

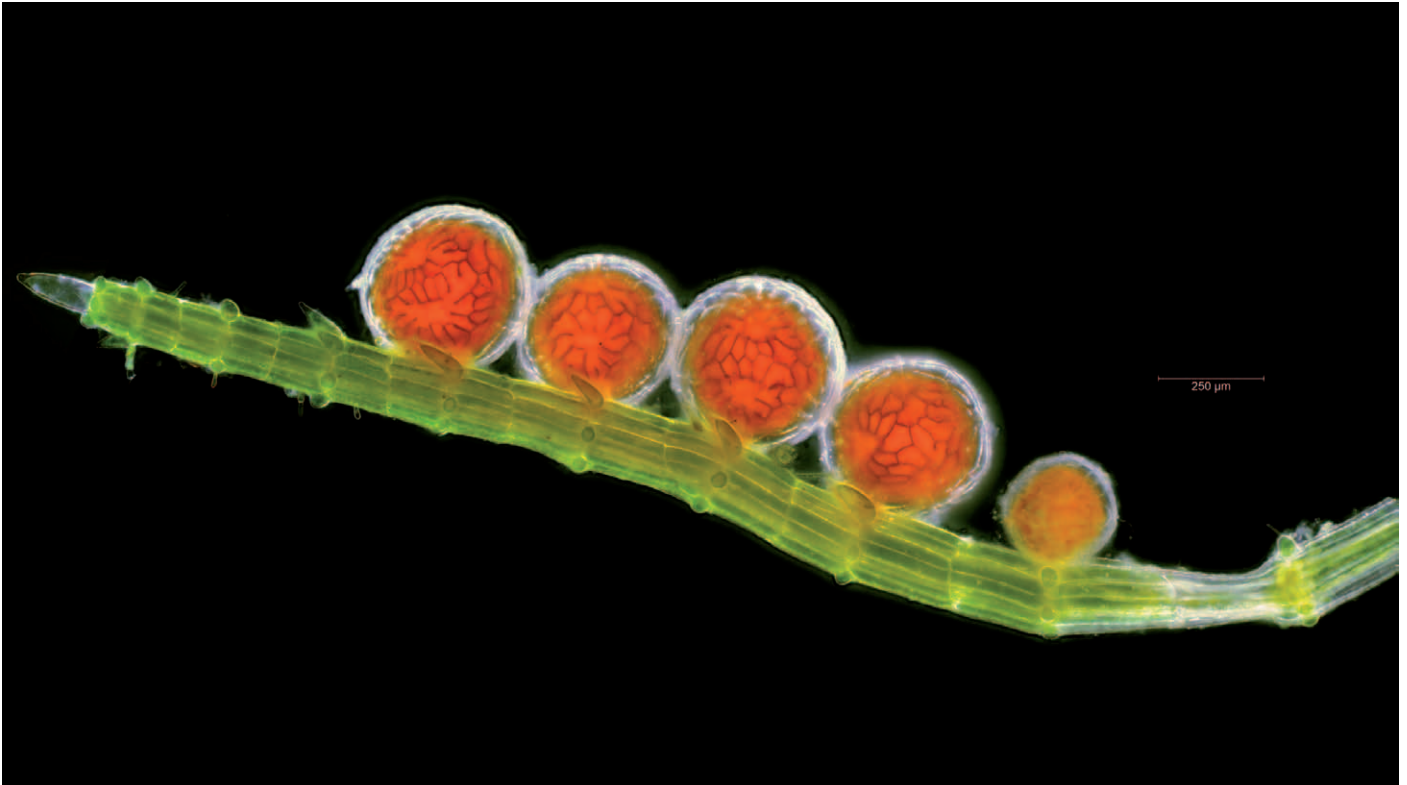


The Phycologist

The Newsletter of the British Phycological Society

Editor: Dr Jan Krokowski

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



66th
Annual General
Meeting

Anna's Dress

Freshwater
Algal Flora - update

Number 94 - Spring 2018

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2018

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I hope everyone enjoyed the Southend meeting, and judging by the people I met on the worlds' longest pleasure pier, everyone also managed to get out and get some fresh air at one pont or another...but how many came back from the end of the pier by train? Well, you can read about the Southend meeting in the newsletter and remind yourself with all the talk and poster abstracts, and you can read about the meeting in an article our new Secretary has provided. A number of us also particularly enjoyed the post dinner 'dance' – we have some photos! There is also an article by the artist Angenita Teekens on seaweed art based on the cyanotype printing process perfected by the first female photographer, Anna Atkins in the mid 19th century.

Many thanks to the organisers – it was another great meeting. I will look forward to our next meeting in Oban, Scotland

Enclosed are many reports from students who received bursaries from the Society to help them attend meetings and conferences. And we have our accounts, albeit late. There is also an update, since publication of the 2nd edition to the British Freshwater Algal Flora of the British Isles, of nomenclatural/taxonomic changes and taxa recorded from Britain and Ireland, plus much more.

Enjoy.

But there is sad news too. Yvonne Chamberlain, one of the BPS's Honorary Members died on 12th January 2018. Yvonne Chamberlain served as Curator of Marine Algae at the Natural History Museum, London, from 1954-1962 and went on to have a major impact on coralline algal research. Condolences to her family and friends.

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>.

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Front cover picture: *Chara antheridia* by Chris Carter

Review of the 66th Annual Meeting

Southend-on-Sea, 8th to 11th January 2018

Based in the imposing Radisson Park Hotel in Southend-on-Sea, the 2018 BPS conference venue overlooked the mouth of the Thames Estuary and the UK's longest pier. It was a setting that reminded me of cruise liner. It's as if conference set sail on a four-day mini-cruise. Here we all were based in the SS Radisson, with the officers (conference organisers Graham Underwood and Claire Passearelli), the crew (hotel staff and Essex University helpers inc. Nicky Slee, Amie Parris, and Philipp Siegel) and passengers (the jolly delegates).

If for one welcome the return to winter for the annual conference as summer is fieldwork time for me. Also, it provides a great opportunity to break out of the Christmas malaise.

When I first heard the BPS conference was to be in Southend-on-Sea in a modern hotel, my heart sank, especially after the 2017 conference overlooking the picturesque Menai Strait. My disappointment was misplaced as it turned out to be one of the most enjoyable conferences I'd experienced. It was well attended (125 delegates), very well organised and ran like a well-oiled machine, or in phycology speak, a well-lubricated frond (with all its underlying biochemical pathways). The hotel staff were welcoming and helpful. The facilities (conference rooms, spaces for posters, teas and coffees and the dining room) were all excellent. The panoramic sea view from the dining room brightened us all up over breakfast and lunch.

The first events of the conference were held on Monday afternoon with Council and Outreach and Education committee meetings. In the evening (and going back to the ocean-liner analogy), we made our own ways ashore to explore. To my surprise I found we'd docked in Turkey. At least that was the cuisine on offer in the restaurant we visited. The locals were very friendly and we returned well fed to our cabins. There was also a special Student Reception at the Fisherman's Wharf.

Graham Underwood opened the conference on a grey and cold Tuesday morning with an introductory talk about what was happening where and when. Parallel sessions were run in two nearby lecture theatres, one concentrating on 'General Phycology' and the other on 'Applied Freshwater Research' and delegates had the opportunity to attend the talks most interesting to them. The quality of the talks over the next three days was excellent but it would be unfair of me to pick out my favourites. With two parallel sessions I didn't get to all of the talks and anyhow, everyone's interests differ.

Coffee time allowed delegates to chat or 'network' and to view the excellent array of research posters. The Manton Prize lectures followed coffee. These lectures are a highlight of the conference for me. Talented young stu-

dents from all over the world present results from their PhD work. These students are an important part of the society's future and are more often than not supervised by established members of BPS. Praise must go to Irene Manton for having the foresight to sponsor this scheme.

After lunch, the parallel sessions continued until 4 pm when there was a break for tea and more poster viewing before we all reassembled for the presidential address. Gill Malin, BPS president for the last two years, gave a lecture entitled 'Phycology on the edge'. Gill traced her career from its beginnings as a student at Liverpool University to her current post as Reader in Biological Oceanography at the University of East Anglia. The story of her career was interwoven with an insight into her personal and family life. Gill wasn't at all phased by a projector failure half way through and this didn't distract from the talk either. What Gill had to say was more interesting than the slides being projected and she showed her skills as an orator.

Festivities followed with a wine reception sponsored by Taylor & Francis. New exhibits appeared in the poster room. The artist Angenita Teekens was showing and selling seaweed art based on the cyanotype printing process perfected by the first female photographer, Anna Atkins in the mid 19th century. The Biodiversity and Conservation committee had a stand to show off the new BPS seaweed recording scheme where verified records are fed in on-line to the National Biodiversity Network.

By the evening, the good ship Radisson was docked once more and many of us had another trip ashore, this time about 20 shipmates ended up in Thailand having green curries in a restaurant where the Thai people spoke in a strange Essex accent.

Wednesday morning brought a different feel to proceedings. The sun was out and the sea front was lit up in brilliant winter sunshine. The day started with two parallel 'special sessions'; one on 'Mapping, conserving and sustainably exploiting seaweed genetic resources in blue biotechnology' the other on 'Microphytobenthic Biofilms'. The Manton Prize lectures continued between coffee and lunch and again an excellent suite of talks was presented by PhD students. With my schoolboy French and rudimentary Spanish, I marvelled at the ability of foreign students to present complex subjects in English with such clarity.

After a light lunch, I couldn't resist the pull of the sunshine and went for a jog along the pier. The tide was low but rising steadily and I was struck by the clarity of the water as it flowed over the sediment.

The special sessions that started in the morning continued all through the afternoon, again with excellent



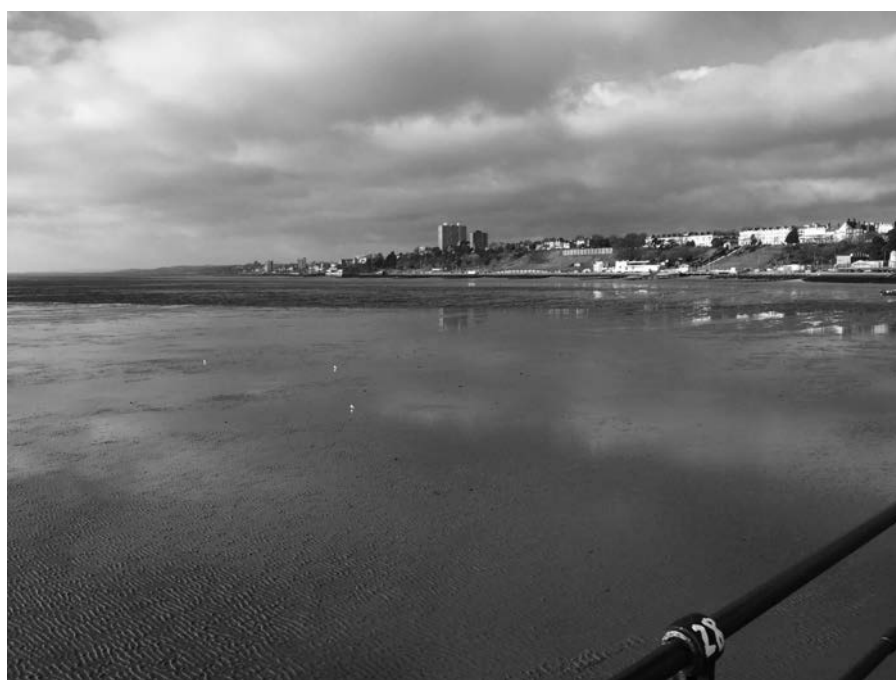
Thank you to the outgoing President and Secretary

There was a short break to get our glad-rags on and digest the constitutional matters of the AGM before for the conference dinner. The grungy casually clad phycologists were transformed to into what looked like the good and the great of Southend-on-Sea. Food was deftly served by a plethora of Radisson stewards and lively conversation flowed and wine was drunk in celebration of our gathering. Conversation was brought to a halt when our Adele tribute act came on stage. This was followed by dancing, at first stilted and then building to riotous. I'm sure the ship started moving as I staggered to bed after 1 am.

Thursday morning marked a return to January gloom but also the start of two new parallel sessions continuing on the themes of 'General Phycology' and 'Microphytobenthic Biofilms'. Then, after coffee, there was a special session for all with more about 'Microphytobenthic Biofilms' for everyone. Soon it was lunch time and time to say goodbyes. Not for me, I had my first council meeting as secretary. I soon found that taking notes (knowing when not to take notes), distilling the essence of discussion and noting relevant action points is no mean task. I bow to you Jane for having done it so well for so long!

Soon it was time to all go our various ways. As a postscript, I notice that a few delegates were coughing and spluttering during the conference and I saw one chap sipping Lemsips in the coffee break. We were at the height of the winter 'flu' epidemic. I thought I'd escaped until I got home when I went down with the lurgy which lasted three weeks and then came back just as I thought it had gone. Oh well, at least we weren't sea sick!

Francis Bunker
BPS Secretary, secretary@brphycsoc.org



Biofilm from Southend pier

talks and finished at 3.40 pm with another look at the posters. So much to read and so many people to talk to.

