lipid production.

Under batch culture conditions it has been possible to follow and profile lipid production throughout the growth cycle of the diatom. A specific focus has been to examine the effects obtained when cultures are exposed to carbon dioxide. Flow cytometry coupled with Nile Red neutral lipid staining has indicated that oil synthesis lags behind cell growth and that the highest oil levels occur once the culture has entered stationary phase. GC-FID analysis has shown the occurrence of fatty acids including eicosapentaenoic acid (20:5 *n*-3), a valuable polyunsaturated molecule. The physiological work has been combined with a molecular biology strategy to elucidate key genes involved in the lipid synthesis pathways of *P. tricornutum*. Suitable reference genes have been determined and validated for the experimental system, which has enabled investigation of gene expression of lipid pathway genes during periods of oil production and storage. Data will be presented describing the expression patterns of the selected lipid biosynthesis genes during oil accumulation in batch culture.

### **Estimating the accumulation of lipid and carbohydrate excess carbon in microalgae from cellular C:N ratios**

Jiyuan Sui, K.J. Flynn & R.J. Shields

Department of Bioscience, Swansea University

Elemental and chemical stoichiometry are factors that affect the value of microalgae as feed for grazers and also as material for commercial exploitation. Despite the importance of chemical stoichiometry, often only elemental stoichiometry (and typically C:N) is measured. Where fatty acids and carbohydrates (collectively comprising cellular excess-C) are determined typically the results are reported per cell, with whole organism elemental analysis absent. In consequence the C-specific content of excess-C, an important basis for determining chemical stoichiometry and for life cycle analysis in algal biofuels studies is rarely reported. Here we present an approach for estimating the C-specific content of excess-C from a knowledge of the elemental stoichiometry (cellular C:N ratio), and discuss how this may be further enhanced for future deployment.

### *SESSION A: Nutrient limitations*

Chair: Prof. Geoff Codd

### **Phosphorus and nitrogen fixation in cyanobacteria**

John A. Raven

Division of Plant Sciences, University of Dundee at the James Hutton Institute

The diazotrophic growth of nitrogen-fixing organisms has experimentally and mechanistically well-characterised requirements for additional iron and (usually) molybdenum compared with growth on nitrate and, especially, ammonium. By contrast, the requirement for additional phosphorus has been less well documented and is mechanistically poorly understood. Data on populations of the marine cyanobacterium *Trichodesmium* show that the diazotrophic growth rate is (partly) limited by phosphorus availability in places where the growth rate other non-diazotrophic phytoplankton is limited by combined nitrogen. For laboratory cultures of four strains of heterocystous cyanobacteria the phosphorus use efficiency (g dry weight increase per mol phosphorus in the organism per day) is highest for ammonium as nitrogen source, lower for growth on nitrate and lowest for diazotrophic growth. In searching for the mechanistic reason for the greater requirement for phosphorus for diazotrophic growth the possibility that additional ribosomes are required does not seem to have been previously examined. The argument is that the potential for irreversible oxygen damage to nitrogenase involves a range of processes which require more protein synthesis, and hence the need for more ribosomes. Examples of requirements for additional protein synthesis include the replacement of oxygen-damaged nitrogenase molecules by de novo synthesis, the production of heterocysts, and the exchange of iron between photosynthetic redox catalysts and nitrogenase on a diel basis in the marine unicellular diazotroph *Crocospaera* which only fixes nitrogen at night. Additional work is needed to measure the phosphorus use efficiency of non- heterocystous diazotrophic cyanobacteria, and the ribosome content of cyanobacteria growing diazotrophically and on combined nitrogen.

### **The effect of long range N deposition on phytoplankton nutrient limitation in Arctic lakes**

Erica J. Hogan, S. Mgowan, & N.J. Anderson

Department of Geography, Loughborough University

There is growing evidence of ecological change in Arctic lakes. The majority of this evidence comes from lake sediment records which suggest the composition of algal communities has changed, and productivity has increased over the past 150 years. This change has commonly been attributed to climate. However, such interpretation often ignores other drivers including long-range N deposition, which has been shown to occur over a similar time. The region of South West Greenland is typical of the Arctic in terms of lake density, precipitation patterns and vegetation. It also provides a unique opportunity to investigate N deposition as a driver of ecological change as it has only recently experienced rapid 20<sup>th</sup> century warming which has been observed elsewhere in the Arctic. Evidence from Greenland ice core records also indicate that N-NO<sub>3</sub><sup>-</sup> availability has increased during the past 150 years. The effect of N deposition on phytoplankton nutrient limitation was investigated in 21 freshwater lakes situated in 3 study regions in South West Greenland. The 3 regions span a gradient of increasing precipitation (and predicted N deposition) from the inland ice sheet margin to the coast. Nutrient limitation was

investigated 3 times between August 2010 and July 2011, allowing both seasonal and regional differences to be explored. Phytoplankton growth was assessed over 14 days following *in vivo* fluorescence of samples treated with 1 of 6 nutrient additions: control (no addition), P (6 mM NaH<sub>2</sub>PO<sub>4</sub>), NH<sub>4</sub><sup>+</sup> (90 M NH<sub>4</sub>Cl), NO<sub>3</sub><sup>-</sup> (90 mM NaNO<sub>3</sub>), P + NH<sub>4</sub><sup>+</sup> (final concentrations as before), P + NO<sub>3</sub><sup>-</sup> (final concentrations as before). A clear response to nutrient addition was found in 95 % of all bioassays, and of these, co-nutrient limitation was most commonly recorded (70 %). Phytoplankton growth showed strong seasonal variation in nutrient limitation, with a shift from P-limitation under ice to co-limitation in spring.

#### SESSION B: Algal secondary metabolites

Chair: Dr Gill Malin

##### Trigonelline and other betaines in species of Laminariales

Gerald Blunden<sup>1</sup>, S. Elgass<sup>1</sup> & M. D. Guiry<sup>2</sup>

<sup>1</sup>School of Pharmacy and Biomedical Sciences, University of Portsmouth; <sup>2</sup>Ryan Institute, National University of Ireland

Recently, the betaine trigonelline was reported as a constituent of *Laminaria digitata* and *L. hyperborea*. This was the first record of this compound in algae. As betaines have been shown to be of taxonomic value, it was considered of interest to determine whether trigonelline was a feature of all *Laminaria* species and to ascertain whether it was present in species in other genera of the Laminariales, as well as in species of other Laminariales families. Samples of 13 out of the 32 genera, but with at least one example in each of the seven families listed by AlgaeBase, were tested for the presence of betaines, using previously published procedures. Samples of each dried and powdered species (2.5 – 4 g) was extracted with aqueous methanol and the extract semi-purified by passage through a column of cation exchange resin. Identification was based on thin-layer chromatographic and <sup>1</sup>H NMR spectroscopic data. Quantification was achieved using a <sup>1</sup>H NMR spectroscopic method. Glycinebetaine was probably present in all the species examined. However, in *Undaria pinnatifida*, *L. setchellii* and *L. sinclairii* the content was very low and absolute characterisation was not possible. Similarly,  $\gamma$ -aminobutyric acid betaine was probably a constituent of all five *Laminaria* species examined and in two of the four *Saccharina* species, but in *L. setchellii*, *L. sinclairii* and the stipe of *L. pallida*, the content was very small, and only partial identification was possible. Trigonelline was identified only in *Laminaria digitata*, *L. hyperborea*, *L. sinclairii*, *Saccharina latissima*, *S. religiosa*, *Akkesiphycus lubricus* and *Pseudochorda nagaii*. Glycinebetaine contents varied from 0.3 (*A. lubricus*) to 0.003% (*L. setchellii*), dry weight,  $\gamma$ -aminobutyric acid betaine from 0.01 (*L. digitata* and *L. hyperborea*) to 0.003% (*L. setchellii*), and trigonelline from 0.02 (*A. lubricus* and *L. hyperborea*) to 0.006% (*L. digitata*).

##### Effect of elevated pCO<sub>2</sub> on the production of dimethylsulfoniopropionate (DMSP) and dimethyl sulfide (DMS) in two species of *Ulva* (Chlorophyceae)

Michael Steinke, Philip Kerrison, Mark N. Breckels & Esther Borell

Department of Biological Sciences, University of Essex

Concentrations of the algal secondary metabolite dimethylsulfoniopropionate (DMSP) and its climate-cooling breakdown product dimethyl sulfide (DMS) have been shown to be sensitive to ocean acidification in phytoplankton. Similar investigations on the response of marine seaweeds under elevated pCO<sub>2</sub> are important for quantifying DMS production in future coastal seas. Here

we report the first measurements of growth, and DMSP and DMS production in two species of chlorophyte macroalgae (*Ulva lactuca* and *U. clathrata*) under future CO<sub>2</sub> concentrations. Laboratory cultures were grown in pH-stated medium that received pulses of CO<sub>2</sub> to create pCO<sub>2</sub> conditions ranging from ambient (432  $\mu$ atm) to future (1514  $\mu$ atm). Intracellular concentration of DMSP remained unaffected in both species (101  $\pm$  21 and 69  $\pm$  20 mmol g<sup>-1</sup> FW in *U. lactuca* and *U. clathrata*, respectively) but significant differences in release of DMSP and DMS were observed. Whilst production of total DMSP (the sum of external DMSP and DMS) was different between replicated experiments, the percentage of total DMSP produced throughout each experiment increased significantly by up to 65% with increasing pCO<sub>2</sub> to 1514  $\mu$ atm. In contrast, DMS production decreased from 0.4 to 0.25 nmol g<sup>-1</sup> FW h<sup>-1</sup>. This decrease was not a linear function of pCO<sub>2</sub> but an almost 50% step-wise loss of DMS production was indicated between 635 and 884  $\mu$ atm, a pCO<sub>2</sub> predicted for the next 100 years. Our data suggest that ocean acidification will have implications for DMS production from benthic seaweeds.

#### SESSION C: Algal adaptations to environmental change

Chair: Dr Rupert Perkins

##### Towards predicting the minimum quantum requirement for carbon fixation in European seas

Evelyn Lawrenz, David Suggett, Elisa Capuzzo, Pasi Ylostalo, Rodney Forster, Stefan Simis, Ondřej Prášil, Anna Hickman, Mark Moore & Jacco Kromkamp

Department of Biological Sciences, University of Essex

Widespread introduction of active fluorometers to oceanography has increased the scale at which aquatic primary productivity can be evaluated. This approach, however, suffers from the limitation that productivity is determined in a photosynthetic 'currency' of electrons produced by the splitting of water at photosystem II (PSII) whereas most aquatic disciplines are based on carbon-specific rates of primary productivity. As such, algorithms are required to accurately convert electron transport rates (ETRs) to carbon fixation rates, which requires knowledge of the minimum quantum requirement for carbon fixation ( $\phi_{e,c}$ ). This parameter quantifies the moles carbon fixed per mol electron produced from PSII, and is dependent upon physiological status of phytoplankton and thus on environmental conditions and taxonomic differences. Here, as part of the EU program PROTOOL, we present a meta-analysis that has compiled existing (>750 data points from ca. 15 studies) and novel  $\phi_{e,c}$  data, predominantly from European shelf seas to examine the underlying nature with which  $\phi_{e,c}$  varies. This exercise demonstrated that temporal and spatial environmental change significantly alters the efficiency with which electrons are used to fix carbon and has resulted in emergence of some major trends with salinity, temperature and nutrient availability. With this knowledge, new environmental/taxonomic-based algorithms can now be constructed to more accurately derive high-resolution carbon fixation measurements from active fluorescence.