Now the highlight of the event, the AGM! This popular session attracted 60 people, all bursting with ideas, hungry to hear the treasure's report and ready to vote on any number of contentious issues and innovative proposals. Joking aside, it was great

to hear summaries of how the society is moving with the times. A new website is coming out soon and a new applied journal is in the pipeline (thanks to the efforts of Juliet Brodie and Christine Maggs). We said goodbye to Gill Malin, president for the last two years, Jane Pottas, secretary for the last 9 years, and hello to our new president Graham Underwood and to me, your new secretary.

Student Bursary Awards

BPS Annual Meeting, Southend, 8-11 January 2018



Joe Penhaul Smith

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<http://www.sams.ac.uk/joe-penhaul-smith?searchterm=joe+penhaul%5D>

https://www.researchgate.net/profile/Joseph_Penhaul_Smith

My attendance to the BPS conference 2018 which took place in Southend between the 8th to the 11th of January would not have been possible without the generous support of the BPS and for that I am extremely grateful. As a second year PhD student this was the first conference of my PhD. As a result, I was mildly apprehensive of giving a talk, not to mention travelling down from Oban to Southend, a journey of approximately 500 miles. Thankfully, my fears were entirely misplaced with the journey working like clockwork. Meanwhile the BPS was the perfect place for a slightly nervous speaker to present their talk with everyone being very welcoming.

The conference itself was over two and a half days and the talks were both wide ranging in subject and ex-

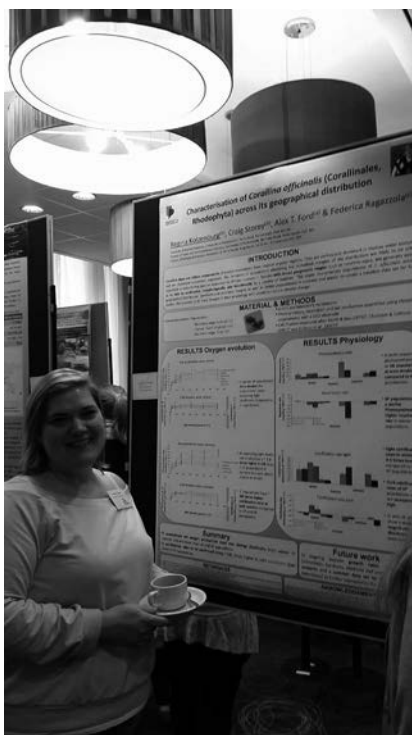
cellent in their delivery. Starting with the general phycology sessions, which set the tone for the conference, covering a breadth of topics with subjects varying from mapping of *Laminariales* using sonar, through to early investigations in the biology of a green algal pathogen of mangroves. Following these one of the main events of the conference, the student talks for the Manton prize. A nerve-wracking experience for those of us who presented, but an excellent experience largely due to the welcoming nature of the audience. The general phycology talks after my nerves abated were excellent examples of just how broad the discipline of phycology has become, ranging from seaweed disease, to a travel advertisement for Tristan de Cunha through to the effects of changing irradiance on the photosynthetic electron production at variable irradiance in *Haslea* diatoms. The special session on mapping, conserving and sustainably exploiting seaweed genetic resources in blue biotechnology was particularly interesting with its focus on advances in macroalgal genetics. Meanwhile the posters ranged from nitrate uptake in *Cladophora* through to plans for extensive monitoring programmes in the Falkland Islands. Each thought provoking in their own ways and strengthened by their diversity, I feel. I look forward to both seeing how the work of others progress the field, but also how other findings can inform my own work.

The student talks were of a similarly high quality, if I do say so myself, with the winners of the presentation and poster prizes thoroughly deserving their accolades with the clear, concise nature of the communication and the visually arresting methods of presentation. Furthermore, the opportunities for getting to know the other PhD students were excellent with the meal and quiz being a fine icebreaker on the first evening, ensuring that it was a pleasure to watch others talks and not see them solely as competitors. The conference experience was an excellent one and very well organised so I must thank all those who had a hand in its creation and delivery and I look forward to next year, where I will have to travel significantly less distance to attend.

Regina Kolzenburg,

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[Saaathend] was the chosen location for this year's 66th Annual Meeting of the British Phycological Society from the 8th – 11th January 2018, organised by a lovely and helpful committee of the University of Essex around Prof. Graham Underwood and Claire Passarelli. After registration and putting up the posters, for those presenting, many of us students gathered for dinner at the nearby Fisherman's Wharf restaurant to mingle and a first "get-to-know-each-other". A thrilling Pub Quiz created particularly for this conference followed enjoyable conversations. Here we could challenge each other's knowledge around seaweed – macro and microalgae –, Southend and the royal family.

The first full day of the meeting started with a warm welcome of Prof. Graham Underwood and lead directly into parallel sessions of "General phycology" and "Applied Freshwater Research". Very diverse and interesting talks from kelp productivity on Ireland's west coast (Kathryn Schoenrock) to an industrial perspective of integrated catchment management of algae control (Thomaz Andrade) were followed by highly va-

luable questions from the audience. Afterwards, a first poster session was held and enabled all scientists to chat with new and old colleagues from all over the world.

In the afternoon of both days the traditional Manton Prize sessions took place with 10 candidates presenting their excellent research in oral presentations. The Irène Manton Prize awards the best student oral presentation as well as poster. Participants are judged by a jury from within the BPS regarding their scientific content and presentation style. Again, the combination of topics was very diverse and hard to judge due to the high quality of presentations and posters. The winner of the best oral presentation Willem Stock (see picture, Ghent University) convinced with his brilliant talk about how the complex interplay between environments, diatoms and bacteria shapes the structure and functioning of biofilms in intertidal mudflats. The winner in the best poster category was Lara Haro (University of Cádiz) who presented her work about self-shading in cultured microphytobenthos and her approach to this topic by tracking production rates, compensation depth and concentration of pigments in an easy to read, clearly structured and well explained way.

The first day closed with the presidential address of Dr. Gill Malin in which she gave an interesting and amusing overview of her scientific career enlightening the different edges in phycology as well as her pioneering research on biogenic production of dimethyl sulphide and other trace gases. The following wine reception offered another opportunity to network and

discuss further questions that came up during the sessions.

The second day parallel sessions on "Mapping, conserving and sustainably exploiting seaweed genetic resources in blue biotechnology" and the "3rd Microphytobenthic Biofilm Symposium" completed the overall very interesting and diverse meeting agenda. As a highlight of the meeting the conference dinner was held on the evening of the second day with a live singer and excellent food. The relaxed atmosphere soon got the majority of participants on the dance floor and dancing as well as conversations held on until the early morning hours.

The last day of the meeting attendees could choose between a "General Phycology" and a "3rd Microphytobenthic Biofilm Symposium" session. And could exchange final thoughts during a last poster session and joined lunch before making their way home.

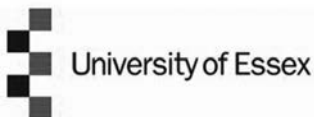
The overall atmosphere of the meeting was welcoming, familial and convivial with plenty of opportunities to network and casual conversations. I would like to thank the BPS for their financial support that made it possible for me to go to the meeting where I was able to discuss my research with international experts, made new contacts and was even able to form new collaborations for future experiments. Overall, it has been a great meeting and experience and I am looking forward to next year's 67th Annual Meeting.



British Phycological Society

66th Annual Meeting, 8th- 11th January 2018

Abstracts



Presidential Address

Phycology at the edge

Gill Malin

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I have worked on algae, ranging from nitrogen-fixing and gliding cyanobacteria, through to various prymnesiophytes, dinoflagellates, diatoms and seaweeds throughout most of my career. Despite this, at times my research has been very much at the edge of phycology or in adjacent subjects. In contrast algae are central to the functioning of the Earth system in being responsible for producing ~50% of the oxygen, as well as the original oxygenation of the planet. Algal photosynthesis fuels vital food webs whilst utilising carbon dioxide and even helping to sequester it on

geological time scales. These important processes limit the global warming arising from man's increasing use of fossil fuels and the associated outputs of greenhouse gases, especially carbon dioxide. At the 'edges' of the wide range of gases found in the Earth's atmosphere are the so-called trace gases. Whilst low in concentration these compounds have high impact in terms of atmospheric chemistry and climate. Starting with an 8-month duration postdoc (that was in the right place at the right time), I began to work with a physicist and a marine chemist who wanted input from someone who could culture microalgae. Together we established one of a small number of pioneering groups working on the biogenic production of dimethyl sulphide, and the research soon expanded to include work on other trace gases – the halocarbons and non-methane hydrocarbons. In this talk I will showcase the knowledge development in this research area.

Abstracts

Manton Prize session

MP1: Phenological change in phytoplankton biomass and community structure across two southeastern UK reservoirs

Amie Parris¹, Etienne Low-Decarie¹, and Tom C Cameron¹

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In the 1980's, eutrophication in southeastern UK reservoirs was a major concern for water resource managers. By the 1990's, engineering works led the way in remedial efforts and our understanding of site-specific nutrient loading had greatly improved. Fast-forwarding almost 30 years, we now have sophisticated filtration systems, modern treatment works, and more eco-friendly agriculture. Yet, we are still plagued with nuisance phytoplankton blooms causing management issues for local water companies. What then is driving phytoplankton communities despite decades of improvements, and in what ways have these reservoirs changed overtime? To address these questions, this study assessed the phenological variation among phytoplankton populations within the littoral and pelagic habitats of two shallow drinking water reservoirs. Our results found the chlorophyll gradient observed in earlier studies is no longer present; supporting the hypothesis that today's reservoirs are not the same ecologically as they were decades ago.

MP2: Utilising microalgal mixotrophy to maximise larval nutrition

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In Scotland approximately 7000 tonnes of the mussel *Mytilus edulis* was produced in 2015. The ability to upscale production of mussels in Scotland is limited by the supply of wild larvae; therefore to expand production, it is necessary to develop a mussel larval hatchery. To ensure profitability microalgal production, which currently represents 40% of the costs of a larval hatchery, need to be reduced.

Mixotrophy, is the ability of microalgae to acquire nutrients from sources other than

Photosynthesis. This may be in addition to, or as an alternative to, photosynthesis, is relatively common in marine microalgae. Utilizing this capability may be a method of reducing the costs of production of microalgae sustainably. However, more work is needed to translate this idea into a commercial scale production of aquaculture relevant microalgal species. This study takes three microalgal species that have previously been reported

to be capable of mixotrophy, which are already used as aquaculture feeds, and screens them for growth with the addition of a carbon source. The effects of the exposure to the carbon source over multiple subcultures was investigated, as were the effects on cellular biochemical profile. In the case of *Tetraselmis suecica* both mixotrophic and heterotrophic growth on glucose was observed, as was mixotrophic growth on glycerol or acetate as the sole carbon source. This contrasts to *Phaeodactylum tri-corantum*, which could only be cultured mixotrophically and to *Cyclotella cryptica*, which showed mixotrophic growth and heterotrophic growth on either glucose or glycerol. All these cultures, after repeated transfer had varying biochemical and fatty acid profiles. Mixotrophy and heterotrophy may be viable methods of increasing the biomass of a given microalgal species, potentially increasing the profitability of the hatchery. Furthermore, tailoring feed to a given biochemical profile may aid larval survival through the creation of a “designer feed”.

MP3: Pepper dulse: the truffle of the sea. Insight in *Osmundea pinnatifida* cultivation

Cecilia Biancacci¹, Dr John Day¹, Dr Gordon McDougall², Marie Clare Russell³ and Dr Michele Stanley¹

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Commercial seaweed production is “booming” with an estimated worldwide annual value of US\$ 6.4 billion. A rising number of valuable application for macroalgae is driving this global seaweed demand. To meet the market needs, sustainable and establishment of supply chains for algal products are required. In Europe, products from seaweeds are breaking new ground, especially in the gourmet food sector and low-volume high-value raw materials. *Osmundea pinnatifida*, also called pepper dulse, is a small red alga currently collected from the wild and marketed at a high price, dried as a peppery seasoning, due to its unique taste. It is mainly used in food preparation and a packet (5g dry weight) retails at approximately £12. The research presented focuses on the supply and establishment of a cultivation system for this species. There is no universal handbook covering how to establish new cultivation systems for new species, such as *O. pinnatifida*, so novel solutions have to be developed, aimed at reducing the harvesting impact, improving the crop yield and understanding how to control the cultivation cycle in order to tailor the final product according to the market needs. Biochemical/chemical composition of the species will be assessed in order to exploit it for further biotechnological applications such as source of bioactive compounds. There is a major need to demonstrate scaling up of cultivation from the lab to a pilot scale. This is fundamental for ensuring eventual commercial exploitation and occupations for coastal communities. This industrial PhD is a challenging project, but represents the chance to translate research from the academic field into a commercial reality by researchers and industry working together.

MP4: Low-cost 3D imaging of *Chlamydomonas reinhardtii* using confocal microscopy (CLSM)

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Confocal scanning laser microscopy (CLSM) was used to 3D image samples of *Chlamydomonas reinhardtii*. Typical CLSM is reliant on laser-excitation to induce fluorescence in a sample for imaging. As such, a variety of fluorescent stains can be used to highlight different structures within the cell.

In an attempt to find low-cost alternatives to expensive biomedical stains, a number of commercial fluorescent whitening agents were used to image the outer cell morphology. Inspired by the use of Uvitex 2B stain on the cellulose walls of fungi (Harrington, 2008, 2009) Uvitex BME (cellulose), Uvitex NFW (polyamide), and Uvitex ERF (polyester) were obtained from a commercial dye company. It was hypothesized that as the BME stain is designed to adhere to cellulose, it should then adhere to the cellulose within the cell wall. The toxicity of the stains was also tested as it was preferable to image live cells to retain all fine-scale structures. All stains were tested on live cultures of the motile *C. reinhardtii*; if the cells were observed to be moving then the stain was deemed non-toxic.

Results show that the autofluorescence intensity of the control cell was markedly below that of stained cells at comparable excitation wavelengths. The BME stains was seen to emphasize the cell wall and flagella while the NFW stain showed improvement to the control but to a lesser extent. Made to chemically adhere to polyester, the ERF stain understandably failed to adhere to any structure within the cell.

The ultimate aim of this project is to produce a series of 3D-printable files to allow physical scale models of various phytoplanktonic species to be produced. These models will be used to test the hydrodynamic behaviour of different species as well as playing a key role in engaging the public in microbiological sciences.

MP5: Rescaling the Contribution of Diatoms Synthesised DMSP in the Biogeochemical Model PlankTOM10

Seth Thomas¹, Martin Johnson¹, Erik Buitenhuis² and Gill Malin¹

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Diatoms are a globally important group of microalgae, contributing as much as 40% of oceanic primary production, and playing key roles in the global biogeochemical cycling of carbon, nitrogen, phosphorus, silicate and other elements. The potential importance of diatoms in the cycling of sulphur has become increasingly evident. Dimethylsulfoniopropionate (DMSP) is the cellular precursor of the volatile trace gas dimethylsulphide (DMS). DMS oxidises to sulphate aerosols in the atmosphere and these can act as cloud condensation nuclei (CCN) forming clouds. Aerosols and clouds increase global albedo resulting in climate cooling. DMSP is produced by various micro- and macroalgal taxa, yet diatoms possess a significantly lower DMSP:C than other groups. This has led to much of the research in this field focusing on coccolithophores and dinoflagellates. However, given recent experimental evidence demonstrating sig-

nificant up-regulation of diatom DMSP concentrations under various 'stress' conditions, including but not limited to nitrogen limitation, and the high diatom global biomass, their contribution to global DMSP and DMS pools may have been underestimated. The overall aim of this study was to improve our understanding of the influence of diatoms on global DMSP and DMS budgets to help us towards understanding the climate of the future. We used experimentally derived DMSP concentrations, synthesis and exudation rates derived from stable isotope methods coupled with mass spectrometric analysis, to attempt to better understand diatom contributions to global DMSP and DMS pools using the PlankTOM10 biogeochemical model.

MP6: Biological mediation of sediment erosion: Can we account for tidal effects?

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Intertidal microbial communities mediate sediment erosion processes, influencing sediment dynamics and coastal morphology. Changes in shear stress due to tidal effects may lead to repeated cycles of biofilm erosion, and regrowth, very different from the steady-state conditions examined in the laboratory. To recreate more natural conditions, cycles of incubation and erosion were conducted in the laboratory. Diatom biofilms were incubated on a non-cohesive sediment bed under low shear (0.06 Pa). After the biofilm reached a quasi-steady state (12 days), the bed was eroded using a step-wise increment of shear force, and then allowed to re-develop for 5 days before being eroded again. This examined whether biological cohesion could return after a relatively short period of calm. This was then followed by experimental runs of six repeated cycles (5 days of growth and bed erosion). Two runs were conducted under limited nutrient supply and four under high nutrients to investigate the responses of the beds with and without nutrient limitation. After the first cycle, the strength of the bed recovered after 5 days, to the stability of the colonised bed incubated for 12 days. However, with nutrients limitation, the resistance to erosion declined dramatically so that after two cycles, the bed stability reverted back to the original non-cohesive condition. After four cycles under high nutrients, the biological cohesion still increased gradually but did not reach the strength of the 12-days-incubation bed. Our results indicated while bio-sedimentary matrix was disrupted during repeated disturbance events and effects were cumulative, the biostabilization was not entirely removed. We hypothesise that extracellular polymeric substances (EPS) contributed to the rapid increase of bed stability in recovering beds during the next calm cycles, especially where nutrients were available. The influence of repeated erosion on bed stability under field conditions will be the subject of further research.

MP7: Diatom competition along a wide temperature gradient

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The distribution of marine phytoplankton is reported to be shifting with warming of marine environments, leading to changes in species frequencies and composition of communities. The capability of phytoplankton to compete against other community members is determined through cellular processes like nutrient uptake rates or growth, which in turn, are affected by external drivers like temperature and nutrient availability. A better understanding of the interplay of temperature and nutrient limitation in controlling the ecology of phytoplankton communities is required to make adequate predictions of the response of marine phytoplankton to global change. This study investigated the physiology, growth and competitive ability of two globally distributed marine diatoms, *Phaeodactylum tricorutum* and *Thalassiosira pseudonana*, along a high-resolution temperature-gradient spanning the breadth of the thermal niche of each species (from 9°C to 35°C in increments of 1.5°C) under nutrient-replete and nitrogen-limited conditions. It was found that competitive ability changed with temperature and that these changes could be well predicted from growth of individual species along the investigated temperature gradient (R^2 between 0.70 and 0.96 for correlations between predicted and actual competition coefficients). These findings were consistent across nutrient-replete and nitrogen-limited conditions. The present study furthers the understanding about links between physiological performance and interactive outcomes amongst phytoplankton, as experimental evidence for such links has been scarce thus far. Being able to determine outcomes of competition based on physiological responses of single species to changes in environmental parameters has the potential to significantly improve the predictive power of models aiming to prognose spatial distributions of phytoplankton and community composition under current and future environmental conditions.

MP8: Drone mapping of the brown seaweed *Ascophyllum nodosum* in Ireland

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The mapping of seaweed populations is important from both an ecological and economic perspective. This research aims to develop an innovative and multi-disciplinary approach to assess the distribution and biomass of the intertidal brown furoid *Ascophyllum nodosum*. This common species often dominates the mid-littoral zone along sheltered, rocky coastlines. Two locations in Co. Galway, western Ireland, were chosen where drone-based remote sensing surveys were conducted. Drones have received recent attention as platforms for Earth observation as they provide greater levels of spatial resolution and flexibility than planes and satellites.

The first site in Kilkieran Bay was surveyed in August 2017 using

a DJI-Matrice 600 PRO mounted with an OCI™-F Ultra Compact Hyperspectral Imager. A DJI-Inspire 1 was also used to capture RGB imagery and multispectral data using a Parrot Sequoia. Ground control points were gathered using a Trimble R8. Supporting field data on site biomass and percent cover was collected. On the day of the survey a TriOS RAMSES Hyperspectral Radiance/Irradiance Radiometer was used to collect pure spectra from intertidal seaweeds and rocky/muddy substrata to support the classification of the hyperspectral data. Two transects were defined consisting of continuous quadrats, from upper to lower shore, which were clearly visible during the drone flights. Data were collected on species composition and percentage cover from each quadrat in both transects. Samples from selected quadrats were measured with the radiometer, removed from the site and analysed for pigments to facilitate the establishment of correlations between the drivers of spectral response in the visible region of the spectrum. Spectral Derivative Analysis (SDA) is used to identify characteristic spectral features for species to assess their spectral separability.

MP9: A life-size experiment coupled to satellite time series reveals living oyster reefs promoting impact on microphytobenthos development

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Despite their microscopic size, microphytobenthos (MPB) photosynthetic biofilms are observable by satellite remote sensing (RS) thanks to their optical characteristics. This allows us to analyse MPB spatio-temporal variations on scales and periods otherwise impossible to investigate by in situ methods only. In this study, we focused on the analysis of MPB interactions with benthic macrofauna communities, previously little described. In the context of the growing impact of invasive species, we analysed the influence of *Crassostrea gigas* oyster reefs on MPB spatial structure and development in Bourgneuf Bay (Atlantic coast, France). In that aim, a long-term RS time series combining Landsat and SPOT data was analysed along with a life-size experiment conducted to evaluate the effect of oyster elimination on surrounding MPB. Based on a Before After Control Impact design, the experiment consisted in burning the oysters from a natural reef within a mudflat. Using the normalized difference vegetation index (NDVI), historical satellite data highlighted the presence of persistent, highly concentrated MPB patches surrounding the oyster reefs. Monthly signals showed marked seasonal variations with higher NDVI occurring during spring and fall, associated to changes in patch shape, size and degree of aggregation around oyster reefs. The before-after analysis of the field experiment revealed the negative impact of living oysters' elimination on both MPB biofilm structure and concentration, while the physical structure of the reef itself was not modified. The hypothesis of nutrient inputs has been advanced as an explanatory factor, where oyster organic matter released through excretion and biodeposition would stimulate MPB development. This is the first study supporting the hypothesis of the positive influence of oyster reefs on MPB biofilm development.

MP10: The complex interplay between environment, diatoms and bacteria shapes the structure and functioning of biofilms in intertidal mudflats

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The relationship between benthic microalgae and heterotrophic bacteria plays a pivotal role in the functioning of marine intertidal mudflats. Algae and bacteria form a biofilm which has been shown to modulate nutrient fluxes and sediment properties, and contribute to the high productivity of these systems. Little is yet known about the nature and specificity of these interactions, and how they shape the diversity and the functioning of the biofilm community.

We performed a series of co-culture experiments with diatoms and bacteria from marine intertidal biofilms. Our results show that diatoms, environmental conditions and bacterial source community affect taxonomic bacterial community composition. However, diatom identity (and even the mere presence of diatoms) had no noticeable effect on the bacterial functional diversity (as assessed using Biolog Ecoplates), which was mainly determined by environmental conditions. We further investigated how bacteria affected the growth and competitiveness of the diatoms. Addition of bacterial communities to axenic diatoms initially strongly reduced diatom growth in all experiments, but the extent of growth reduction differed between diatom species. This species-specific effect on diatom fitness had important implications for the outcome of competitive interactions between diatom species. The growth of the diatoms recovered gradually after several rounds of reinoculation of the co-cultures, suggesting a shift from antagonistic (e.g. competition) towards more neutral or mutualistic interactions.

GP1: Environmental entrainment of the endogenous annual rhythm of *Alexandrium catenella* cysts from the Gulf of Maine

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The Gulf of Maine (GOM) is an extensive stretch of coast on the eastern seaboard of the US that is subject to annual *Alexandrium catenella* blooms and consequent shellfishery closures. Extensive study of this coastal system has determined the importance of life cycle transitions between benthic cysts and motile planktonic cells in the timing and extent of these events. Of key interest to modelling efforts is understanding the drivers and timing of germination of cyst populations lying in the deep areas

of the GOM (100–200 m). An endogenous circannual rhythm is known to regulate dormancy cycling, such that cyst germination occurs exclusively in the spring when conditions in overlying euphotic waters are favorable to blooms. In the absence of environmental cues, the reported period of this annual rhythm is only 11 months. *In situ*, such a short period would pose a substantial ecological disadvantage to older year classes of cysts, especially considering that the lifetime of a cyst in sediment can be several decades or more. Here, we demonstrate that the annual dormancy rhythm in GOM cysts is not as rigid as originally thought, and instead can be entrained by environmental temperature, specifically cold conditioning (or ‘chilling’). The colder the storage temperature that cysts were exposed to, the earlier dormancy was broken (i.e. cysts would germinate) – similar to the behaviour recently reported for *A. catenella* cysts in the much shallower (2–8 m) Nauset Marsh on Cape Cod, MA. These results suggest that GOM bottom water temperature is a potential mechanism for entraining the dormancy rhythm of cysts to adjust it appropriately to local conditions on an annual basis.

GP2: What do Laminariales sound like? Mapping kelp distribution and abundance using multibeam sonar in the NE Atlantic

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Kelps (Laminariales, Ochrophyta) are an important component of coastal ecosystems. They form dense forests of high productivity, providing food and nursery habitats for many ecologically and commercially important species. There has been growing interest in these large brown algae for use as foods, fertiliser, biofuels, cosmetics and medicines, leading to a rise in harvesting of wild kelp. Simultaneously, kelps face other pressures including climate change, overfishing and an increase in the arrival of invasive species. Kelp habitats are difficult to monitor and remain relatively understudied. Consequently, detailed baseline information is patchy or non-existent. Remote sensing technologies provide great opportunities to make up for the data deficit that previous efforts such as traditional monitoring and species distribution models (SDMs) have failed to fill. Here, we offer a transferrable, rapid monitoring procedure for kelp using a combination of readily available multibeam sonar data and species distribution modelling. Data obtained from the United Kingdom Hydrography Office (UKHO), and ground-truthing information gathered from field surveys were used to train models and produce predictive habitat maps of kelp distribution and abundance along ~20km of the English coastline, at a resolution of 5m x 5m. Bathymetric derivatives (roughness and fractal dimension) were used with sonar backscatter intensity as environmental layers for predictive modelling using a generalised boosting model (GBM). The model proved an effective predictor of kelp habitat (TSS= 0.860). We estimate 7590m² of kelp habitat in the area of Dorset between Lulworth Cove and Worth Matravers, which represents 40% of available habitat up to 1km offshore. Backscatter proved to be the most important factor for kelp detection. Multibeam acoustic surveys routinely collected for navigation purposes could be a valuable resource for kelp habitat mapping and monitoring, but we identify issues with collection and retention of backscatter data that currently inhibit this potential.