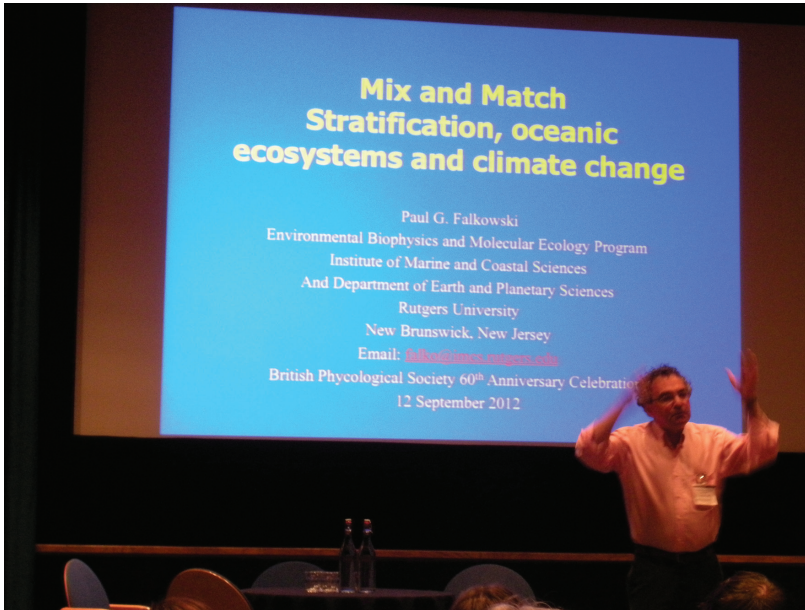
##### Effect of short duration UV irradiation on *Dunaliella salina* growth and recovery

Jorge Munoz<sup>1</sup>, Fabián Troncoso<sup>1</sup>, Gonzalo Padilla<sup>1</sup>, Fabián Figueroa<sup>1</sup> & Stephen M. Mudge<sup>2</sup>

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The genus *Dunaliella* is particularly known for its ability to adapt to some extreme environmental conditions such as high external

# 60<sup>th</sup> Anniversary of the BPS at the Natural History Museum





salinity and is tolerant to a high photon flux and temperature. This present study investigates the effect of short exposures to UVA/B radiation on cultures of *D. salina* to quantify cell damage, assess the resilience of subsequent growth and to determine the level of UV photon flux at which the culture loses its ability to restore growth. Results showed that UV radiation exposure to a dose 2.4 mW, which corresponds to a 10 seconds exposure, induced a reduction in the number of viable cells by 7% compared with those cultures not exposed to UV. Hence, these cultures did demonstrate some growth recovery in cell numbers increasing during the seven days recovery period. However, the cell number did not achieve the same density as exhibited by non-UV irradiated cultures, although, they did retain the ability to grow. Consideration should be given to the 2.4 mW dose of UV radiation since between this dose and double its value *D. salina* loses the ability to continue growing. UV doses of 4.8 mW to 14.3 mW led to a decrease of cell density from 48 to 94% respectively compared to the unexposed cells. All doses above 2.4 mW also disabled the ability of *D. salina* to grow after exposure; their growth capacity could not be recovered over a period of 7 days in culture conditions identical to the pre-exposure to UV. Further results obtained by exposing *D. salina* to 120 seconds lead to cell disruption and results in the loss of cell content. Although, UV spectral composition used here contains high proportion of UVB, which does not occur naturally, it should be considered that from 2001 to 2011 the UVB natural spectral proportion has double its value.

#### Measuring planktonic diatom aggregation using laser scattering

Daniel C.O. Thornton, Chen Jie & Charles E. Rzadkowski

Department of Oceanography, Texas A & M University

Planktonic diatom blooms often terminate with the formation of sticky aggregates of cells known as marine snow. Marine snow formation plays an important role in the biological carbon pump and the export of inorganic nutrients from the euphotic zone, as large particles generally sink faster than small particles. The objective of our on-going research is to test the hypothesis that diatom aggregation increases with increasing temperature. We used a laser *in situ* scattering and transmissometry (LISST) instrument to determine the effect of temperature and growth rate on aggregate formation by diatoms grown in semi-continuous and continuous cultures in the laboratory. 'Scattering signatures' of six different diatom species were measured using the LISST. The scattering signature of each diatom was affected by the size and shape of the species and did not change over time. The LISST was successfully used to monitor the formation of aggregates in cultures. Aggregation resulted in a change in the particle size distribution (PSD) within the cultures as the volume concentration of small particles decreased with a simultaneous increase in the volume concentration of larger particles. Temperature increase affected the aggregation of diatoms. Aggregation indicates that the diatoms became sticky at higher temperature; this may have been the result of increased acid polysaccharides on the cell surface or the enhanced production of extracellular dissolved organic carbon, resulting in transparent exopolymer particle (TEP) formation.

*SESSION D: Making seaweeds accessible for all*

Chair: Prof. Martin Wilkinson

#### Whither phycology and the information technology revolution?

Michael D. Guiry

AlgaeBase, Ryan Institute, National University of Ireland

Twenty years of the Internet has profoundly influenced phycology. The upside is that information has become freely and instantly available electronically thereby greatly accelerating the scientific process. Publication and communication have become more rapid and are much facilitated by e-mail, on-line submission, PDF technology, and image manipulation software. The downside is that—in the virtually exponential world of information—sorting the grain from the chaff becomes increasingly burdensome. SPAM has been close to drowning legitimate e-mail for quite a while now. And too much image management is sometimes the case. Taxonomy and literature access, in particular, are becoming seen as something that can be entirely IT-driven, but, while better access is aiding both, IT is not the universal panacea that it is often seen to be. Because taxonomy is now habitually seen as outdated and passé by funders the science may become extinct in "developed countries" and its survival may ultimately depend on "developing countries." Is the future bright? Probably not without a common strategy. On-line publication and non-existent or indifferent peer review from increasingly overstretched scientists are becoming all-pervasive. Both are a grave threat to our scholarly societies, the income for which is now mostly derived from printed periodicals. In competitive science driven by impact factors and relying on a faltering peer-review process and an practically risible impact-factor-driven system more suited to the shareholders of the publication giants than to science, we need revolution not more evolution. Resist to exist? A common strategy to assure the future of our science is urgently required.

#### Recent Seaweed Identification Initiatives

Francis Bunker<sup>1</sup>, Juliet Brodie<sup>2</sup>, Christine Maggs<sup>3</sup> & Anne Bunker<sup>1</sup>

<sup>1</sup>MarineSeen; <sup>2</sup>Natural History Museum, London; <sup>3</sup>Queen's University Belfast;

The structured approach taken during BPS field courses enables students from all walks of life to participate and learn about seaweeds. Introductory lectures introduce students to the main seaweed groups and seaweed habitats. In the field, a 'walk and talk' approach is taken to show features of rocky shores such as zonation and habitat preferences after which students are directed to work in small groups finding seaweeds for themselves. Where courses involve divers, they are instructed on recognising and collecting from particular seaweed habitats.

Courses allow for as much time in the laboratory as possible. Microscope time is interrupted by a series of short lectures on topics such as seaweed reproduction. Practical instruction is also given on making a herbarium and culturing seaweeds.

Seaweed identification depends on the availability of guides and many academic texts are out of print, expensive or difficult to obtain. Recent advances in the accessibility of publishing with colour photographs at reasonable prices makes the production of non-academic guides a realistic prospect. The *Seasearch Guide to Seaweeds* (2010) is one such guide.

Producing and updating paper guides can be expensive and the advent of e-publishing offers a potentially cheaper and more useful alternative. Electronic formats can also offer capabilities not available in conventional guides e.g. the inclusion of video clips.

Scientific names for species have the potential to act as a barrier to those trying to get to grips with a new subject. In the 2010 publication *Seasearch Guide to Seaweeds*, we included common names for approximately a third of seaweed flora for Britain and Ireland. Where possible we have used common names in current usage but where existing common names are obscure or unhelp-



ful we have provided new alternative names. The authors intend to complete this task for the remaining species currently without common names.

## Poster Abstracts

## Poster Session sponsored by Taylor and Francis

Wednesday 4<sup>th</sup> January 2012**What is the cost of environmental complexity on adaptation?**Georgina Brennan & Sinead Collins

University of Edinburgh

Here I discuss my plans to investigate the cost of complexity in adaptation and will elucidate how interactions between several factors in global change may affect evolution in large microbial populations.

The research proposed here will expand evolutionary theory that is applicable to large microbial populations experiencing global change to examine adaptation to several simultaneous environmental changes, and then to experimentally measure the cost (or benefit) of adapting to multiple environmental changes simultaneously. *Clamydomonas reinhardtii*, a unicellular, freshwater alga will be used as a model system with the intention of using results from this system to compare with marine algae. Existing evolutionary theory, suggests that increasing organism complexity increases the cost during adaptation (Fisher, 1930; Orr, 2000). We want to identify if this theory can be used to assess the cost of increasingly complex environments on adaptation or if they always have to be treated separately, in which case an alternative evolutionary theory would be required in order to understand evolutionary adaptation within an increasingly complex environment.

**Interesting new records of British freshwater algae from Pitsford Water, Northamptonshire**Chris F. Carter<sup>1</sup> & David M. John<sup>2</sup><sup>1</sup>6 Church View, Wootton, Northampton, NN4 7LJ; <sup>2</sup>Department of Botany, Natural History Museum, London

The second edition of *The Freshwater Algal Flora of the British Isles* (John *et al.* 2011) includes 200 species not in the 2002 edition. About two-thirds of these are new records and at least 16 of these require further verification. One of these doubtful records was the chlorophyte *Helicodictyon planctonicum* which was collected in a surface film on flooded terrestrial plants in Pitsford Water, Northamptonshire. Some of the doubt attaching to it was because illustrations of *Helicodictyon planctonicum* by Bourrelly (1972). *Les Algues d'Eau Douce. I. Boubée et Cie, Paris* of material sent to him by Whitford show little resemblance to Whitford's original description (as *Heterodictyon planctonicum*) and photographs. The strain of *Helicodictyon planctonicum* in the UTEX culture collection (LB 1570) closely resembles *Rhexinema* and this has been confirmed by phylogenetic analysis of the SSU rDNA sequence. The Pitsford Water material has been isolated by Dr Thomas Pröschold (University of Rostock) who is proposing to carry out a genomic analysis to determine its relationship to other closely related Ulvophyceae taxa. *Asterosiphon dichotomus* is the third new xanthophyte to be discovered in the British Isles since 2002. It was also discovered in Pitsford Water

on the seasonally-exposed muddy 'drawdown' area of this reservoir along with *Botrydium granulatum* and *Vaucheria bursata*. This terrestrial alga forms macroscopic, cushion-like colonies of dichotomously branched siphonaceous filaments; frequently these filaments are divided into a series of barrel-shaped akinetes. Undoubtedly many more freshwater algae remain to be discovered in the British Isles and new edition of the 'Flora' will undoubtedly stimulate further interest in this fascinating group.

**Anaglyphs as a tool for algal identification and appreciation**Christopher F. Carter

6 Church View, Wootton, Northampton, NN4 7LJ

Algae have features which can sometimes make them exceedingly difficult to present as still images. Even the best line drawings do not always relate easily to what is seen down a microscope, especially if the structures are compressed under a coverslip. Some of these problems are addressed in the 2nd edition of "The Freshwater Algal Flora of the British Isles" through the use of video clips, automontaged images, views from three angles and anaglyphs. An anaglyph is a picture in which the left eye and right eye views are converted to superimposed red and cyan images respectively; the original subject is thus recreated when suitable coloured spectacles are worn. Such pictures are more easily distributed than alternative 3D viewing aids. The technique has been particularly successful in interpreting the taxonomic features of *Chara* and demonstrating 3-dimensional structures in living material of genera such as *Chaetophora*, *Draparnaldia*, *Batrachospermum*, *Rivularia* and, more recently, *Asterosiphon dichotomus*. The technique is limited since only two out of three primary colours are available — so, for example, red objects are seen as very dark whilst green objects are satisfactory. As software becomes available for processing still images to give compatibility with modern polarizing spectacles this will improve. There are also technical problems in processing images at very high magnifications even with z-compression programmes, such as 'Image Automontage' and 'Helicon Focus'.

**Reaction-diffusion models of diatom pore occlusions**Lisa Willis<sup>1</sup>, Tom Duke<sup>2</sup> & Eileen J. Cox<sup>3</sup><sup>1</sup>CoMPLEX, University College London; <sup>2</sup>London Centre for Nanotechnology; <sup>3</sup>Natural History Museum, London

The species-specific biosilica cell walls of diatoms exhibit astoundingly diverse morphologies, with structures that span scales from 5 nm to 0.5 mm. Under normal physiological conditions, the finest structures, pore occlusions, assemble and solidify into roughly deterministic, delicate patterns in a matter of minutes. These patterns are believed to be conserved within species and to be propagated faithfully between generations, but vary between species. However, there is evidence of variation in morphology and nano-scale structure with growth conditions. Nevertheless, very little is known about the biological and physicochemical mechanisms that direct nano-mesoscale diatom silica assembly. If the mechanisms are simple or synthetically imitable, or if they can be externally manipulated, then they are potentially of great interest to the nanotech industry.

We are using abstract and physical models to help identify the physical processes that govern pore occlusion formation and their susceptibility to genetic change. Many diatom pore occlusions seen in nature are reminiscent of the products of reaction-diffusion models. Making only a few basic assumptions we have developed a Laterally Inhibited Stochastic Aggregation (LISA)

model that replicates some of the pore occlusion patterns seen in diatom genera, which also allows the effects of changing pore shape and size on occlusions to be explored. Some preliminary results and future directions are presented.

### Macroalgal biodiversity in the Beaufort Marine Biodiscovery Project

Svenja Heesch, Mónica Moniz, Margaret Rae, Fabio Rindi & Mark Johnson

Irish Seaweed Research Group, Ryan Institute, National University of Ireland Galway

The overall aim of the Beaufort Marine Biodiscovery Project is to sample and assess the Irish marine biodiversity, and to extract, identify and develop natural products and other biomaterials for application in areas such as drug discovery and biomedical research.

Among marine macroalgae, especially members of the Rhodophyta and Phaeophyceae are known to contain secondary metabolites, which may show anti-viral, anti-fungal, anti-helminthic, anti-bacterial or cytotoxic activity. With around 520 recorded species of red, green and brown algae, the coasts of Ireland harbour a high macroalgal biodiversity, offering a huge potential for biodiscovery. We currently study this biodiversity and screen the marine macroalgal flora of Ireland for novel bioactive compounds.

### The spread of *Undaria pinnatifida* in Plymouth Sound Special Area of Conservation, UK

Sabrina Heiser, Jason Hall-Spencer & Keith Hiscock

University of Plymouth

*Undaria pinnatifida* is a temperate kelp native to SE Asia. It was first discovered in Europe on the Mediterranean coast of France in 1971, and was deliberately introduced to Brittany in 1983 for aquaculture. In the NE Atlantic, it now occurs in Spain, France, southern England, Belgium and Holland. The first UK record was in the lower Hamble estuary in 1994. It was first recorded from Plymouth Sound in July 2003. Observations during 2010 and 2011 had established that *Undaria* was widespread in the wave-sheltered parts of the Sound occurring from +1m to -7m relative to chart datum, the same vertical extent as other kelps. Here, we assess the distribution of *U. pinnatifida* and native kelps (*Saccharina latissima*, *Saccorhiza polyschides*, *Laminaria digitata*, *L. hyperborea* and *L. ochroleuca*) in shallow waters of the Sound. In Aug-Sept 2011, mature individuals were recorded on vertical and horizontal surfaces (at 0 to +1 m relative to chart datum) at 17 sites throughout the Sound. *Undaria* was widespread along rocky shores, with a peak abundance of 23.9 m<sup>-2</sup> (± 2.0 ind. m<sup>-2</sup>, n=60) in a marina. It was significantly more abundant on vertical rock (pooled data from 13 sites had 6.7 ± SE 0.5 ind. m<sup>-2</sup>, n=375) than on horizontal rock surfaces (3.5 ± 0.4 ind. m<sup>-2</sup>, n=375). *Undaria* was almost as common as all of the other kelp species combined on vertical rock (they had a combined abundance of 10.2 ± SE 0.3 ind. m<sup>-2</sup>, n=375) but was outnumbered by native species on horizontal rock (combined native kelp abundance 20.7 ± SE 0.5 ind. m<sup>-2</sup>, n=375). *Undaria pinnatifida* is now widespread in Plymouth Sound SAC; it quickly became the dominant alga in marinas and then spread to surrounding natural habitats. Other kelp species do not compete well with it on vertical surfaces and the extent to which it will out-compete native kelps requires careful monitoring, especially in conservation areas.

### *Hydrodictyon reticulatum* – most northerly documented record in the UK

Alison McManus, Thomas Coy & Jan Krokowski

Scottish Environment Protection Agency (SEPA)

*Hydrodictyon reticulatum* is a fast-spreading nuisance green alga. It has become widely distributed over the past two decades throughout England and Wales, and has been reported from several sites in Dumfries and Galloway, Scotland. *H. reticulatum* was recorded on a recent macrophyte survey of Strathclyde loch, Motherwell, Scotland, and is the northern-most documented record for the UK so far. *Hydrodictyon* is associated with nutrient-enriched waters and has a preference for high light and water temperature.

### Community interactions and local adaptation

Ilkka Kronholm, Heidi Kuehne & Sinead Collins

University of Edinburgh

Are communities locally adapted, and if so, are they made up of locally adapted species, or are interactions between species what drive community productivity? We tested this experimentally by isolating several strains of microalgae either from high CO<sub>2</sub> springs or from surrounding regions with normal levels of CO<sub>2</sub>. We measured productivity of single strains and communities, and then assessed whether communities were locally adapted in terms of the ability to thrive at particular CO<sub>2</sub> levels, in terms of their ability to resist invasion, or both.

### Environmental drivers of benthic diatom communities in the River Clyde, Scotland

Pauline Lang & Jan Krokowski

Scottish Environment Protection Agency (SEPA)

The River Clyde is a major watercourse in Scotland, flowing through Lanarkshire towns and the City of Glasgow, before discharging into the Clyde Estuary and eventually to the Firth of Clyde. The river has suffered a lengthy pollution history from sewage disposal and remnant industry, though legislative control measures have improved water quality and encouraged biological recovery. Eutrophication is a widespread environmental threat of international significance given the stringent 2015 target of achieving at least good ecological status of EU inland waters, set by the Water Framework Directive. In this study, benthic diatoms were used as a means of characterising ecological status of the River Clyde from source-to-sea and for assessing the main environmental pressures affecting the river water quality, from 1999 to 2008. Multivariate analyses revealed an ecological shift in diatom species composition along the River Clyde from the upstream community at Wolfclyde (indicated by *Achnantheidium minutissimum*), to a diverse assemblage co-dominated by *Navicula gregaria*, *Navicula lanceolata* and *Navicula tripunctata* indicative of mild eutrophication at the majority of sampling sites, and downstream to Tidal Weir where *Tabularia fasciculata* denoted a small sub-assemblage impacted by historic chromium waste. Underlying pollution gradients of eutrophication and heavy metal contamination explained the observed shifts in the benthic diatom communities in the River Clyde, over the 10 year period. From the upper catchment, Wolfclyde was identified as a potential ecological benchmark, supporting an assemblage of diatom species indicative of high water quality status and minimally impacted by pollution.

duce guidelines for future lake management regarding potential climatic alterations.

### Population study of *Gracilaria tenuistipitata* (Gracilariales, Rhodophyta) based on microsatellite markers from chloroplast genome

Sze-Looi Song<sup>1,2</sup>, Phaik-Eem Lim<sup>1,2</sup>, Siew-Moi Phang<sup>1</sup>, Weng-Wah Lee<sup>3</sup>, Dang Diem Hong<sup>4</sup> & Anchana Prathep<sup>5</sup>

<sup>1</sup>Institute of Biological Sciences, University of Malaya; <sup>2</sup>Institute of Ocean and Earth Sciences (IOES), University of Malaya; <sup>3</sup>ACGT Laboratories; <sup>4</sup>Algal Biotechnology Department, Institute of Biotechnology (IBT), Vietnamese Academy of Science and Technology (VAST); <sup>5</sup>Seaweed and Seagrass Research Unit, Centre for Biodiversity of Peninsular Thailand

*G. tenuistipitata* is becoming commercially important as it has high growth rate, tolerance to wide range of environments as well as high agar yield. It is cultivated intensively in China for production of agar and fodder for abalone. In Vietnam and Thailand, this species is cultured in a small-scale. Microsatellite markers were developed from the chloroplast genome of *G. tenuistipitata* var. *liui* deposited at the National Centre for Biotechnology Information (NCBI) database. The developed microsatellite markers were used for population study on *G. tenuistipitata* from six different localities; four were from Peninsular of Malaysia, one was from Thailand and the other was from Vietnam. Eighty *G. tenuistipitata* specimens were analysed using the three developed SSR primers for PCR amplification. One primer pair gave significant results that can separate the *G. tenuistipitata* species according to localities based on the variation in repeated nucleotides. The UPGMA dendrogram analysis revealed three main clades: (i) specimens from west coast of Peninsular Malaysia: Kuala Selangor, Penang and Pulau Langkawi (ii) specimen from east coast of Peninsular Malaysia: Kelantan and (iii) specimens from Thailand and Vietnam. This suggested that the order of clustering was in accordance to the geographical distribution. The correct identification of *G. tenuistipitata* strains with good economic traits is important to facilitate the cultivation of seaweeds.

### The effects of climate change on freshwater planktonic food webs in Cardiff Bay

Sarah Moore  
Cardiff University

Climate change is a severe threat to ecosystems worldwide. However, in comparison to marine environments, studies concerning freshwater responses are limited, and results published are largely site or ecosystem specific, allowing only possible modelled parameters to be transferred generically. This project will study the effects of climate change on the newly formed (2001) and actively managed freshwater lake of Cardiff Bay, South Wales. This ecosystem is eutrophic and is host to the invasive, non-native zebra mussel *Dreissena polymorpha*. The investigation will focus on the freshwater planktonic food web and responses of the lakes' oxygen dynamics in relation to climate change and invasive species population dynamics. The study will comprise of three phases. Initial analysis of historic data taken within Cardiff Bay will be performed, including lake chemistry, meteorological data, and species records. The analysis of these data will provide the current seasonal fluctuations within the system to be identified and chemical extremes to be noted. Cardiff Bay will then be spatially surveyed over the next two years, allowing the present ecological and chemical state of the ecosystem to be determined. Mesocosms (computer controlled environmental cabinets at Cardiff University) will be used to simulate predicted changes in the lake (e.g. enhanced temperature, CO<sub>2</sub> etc.). These will imitate changes in temperature / CO<sub>2</sub> predicted by the IPCC report; aeration levels following the aeration system used in Cardiff Bay; situations where invasive species are present and absent; and nutrient dynamics. The results from these simulations will be used to pro-

### Heterotrophic grazing by toxic and non-toxic strains of the harmful dinoflagellate *Alexandrium tamarense* with application to Scottish Waters

Ruth F. Paterson; K. Davidson & C. Campbell

Scottish Association for Marine Science, Scottish Marine Institute

A large number of dinoflagellates are widely assumed to be obligate phototrophs, although recently many species have been shown to be capable of mixotrophy. *Alexandrium tamarense*, which has both toxic and non-toxic strains, is a suspected mixotroph. The toxicity of this species highlights the importance of monitoring, and the presence of the non-toxic strains highlights the importance of ecophysiological research – recently the toxic strain has been shown to out-compete the non-toxic strain when cultured together. Mixotrophy could provide the necessary mechanism for the increased growth of the non-toxic strain. This study aimed to determine whether heterotrophic grazing by *A. tamarense* was possible. Traditional incubations with 10µm fluorescently labelled latex beads and FLAs (fluorescently labelled algae) were carried out over various time intervals. Observed fluorescent inclusions within the cells were stained with acridine orange to highlight the identity of the structures. It was found that inclusion counts increased with time for both toxic and non-toxic strains; however, inclusion rates were higher for the toxic strains. The problem of assessing whether these structures occurred within the cells as part of their structure or represented true ingestion was not conclusively resolved. Nevertheless, significant evidence (both numerical and photographic data) exists to suggest cell feeding by this species. Further incubation experiments need to be conducted, using different stains and potentially a flow cytometric method, because it is important to assess the trophic ecology of the species. Predictions can then be made about bloom lengths and times of year to protect interests in the shellfish aquaculture industry and safeguard human health.

### Assessment of the genus *Lithophyllum* in the Atlantic Iberian Peninsula: an ongoing research project supported by the British Phycological Society

Viviana Peña<sup>1,2</sup>, I. Bárbara<sup>1</sup>, R. Barreiro<sup>1</sup>, C. Pardo<sup>1</sup>, O. De Clerck<sup>3</sup> & L. Le Gall<sup>2</sup>

<sup>1</sup>BIOCOST Research Group, Universidade da Coruña; <sup>2</sup>Muséum National d'Histoire Naturelle (MNHN), France; <sup>3</sup>Phycology Research Group, Ghent University

The genus *Lithophyllum* Philippi encompasses a broad range of non-geniculate crustose and unattached species that contribute to the extent and appearance of coralline cover throughout the littoral zone. Nine *Lithophyllum* species are cited from northern European coasts (Britain, Ireland and France): *L. byssoides*, *L. crouaniorum*, *L. dentatum*, *L. duckerae*, *L. fasciculatum*, *L. hibernicum*, *L. incrustans*, *L. nitorum* and *L. orbiculatum*. From the Atlantic Iberian Peninsula, however, only four species were reported: *L. incrustans*, *L. byssoides*, and more scarcely *L. orbiculatum* (one record in NW Spain) and *L. vickersiae* (one record in Portugal). Given the poor knowledge of non-geniculate coralline algae diversity in the Atlantic Iberian Peninsula, we launched a research project focusing on diversity and distribution of the genus *Lithophyllum*. This ongoing project was awarded by the BPS small grant scheme (2011-2012). Along the study area (from Basque Country to Portugal), 12 localities were sampled, mostly

from the intertidal zone. Additional collections were provided from other current research projects. Likewise, samples from northern localities (Brittany) and from the Mediterranean were also collected. In the laboratory, specimens were tentatively identified to genus level or below using a stereo microscope. Diagnostic features for the genus *Lithophyllum* such as the presence of uniporate asexual conceptacles were taken into account for this preliminary identification. Specimens were preserved in silica gel for forthcoming anatomical examination of the specimens and molecular analyses (barcode and phylogenetic gene markers). Results obtained will provide interesting information regarding the biogeographic and phylogenetic relationships of the Atlantic Iberian flora with adjacent regions.