GP3: A study in ochre: kelp forest productivity in Ireland.

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Seaweed has always been a part of Ireland’s rich cultural heritage, but much is unknown about subtidal kelp communities that skirt the rocky coastlines. These communities are rich habitats that extend down to depth of 12-15m, and despite the fact that kelp forest ecology has been studied for decades around the world it is imperative that we understand Irish kelp forest dynamics at a local level. This research evaluates kelp forest productivity at four sites dominated by *Laminaria hyperborea* in western Ireland. Three seasons of subtidal observations and collections present patterns in productivity, species distribution, age distribution and recruitment to date. Juveniles of the dominant kelp *L. hyperborea* appear in winter-spring but few individuals reach 1 year of age within dense kelp forests. In late October sori begin appearing on *L. hyperborea* blades aged 5 years and older. We observe juveniles of an annual species, *Sacchoriza polyschides*, in winter-spring, and the species grows quickly to become a prominent member of the kelp forest in summer but then disappears in early autumn. *Saccharina latisima* and *Laminaria digitata* are sub-dominant canopy species that show no seasonal trends in the Irish kelp forests studied but were variably present across sites. Although *Alaria esculenta* is thought to be a common contributor to kelp forest communities in Ireland, it has not been recorded outside of the drift community in the four permanent monitoring sites to date most likely to due its preference for exposed habitats. First results highlight the importance of kelps as a carbon resource, reaching up to 9.6 kg FW m⁻² depending on the site and depth on the west coast of Ireland. Such data are useful when trying to address more advanced questions regarding kelp forest dynamics from an ecological and industrial perspective in Ireland.

GP4: Histological, molecular, and physiological investigation of a novel gall-forming green algal pathogen

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We have initiated the description of a pathogenic green alga that causes galls on stems of wild pepper plants (*Piper borbonense*). We have isolated clones in pure culture, and obtained molecular barcodes for them using the 18S rRNA gene marker:

this revealed that the isolated pathogen, which can grow autotrophically in minimum freshwater medium belongs to an undescribed species closely related to the pathogenic green algal genus *Phyllosiphon*. It is related to species that infect monocotyledonous plants, such as *Arum* and *Arisarum*. Typical for these parasites, our organism produces unpigmented siphonous syncytia devoid of chlorophyll whilst in the plant. The objectives of the project are to finalise the morphological description of the unpigmented parasitic and of the free living chlorophyll stage, to enable the formal description of the pathogen as a novel species. Techniques to be used include: bright field, epifluorescence, histology and staining of fixed plant tissues (available in the lab), in vivo staining of clonal isolates available in liquid culture.

GP5: The changing *Ulva* flora of Israel coasts

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The genus *Ulva* (Chlorophyta) is ubiquitous along Israeli Mediterranean shores where it has been studied extensively due to its important ecological role and potential value in biotechnology and aquaculture. Previous identifications of *Ulva* in Israel were based only on morphology. We compared species found in 2002 with those in 2014-2016. Analyses of ribulose-1,5-bisphosphate carboxylase/oxygenase (*rbcl*) and elongation factor 1-alpha (*tufA*) plastid genes (2014-2016 samples only), combined with morphological data, identified six *Ulva* species, three of which are new records for Israel and probably originate from the Indo-Pacific. *Ulva compressa*, rarely found in 2002, is now the most abundant species and exhibits two fairly distinct morphologies correlated with different haplotypes for both genes. *Ulva fasciata* was common in 2002 but very rare in 2014-16, whereas the morphologically similar, and closely related, invasive species *U. ohnoi* is now common. The finely branched tubular *Ulva tepida* was found in 2002 and 2015/16, and *U. chaugullii* and *U. mediterranea* were discovered for the first time in 2015/16. The changing *Ulva* flora of the Israeli Mediterranean may be correlated with major environmental changes including 3°C increase in sea surface temperatures over the last two decades, as well as a generally increasing prevalence of non-native species. The local *Ulva* species now found in Israel could be of value for various industrial uses.

GP6: Taxonomic revision of *Eudesme* (Ectocarpales s.l., Phaeophyceae)

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Molecular phylogeny of *Eudesme* species collected from various localities in Japan, Alaska and Northern Europe using mitochondrial *cox1* and *cox3* and chloroplast *atpB*, *psaA*, *psbA* and *rbcl* gene sequences revealed considerable species diversity in the genus. In the analyses three distinct clades (clade-1, -2 and -3) with high statistical supports were recognized. Specimens of clade-1 corresponded the generitype *E. virescens* because the morphology agreed with the reported descriptions of the species, and the distributional range (central Europe) included the type locality. Clade-2 has broad distributional range in the arctic region and cold water region of the northern Pacific from Hokkaido to Alaska. They were morphologically distinguishable from *E. virescens* in having thicker sporophytes. Specimens of clade-3 collected from western Honshu, Japan had identical *cox3* sequence as one of the voucher specimens of *E. shandongensis*. In summary, we propose the establishment of a new species distributed in the arctic and northern Pacific regions, and occurrence of *E. shandongensis* in Japan.

GP7: Warmer doesn't mean weaker: impact of heatwaves on marine foundation macrophyte species

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Marine heatwaves (MHWs) have been observed throughout the world and are expected to increase both in frequency and intensity under climate change scenarios causing additional stress to organisms. Macrophytes like the temperate brown seaweed *Fucus vesiculosus* and the seagrass *Zostera marina* are widespread in the northern hemisphere providing core ecological and biogeochemical services. Thus, understanding the response of such foundation species to extreme events will improve our predictions of the responses of coastal marine ecosystems under climate change. Healthy functioning of macrophytes is intimately linked to the maintenance of growth, photosynthetic efficiency, resistance against pathogens, epibionts and consumers.

Thus, we tested the physiological and chemical defence responses of western Baltic Sea *Fucus* and *Zostera* population to simulated heatwaves in a novel outdoor mesocosm with a multidisciplinary approach. Along with control tanks, two different treatments were applied: treatment experiencing two spring heatwaves followed by a summer heat wave, a treatment experiencing just the summer heat wave. For both the macrophytes, physiological and chemical defence responses was not significantly affected among controls and two different treatments.

Thus, we conclude that the well-being of *Fucus* and *Zostera* populations in the western Baltic Sea will hardly be weakened by such extreme heat bursts.

GP8: Toward a monograph of non-marine Ulvophyceae using an integrative approach

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Phylogenetic analyses of SSU rDNA sequences have shown that coccoid and filamentous green algae are distributed among all classes of the Chlorophyta. One of these classes, the Ulvophyceae, mostly contains marine seaweeds and microalgae. However, new studies have shown that there are filamentous and sarcinoid freshwater and terrestrial species (including symbionts in lichens) among the Ulvophyceae, but very little is known about these species. Ultrastructural studies of some of them have confirmed that the flagellar apparatus of zoospores (counterclockwise basal body orientation) is typical for the Ulvophyceae. In addition to ultrastructural features, the presence of a „*Codiolum*”-stage is characteristic of some members of this algal class. We studied more than 50 strains of freshwater and terrestrial ulvophycean microalgae obtained from the different public culture collection and our own isolates using an integrative approach. Three independent lineages of the Ulvophyceae containing terrestrial species were revealed by these methods. Unexpectedly each of these lineages contained several isolates that morphologically developed a high degree of phenotypic plasticity, and included hidden phylogenetic diversity that let us to the description of several new genera and species.

GP9: Programmed cell death and autophagy are multi-layered defence reactions of brown algae against intracellular oomycete pathogens

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The fundamental role of microbes in the physiology, development, ecology and evolution of algae is now well established, yet the detailed mechanisms of these interactions often remain to be elucidated. The oomycetes *Eurychasma dicksonii* and *Anisolpidium ectocarpii* are two obligate intracellular pathogens with a broad host range that we are using to investigate the immune system of brown algae. We find that initially, resistance to infection by *Eu. dicksonii* is mediated by the hypersensitive death of the algal cells attacked. This response is accompanied by the deposition of beta-1, 3-glucan in the cell wall and of

blue-fluorescent metabolites, the production of reactive oxygen species, and the induction of markers usually associated with programmed cell death, such as DNA fragmentation and metacaspase expression. In *A. ectocarpii*, autophagy is integral to the parasite's normal development; our data suggest that this process may be hijacked by the alga to kill the intruder. Finally, TEM and *in vivo* staining assays suggest that the induction of algal autophagy might be a second, inducible line of defence against *A. ectocarpii* and *Eu. dicksonii*, allowing both the elimination of the pathogen and the survival of the attacked host cells.

GP10: Coralline algae (Corallinales, Rhodophyta) of Tristan da Cunha: documenting diversity in the South Atlantic

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Tristan da Cunha, a group of volcanic islands in the South Atlantic Ocean, is the most remote inhabited archipelago in the world. Its economy is crucially reliant on its marine resources, notably the Tristan rock lobster fishery which is dependent on viable seaweed habitats. Integral to the functioning of these marine ecosystems are the coralline algae (Corallinales, Rhodophyta). These calcifiers are ecosystem engineers that provide habitat for a rich diversity of organisms and cues for the settlement of larvae. A molecular taxonomic study of geniculate Corallinales collected from Tristan da Cunha between 2005 and 2014 revealed four genera and six species, of which two of the genera were identified as *Corallina* and *Arthrocardia*. The other two genera did not match any other in the Corallinales. Only one of the species, *Arthrocardia goughensis* (described originally as *Corallina goughensis*), was named, although tentatively, pending study of type material. Another specimen appeared to represent an unidentified species of *Arthrocardia*, and there were several specimens of an undescribed species in the genus *Corallina*. For the other three species, one fell into one of the two unknown genera, and two into the other. These results will contribute to the understanding of taxonomic and phylogenetic relationships of the Corallinales. However, studies of Corallines from the South Atlantic are sparse or non-existent. Given we estimate that > 25% of the world's seaweed flora might be in the South Atlantic (which has strong biogeographic links with UK overseas territories in the region) and recent work indicates the high diversity and degree of endemism in the marine algae, there is a pressing need to document these seaweed floras. Such knowledge is vital to understand the value of and threats to biodiversity, for conservation policy and management, and for the economy of these remote regions of the planet.

GP11: Phytoplankton are a source of the biogenic volatiles isoprene and dimethyl sulfide in oligotrophic Lake Constance

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Biogenic volatile organic compounds (BVOCs) affect atmospheric chemistry, climate and regional air quality in terrestrial and marine atmospheres. Although isoprene is a major BVOC produced in vascular plants, and marine phototrophs release dimethyl sulfide (DMS), freshwater algae have been widely ignored for their production. Here we demonstrate that oligotrophic Lake Constance, a model for north temperate deep lakes, emits both volatiles to the atmosphere. Depth profiles indicated that highest concentrations of isoprene and DMS were associated with the chlorophyll maximum, suggesting that their production is closely linked to phototrophic processes. Significant correlations of the concentration patterns with taxon-specific fluorescence data, and measurements from unialgal cultures confirmed the phototrophic production of isoprene and DMS. Diurnal fluctuations in lake isoprene suggested an unrecognised physiological role in environmental acclimation similar to the antioxidant function of isoprene that has been suggested for marine biota. Flux estimations demonstrated that lakes are a currently undocumented source of DMS and isoprene to the atmosphere. Lakes may be of increasing importance for their contribution of isoprene and DMS to the atmosphere in the arctic zone where lake area coverage is high but terrestrial sources of BVOCs are small. Based on our measured isoprene fluxes at Lake Constance and sparse data of emissions from high latitude terrestrial ecosystems, we estimate that northern lakes may increase terrestrial emissions by 20% (forest or shrubland vegetation) and up to several-fold in low-emitting Arctic tundra regions with high limnicity. This additional source of isoprene is currently unaccounted for in Earth System Models but could significantly affect regional climate.

GP12: Physiological responses of *Corallina officinalis* to an increase in total alkalinity-an ex-situ study.

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Under the International Paris Agreement [United Nations Framework Convention on Climate Change, 2015], which aims to restrict global temperature change below 2°C, Carbon Dioxide Removal (CDR) technologies will be required alongside reduced greenhouse gas emissions. One possible CDR technology is coastal Artificial Ocean Alkalinisation (AOA) which stores atmospheric carbon dioxide (CO₂) in the ocean as bicarbonate ions (by increasing ocean alkalinity). Increasing ocean alkalinity could potentially have a large impact on ocean carbonate chemistry, namely increasing ocean pH and calcium carbonate saturation state (Ω) in localized coastal regions. However, little is known about the biological impact of increased alkalinity. Results from an ex-situ “microcosm” experiment are presented, in which the coastal calcifying species, *Corallina officinalis*, was subjected to increased alkalinity. The calcification rate, carbon fixation rate, and photophysiology, of *C. officinalis* were assessed for 2 weeks, with preliminary results indicating that calcification rates increase under elevated alkalinity. This suggests that coastal AOA could be used to in part to alleviate some of the impacts of ocean acidification. However, increased calcification acts to increase the amount of dissolved CO₂ in the ocean, and crucially, this would decrease the efficiency of the oceanic sink for atmospheric CO₂ and so act against the primary pur-

pose of AOA as a CDR technology.