Financial support: British Phycological Society (Small Grant Scheme-Project Award 2011-2012 *Assessment of the genus Lithophyllum in the Atlantic Iberian Peninsula*), Spain's Ministerio de Ciencia e Innovación (CTM2010-18787), CGL2009-09495/BOS (partially founded by FEDER) and Xunta de Galicia (10MMA103003PR). VP acknowledges support by Spain's Ministerio de Educación (Programa Nacional de Movilidad de Recursos Humanos, 2008-2011). We sincerely thank Antonio Secilla, Pilar Díaz and Alberto Santolaria for fieldwork collaboration.

### **The effect of an enhanced UV AB:PAR ratio on pigmentation and ultrastructure of *Zygnema* from polar regions**

Martina Pichrtová, Daniel Remias & Andreas Holzinger

Charles University in Prague, Department of Botany

We investigated the effect of an experimentally enhanced UV A/UV B:PAR (photosynthetic active radiation) ratio on various strains of the green alga *Zygnema* isolated from Polar regions. The potentially harmful effects of UV irradiation have been studied in connection with the depletion of the stratospheric ozone layer. Generally, many algae are able to produce special secondary metabolites (e.g. carotenoids or phenolics) as a protection against UV radiation. The aim of our study was to test by HPLC if such adaptations also take place in the studied strains from the Arctic and Antarctic. Furthermore, we screened for possible changes or damages in the cellular ultrastructure (TEM) after the UV exposure, especially in the chloroplasts.

The study object was the filamentous green alga *Zygnema* sp. (Zygnematophyceae), which usually grows in shallow marshes, pools or on the surface of wet soils, where it can form massive mats. In such habitats they are naturally exposed to higher UV radiation than e.g. planktonic algae and adaptations to such stress is therefore expected.

The experiments were conducted in climate chambers and the UV was induced by using a combination of fluorescence tubes which produced an enhanced UVA/UVB:PAR ratio. The results showed that all of the studied strains were able to produce metabolites that absorb in the UV B range. These substances, most likely phenolics that are stored in vacuoles, protect against harmful effects of an enhanced level of UV irradiation. Their presence in the investigated strains can be regarded as an adaptation of life to extreme habitats at Polar regions.

### **Capturing the aliens: Using herbarium specimens to track the arrival and spread of non-native seaweeds**

Juliet Brodie, Linda M. Irvine, Jane Pottas & Jo Wilbraham

Department of Botany, Natural History Museum, London

E.M. Holmes published a note in 1897 on the red seaweed *Bonnemaisonia hamifera* as the first species of marine alga known to be naturalised in Britain but it was the report of the arrival of the brown alga *Sargassum muticum* in Britain in 1973 that aroused public attention. An increasing number of alien species have since been recognised and we currently estimate that at least 6% (40+ species) of the British seaweed flora fall into this category. As part of the Marine Biological Association's project, *The GB Non-native Species Information Portal*, we are using records from the Natural History Museum algal herbarium (BM) to chart the arrival and subsequent temporal and spatial distribution of these alien seaweeds. With over 60,000 British seaweed specimens, the herbarium represents a considerable resource with which to study the alien flora. Results so far indicate that some arrivals have remained at or near their point of introduction (e.g. *Pikea californica*), others have spread but have a limited distribution (e.g. *Solieria chordalis*) and others have spread rapidly over a wide area (e.g. *Sargassum muticum*, *Colpomenia peregrina*). Some species have been in the flora for such a long time that they have been considered part of the natural flora. For example, there are specimens of the red seaweed *Porphyra leucosticta* dating back to the beginning of the nineteenth century. In such cases, only the analysis of molecular data has revealed their origins. Other aims of the project include the production of an up to date list of alien seaweed species, verification of the identification of some species in the herbarium and collaboration with other herbaria to reduce the acknowledged temporal and spatial gaps in the BM collection.

### **Microscopic studies of microalgae in mass culture: Assessing cellular diversity in the genus *Botryococcus* and the effect of info-chemicals in optimizing biomass and oil production in *Nannochloropsis* and *Dunaliella***

Alanoud Rawdhan<sup>1</sup>, G. Beakes<sup>1</sup>, G. Caldwell<sup>2</sup> & R. Taylor<sup>2</sup>

<sup>1</sup>School of Biology, Newcastle University; <sup>2</sup>School of Marine Science and Technology, Newcastle University

Microalgae are a potential source of biofuel production, and therefore they are attracting a lot of interest. *Botryococcus braunii* reported to accumulate up to 86% dry weight as lipids. *Botryococcus braunii* belongs to chlorophyta (green algae) and is a member of the Trebouxiophyceae. It is classified initially into three chemical races according to three different classes of lipids produced by different strains. The three chemical races stains classified using the molecular phylogeny, through sequencing 18S rRNA, into a monophyletic group. The classification of the diverse strains of *B. braunii* into a single species, three species, or several subspecies under debate. One aim of this study is to compare different strains of *B. braunii* to assess its morphological biodiversity in relation to its genetic diversity. Algal info-chemicals affect different aspects of the algal life cycle. For example they can affect the reproductive status and ageing. It has been reported that algae info-chemicals have an important role in diatom biology. The second aim is to evaluate the effect of algal info-chemicals on *Dunaliella salina* and *Nannochloropsis oculata* cell structure and lipid production and compare it with lipid production in exponential and stationary growth phases in cooperation with the School of Marine Sciences. These known info-chemicals include oxylipins. Lipids are found in all cell membranes and as well as in storage lipid bodies. Electron microscopy and stereology enables us to differentiate between these two types of lipid structure whilst chemical extraction methods evaluate the total lipids in the cell.

### **The Good, the Bad and the Algae: a public engagement activity**

James Redfern<sup>1</sup>, Joanna Verran<sup>1</sup>, Peter Gilroy<sup>1</sup> & Dariel Burdass<sup>2</sup>

<sup>1</sup>Manchester Metropolitan University; <sup>2</sup>SGM

Science festivals and similar events provide excellent opportunities for the public to engage with 'hands-on' microbiology. However, in addition to safety concerns, many microorganisms can be difficult to visualize without appropriate equipment. Algae are safe to handle, relatively large and sufficiently different in appearance to enable viewing under a microscope with little technical ability. As part of the 2011 National Science and Engineering Week a public engagement event, 'The Good, The Bad and The Algae' was delivered in MMU's microbiology laboratory. After an introduction to the importance and diversity of algae, participants were asked to identify algae present in a sample using an identification key, which had been developed for use in schools, as part of a research project. The event provided an excellent opportunity to trial the key with a non-scientist audience. The feedback was overwhelmingly positive. People of all ages were able to use the key to correctly identify the algal species. Feedback enabled minor modifications to the key, and provided useful additional evaluation of the resource.

### The development of algae: A practical resource for schools

James Redfern<sup>1</sup>, Joanna Verran<sup>1</sup>, Peter Gilroy<sup>1</sup> & Dariel Burdass<sup>2</sup>

<sup>1</sup>Manchester Metropolitan University; <sup>2</sup>SGM

Practical science activity in the classroom is an essential part of science education in secondary schools. Microbiology, the study of microorganisms (including bacteria, fungi, protozoa, algae and viruses) relies heavily on practical activity in its teaching. As advances in medical microbiology focus the future of the field in that direction, it is important not to forget other areas, such as mycology, or phycology. Algae have significant potential for use in schools, because they are cheap and easy to source and maintain, safe to handle, and exciting to see, being relatively 'large', morphologically diverse, colourful and often motile. Algae also have many key functions in the world around us, and therefore it is possible to link algae with many aspects of a teaching specification. 'Algae: a practical resource for schools' is a new 64-page colour educational resource aimed at key stage 3 and 4. The booklet contains background information on algae and five practical activities (identifying algae using a microscope, investigating phototaxis, demonstrating bioluminescence, eutrophication and gas cycling in microorganisms) accompanied by guides for teachers, students and technicians, copies of an algal identification key, and a poster conveying 'fascinating facts about algae'. The booklet has undergone extensive formative evaluation in preparation for the launch, including trials with students and teachers in and out of the classroom environment. The Society for General Microbiology (SGM) will publish and distribute the resource, launching it at the Association for Science Education meeting in January 2012. Upon its launch the resource will be distributed free of charge to over 750 SGM school members, and will undergo an extensive summative evaluation up to 12 months after its release.

### Preliminary results of testing of the MIDTAL microarray chip to monitor harmful algae species in the Orkney Islands, UK

Joe Taylor<sup>1</sup>, Jane Lewis<sup>1</sup>, Linda Percy<sup>1</sup>, Marco Berzano<sup>1</sup> & Linda K. Medlin<sup>2</sup>

<sup>1</sup>School of Life Sciences, University of Westminster; <sup>2</sup>Marine Biological Association of UK

Harmful or nuisance algal blooms can cause economic damage to fisheries and tourism. Also, toxins produced by harmful algae and ingested via contaminated shellfish can be potentially fatal to humans. Therefore monitoring programs are a necessity. However, the effectiveness of monitoring these harmful algae can be difficult. It is time consuming and cell morphology as determined by light microscopy may be insufficient to give definitive species and toxin attribution. The goal of the EU FP7 project MIDTAL (microarrays for the detection of toxic algae) is to achieve rapid species identification using rRNA genes as the targets on a microarray chip format. In the project existing rRNA probes for toxic algal species/strains have been adapted and optimized for microarray use. The second generation of the array was used to test for the presence of toxic species in the Orkney Islands, an area of the UK with a phytoplankton community in which a number of nuisance and toxic species have been found previously. These were compared with light microscopy cell counts in order to test the sensitivity and specificity of the microarray. Both the chip and counts were used to look at the seasonal dynamics of harmful species over the course of the year. Overall a good agreement was found between the microarray and counts with the microarray proving to be more sensitive in some months. Toxic *Pseudo-nitzschia* species were more prevalent in the early spring to mid-summer months whereas toxic dinoflagellate species such as *Alexandrium tamarense* and *Dinophysis acuta* were much more prevalent during the late spring to summer months when primary production was higher. This study shows that the MIDTAL microarray chip is potentially a very effective monitoring technique for field samples. Further development and testing of the 3<sup>rd</sup> generation of the chip is currently underway.

### Recovery of seaweed communities from coal-mining effects on the shores of the Firth of Forth

Martin Wilkinson, Caitriona Buggle & Sharon Woolsey

Centre for Marine Biodiversity & Biotechnology, School of Life Sciences, Heriot-Watt University

The coal industry has affected the Firth of Forth at several sites by minewater discharge from abandoned mines and by intertidal dumping of minestone. Minewater particularly polluted the tributary estuary of the Keithing Burn for three decades until about 2002. For the last ten years there has been a water quality improvement consequent upon filtration of the Acid Mine Drainage (AMD) water at source. Despite this there has not been a change in the communities of attached macroalgae. It seems that the community which flourished in mats of ferruginous solids deposited from the waste in past times was a species-poor community tolerant to stressful estuarine conditions. The estuarine conditions remain after removal of the AMD from the estuary and the algal community has not changed. This supports the idea that the upper estuarine mat-forming seaweed community is so adapted to stress that it cannot be used by its composition as a pollution indicator. By contrast, on an otherwise species rich open coast shore at St. Monans in the outer Firth, a 200 year old discharge of AMD does have major effects on the upper shore community. The dumping of spoil was practised at three sites on the north bank of the mid-Firth until the 1970s. Since then the shores have been modified by natural erosion of dumped material. Long-term studies of the seaweed recovery of the shore are hampered by lack of species lists from the pre-mining era. Nonetheless, regular surveys since the 1970s show that there is gradual recovery of the seaweed community, but it is a slow process, and this part of the Firth of Forth remains more species-poor than would be expected from its physical situation.

## Why *Fucus ceranoides* does not dominate every British estuary – Further experimental studies

Callum Wood, Holly Brown & [Martin Wilkinson](#)

Centre for Marine Biodiversity & Biotechnology, School of Life Sciences, Heriot-Watt University

The recent need for seaweed based ecological quality assessment tools for transitional waters to meet the requirements of the EC Water Framework Directive has focussed attention on the seaweed communities of estuaries. *Fucus ceranoides*, the brackish-water fucoid, only dominates the mid-reaches about 2/3 of British estuaries, with the remainder dominated mainly by *F. vesiculosus* and a few by *F. spiralis*. Subjective observations initially led to a false conclusion that *F. ceranoides* might indicate cleaner waters than the other fucoids but a detailed desk study of over 100 estuaries indicated that the situation was more complex. While *F. ceranoides* was found to be significantly less tolerant to some forms of pollution than other fucoids, the desk study also indicated that there were statistically significant differences in natural factors such as the variability of salinity over a tidal cycle and the level of suspended solids, and hence turbidity, that favoured the presence of certain fucoid species in different types of estuary. Previously published experimental work on *Fucus* salinity tolerances, often using adult plants, does not really explain why *F. ceranoides* seems to prefer particular estuaries. This poster describes experimental investigations on newly fertilised zygotes of estuarine *Fucus* species, when grown under complex salinity regimes in the laboratory and when explanted to different estuarine situations in the field. In summary, the results suggest that *Fucus ceranoides* zygotes perform significantly better in culture than those of *F. vesiculosus* or *F. spiralis* when subjected to regimes involving widely fluctuating salinities soon after fertilisation, and they perform better in the field explants in estuarine situations that involve such conditions. These results give support to the desk study conclusions even though all *Fucus* species tested were able to survive to a greater or lesser degree in all conditions presented.

## Ocean acidification: impact on calcifying macroalgae of the genus *Corallina* (Corallinales, Rhodophyta) and their associated biofilms

[Christopher Williamson](#)<sup>1</sup>, Rupert Perkins<sup>2</sup>, Juliet Brodie<sup>1</sup> & [Marian Yallop](#)<sup>3</sup>

Botany Department, Natural History Museum, London; <sup>2</sup>School of Earth and Ocean Sciences, Cardiff University; <sup>3</sup>School of Biological Sciences, Bristol University

This study addresses the impacts of ocean acidification (OA) on three geniculate (articulated) species of the calcified red algal genus *Corallina* (*C. caespitosa*, *C. elongata* and *C. officinalis*) and their associated biofilms in the northeastern Atlantic. OA has resulted in a decrease of surface water pH by 0.1 relative to the pre-industrial value of 8.18, with further pH decreases of 0.3 - 0.5 being predicted by the end of this century. Concomitant alterations of seawater carbonate chemistry include decreases in  $\text{CO}_3^{2-}$  and the saturation state of minerals essential for the deposition of  $\text{CaCO}_3$ . Among marine calcifiers, those that deposit high-Mg calcite ( $> 4 \text{ mol } \% \text{ MgCO}_3$ ) are likely to be the first responders to such alterations in seawater carbonate chemistry, given the minerals increased solubility in comparison with other forms e.g. pure calcite. Species of *Corallina* deposit high-Mg calcite, are widespread in shallow rocky temperate and boreal areas, and are 'autogenic ecosystem engineers', providing habitat and shelter for numerous small invertebrate species and surfaces for the settlement of microalgal epiphytes and endophytes. Seasonal sampling for the assessment of growth, calcification, skeletal composition (Mg:Ca), morphology and reproductive characteristics will be performed along a latitudinal gradient in the northeastern Atlantic from northern Spain to Iceland. Variable chlorophyll fluorometry and oxymetry will also be applied to both macroalgae and their associated epiphytic biofilms to examine potential photophysiological adaptation along this gradient. Comparisons will be made of morphology and skeletal composition (Mg:Ca) of present day material with pre-industrial samples from the Natural History Museum herbarium (BM). In addition, differences in the responses of the three *Corallina* species and their associated biofilms to Intergovernmental Panel on Climate Change (IPCC) future OA projections, will be assessed via long-term mesocosm incubation experiments.

Algal humour...



# British Psychological Society

## 60th Annual General Meeting

### Newcastle, Friday 6th January 2012

#### Present

John Bothwell, Paul Brazier, Juliet Brodie, Gary Caldwell, Christine Campbell, Chris Carter, Geoff Codd, Eileen Cox, Maeve Edwards, Tim Entwisle, Claire Gachon, Steffi Gaebler-Schwarz, Naomi Ginnever, Michael Guiry, Paul Hayes, Sabrina Heiser, Elizabeth Haworth, David John, Stacy Krueger-Hadfield, Svenja Heesch, Sue Knight, Evelyn Lawrenz, Jane Lewis, Gill Malin, David Mann, Sara Marsham, Sarah Moore, Jeanine Olsen, Marie Pažoutová, Rupert Perkins, Siew Moi Phang, Philippe Potin, Jane Pottas, John Raven, Marine Robuchon, Helen Rosencranz, Clare Scanlon, Carole Shellcock, Elliot Shubert, Stephen Slocombe, Joe Taylor, Wytze Stam, Michele Stanley, Michael Steinke, Daniel Thornton, Brian Whitton, Jo Wilbraham, Martin Wilkinson, Chris Williamson

#### 1. Apologies

Jan Krokowski, Michelle Tobin, Marion Yallop

#### 2. Minutes of the 59th Annual General Meeting, January 2011

Accepted

#### 3. Matters arising

None

#### 4. Reports from Officers

##### i) Secretary (Jane Pottas)

Normal secretarial duties have been carried out this year. Enquiries from BPS members, potential members and the general public have been answered quickly, often with help from Council and other BPS members. The procedure to elect new Council members this year underlined the need to update certain sections of the constitution, emphasized the importance of members notifying the membership secretary/secretary of any changes to their contact details and prompted consideration of developing a members' page on the BPS website for voting and canvassing opinions. The role of Secretary is interesting and stimulating. Thanks were expressed for the support of Council and BPS members.

##### ii) Treasurer (Michelle Tobin)

Sara Marsham commented on the report in the absence of the Treasurer.

This is the eighth Annual Report presented by the current Treasurer. The Society's financial situation remains good and this has allowed the continued support of a wide range of projects. The Scientific Meetings Fund of £25000 allowed the Society to support students with bursaries from the interest it receives. The Society supported nine students to attend identification courses, workshops and conferences and in 2011 two summer studentships were awarded. The small grant/project award received a high number of applications and eleven awards were made including sponsorship of meetings, research project grants and publications. The Journal performed very well financially and the final

profit share from Volume 45 was £47,930.13 (an increase of approximately £5000 from volume 44). In addition the Society has received an advance of £30,000 guaranteed income for Volume 46. Production costs of the Journal remain low. This is the last report which will be given by Michelle as her term of office ends at the end of this year. Michelle thanked all Council and Society members for their co-operation and support during this financial year.

##### iii) Membership Secretary (Sara Marsham)

The introduction of PayPal as a payment method has been a success with only a few minor problems. Members have the assurance of a secure and instant online transaction which is easier and quicker to administer. Clear instructions are provided to help members use PayPal correctly and an automatic alert is sent informing that a payment has been made. The PayPal account is checked regularly so that manual updates of the membership database can be made in cases where the procedure has not been followed correctly. A renewal notice was sent in December via email, on Algae-L or by letter. Members are reminded that they can check their membership details via the BPS website. The current active membership of the society is 477 (359 fully paid up, 106 paid to end of 2010, and 12 Honorary Life Members) which overall is down by 4 members from January 2010. Renewal and recruitment rates have decreased in 2011. Of the fully paid up members 206 receive the *European Journal of Psychology* including 23 of the student members. Late applications and renewals can cause difficulties with the distribution of *EJP* but Taylor and Francis are always extremely helpful in resolving these problems. Members who subscribe to the journal are now able to access all volumes of the *EJP* from the link on the BPS website (<http://www.brphycsoc.org/ejp/>) which directs them to the Taylor and Francis website. Sara thanked the Treasurer for her help in processing payments, Michael Guiry, Pier Kuipers and Caoilte Guiry for their continued support.

##### iv) Student Representative (Helen Rosenkranz)

There is now a student group on Researchgate called BPS Students (<http://www.researchgate.net/topic/BPSStudents/>) which has 62 followers/members. Since the group was established the website design has changed and the calendar function has been deleted, but a Google calendar has been set up which is populated with psychology related dates, e.g. workshops and conferences (<https://www.google.com/calendar/embed?src=mulemer%40gmxd&ctz=Europe/London>). Engagement of BPS student members is low and they are asked to contact the Student Representative with suggestion about how the group can be improved. BPS members are asked to encourage their students to join up. Sara Marsham was thanked for scheduling and helping to organise two special sessions for student members at the Annual Meeting in Newcastle - a lecture on mul-

tivariate statistics by Steve Juggins and an informal meeting for student members. The possibility of creating a resource list of people working in phycology is being investigated.

v) Editor of the *European Journal of Phycology* (David Mann)

David Mann assumed the job of *EJP* Editor-in-Chief in 2011. Erica Young remains as Editorial Assistant. An international Editorial Board meeting took place at the International Phycological Congress in Rhodes in 2011 with six Associate Editors and both Editors-in-Chief present. Taylor and Francis continue to publish the journal but some difficulties have been encountered because of staff changes. The Editorial Board will be reconstituted and details published in Issue 47. Hoeren Verbruggen and John Bothwell have recently become Associate Editors but additional Associate Editors are required, particularly in molecular systematics. If more Associate Editors can be recruited this will help to reduce the time from submission to publication which is currently too long. However, once accepted, papers do go on line quite quickly and are paginated and all issues of Volume 46 were produced approximately on time although there was a slight delay with Issue 4. Almost 30% of papers submitted are rejected because they are of low quality. Relatively few submissions are received from the UK and more are encouraged. In 2010 the impact factor increased to 1.901 and *EJP* moved up the rankings to 29/92 in Marine and Freshwater Ecology and to 61/187 in Plant Sciences. The journal's five-year impact factor has also grown to 1.897. These are encouraging signs.

vi) Editor of *The Phycologist* (Jan Krokowski)

This report was delivered by Paul Hayes in the absence of Jan Krokowski.

The layout and typesetting continue to be provided by Ms Agnès Marhadour, and the printing by Monument Press in Stirling, Scotland. The middle pages are now a colour spread. SEPA's Admin staff in East Kilbride (managed by Allison Currie) help in posting the newsletters (special thanks to Donna Farren, Kirsten Knight and Yvonne McGowan). There continue to be a small number of returns and members are again advised to check and amend their address details. There is a continued significant increase in costs which can be attributed to increased costs for printing and postage as typesetting costs have remained unchanged since 2005. Members were thanked for their contributions, and are encouraged to keep sending in phycological views, news, work events etc. 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. The deadline for submission of articles for the spring edition is March 1st, and for the autumn edition is September 1st.

vii) Webmaster (Michael Guiry)

The BPS website had 18,000 visits and 550,000 page views in 2011 with an average of 2.77 pages per visit. Daily unique visits are usually less than 50 but there were 500 on December 6th. Most visitors are from the UK fo-

llowed by the USA, Canada, Germany, Ireland, France, India, Japan, Spain and Chile. The most visited page was the Meetings page followed by the Congresses, the Journal and the Funding pages. There have been some difficulties with the payment system using PayPal which have largely been resolved. Members who do experience problems with PayPal are requested to contact Michael Guiry or Sara Marsham so they can resolve them.

viii) Student Awards and Training Committee (Juliet Brodie)

The financial support of students is an important part of the work of the society and approximately £24,000 has been disbursed in 2011. Thirty nine applications were received in from 6 countries (UK, Czech Republic, France, Greece, USA and Pakistan) and twenty three awards were made. Of these applications two were for summer studentships (both received awards), twenty eight applications for bursaries (sixteen awards made) and nine for projects (four awards made, five pending). The main reason for rejecting applications was the failure of applicants to meet the 3 month membership requirement. The form on the website will be amended to make this requirement clearer. A condition of receiving funding is that recipients are required to write a report for *The Phycologist*. Juliet thanked the committee of Gill Malin, Rupert Perkins and Michelle Tobin.

ix) Biodiversity and Conservation Committee (Martin Wilkinson)

The committee met twice in 2011 to discuss ways of promoting biodiversity activities through publications to help with identification, and supporting field recording. The second edition of the *British Freshwater Flora*, edited by David John, Brian Whitton and Alan Brook, was published in October 2011. Regular updates to the book will be published in *The Phycologist* and there is an accompanying DVD which has both still and moving images of the algae. In addition two A1 size posters have been produced by David Williamson showing the common desmids using material from the flora. The Fritsch Collection of algal images is believed to have an assured future with the Freshwater Biological Association (FBA), thanks to the actions of the B&C Committee and in particular to David John and Juliet Brodie. David John will continue to represent the views of the BPS at the FBA which is seeking financial support for complete digitisation of the collection. The Seasearch Guide to Seaweeds of Britain and Ireland, published in 2009, continues to sell well and the development of an electronic format is currently being investigated. The Seaweeds of the British Isles volumes which have been out of print are now available as print on demand (except the green volume which has been succeeded by a new book). The second brown volume is nearing completion. Detailed discussions have been held about algal biodiversity recording and the possibility of linking a mapping scheme and mass observation schemes to the BPS website is being investigated. Algal conservation, hampered by the absence of a red data book for seaweeds, is under discussion. Discussions have commenced with the Education and Outreach Committee on electronic and meeting/workshop



approaches to improve the teaching of algae. The B&C Committee has active and dedicated members but would welcome the involvement of BPS members in the statutory agencies. On behalf of the BPS the committee recorded its appreciation of the energetic involvement of its work by Gill Stephens (Douglas) who sadly died in 2011.

x) Education and Outreach Committee (John Bothwell)

Changes to the committee following the resignation of Marian Yallop as chair and the recent appointment of John Bothwell in this role have meant that the committee has not met this year. The committee will convene in early 2012 to discuss their remit.