GP13: Genome mergers in young allopolyploid brown algae: increased evolutionary rates and conserved transcriptional responses

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The effects of genome mergers between independently evolving lineages via allopolyploidy can lead to instantaneous sympatric speciation. However, little is known about allopolyploidy and the resultant “genome shock” on the evolution and expression of gene copies beyond the plant and fungal branches of the tree of Life. Here we used transcriptome sequencing (RNA-seq) to determine the effects of allopolyploidy on evolutionary rates and gene expression conservation in two recently identified allopolyploid species of brown algae in genus *Pelvetiopsis* (Phaeophyceae: Fucaceae), in the north-eastern Pacific ocean. Phylogenetic reconstruction using multiple nuclear loci confirmed their recent origin in the late Pleistocene. An overall increase in evolutionary rates, particularly in non-synonymous substitutions, was found even in the most modern species, *P. hybrida* (ca. 0.2 MA), suggesting early effects of relaxed selective constraint following allopolyploidization. Gene expression patterns in homoeologues (allopolyploid gene copies) and parental orthologues of *P. hybrida* and the diploid progenitors *P. arborescens* and *P. californica* (= *Hesperophycus californicus*) re-confirmed patterns previously found in allopolyploid organisms across different kingdoms, with the majority of homoeologues exhibiting conserved expression levels. Interestingly, high non-synonymous substitution rates were found in functional homoeologues with equal expression, suggesting that increased evolutionary rates occur independently of neo-functionalization/pseudogenization. We also found evidence for extensive expression-level dominance (where expression in the allopolyploid is similar to one or other parent, rather than being an average of both), which was strongly linked with regulatory changes in the non-dominant homeologue. Finally, gene expression was partially linked to the ancestral gender of homoeologues. Our results expand the study of genome evolution in allopolyploid organisms to heterokont brown algae, an evolutionarily distinct marine lineage.

GP14: Re-analysis of the Theriot et al. 2016 7 Gene Data Set Using Multiple Outgroups

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A previous study of available diatom sequences tested the value of multiple outgroups in analyses of the 18S ribosomal RNA gene aimed at recovering the three diatom Classes (Coscinodiscophyceae, Mediophyceae, Bacillariophyceae) as mono-

phyletic groups (Medlin 2014). When certain outgroups were used (haptophytes ciliates, prasinophytes and chlorophytes), these classes were recovered with strong boot strap support as monophyletic clades. This analysis used the variable V4 region of the 18S rRNA gene. In the phylogenetic analysis performed by Theriot et al. (2015), an additional 6 plastid genes were added to the dataset and this dataset was used with only one outgroup, *Bolidomonas*, and did not include the V4 region of the 18S RNA gene. Their analyses recovered a grade of clades from the so-called radial centrics into polar centrics, into araphid pennates, which themselves grade into the monophyletic raphid pennates. Theriot et al. have termed this grade of clades the structural gradation hypothesis (SGH) in contrast to the CMB hypothesis (Coscinodiscophyceae, Mediophyceae, Bacillariophyceae) of Medlin and Kaczmarska (2004). The analysis performed in this study took the 7 gene data from Theriot et al. and extracted only those species with a full complement of genes and added multiple outgroups and the V4 region of the 18S RNA gene. This new analysis recovered a monophyletic Coscinodiscophyceae and Bacillariophyceae and a Mediophyceae with 2 clades, each with strong bootstrap support. Using a tree with three monophyletic clades to constrain the analysis, no significant difference between the two trees was recovered.

GP15: Biosorption of heavy metals from aqueous solutions by dried *Cladophora parriaudii* cultivated under different nutrient regimes

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Growth in industry and the human population has led to increasing levels of metal pollution entering our water bodies. For instance, concentrations of copper and lead reported in surface waters have been in the range of 0.002-3.95 and 0.0003-0.4 mg L⁻¹, respectively, which are in excess of those of the drinking water quality standards set by the WHO. Conventional metal treatment technologies have their limitations, e.g. high cost, inefficiency, or the generation of sludge. Alternative technologies are therefore required. Macro-algal biosorption is an effective method to remove metals from wastewater. The macro-alga *Cladophora parriaudii* is an ideal candidate for biosorption as it is inexpensive, renewable, has a large surface area, and interesting cell wall characteristics which give it a potentially high metal sorption capacity. However, the biological aspect of biosorption has been largely overlooked and is poorly understood.

In this work, *C. parriaudii* was cultivated under six nutrient regimes designed to produce biomass with varying cellular properties. After cultivation, the biomass was biochemically profiled and used to remove different individual metals from solution. The maximum metal removal achieved was 63.41, 39.4, 26.37, and 126.39 mg g⁻¹ of aluminium, copper, manganese, and lead, respectively. FTIR and SEM-BSE analysis suggests that biosorption is a complex process with multiple mechanisms involved in removal, including: adsorption, ion exchange, micro-precipitation, and complexation. These mechanisms result in biosorption occurring in “clusters”, rather than as a single mono-layer, on the algal cell surface. Interestingly, there was not a single cultivation regime tested which consistently yielded biomass that was the most, or least, effective at metal removal. This novel

research indicates that nutritional history and cultivation conditions play a major role in biosorption. This work paves the way for a new, exciting, avenue of research: producing “designer algae” via tailored nutrient regimes, or bioengineering, for specific biosorption purposes.

GP16: Optimising light environment to up-regulate electron transport rate in *Haslea* “blue” diatoms

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Optimisation of the light environment is a key step in maximising microalgal productivity in photobioreactors. This is a key focus of the Horizons 2020 research consortium investigating commercial exploitation of *Haslea* “blue” diatoms for blue pigment production. This talk will present initial findings for rapid up-regulation of electron transport and excitation dissipation by species of *Haslea* investigated using Fast Repetition and Relaxation fluorescence (FRRf). Cultures were exposed to non-sequential rapid light curves where, post saturation of the electron transport rate (ETR), light intensity was decreased and then further increased prior to returning to near growth irradiance. Findings presented reveal that both ETR and excitation dissipation Y(NPQ) followed patterns that were not proportional to the applied light intensity. The effective absorption cross sections for open PSII reaction centres (σ_{PSII}') decreased as a function of an observed time-dependent induction of regulated excitation dissipation Y(NPQ), and hence σ_{PSII}' was not responsible for the observed up-regulation of ETR. Instead, observed increases in ETR were the result of an increase in the rate of PSII re-opening, indicating rapid up-regulation of processes down stream of PSII. Overall, a time-dependent induction of excitation dissipation, in parallel with very rapid photoacclimation of electron transport, combined to make ETR independent of short-term changes in PAR, which potentially could be exploited for optimisation of bioreactor light conditions for commercial upscaling of blue pigment production by *Haslea* spp.

FW1: Catchment drivers of nutrient enrichment: the need for holistic science to underpin effective management and policy

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Nutrient enrichment in catchments is a critical, cross-cutting issue impacting on the chemical and ecological quality of soils

and freshwaters, on both terrestrial and freshwater ecosystem health, on air quality and the greenhouse gas balance. The problem is rising, worldwide, in association with the development of nations out of poverty, a trend of increasing water resource use and per capita consumption of meat and dairy foods. Efforts to halt or reverse this trend through policy and management have met with limited success, with current policies lacking engagement with the science evidence base, which points to a much wider range of sources, pollutant forms, pathways of delivery and impacts of nutrient enrichment in catchments. This presentation will discuss the need for holistic science to underpin the development and delivery of effective management and policy.

FW2: Integrated catchment management for algae control – A water industry perspective

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Understanding the drivers of algal growth in rivers and reservoirs has become one of the key challenges the water industry faces in the effort to reduce water quality risks and improve the resilience of public water supplies. In the 21st century, sustainability paradigm shifts, with follow up regulatory changes, as well as climate change, have put catchment and reservoir management at the heart of the water industry's short and long term strategies. These aim to achieve a more sustainable future with less dependence on energy and chemical intensive treatment arrangements. While increases in biomass are a concern to the industry, the most critical phytoplankton related issues are shifts in succession dynamics, both in terms of species composition and physiological responses to environmental change leading to the production and release of problem metabolites such as cyanotoxins and taste and odour compounds. There are a number of challenges with the removal of these compounds via water treatment, such as high chemical and power costs, sludge disposal, need for space and planning permission to expand existing facilities within protected areas. The presentation will discuss Welsh Water's approach to assessing the risks and formulating a long term evidence-based management strategy. Case studies have suggested that metabolic responses to nutrient dynamics are key to an increasing trend of the taste and odour compounds geosmin and 2-Methylisoborneol (MIB) in recent years. Therefore, a robust understanding of the factors affecting nutrient availability, as well as the distribution of metabolites within a reservoir are key to identifying suitable management alternatives.

FW3: The bioavailability of organic forms of nitrogen and phosphorus to river phytoplankton: an overlooked source of nutrients?

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Nutrient enrichment has been, and continues to be, a major threat to the structure and function of inland waters causing increases in algal populations, often potentially toxic cyanobacteria, reduced light penetration, oxygen depletion and further knock-on effects on the entire food-web. Typically, only inorganic nutrients have been considered in lake and river eutrophication, but in some systems the concentration of dissolved organic nutrients exceeds that of their inorganic counterparts. As part of a NERC Large Research Grant, led by Bristol University, DOMAINE (<http://www.nerc-domaine.uk/>) that aims to assess the origins and rates of dissolved organic phosphorus (DOP), nitrogen (DON) and carbon (DOC) flux from the land to freshwaters, we have been assessing the potential bioavailability of DON and DOP to riverine phytoplankton using laboratory bioassays under controlled conditions. Results will be presented on: i) *seasonal changes* in the bioavailability of four DON compounds and four DOP compounds at six contrasting sites, three on the Hampshire Avon and three on the Conwy in north Wales; ii) *phylogenetic responses* based simply on chlorophyll composition from these experiments; and iii) *geographic patterns* based on geology from sites around the UK. While these results represent the potential to use DON and DOP, further work will be needed to assess the extent to which these organic nutrients support river phytoplankton growth in rivers and thus contribute to eutrophication.

FW4: A risk assessment model for taste & odour (geosmin and MIB) – Scottish Water's perspective

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Scottish Water receives a significant number of customer complaints every year regarding the earthy/musty taste and odour (T&O) of their drinking water. The formation of the principle T&O causing compounds (geosmin and 2-methylisoborneol (MIB)) is related to a range of environmental and catchment conditions, including the growth and decay of algae in surface waters. It is crucial that Scottish Water gain a better understanding of the main catchment controls on T&O. This will assist in identifying and controlling the risk within source water catchments, meeting regulatory requirements and ensuring great tasting water is delivered to customers.

To better quantify the relative level and distribution of T&O risk across Scotland, Scottish Water have developed a risk assessment model. This combines existing data on catchment factors (land-cover, runoff risk and water body characteristics), historic water quality, public health algae risk assessment scores and customer contacts. The model has helped identify water supply catchments across Scotland with higher risk of T&O events and limitations in existing water quality monitoring programmes. This risk assessment methodology, using data generally collected by or available to other water companies, provides a new, widely applicable approach to better understand current T&O issues. It will also help focus research efforts aimed at improving knowledge on the production mechanisms and future trends of T&O causing compounds.

Mapping, conserving and sustainably exploiting seaweed genetic resources in blue biotechnology session

SW1: GlobalSeaweedSTAR – Safeguarding the future of the seaweed industry in developing countries

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GCRF GlobalSeaweedSTAR (www.globalseaweed.org) is a 4 year, multidisciplinary programme with a vision to grow the research and innovation capacity of DAC-list countries (www.oecd.org) engaged in seaweed farming. This £6M programme is supported by the Research Councils UK - Global Challenge Research Fund (www.rcuk.ac.uk) and directly addresses key UN Sustainable Development Goals.

This Programme aims to address the acute problem of disease and pest infestations, which are threatening the sustainability of an industry that provides income to millions of families in developing countries and has enabled women to become economically active, in areas where fewer opportunities exist. In the Philippines alone, losses over US\$ 100 million a year were attributed to disease, representing 15% of the country's farmed seaweed production.

Key ecological and socio-economic challenges preventing the sustainable economic growth of this industry were assessed and presented in a recent United Nations University Policy Brief and the UN's 'First Global Integrated Marine Assessment'. Two major challenges highlighted in these reports were the high vulnerability of crops to disease outbreaks and pest infestation and the lack of biosecurity measures and legislation governing the movement of seaweeds between regions and continents. Red seaweeds, in particular (*Kappaphycus* and allies), are an iconic example of how one group of seaweeds have been introduced to over 30, predominantly DAC-listed countries worldwide with minimal biosecurity measures in place.