Paul Hayes thanked Council members, officers and committees for their work.

All reports were accepted: proposed by Gill Malin, seconded by John Raven.

## 5. Federation Reports

i) Federation of European Phycological Societies (FEPS) (Geoff Codd)

The Macedonian Phycological Society has been admitted to membership of FEPS, increasing the number of National Member Societies to 12, representing 14 European countries with a total individual membership of 1133. EPC5 was held in Rhodes in September, attended by about 350 participants from almost 40 countries. The BPS and other National Member Societies were thanked for their sponsorship of the Congress. The book of abstracts was published by Taylor & Francis as a supplement of the European Journal of Phycology (vol. 46, suppl. 1, 2011). Agenda items at the FEPS Council Meeting and AGM in Rhodes included a proposal to increase the annual subscription from 1 to 2 Euros per member of each National Member Society, FEPS vision and funding strategy and a proposed FEPS reviews journal. EPC6 will be held in London in 2015. The London Local Organising Committee will include representation from the Natural History Museum, universities and BPS Council. The Scientific Organising Committee (SOC) for EPC6 will be co-chaired by Dr. Peter Kroth (Germany) and Dr. Olivier De Clerk (Belgium). The FEPS Website is managed by Michael Guiry (<http://www.feps-algae.eu/cms/>). All National Member Societies have been asked to produce a 1-page summary of their Society for the website. The next FEPS Council Meeting will be held during the Annual Meeting of the Polish Phycological Society (May 17-20, 2012) at the University of Olsztyn, Poland.

ii) Federation of European Microbiological Societies (FEMS) (Paul Hayes)

The BPS is a full member of FEMS and BPS members are eligible to apply for research fellowships, visiting scientist grants, young scientist meeting grants and support for organizing meetings.

iii) Society of Biology (SB) (Paul Hayes)

The BPS is a full member of SB and as such is entitled to all Society benefits. The possibility of establishing a closer working relationship between the SB in terms of education and outreach is to be explored.

## 6. Algaebase Foundation (Michael Guiry)

It is proposed to form a charitable foundation for AlgaeBase to be registered in Ireland with Wendy and Michael Guiry as founding members. The BPS, PSA, IPS and Korean Phycological Society have agreed to provide financial support of €2000 each. Juliet Brodie is the BPS representative on the committee.

## 7. Constitution

A copy of the constitution with the proposed changes was circulated 2 months prior to the AGM, in accordance with the constitution. All changes were approved. Proposed by Michael Guiry, seconded by Claire Gachon. The new version of the constitution is available on the BPS website.

## 8. Council Membership

Paul thanked the retiring members of Council, James Metcalf, Marian Yallop and Martin Wilkinson and welcomed the new Council members Clare Scanlon and Martyn Kelly elected following a ballot of BPS members. Jane Pottas will continue as Secretary no other nominations having been received. A description of the new post of Meetings Secretary will be circulated and nominations invited. Michelle Tobin's term as Treasurer will end at the end of 2012 and nominations are invited for this position also.

## 9. Future meetings

i) 60th Anniversary meeting 2012 (Juliet Brodie)

A 60th Anniversary meeting is planned for September to be held at the Natural History Museum, London. Tentative plans for the day include debate, talks and display of archive material. Students are to be involved in chairing some of the sessions. A jubilee publication of *The Phycologist* is planned.

ii) Leicester 2013

It is proposed to move the annual meeting to the summer as of 2013. The venue for the next annual meeting is Leicester. Date to be announced. Please note this is now to be held in Belfast. Details are in this issue and also available on the BPS website.

iii) 2014

It is proposed to hold the annual meeting in Galway in 2014.

## 10. Hilda Canter Lund Prize (Martyn Kelly)

There were over 50 entries, although few from the UK, and the shortlisted entries were on display in the Great North Museum during the BPS Winter Meeting and afterwards until the end of February. QR codes on each photograph enabled i-phone users to access additional information. Twenty two of the photographs have been packaged as a travelling exhibition and venues are being sought during the 60th anniversary year. Michael Guiry was thanked for his help in putting the photographs on the BPS website. Paul thanked Martyn for organising the competition.

## 11. Any other business

i) BPS Archives – members are asked to contact the Secretary with information about any archive material.

The meeting ended at 5.45pm.

# Ninth International Conference on Modern and Fossil Dinoflagellates

University of Liverpool. 28th August – 2nd September 2011



The Ninth International Conference on Fossil and Modern Dinoflagellates was held at the University of Liverpool in late summer 2011. The week-long conference brought together 120 delegates with diverse research interests in dinoflagellates. The conference series began in 1978 when William R Evitt proposed the dedication of a Penrose conference to fossil and living dinoflagellates. The desire was that two communities of workers, with dinoflagellates in common, come together to learn from each other and to discuss their science and to progress interdisciplinary working. This spirit was evident in Liverpool with the four major sessions comprising, Environmental Change, Ecology/Palaeoecology, Life cycles and diversity and Stratigraphy and Evolution. Key note talks from Stijn de Schepper (University of Bergen), Edwige Masure (Université Pierre et Marie Curie, Paris), Anke Kremp (Finnish Environment Institute), Linda Medlin (University of Pierre and Marie Curie, Banyuls sur Mer) set the theme for each session followed by talks and a large number of posters.

Four workshops were designed to disseminate skills and discuss research methods. Christopher Bolch (University of Tasmania) led a hand-on laboratory based session 'Linking dinoflagellate lifecycle stages using single-cell isolation and molecular typing'. Stijn de Schepper, Martin Head (Brock University), Kazumi Matsuoka (Nagasaki University) and André Rochon (Université du Québec à Rimouski) led two discussion and microscope sessions

examining taxonomic issues surrounding 'Quaternary and Neogene dinocyst' and 'Round Brown Cysts (with or without processes)'. A number of delegates brought their own material for examination by other delegates. A final computer based workshop led by Anne de Vernal (Université du Québec à Montréal) examined 'Dinocyst assemblages as proxy in late Cenozoic paleoceanography: towards quantitative reconstructions using transfer functions'. All four workshops were extremely popular.

Complementing the scientific program was a busy social program, including a geological walk around Liverpool, conference dinner and a half day excursion to Ainsdale National Nature Reserve. Prof. Chris Reid delivered a stimulating Public Lecture examining 'Climate Change: Impacts and Consequences for Mankind'. The conference was concluded by presentation of awards for the best student posters (Audrey Limoges & Mirja Hoins) and talks (Stefanie Dekezyer & Eric Potvin), the prizes for the photographic competition (won by Silvia Anglès) and the lifetime achievement award to Rob Fensome (Geological Survey of Canada).

The conference was particularly well attended by a large number of students. Sponsorship from a number of companies, institutions and societies including the British Phycological Society, The Micropalaeontological Society, Petrostrat, Beta Analytic and the Universities of Liverpool and Westminster which allowed registration fees for students to be relatively low. This no doubt contributed to the number of students in attendance, all of whom benefited from having their talks, posters and projects being discussed with other delegates.

The conference organisers would like to thank the international scientific committee and local organisers for their tireless efforts towards this successful conference. A TMS special publication entitled 'Biological and Geological Perspectives of Dinoflagellates' is under preparation and will be published as a result of the conference.

Lee Bradley, Fabienne Marret (University of Liverpool) & Jane Lewis (University of Westminster)

# Report for Introductory Course on Freshwater Algal Identification (1 - 6 July 2012)

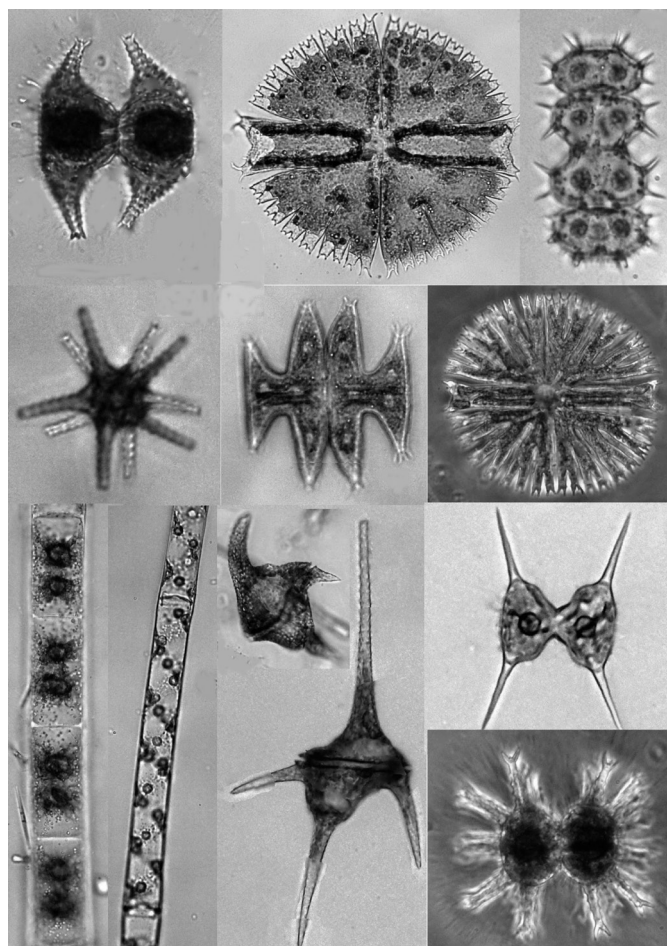


As a PhD student studying freshwater planktonic food webs at Cardiff University, accurate algal identification is a large part of my work. To ensure I was competent and confident in identifying freshwater plankton I attended an introductory course run by Professor Brian Whitton (Durham University) and Professor David John (National History Museum, London) on freshwater algal identification.

The six-day course was held in the beautiful city of Durham and each day was packed with lectures and practical sessions. Lectures covered algal identification procedures, the effective use of identification books, and preservation techniques. The practical sessions introduced us to cyanobacteria and blooms, green algae, flagellates and yellow-green algae, red algae, stoneworts, and terrestrial algae; all rounded off with a slide show quiz! Despite bad weather towards the end of the week we also managed to go on two field trips, the first to Cassop Vale Nature Reserve to study sampling techniques and collect material, and the second a tour of the River Wear.

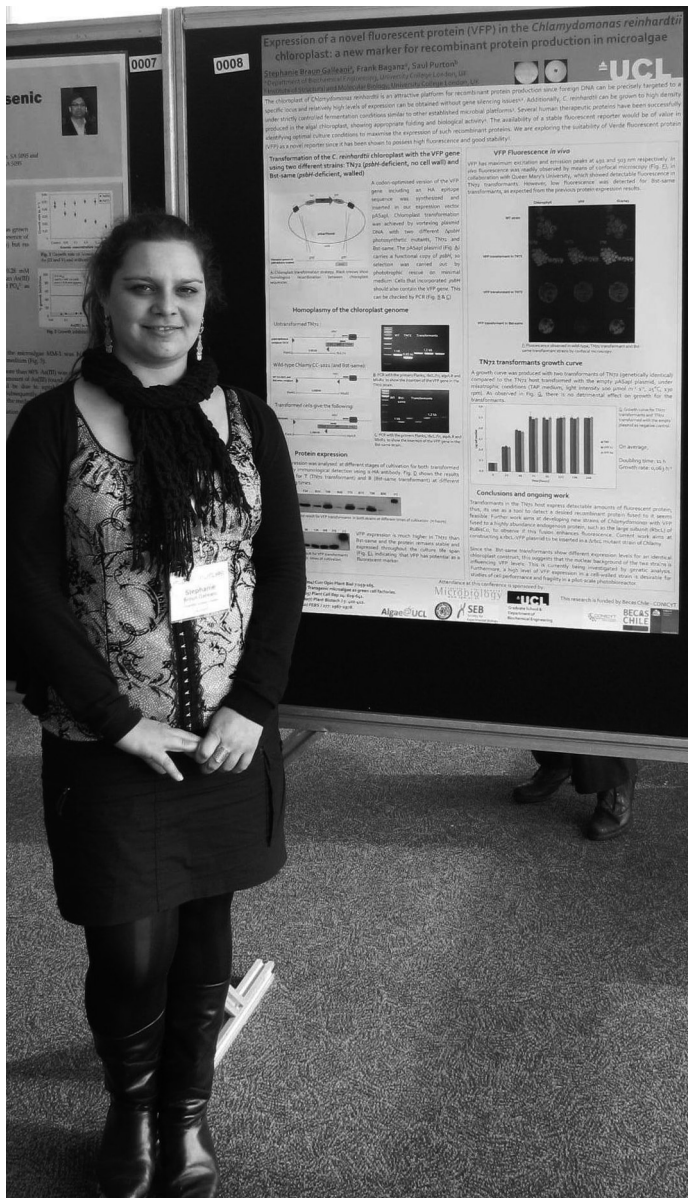
During the week additional lectures and practical sessions were held by Dr Alan Donaldson on microscope set up, and interactive identification software and keys, Dr Gordon Beakes (University of Newcastle) on microscopy techniques, and Dr Martyn Kelly (Bowburn Consultants) on the taxonomy of diatoms and identification techniques.

A selection of individuals from the Environment Agency, UK Water companies and overseas Universities attended the course and by the end we were all able to identify several algal genera and understand the ecology of each of them. The course was interesting and educational, and will allow me to progress with my PhD studies.



Sarah Lee (nee Moore), Postgraduate Researcher, School of Earth and Ocean Sciences, Cardiff University, Cardiff

# 8th Asia-Pacific Conference on Algal Biotechnology – APCAB 2012



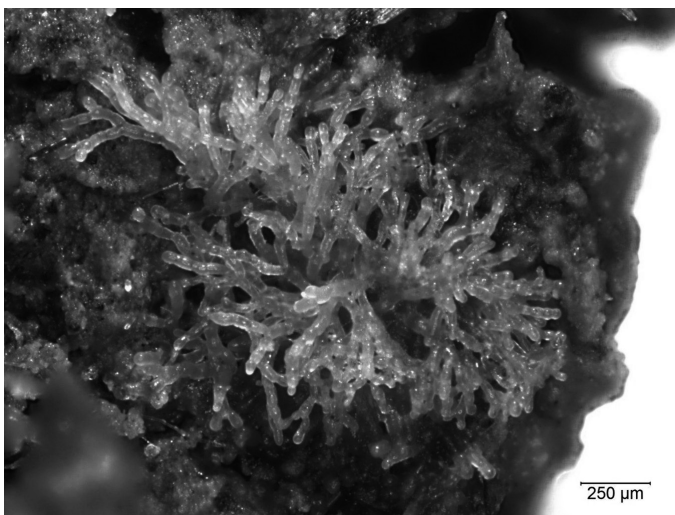
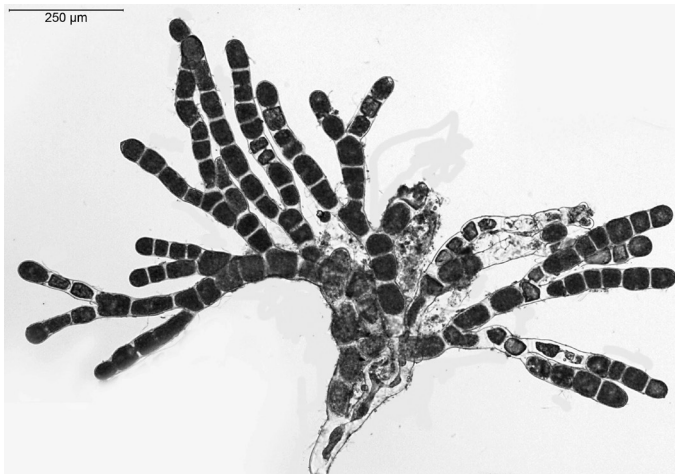
The 8th version of the APCAB conference, which takes place every three years in a different country belonging to the Asia-Pacific region, was held this time in Adelaide, Australia, from the 9-12 July. This conference brings together experts and young researchers in the fields of macro and micro-algae cultivation, algal genomics, algal aquaculture, biorefinery, taxonomy, ecology and environmental management to discuss current progress and new challenges in which algae seem to offer a very promising alternative.

The main sections considered were Industrialisation of Algae, Algae and the Environment, Algal Aquaculture and Feeds, Seaweed Cultivation and Products, Algal Genomics and Proteomics, Algae Culture, Algae and Wastewater Treatment, Microalgae, Taxonomy-Ecology-and Biodiversity, and finally Algae Biorefinery Concept, being of great interest for my own research the sections on Algal genomics, cultivation and biorefinery. There were three distinguished keynote speakers starting the session every day, which gave a very interesting and thorough presentation in their respective fields.

Additionally, I had the opportunity to present a poster with the results of my ongoing work on the expression of a novel fluorescent protein in the chloroplast of the green microalga *Chlamydomonas reinhardtii*. Attending this conference allowed me to interact with leading phycologists and networking with many researchers from various backgrounds and origins. I am very grateful to the British Phycological Society for supporting my attendance to such an important and relevant conference.

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# *Asterosiphon dichotomus* (Kützing) Rieth: a new record of an edaphic xanthophyte for the British Isles



The annually exposed margin or ‘drawdown’ zone of a reservoir can act as a magnet for bryologists who might spend hours crawling on mud in search of small and often seasonally developed mosses and liverworts. Thus it was that the bryologist Rachel Carter discovered an unusual looking alga along the exposed muddy margin of a reservoir in Northamptonshire known as Pitsford Water. It formed small, green rosettes of filaments growing in among patches of the liverwort *Riccia cavernosa* and the xanthophytes *Botrydium granulatum* and *Vaucheria* (principally *V. sessilis*). The spread of these colonies was followed for a few weeks in late summer 2011 during which time various life history stages were observed. Some colonies were collected for further study before the drawdown became inundated once more or covered by dense seasonal vegetation.

The alga from Pitsford Water was *Asterosiphon dichotomus* (Vaucheriales, Ochrophyta, Xanthophyceae), a new record for the British Isles. Its green, cushion-like rosettes were 5–20 mm across and consisted of radially arranged, dichotomously branched, coenocytic filaments 40–50 µm in diameter. These rosettes were attached by

colourless rhizoids and grew below the mud surface. One of the features of *Asterosiphon* is its ellipsoidal akinetes, about 45–50 µm in diameter and 80–95 µm in length, with these forming distinctive rows towards the ends of the filaments. The spherical aplanospores develop within swollen cells and are released singly or in masses. Most aplanospores are thick-walled and darkly coloured, although some are thin-walled and show amoeboid movement.

*Asterosiphon* was recognized in 1940 by Pierre Dangeard, but it was two years later that he published a formal diagnosis with *Asterosiphon terrestre* the type species. The first comprehensive culture investigation was carried out by Rieth in 1962 who observed several stages not recorded hitherto. He also recognized that *Asterosiphon terrestre* P. Dangeard was identical to the much earlier *Protoneuma dichotomum* Kützing and therefore created the new combination *Asterosiphon dichotomus* (Kützing) Rieth. It probably is cosmopolitan since known from Europe (Denmark, France, Germany, Greece, Norway, Spain, and Switzerland) as well as from Asia, North Africa and Argentina in South America (see Cambra-Sánchez, 2010).

*Asterosiphon dichotomus* is the third xanthophyte to be discovered in the British Isles since publication of the first edition of ‘*The Freshwater Algal Flora of the British Isles*’ (John et al. 2002), but was too late to be included in the second edition (published October, 2011). For further information on this taxon, see the abstract for the poster presented at the January 2012 meeting of the British Phycological Society (see this edition) and AlgaeBase ([www.algaebase.org](http://www.algaebase.org)) for a selection of colour images and an anaglyph.

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# *Hydrodictyon reticulatum* – where next?



The ‘water-net’, *Hydrodictyon reticulatum*, has been considered to have a fairly southerly distribution in the UK. The recent ‘*Freshwater Algal Flora of the British Isles*’ (Eds. John et al, 2011) describes it as being “Probably cosmopolitan, apparently becoming more widely distributed over the past two decades and now known throughout England, parts of Wales and several localities in Dumfries and Galloway in the Scottish lowlands...”. The NBN shows it occurring mainly in the south, but with a few occurrences in the north-east of England. It has been recorded in the Tweed river system (John, 1998). In 2011 McManus (2012) discovered *Hydrodictyon* in Strathclyde Loch as part of monitoring by the Scottish Environment Protection Agency (SEPA).

In August this year I came across a striking algal bloom in the Loch of Fyvie (NJ 767 390) in Aberdeenshire. The loch lies within the policies of Fyvie Castle, which is owned by the National Trust for Scotland (NTS). The bloom covered the surface of the northern end of the loch, formed a fringe around the edges and a dense bloom around the southern end. The main area of the loch was clear of visible bloom. I collected samples from all around the loch, mostly from the shallow edge, but also some stranded on mud. All proved to be *Hydrodictyon*. While it was possible to identify it in the field with the naked eye, it was later examined microscopically and confirmed as *Hydrodictyon*. It’s a very attractive alga, forming three-dimensional nets, with daughter nets forming within the cells of mature nets. Thus, small nets occur alongside larger ones.

The NTS Ranger Service didn’t appear to have identified the alga, but rangers were aware of blooms at this site for the past few years. It is unclear exactly how recent

an introduction it is. They are currently considering the use of straw bales as a possible control measure. Inquiries among SEPA colleagues turned up an undocumented finding of *Hydrodictyon* slightly further south in the River Don at Kintore (NJ 799 163) (R.Guthrie, pers. comm.), probably several years ago. We have no information on when or how it spread so far north. One possibility could be transfer by birds – the loch is visited regularly by a variety of waterfowl. It’s possible too that the alga could be much more widespread than previously thought. This is a potential nuisance alga (e.g. Whitton, 2000), and it would be interesting to know its current distribution.

## Acknowledgements

My thanks to Dave John for information and Robin Guthrie (SEPA) for the location on the R. Don.

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# BRITISH ISLES FRESHWATER ALGAL FLORA MATTERS

## CORRECTIONS AND ADDITIONS

The second edition of *The Freshwater Algal Flora of the British Isles* (D.M. John, B.A. Whitton & A.J. Brook, eds) was published in October 2011. Listed below are some errors in the text and the accompanying DVD.

We have also added some information (including relevant references) overlooked at the time or published subsequently. Further information, such as new taxa and nomenclatural revisions will be published regularly in *The Phycologist*.

We would be grateful to learn of other errors, omissions and important new records. Anyone requiring a PDF with the present list of errors and additions should contact one of the editors. We can also send a file listing new records along with nomenclatural and coded number changes yet to be included in the file downloadable from the Centre for Ecology and Hydrology website (<http://science.ceh.ac.uk/data/dict/algae/>).

### Text

p. 133, Plate 28G-J and I. Mention of p. 96 should be p. 126 in both cases.

p. 280, column 2, lines 26-29. Details under *Prymnesium parvum* concerning Strathclyde Loch and fish mortalities in Scotland are incorrect and the information should be under *Chrysochromulina parva* (p. 279).

p. 306, column 1, last line under *Bitrichia longispina*. 'Oute' should read Outer.

p. 334, line 20. *T. affine* should be *T. minus*

p. 334, line 21. *T. minus* should be *T. affine*

p. 373, column 2, line 39, p. 529 should read p. 435

p. 466, column 1, line 18, p. 342 should read p. 433

p. 530, 549, Plate 2F. *Draparnaldia glomerata* (Vaucher) C. Agardh 1824 should be *Draparnaldia mutabilis* (Roth) Bory St Vincent 1808; the former is a synonym of *D. mutabilis*.

p. 530. Penultimate line should read '24130020 (now includes former 24130010)'

p. 536. Plate 133, fig. I. Caption transposed, 'a' should be 'b'

p. 538. *Koliella spirotaenia* – Coded number 25030030 needs adding

### DVD

#### Cyanobacteria

All mentions of *Cuspidothrix issatschenkoi* (Usačev ex Proškina-Lavrenko) Rajeniemi et al. in the index and image captions should read *Aphanizomenon flos-aquae* Ralfs except for first image on 3rd line of the index. The Coded number for *Aphanizomenon flos-aquae* is 01040020.

#### Chlorophyta

*Draparnaldia mutabilis* (Roth) Cedergren in the image

captions should read *Draparnaldia mutabilis* (Roth) Bory St Vincent.

First image on *Chara contraria* index is of *Chara aspera*

### Additional Taxa

*Asterosiphon dichotomus* (Kützinger) Reith 1962

Coded number 10290010

p. 319 Keys. The genus *Asterosiphon* keys out with *Vaucheria* (couplet 7) and is distinguished from it by having dichotomously branched filaments and often series of ellipsoid akinetes in the upper branches. For further information, see article and poster abstract by Carter & John (BPS winter meeting) published in this issue of *The Phycologist*.