By providing solutions, training and guidance, this Programme, together with a £900k GlobalSeaweedSTAR Research and Travel Fund, aims to grow the research and innovation capability of DAC-list countries engaged in seaweed-production. We will be working primarily with Philippines, Indonesia and Tanzania, but we are keen to work with as many other seaweed producing DAC-list countries as possible, thus ensuring the sustainable growth of this global industry.

SW2: Genetic and genomic tools for efficient and sustainable seaweed aquaculture

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Seaweed aquaculture is an expanding domain as witnessed by the impressive growth of the global seaweed industry in recent years, particularly in Asia, and increasing interest in this sector in western countries. However, efficient and sustainable cultivation of these organisms will require investment in several areas. The history of terrestrial crop cultivation has highlighted the importance of understanding both the biology and the genetics of the organism to be cultivated. In particular, increasingly sophisticated breeding programs have had an enormous impact on terrestrial agriculture. The seaweed sector is several decades behind terrestrial crop plants in this area and a concerted effort is necessary to understand many basic biological processes in these organisms and to develop the tools and resources for efficient cultivar improvement. Here we will describe several initiatives aimed at establishing some of these resources. These will include use of the model brown alga *Ectocarpus* to generate a high quality reference genome and as a test system to adapt genetic methodologies such as QTL detection for the brown algae. We will also discuss how these tools are now being extended to other brown algal species, including seaweeds of aquanomic interest such as *Saccharina latissima*, and a recently initiated project aimed at producing genome sequences for a broad range of brown algae.

SW3: Optimising the sustainable cultivation of seaweeds for bioenergy: does bigger biomass equal better biogas?

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Through the EnAlgae (Interreg) and SeaGas (BBSRC/Innovate UK) projects, we are investigating the applicability of using seaweeds to produce sustainable bioenergy for the future. This presentation will cover the development in optimizing kelp cultivation and establishing the largest kelp growth system in the UK based at the QUB Marine Laboratory, harvesting over 20 tonnes of kelp in summer 2017. As part of this project, we are researching how this technology may be used to produce biomethane from kelp and the potential for large scale cultivation in the future. In particular, we are examining the environmental and genetic impacts of cultivation to answer the question of how best to locate cultivation sites. We examine how

nutrients, temperature and PAR affect biomass growth with reference to optimal biogas production. Research on hydrodynamics influence the genetic differentiation and morphology of kelp communities across Northern Ireland, Scotland and the Isle of Man has implications for large scale cultivation and hatchery development. Stakeholder engagement and public outreach has been a vital part of this research and inform the socio-economic research into public attitudes to seaweed farming. We are conducting a survey of 2,500 respondents using non-market valuation techniques (e.g. contingent valuation, choice experiments) to assess the preferences, attitudes and willingness to pay to support the seaweed fed AD technology.

SW4: Inheritance of thermal tolerance traits in hybrids between *Laminaria digitata* and *Laminaria pallida*

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Kelps are globally important foundation species with high economic value as food, phycocolloids, fertilizers, pharmaceuticals and biofuels. Seaweed aquaculture is an expanding industry aiming to cope with the growing market demand for algae biomass, with extensive research dedicated to optimizing the process. The genetic transmission of important traits from parent to offspring is of utmost interest to seaweed farmers wishing to select offspring with superior performance. However, little of the underlying processes are known in kelps. To investigate thermal trait inheritance in kelps, the hybridizing species *Laminaria digitata* and *Laminaria pallida*, which differ in upper thermal tolerance were selected to generate two reciprocal interspecific crosses (*L. digitata*♀ × *L. pallida*♂, *L. pallida*♀ × *L. digitata*♂), intraspecific controls (*L. digitata*♀♂, *L. pallida*♀♂) and parthenogenetic controls (*L. digitata*♀, *L. pallida*♀). For all combinations, we investigated the responses of microscopic life cycle stages, F1 sporophyte recruitment capacity, and the physiological resilience of F1 sporophytes under temperature stress. The presence of male gametophytes enhanced the reproductive output of female gametophytes, as higher fertility was observed in intraspecific controls than in parthenogenetic controls. Compared with both intraspecific controls, *L. digitata*♀ × *L. pallida*♂ hybrids showed the fastest development of gametogenesis, while the reciprocal hybrid *L. pallida*♀ × *L. digitata*♂ exhibited the slowest gametogenesis and the lowest sporophyte recruitment. Both interspecific hybrid sporophytes exhibited heterosis, with greater tolerance to high seawater temperature than the intraspecific controls. Our results indicate that the transmission of thermal traits is sex-dependent, with female parents being more important in determining the heat-tolerance of hybrids than male parents. This study provides valuable insights to improve breeding programs and aquaculture practices in the face of a changing environment.

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SW5: Disparity of vegetative sporophyte and gametophyte of *Kappaphycus alvarezii* (Doty) Doty

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One dilemma of farming *Kappaphycus* is the deteriorating quality of planting materials or explants due to recurrent adverse changes in the culture conditions resulting in the decrease in the harvested biomass. In most cases surviving seaweeds would then be utilized as explants for the next cropping. The continuous use of vegetative method of propagation could change the pool of traits that would result to “loss” of some desirable characteristics like good growth. Rejuvenating the stock by using spores from wild parents that are sexually and asexually produced could perhaps restore the traits that are useful for culture. The use of haploid gametophyte and diploid sporophyte *Kappaphycus alvarezii* (Doty) Doty from spores is explored as source of explants. The growth and physical properties of carrageenan of sporophytes (2N) and gametophytes (N) were determined. Growth of diploids was significantly higher than the haploid *Kappaphycus* in vitro (2N, 3.23% day⁻¹; N, 1.70 % days⁻¹) and ex vitro (2N, 2.57% day⁻¹; N, 1.84% day⁻¹). Gel strength (>400 g cm⁻²) and yield (> 35%) of 2N and N were not significantly different, while viscosity was significantly higher in 2N than in N. In terms of growth rate and physical properties of carrageenan of vegetative life stages, sporophytes showed superiority over gametophytes. Sporophyte *Kappaphycus* could be a better source of explants than gametophytes for seaweed mariculture.

SW6: Resiliency of *Gracilariopsis heteroclada* (Zhang et. Xia) to different salinities and temperatures

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Environmental phenomenon such as El Niño and La Niña is unusually experienced recently. Water parameters are slowly deviating from what used to be normal and this is brought about by changing climate condition which is a major challenge now. Environmental factors like temperature and salinity play an important role in the growth and reproduction of aquatic organisms such as seaweeds. *Gracilariopsis heteroclada* (Zhang et. Xia), an agarophyte and as a representative of euryhaline tropical Rhodophytes was studied for resiliency to different temperatures and salinities. Diploid spores from mature cystocarpic thalli of *Gp. heteroclada* collected from the wild were shed and grown at different temperatures and salinities. Higher fecundity was obtained at 20°C (152.21±69.88 spores) and 30°C (155.58±65.78 spores) than at 40°C (7.56±6.54 spores) and 10°C (no spores were shed). Spores shed at 40°C were degraded after 2 days. Growth rates of *Gp. heteroclada* after 56 days at 20°C and 30°C were 4.80±0.62% day⁻¹ and 3.01±0.17% day⁻¹, respectively. Fecundity of *Gp. heteroclada* at 30 ppt (221.88±76.52 spores) is significantly higher than 20 ppt (85.92±54.34 spores) and 40 ppt (7.58±6.54 spores). No spores were shed at 10 ppt. Growth rates of *Gp. heteroclada* at salinities 20, 30 and 40 after 56 days were 1.54±0.78% day⁻¹, 3.96±0.58% day⁻¹ and 3.09±0.52% day⁻¹, respectively. There is no significant difference observed on the specific growth rate of *Gp. heteroclada* grown in salinities 20, 30 and 40 after 150 days. These results show that *Gp. heteroclada* can shed spores at a range of 20-40°C and 20-40 ppt. Optimum temperature for growth is at 20°C and can grow in salinities between 20 and 40 ppt. Extreme low salinity (10 ppt) and temperature (10°C) seemed to be lethal to spore-shedding for *Gp. heteroclada*.

SW7: Microalgae as larval food of sea cucumber *Holothuria scabra*

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Different microalgae, *Chaetoceros calcitrans*, *Rhodomonas* sp. and *Tetraselmis tetrathele*, as larval food of sea cucumber *Holothuria scabra* were studied. In the first experiment, each microalga was fed daily at 20000 cells ml⁻¹. In the second experiment, three combinations of microalgae containing 10000 cells ml⁻¹ of each microalga were used: *C. calcitrans* and *Rhodomonas* sp., *C. calcitrans* and *T. tetrathele*, and *Rhodomonas* sp. and *T. tetrathele*. Hatched larvae, 2 days post-fertilization (DPF), were distributed to experimental containers with an initial stocking density of 200 larvae L⁻¹ (N≈3200/replicate). Each treatment had three replicates. Survival was monitored every two days starting at 4 DPF while larval growth and development were monitored starting at 3 DPF until more than 50% of the larval population were considered as competent larvae (late auricularia stage). In the first experiment, larvae fed with *Rhodomonas* sp. had the highest mean body length (BL) of early auricularia (618.5±8.8 µm). Only the larvae fed with *C. calcitrans* and *Rhodomonas* sp. have reached the middle auricularia. Those fed with *C. calcitrans* have significantly higher (p<0.05) mean BL of middle auricularia (795.7±14.5 µm). Also, only those larvae have reached the late auricularia with mean BL of 975.7±13.5 µm. *C. calcitrans* showed significantly higher (p<0.05) daily growth rate (DGR) of the larvae (31.4±5.2 µm d⁻¹). It also showed faster development to competent larvae and significantly higher (p<0.05) survival (53% at 12 DPF). In the second experiment, larvae fed with mixed *C. calcitrans* and *Rhodomonas* sp. showed better performance in growth, development and survival of *H. scabra* larvae. It showed significantly higher (p<0.05) mean BL of early, middle and late auricularia with 634.7±5.2, 767.5±10.3 and 991.0±15.8 µm, respectively. It also showed significantly highest DGR (43.8±9.9 µm d⁻¹), faster development to competent larvae and higher survival (86% at 10 DPF).

3rd Microphytobenthic Biofilm Symposium

BS1: Processing and fate of carbon and nitrogen in phototrophic biofilms from tropical, temperate, and high latitude environments

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Microphytobenthos (MPB) in photic sediments are potentially important for global carbon (C) and nitrogen (N) processing. However, studies investigating the transformation and fate of MPB-derived C and N (MPB-C and MPB-N) have had limited scope, focusing on temperate muds and relatively few processing pathways. Deliberate additions of stable isotope tracers can improve our understanding of the role of MPB in coastal sys-

tems and how this may be affected by environmental change. Isotope tracers allow quantification of C and N uptake into MPB, and subsequent transfer of MPB-C and MPB-N into sediment compartments (organic carbon, bacteria, fauna), sediment-water fluxes (dissolved inorganic carbon (DIC), dissolved organic carbon (DOC), NH₄⁺, NO₃⁻, N₂, dissolved organic nitrogen (DON), resuspension) and sediment-air fluxes (CO₂, N₂). Using this approach we developed comprehensive budgets for the processing and fate of MPB-C and MPB-N in sub-arctic, temperate, and sub-tropical intertidal sediments. These budgets revealed differences in uptake and loss, but similarities in processing, for MPB-C and MPB-N. Sub-tropical MPB fixed 2× more C than their sub-arctic and temperate counterparts, whereas N uptake was similar for sub-tropical and sub-arctic MPB, but lower for temperate MPB. The proportion of MPB-C and MPB-N lost from the sediment varied across climates, but loss pathways were similar. MPB-C loss over 30 d resulted from efflux of DIC (~0.5% d⁻¹), DOC (<1%), CO₂ (<1%), and resuspension. MPB-N loss over 20 d was via efflux of N₂ (10-24%) and DON. Similarities in MPB-C and MPB-N processing suggest that sediment microbial communities are functionally similar across climates - local conditions may play a greater role than climate in determining the fate of MPB-derived material. Supporting this, we used manipulative experiments incorporating isotope tracers to show that increased nutrient availability reduces bacterial remineralisation of MPB-N, reduces loss of MPB-derived DON and enhances loss of MPB-C from sediments.

BS2: Interactions between diatoms and bacteria in phototrophic biofilms

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Phototrophic, epilithic biofilms are a typical feature of aquatic ecosystems. To study interactions between diatoms and bacteria we isolated and identified different diatoms and associated satellite bacteria from Lake Constance. Interestingly, purified diatom cultures showed significant differences with respect to biofilm formation when compared to the corresponding xenic cultures. The diatom *Achnanthydium minutissimum* forms capsule-like structures in the presence of an isolated bacterial strain, but not in axenic state. Interestingly, the formation of the capsules can be induced by substances secreted by satellite bacteria. SEM analyses show that capsule material that was mechanically stressed by being stretched between or around cells displayed fibrillar substructures. Fibrils were also found on the frustules of non-encapsulated cells, implicating that *A. minutissimum* capsules may develop from fibrillar precursors. We furthermore have screened the genome of the marine diatom *Phaeodactylum tricorutum* for gene models encoding proteins exhibiting leucine-rich repeat (LRR) structures. We were able to identify several transmembrane LRR-proteins, which are likely to function as receptor-like molecules. Moreover, *P. tricorutum* encodes a family of secreted LRR proteins likely to function as adhesion or binding proteins as part of the extracellular matrix. We furthermore have analyzed the extracellular proteome of *P. tricorutum* in the presence and absence of *Roseovarius bacteria*.