*Komphovoron hindakii* Hašler et Pouličková 2010. Hašler and Pouličková (2010) mention this species from Ellesmere, Malham Tarn, Blandford Pond and Loch Leven. Other UK lakes sampled are shown in a figure, but *K. constrictum* is the only other *Komphovoron* species mentioned and was in Ellesmere. This genus is not described in the Flora.

*Koliella tatrae* (Kol) Hindák 1968

Coded number 25030040

New species recorded by Allan Pentecost (2011) who collected it on 20 August 2010 'from a snow patch on Cairngorm known as Cuidhe Crom on the head wall of Coire Cas [NJ002042] about 250 m NW of Cairngorm summit at an altitude of 1010 m' and mentions 'a few cells were subsequently observed on a winter snow patch on the slopes of High Street in Cumbria in February 2011'. Accompanying this snow alga was a *Chromulina* which resembled *C. sphaeridia* Schiller although had smaller dimensions.

p. 538. *Koliella tatrae* differs from the other three *Koliella* species recorded from the British Isles by its greater cell curvature (p. 544, fig. 1a-e) and smaller dimensions (cells 1.5-2 µm in diameter, 20-35 µm in length).

### New Records

*Pediastrum privum*: recorded by Lang et al. (2012) from Loch Kinord, a small kettle lake in Aberdeenshire, Scotland (NO 44150 99388).

*Hydrodictyon reticulatum*: recorded by McManus (2012) from Loch Strathclyde, Strathclyde Country Park, Motherwell (NS 73290 56980) who mentions 'undocumented reports of the species as far north as Aberdeenshire. There are also anecdotal records of the species in Castle Semple Loch, Renfrewshire'.

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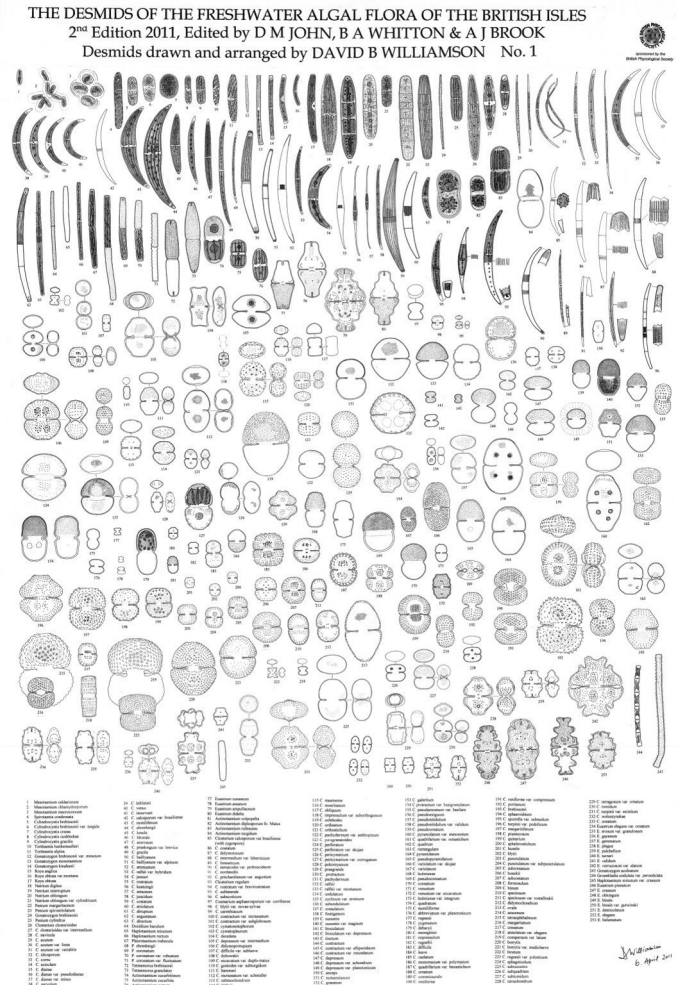
# NEW DESMID POSTERS

## *Desmids of the Freshwater Algal Flora of the British Isles*

Two posters containing 437 desmids illustrated in the second edition of *The Freshwater Algal Flora of the British Isles* (John et al., 2011; published by Cambridge University Press) are now available from the Natural History Bookshop (NHBS), Totnes, Devon ([www.NHBS.com](http://www.NHBS.com)). The illustrations have been drawn to scale by David Williamson who has arranged them so as to enable a ready comparison of the relative sizes and morphology of members of each genus. The poster set is a tool to assist identification of desmids worldwide since many of the British desmids are probably cosmopolitan. The posters are sponsored by the British Phycological Society and are on sale. Posters are approximately 86cm x 58cm.

**Publisher: David B. Williamson.**

**NHBS price £14.99 (excluding post and packaging).**



## Important reminder from the Secretary

The Annual Meeting of the BPS in 2013 is 8th – 10th July in Belfast.

Several years of bad winter weather have severely affected attendance at the Annual Meeting and after much deliberation it was decided to move the meeting to the summer in the hope that travel arrangements are less likely to be disrupted by wind and snow. Naturally this will inevitably mean that we can look forward to grey skies and worse in Belfast next year. The AGM will be held during the annual meeting as normal but the move to the summer will mean that there is an 18 month gap between AGMs. Elected officers and Council Members will take over at the AGM. If you have any views on the decision to move the Annual Meeting to the summer please contact me [secretary@brphycsoc.org](mailto:secretary@brphycsoc.org)

**Jane Pottas, BPS Secretary**

## Your society needs you!

If you, or someone you know, would like to serve on BPS Council then this is your chance. **Nominations** are called for the following Officers and for Ordinary Members of Council:

Treasurer

Membership Secretary

Meetings Secretary

Student Representative

Ordinary Members of Council – 2 places

All roles are held for three years in the first instance.

If you would like to nominate yourself or someone else (remember to ask them first!) please send me your/their name, the name of a seconder and which role (Officer or Ordinary Member) the nomination is for. Please also include brief details of your/their area of interest in phycology so that these details can be circulated to the electorate in the event of an election.

Nominations to be received by **November 9th 2012** (Jane Pottas, BPS Secretary, [secretary@brphycsoc.org](mailto:secretary@brphycsoc.org))

# Obituary

## Patrizia Albertano 1952-2012

In the last issue of *The Phycologist* the untimely death of Patrizia Albertano was announced. Patrizia was a past Overseas Vice President of the BPS and had been very active in the formation of the *Federation of European Phycological Societies*. Patrizia was a wonderful person to know and work with. I had the privilege to spend many happy hours cast adrift with her on a variety of research ships as we sought to improve our understanding of the biology and ecology of cyanobacteria in the Baltic Sea. Life on board ship was always informal, and sometimes a little basic, but Patrizia managed to maintain the poise and style that we north Europeans always associate with Italy. She was fun, hardworking, generous and always ready to spend time in conversation, preferably over a glass of wine or cup of coffee.

The world of phycology is a poorer and less interesting place without our colleague and friend Patrizia. Those who knew her will have fond memories of time spent in her company, as typified by Elliot Shubert's personal recollections (see below), and we will all miss her. Inevitably, however, she will be missed most by her immediate colleagues. Those colleagues provide their tribute to Patrizia in the following paragraphs.

Paul Hayes



Patrizia Beatrice Albertano, Full Professor of General Botany, in the Department of Biology, University of Rome "Tor Vergata", Italy, died on the morning of 14th March 2012 from complications brought about by pancreatic cancer, she was 59.

Patrizia graduated in Biological Sciences from the University of Naples in 1978, where she remained conducting research until 1982. In 1983-1984 she taught Plant Physiology at the University of Cosenza as an adjunct professor. From 1984 to 1997 she was employed as a researcher at the Department of Biology, University "Tor Vergata", where she was made an associate professor in 1998 and then a full professor in Botany from 2001, running numerous courses in the Biology of Algae and Botany.

Patrizia was the group leader of the Laboratory of Algal Biology at "Tor Vergata" and her work contributed substantially to progress in various areas of phycological research. Her main research interests involved the basic biology and systematics of cyanobacteria and microalgae. In particular, her interests lay in the study of the structure and function of phototrophic biofilms in subaerial and aquatic environments as well as freshwater and marine blooms of toxic microalgae and cyanobacteria. More recently, her work had taken on a more applied focus in the fields of biotechnology for cultural heritage, biosensors for the traceability of phycotoxins, algal biomass for innovative applications, bioremediation of wastewater and desertified soils. This led her to establish the University spin off AlgaRes s.r.l. in 2009 in the position of President of the Scientific and Technical Board. She was also played a leading role within the PhD School of the University of "Tor Vergata", where she coordinated the Course/Program in Evolutionary Biology and Ecology.

Patrizia, as the many who knew her would agree, was a warm, friendly and approachable person yet she was also a dedicated and tenacious scientist with the ability to see opportunity where most people could not. This part of

her character led her to diversify her interests and during Patrizia's career she essentially took cyanobacteria out of the water and onto the terrestrial environment and then underground, to the catacombs of Rome. Patrizia's openness to a new idea meant that on entering her office, one could never be sure who you would come across be it fellow professors from all disciplines and countries, past students (now professionals themselves), engineers with designs on green energy, business men, journalists, cultural heritage conservationists or environmental managers. It was not an unusual sight to come across these people queuing to enter her office, which normally meant that her lab collaborators would have to wait their turn that would frequently not be before 8 pm, when she would received us in a cloud of smoke, and always surprisingly fresh and sharp, with a beautiful smile and a laugh. This was the time for sending out project proposals, manuscripts, and conference abstracts, the latter of which, inevitably, were submitted the day after the deadline along with an apologetic letter!

That Patrizia's resourcefulness knew no bounds and no street was unexplored was not a recent phenomenon and stories of her making and selling jewelry on the streets of Naples to get through her first degree showed that the roots of her ingenuity and her originality were already firmly in place from the beginning. Jewelry was also to remain a theme in Patrizia's life and her return from her many trips abroad were eagerly awaited by 'her girls' who would receive some bejeweled keepsake that always had a particular significance. Any male in the lab would receive this gift with an apologetic smile from her, but in the end at least he had something to give to a wife or girlfriend. You will still recognize her girls wearing that fancy bracelet from Turkey or the small handbag from Mexico.

Patrizia was an inspiration and mentor of numerous students and the only reason there have not been more was because of the limit space she had available in her laboratory, such was the interest to work in her group. Her seemingly



endless knowledge, energy and enthusiasm in combination with her humbleness gave one the feeling of being able to approach her with any problem. Patrizia was able to instill so much confidence and courage in her collaborators so that if you entered her room discouraged or troubled with regard to your project, you were sure to leave it with the vigor to overcome any problem.

Stromboli, it is an island that some have possibly heard of and some may even know it as a tiny volcanic island just north of Sicily, but few have been to this tranquil and beautiful haven, or if they have they did not take in the rustic and isolated town of Ginostra on the south-western flank of the volcano. Put together Patrizia's hectic work schedule and her altruistic nature, it is not difficult to understand why she never failed to go there for summer vacation year after year, the island obviously represented the perfect sanctuary for Patrizia. After these trips, Patrizia would return very relaxed, very tanned and ready to start work with even more enthusiasm than before, batteries fully charged.

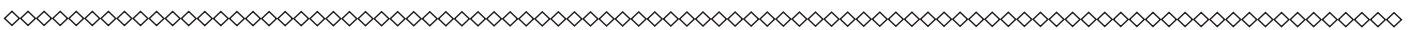
Roberta Congestri, Laura Bruno, Emanuela Viaggiu, Daniela Billi, Francesca Di Pippo, Simona Bellezza, Neil T.W. Ellwood



### ***A personal tribute from Elliot Shubert***

The first time that I met Patrizia was at an International Diatom Society meeting in 1994 in Maratea near Naples, Italy. She was immediately friendly and talkative about diatoms, algae and life in general. Subsequently, we met again in 1996 at the International Phycological Congress held in Leiden, The Netherlands. During the course of our conversation, we discussed mutual research interests and decided to apply for funding to conduct a research project on biofilms growing in a sewage treatment plant near the Rome airport. With funding from the British Council, we started the two-year project in 1996. I made numerous trips to Rome and Patrizia made trips to London as a part of our collaboration. Patrizia was always the consummate host when I visited Rome and we had many enjoyable hours together working on the project and relaxing in the eve-

ning socially. I had an opportunity to observe Patrizia in her work environment. She was constantly busy meeting people, teaching and discussing research ideas. However, she always took time for an espresso break at the university café with friends and colleagues. She drove an older small car, which she drove cautiously around Rome ignoring the aggressive drivers in large cars. I recall a memorable trip driving from Rome to Taranto to attend a phycological meeting of the Italian Botanical Society. I was the only male with four Italian women and we had a crazy and enjoyable trip and meeting. Patrizia never complained and she just got on with the work at hand. She kept her personal life separate from her professional life. I have fond memories of Patrizia; she will be missed.



# 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 as 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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