BS3: The ecological potential of geotextiles to provide novel habitat for biofilms and trap sediment

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Intertidal mudflats and saltmarsh function as a natural coastal defences, but have declined due to anthropogenic influences and 'coastal squeeze'. They form a natural barrier to the seas energy, dampening waves and reducing the amount of coastal erosion. With a changing climate and rising sea levels these natural coastal defences are highly prized, as they are able to keep pace with rising sea level due to the trapping of sediment and subsequent accretion. This is partly due to the presence of microphytobenthos, such as diatoms and cyanobacteria, living on the sediment surface forming a biofilm.

The microphytobenthos secrete carbohydrate polymers (Extracellular Polymeric Substances), which increase the stability of sediment, protecting it against erosion. This process is called biostabilisation and it plays an important role in the accumulation of sediment, accretion of mudflats and subsequent formation of saltmarshes.

Although hard engineered sea defences were preferred for decades, the use of soft and natural sea defences is now recognized as a flexible and cost effective alternative. Geotextiles are permeable fabrics that are increasingly being used to create sea defences. Dredged material (waste that would otherwise have to be disposed of) is pumped into a high-tensile geotextile fabric 'tube' and laid upon the existing substrate to raise the intertidal elevation, protecting against erosion and enhancing sedimentation by decreasing tidal current velocities. With the growth in the concepts of bio-engineering, green infrastructure and 'working with nature', the ecological characteristics of these fabrics are becoming a more important element.

This study investigates the potential of geotextiles to trap sediment on their surfaces and provide habitat for stabilising biofilms, as a precursor to saltmarsh formation. We investigated eight different geotextiles used in marine engineering (supplied by Tencate Geosynthetics), for their potential to trap sediment and provide habitat for microphytobenthos in the intertidal environment.

BS4: NDVI time-series: a tool for water quality assessment in transitional water?

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The Normalized Difference Vegetation Index (NDVI) which combines information contained in two spectral bands, the red and near infrared is commonly used to assess microphytobenthos (MPB) biomass. It can be calculated from reflectance spectra (the ratio of upwelling radiance to downwelling irradiance) at various scales from ground-based to satellite measurements. With the full record of 17 years of MODIS (Moderate Resolution

Imaging Spectroradiometer) NDVI data from the Terra satellite, we estimated the trend and seasonality of MPB in estuaries and coastal areas of the Atlantic French coast. Trends in time-series were identified with dynamic linear models adapted to the irregular sampling frequency. All time-series showed comparable seasonality with the main NDVI peak in spring and a secondary peak in fall. However, opposite trends were observed between the different sites. In the Loire estuary, MPB steadily declined since 2000 and we investigated if this could be related to the trends in nutrients concentrations. The Loire as other estuaries in Europe is characterized by a significant decrease in phosphorus concentration since the last two decades. We also tested the suitability of different satellite sensors to map MPB in the 43 French estuaries and water bodies considered as transitional waters in France. MODIS low spatial resolution (250 m) was not adapted for many small estuaries, notably in Brittany. Combining spatial and spectral resolution, revisit time, cost, field-of-view, we suggest that LANDSAT 8 and Sentinel 2 could be an alternative to build up time-series for estuaries.

BS5: Modelling the development of microphytobenthos in a tidal system

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Tidal dynamics of microphytobenthos (MPB), bacteria and nutrients in the first centimeter of surficial sediment was modelled. Physiological processes of MPB development (vertical migration and exudation of Extracellular Polymeric Substances: EPS) were taken into account in the formulation of the model. Moreover, endogenous cell quota (C:N) was hypothesized as a triggering factor of MPB vertical migration within the sediment. Results highlighted the importance of nutrient availability in the sediment to reproduce the three distinctive developments of MPB observed during a 10-day mesocosm experiment (latency, exponential growth, and plateau phases). MPB development is thus controlled by exogenous processes such as faunal bioturbation which induces the availability of nutrients in the sediment through biodiffusion and excretion. This study also points to the importance of considering endogenous processes, the internal quota C:N in this case, in the functioning of the MPB. The model developed in this study could be used for a better understanding of tidal systems functioning.

BS6: Drivers of microphytobenthos seasonal cycle on a temperate intertidal mudflat: a modeling experimental approach

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Intertidal mudflats in temperate latitudes are among the most productive ecosystems on Earth. In the absence of macrophytes, microphytobenthos (MPB) is the most important primary producer in those areas. While first attempts to model factors driving phytoplankton bloom date back to Riley's work in 1946, efforts to understand microphytobenthos seasonal cycle are relatively new (Guarini developed a first MPB model in 1997). The drivers controlling the MPB seasonal cycle are still in debate. In this study, we use a MPB 1D model to test different hypotheses regarding potential factors controlling MPB production and biomass at low tide over a seasonal cycle on a mudflat of the Atlantic Coast of France. The model explicitly simulates MPB and grazers over and within the first centimeter of sediment. It is forced by realistic daily to seasonal cycles of irradiance and temperature. Roles of sediment temperature and grazing will be particularly considered. In situ and remote sensing time series based on the Normalized Difference Vegetation Index will be used to calibrate and assess the model behavior. Regarding the high variability of abiotic and biotic factors on an intertidal mudflat, this modeling approach will allow us to realize multiple experiments and to separate the contribution of a single driver in such a mixed-signals area. This preliminary study will help us to couple a MPB module to the 3D ocean model MARS3D to assess primary production and biofilm resuspension during high tide within coastal waters of the French Atlantic coast.

BS7: Single-cell analysis of species-specific photo-regulation and photo-acclimation status of microphytobenthic diatoms

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Microphytobenthic diatom biofilms are important communities in coastal benthic systems that exhibit high primary productivity rates as the result of their highly effective photo-regulation mechanisms. While these biofilms are taxonomically diverse, they are often analyzed as a single homogeneous entity ignor-

ing their species composition. Using microscopic variable chlorophyll fluorescence imaging, we show that photo-acclimation status and photo-regulation strategies of diatoms from the same biofilm can vary significantly and are most likely species-specific. Mixed assemblages of pennate diatom were extracted from intertidal biofilms of the French Atlantic coast (Bourgneuf Bay). Four of the larger biofilm species (*Pleurosigma angulatum*, *Pleurosigma* sp., *Gyrosigma* sp., *Plagiotropis* sp.) were selected and their photoacclimatory response was measured using rapid light curves (RLC) and by fitting light-response models to relative electron transport rate (rETR) and non-photochemical quenching (NPQ) data. All species showed significant differences in most parameters. The average rETR_{max} ranged between 19 (*P. angulatum*) and 65 (*Plagiotropis* sp.), α ranged from 0.21 (*Plagiotropis* sp.) to 0.26 (*P. angulatum* and *Gyrosigma* sp.), E_k ranged between 62 (*P. angulatum*) and 516 (*Plagiotropis* sp.) $\mu\text{mol photons m}^{-2} \text{s}^{-1}$, and E_{opt} from 243 (*Pleurosigma* sp.) to 691 (*Plagiotropis* sp.) $\mu\text{mol photons m}^{-2} \text{s}^{-1}$. Overall, *Plagiotropis* sp. and *Gyrosigma* sp. were acclimated to higher irradiance than the two *Pleurosigma* species (i.e. higher E_k , E_{opt} and lower α). NPQ data confirmed this, with NPQ of *Pleurosigma* sp. and *P. angulatum* increasing very quickly at low light levels in comparison to *Gyrosigma* sp. and *Plagiotropis* sp., as well as the two *Pleurosigma* species exhibiting fourfold higher NPQ values at the highest RLC light levels (410 $\mu\text{mol m}^{-2} \text{s}^{-1}$). Our study shows that species from the same biofilm can have very different photo-regulation and photo-acclimation status, probably as an adaptation to different optical niches in the sediment.

BS8: Influence of TiO₂ and Ag nanoparticles on microphytobenthic biofilms: consequences on oxygen and nutrient fluxes

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With the rapid development of nanotechnologies since the 1990s has come the release of nanoparticles in the environment. Used in particular as anti-microbial agents, nanoparticles have been shown to have genotoxic and cytotoxic effects on a wide range of organisms, mostly in culture-based studies, and at high concentrations. In marine environments, NPs tend to aggregate and deposit onto sediment, which modifies their properties and increase their potential toxicity for benthic organisms. This study aims to investigate the toxicity of two nanoparticle species (silver and titanium oxide NPs) on mudflat microphytobenthic biofilms, using environmentally relevant concentrations and experimental conditions. One month-experiments in tidal mesocosms with natural assemblages were performed at three seasons (autumn, winter and summer). We assessed the effect of these NPs on microorganisms and, through them, on important biogeochemical processes in intertidal areas, i.e. oxygen and nutrient cycling. NPs only slightly influence biofilm development in cold seasons, as seen by a small reduction of chlorophyll content; however, TiO₂-NPs largely reduced sediment EPS content in summer, which was unexpected as EPS can act as a protection mechanism against contaminants. NPs also reduced oxygen production by microbial biofilms in the light in autumn, even at low concentrations, and in summer, but seemed to stimulated production in winter months. Effects of NPs on nitrate, silicate and ammonium fluxes between water and sediment were not consistent between nutrients, light conditions and seasons. Most effects on oxygen and nutrient flux were transient and biofilms were observed to recover towards the end of the experiment. In summary, we have found that under a range of environmentally realistic conditions, TiO₂- and Ag-NPs can have significant sub-lethal effects on microbial assemblages and several aspects of ecosystem functioning.

BS9: Birds and Biofilms: Impacts of Waders (Charadrii) on mudflat biofilms

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Intertidal mudflats support internationally important numbers of migrating and over-wintering waders, giving them critical conservation importance. Waders are treated largely as secondary consumers in mudflat ecosystems, feeding upon macro-invertebrates (macrofauna) which graze biofilms. This research project aims to test the influence of wader-mediated trophic interactions on biofilm communities, and the consequences for sedimentary characteristics and biogeochemical cycling of intertidal sediments. We tested the hypothesis that where waders were present, biofilm coverage (and by proxy sediment erodibility) would increase, due to the birds eating macrofauna, leading to a reduction in macrofauna grazing of the biofilm layer. It was also anticipated that sediment properties and biogeochemical cycling (tested in both light and dark conditions) would be affected.

Wading bird densities were manipulated on an estuarine mudflat in Essex, England. Chlorophyll *a* fluorescence (F_o) was significantly lower where waders were present ($p=0.04$). This was the opposite result to that expected, and may have resulted from bioturbation by the birds causing physical removal and disturbance of the biofilm, or the direct biofilm-feeding by small sandpipers (such as Dunlin *Calidris alpina*). If confirmed, to the author's knowledge, this biofilm feeding would be the first documented observation of this behaviour in the UK. The erosion threshold of the sediment was lower where waders were present, though not significantly, possibly due to large spatial variability and the low number of sample replicates ($n=6$) masking differences. Measurement of nutrient fluxes under lit conditions, between the sediment surface and water column, showed significant differences in four nutrients between areas with and without waders: nitrate (uptake by the sediment was lower where waders were present, $p=0.001$), phosphate (uptake by the sediment was lower where waders were present, $p=0.02$), ammonia (release from the sediment was inhibited where waders were present, $p=0.05$) and nitrite (uptake was inhibited where waders were present, $p=0.04$). Under dark conditions, nitrate uptake was lower ($p=0.05$) and ammonia release from the sediment was higher where waders were present ($p=0.04$).

These data suggest that wading birds have a significant effect upon the biofilm coverage of a mudflat, although the process by which this occurred during the experiment was not identified. The biogeochemical cycling of nutrients between the benthic and pelagic zones within an estuarine environment are also significantly altered. Further research is required to identify the process by which waders (in particular small sandpipers, the most frequent foraging bird at the study site) impact biofilms and biogeochemical cycling in our estuaries.

BS10: Viral transmission of μ var OSHV1 for spat mortality of *Magellona gigas* : comparison between Water infection, sediment infection and microphytobenthic biofilm infection.

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Since 2008, a viral epizooty is responsible for massive mortalities of Pacific oyster spats (*Magellona gigas*), after a mutation of the Ostreid Herpes Virus (OsHV-1). Every year, massive mortalities occur in all french estuarine ecosystems where oyster-farming is developed. A latitudinal gradient exists, since mortality episodes occur when the water-temperature exceeds 15,5°C. We put in question the horizontal transmission of this virus from contaminated animals to non-infected farms by a series of experiments using a benthic flume by testing 2 current velocities (0.5 and 3 m.s⁻¹). Controlled loads of virus were dispersed in the water column of the flume and water samples were taken at different recirculating times to inject in the sentinel oyster adductor muscles (100 individuals / test). Injected oysters were surveyed in terms of mortality in challenge basins (temperature of 20°C). A decrease of mortality rates were observed with recirculating time in the flume, probably because of decline of virus persistence in the water current. In strong currents experimented in the flume, the rate of decrease with time was higher. The persistence of virus is then higher and more efficient in terms of transmission in low currents (0.5 m.s⁻¹). The same experiments were then repeated by infecting sediments with or without colonisation by microphytobenthic biofilms, instead of a direct injection in the seawater of the flume. With slow currents and sediment, the viral contamination was not transferred to sentinel oysters, with or without biofilms. Nevertheless, with strong currents of 2 m.s⁻¹, the mortality rates was similar between water-infected and sediment-infected treatments. This reveals that sediment erosion can resuspend infected that can contaminate distant farms when there are strong current velocities. The mortality rates of sentinel oyster were higher after long recirculating time in the flume, when the viral loads is injected in the sediments compared to water-injection treatments. The presence of biofilm did not seem to change the transmission rates.

BS11: Characterisation of cyanobacteria-based biofilms in meltwater pond on the McMurdo Ice Shelf, Antarctica

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Cyanobacteria-based biofilms dominate terrestrial and ice-based aquatic ecosystems in Antarctica. On the McMurdo Ice Shelf, meltwater ponds contain liquid water during the summer months, but completely freeze over the winter. The biota of these habitats is dominated by thick benthic cyanobacteria-based biofilms that must contend with extreme temperature changes, freezing and desiccation stress, and high salinities.

In this study, bacterial and microbial eukaryote assemblages in biofilms were characterised from six different McMurdo Ice shelf meltwater ponds ranging from 200 - 41000 μ S m⁻¹ using 16S rRNA and 18S rRNA gene sequencing. Six replicates per pond were assessed along a six meter transect. Microbial assemblages showed considerable heterogeneity and dissimilarity did not correlate with geospatial distance, which has implications for sampling design and establishing relationships between communities and environmental variables. The 16S rRNA gene analysis showed that Proteobacteria and Cyanobacteria were the most abundant bacterial phyla. The overall prokaryotic assemblages were significantly different across ponds, and appear to be driven by changes in abundance and diversity of Proteobacteria taxa. The 18S rRNA gene eukaryote communities in the meltwater biofilms had a lower richness than the bacterial communities and were dominated by Ochrophyta,

Chlorophyta, and Ciliophora. Other taxa included Amoebozoa, Cryptophyta, Haptophyta, Fungi and Cercozoa. The eukaryotic communities had a patchy distribution with most pond communities showing no significant differences at the OTU-level. Prokaryotic community dissimilarity was correlated with salinity whereas eukaryotes assemblages could not be well explained by the measured environmental variable.

In summary, benthic cyanobacteria-based biofilms in meltwater pond on the McMurdo Ice Shelf are diverse and heterogeneous communities of prokaryotes and microbial eukaryotes. Prokaryotic community structure appears to be affected by salinity whereas further analysis is needed to identify potential drivers for the distribution and assembly mechanisms of microbial eukaryotes in Antarctic ice shelf ecosystems.

BS12: Hyperspectral remote sensing of epilithic microphytobenthos assemblages on oyster shells.

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Pacific oyster *Crassostrea gigas* introduced worldwide for aquaculture is now recognized as an invasive species which creates wild oyster reefs in intertidal areas. Recent studies tested the possibility to use airborne hyperspectral remote sensing to map their spatial distribution. Oyster shell spectral signatures systematically revealed absorption bands at 632 and 673 nm suggesting the presence of unicellular photoautotrophs. In this work, we investigated the microphytobenthic assemblages associated with oyster shells using high spectral and spatial resolution data combined to chromatographic analysis. Oyster shells were imaged in a laboratory using the hyperspectral HySpex spectrometer with a sub-millimeter spatial resolution. Specific vegetation indices were applied on images considering two conditions: untreated shells (shells covered by mud and epibionts) and superficially cleaned shells (epibionts and mud removed by scraping and washing). Second derivative analysis ($\delta\delta$) of reflectance spectra from four microbial cultures were applied to images using a Spectral Angle Mapper (SAM) classification. SAM maps revealed the presence of an epilithic biofilm mainly composed of diatoms and rhodophytes and an endolithic community mainly composed of cyanobacteria and chlorophytes. Pigment analysis identified fucoxanthin, myxoxanthophyll and chlorophyll b which are markers of diatom, cyanobacteria, and chlorophytes respectively. Significant linear relationships were obtained between pigment concentrations and second derivative peaks at $\delta\delta_{548}$ (Fucoxanthin), $\delta\delta_{548}$ (Myxoxanthophyll), and $\delta\delta_{650}$ (Chlorophyll b). Chlorophyll a concentration was significantly related to NDVI. Concomitant taxonomic observations identified 53 diatom taxa dominated by tychoplanktonic species (*Thalassiosira pseudonana* and *Plagiogrammopsis vanheurckii*). Endolithic photosynthetic organisms were characterized by three species of cyanobacteria and two chlorophytes. This study shows that oyster shells are an idiosyncratic but ubiquitous habitat for phototrophic assemblages.

BS13: Microphytobenthic primary production estimation in heterogeneous mudflats of an anthropized estuary (Seine estuary, France).

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The understanding of the spatial and temporal dynamics of intertidal microphytobenthos in terms of primary production is of fundamental concern in tidal flat ecology. The main objective of this study was to estimate the contribution of the benthic compartment to the autochthonous primary production in the Seine estuary, a highly dynamic and anthropized estuary and to interpret by comparing them to sediment and benthic variables. PAM fluorescence method was applied to quantify benthic primary productivity along several spatial gradients on the different intertidal zones of the estuary during the two microphytobenthic productive periods of September and April. Our results showed the weak photosynthetic performance in sandy zones and during fluid mud deposit in relation with the biofilm structuration in those both conditions. This study also highlight the strong influence of the chl a content, the biofilm structuration, and the photosynthetic efficiency in the production rates dynamics. A strong negative relationships observed between phaeopigment percentage and chl a biomass also confirmed the influence of grazers on microphytobenthic biofilm but not directly on primary production whose seasonal variability depended on irradiance levels, migratory capacities or temperature. At last, this study has estimated the contribution of the microphytobenthic compartment in the autochthonous primary production which do not exceed 18% due to the reduction of mudflat areas induce by the intense hydrodynamics and anthropic disturbance of this estuary.

BS14: Evaluation of impact of chlorination on MPB communities representative of the Severn Estuary

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Microphytobenthos (MPB) is composed of mainly diatoms which live closely associated to sediment particles. In an estuary such as the Severn Estuary, these communities are the dominant group responsible for primary production. Chlorination is a commonly used antifouling agent for power plants cooling water systems. Chlorine produced oxidants (CPO) can be released into the environment with discharged cooling water and have the potential to impact non-target organisms such as benthic diatoms. The elevated temperature of the cooling water may also influence the extent of any impact. To assess the impact of CPO and temperature elevation on MPB in the laboratory it is necessary to run constant dosing systems to maintain the oxidant concentration. Thus, the impact of chlorinated discharges and temperature on single species and communities were evaluated in different laboratory experiments. Single species toxicity tests were initially performed using immobilisation of *Achnanthes* spp, *Navicula pelliculosa* and *Amphora coffeiformis* cells in alginic beads. Community studies were conducted on isolated sediment cores (microcosms) with microalgae assemblages previously collected in the field. Photosynthetic activity was determined using chlorophyll fluorescence variability. Pigment and genomic analyses were applied to measure the change of diversity of the community in the microcosms. Contrasting results were shown by the single species experiments compared to those involving the use of communities in microcosm studies

with single species showing up to 10 fold higher sensitivity. The reason for the higher sensitivity indicated by the single species studies may relate to some degree of protection from exposure to CPO in the microcosm system e.g. through downward migration of species in the sediment observed during the study. However, other potential factors such as the production of extracellular polymeric substances will be investigated in the future.

BS15: Ecological status assessment in estuaries using diatom-based metrics: Could microphytobenthos become a new biological quality element?

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Diatoms are at the basis of most of the phytobenthos assessment methods for rivers in the majority EU Member States since the Water Framework Directive (WFD) was implemented. In spite of dominating most microphytobenthic assemblages in intertidal estuarine and coastal areas, marine and brackish benthic diatoms have never been considered as viable indicators of ecological status in transitional waters. With the aim of evaluating if intertidal diatoms could potentially be used as indicators of environmental change and anthropogenic pressure in a large macrotidal estuary, three impacted sites in the Loire estuary were surveyed during spring and autumn 2016. Diatom analysis was coupled with the collection of a thorough set of physical-chemical parameters (e.g. sediment analyses, nutrients, heavy-metals, polyaromatic hydrocarbons), as well as of other biotic assemblages (e.g. meiofauna, macrofauna). The preliminary results of this study will be presented here for the first time. A total of 351 diatom taxa were found and belonged to 98 different genera. A species-by-species literature research allowed the description of the assemblages in terms of their ecology, namely, salinity and habitat preferences (i.e. freshwater, benthos, etc.), as well as growth-forms (e.g. epipelton) and tolerance to pollution (according to the OMNIDIA database). Multivariate analysis revealed that, of the biotic datasets, only macrofauna and diatoms had a significant, if low, correlation between them. Both datasets had moderate to strong correlations with environmental datasets (i.e. $\rho \geq 0.5$, BIOENV routine), which always selected as variables nutrient and heavy-metal (e.g. Cu) concentrations. Macrofauna multivariate pattern showed a clear distinction between tidal creek and mudflat assemblages, whilst the diatom dataset was the only one with a clear seasonal pattern. Tidal creek/mudflat distinction was also noticeable in the diatom dataset. The advantages and caveats of using microphytobenthos or diatom-based indices as environmental assessment tools will also be addressed.

BS16: Radiometry vs. fluorometry: the use of hyperspectral reflectance to retrieve photosynthetic parameters from algal biofilms

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A remote sensing method to estimate microphytobenthos (MPB) photosynthetic parameters is presented. This was achieved by coupling hyperspectral radiometry (reflectance, r) and fluorometry (PAM and FRR). Data were obtained on MPB monospecific cultures photoacclimated at low light ($LL = 50 \mu\text{mol photons.m}^{-2}.\text{s}^{-1}$) and high light ($HL = 300 \mu\text{mol photons.m}^{-2}.\text{s}^{-1}$) and known for their differing photophysiology. Photosynthetic parameters, ΦPSII and $s\text{PSII}$ were retrieved from non-sequential light curves (NSLC) by PAM and from rapid light curves (RLC) by PAM and FRR. Absorbance was obtained from reflectance measured during the same experiments using the radiative transfer model MPBOM to estimate the absorption cross section (a^*). Radiometric indices based on Chl a and xanthophyll (diadinoxanthin, DD and diatoxanthin, DT) absorption bands were also calculated. Radiometric indices and a^* patterns with light were compared to ΦPSII and $s\text{PSII}$ trends measured by fluorometry.

Based on NSLCs and RLCs, ΦPSII was highly predictable ($R^2 > 0.6$) by the radiometric index MPB_{LUE} derived from absorption bands at 496 and 508nm that correspond to the DD/DT ratio. A significant relationship ($R^2 > 0.9$) was further identified between ΦPSII and SlopeChl a , an index based on Chl a absorption bands at 670 and 680nm. $s\text{PSII}$ from FRR and a^* from radiometry followed the same patterns with light intensity. Results therefore supported the use of radiometric indices including MPB_{LUE} , SlopeChl a , and a^* as proxies of photosynthetic parameters, and were used in this study for ETR estimation following the equation:

$$\text{ETR} = \text{MPB}_{\text{LUE}} \times a^* \times E \quad (1)$$

$$\text{ETR} = \text{SlopeChl}a \times a^* \times E \quad (2)$$

This calibration of hyperspectral data using fluorometry is a significant step in the challenge of primary production remote sensing from space and enabling the mapping of primary productivity at ecosystem level. The first ETR map from hyperspectral sensor is presented.

BS17: Extracellular polymeric substances (EPS) production in benthic diatom biofilms"

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The important roles played by extracellular polymeric substances (EPS) in the functioning of microphytobenthic biofilms are well recognised. A large proportion of these EPS are produced by diatoms. Benthic diatoms are able to alter the patterns of production, and the chemical composition of their EPS in response to environmental changes. However, the metabolic pathways for EPS production have not been described. Using the sea-ice biofilm-inhabiting diatom *Fragilariopsis cylindrus* as a model species, we present the first published metabolic pathway for EPS production in a pennate diatom and show how gene expression, physiology and EPS composition responds to changes in salinity and temperature, and correspond to field measurement of EPS. This pathway provides a model of diatom EPS production to test in intertidal systems, and raises questions of how environmental changes are perceived and communicated within cells.

General phycology posters**(P-GP1) Mitochondrial markers for benthic diatoms monitoring of the west coast of Korea**

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Diatoms are an important primary producer in coastal ecosystems and functional group for carbon, nitrogen, and silicate exchanges between the water column and sediments. In spite of ecological importance of diatoms in mudflat, the diversity and ecological researches have largely relied on morphological and ultrastructural characteristic and a couple of gene of nuclear and plastid i.e., LSU and SSU rRNAs, and rbcL. Utility of molecular markers in phylogenetic, evolutionary, and ecological studies are in debate. Alternative markers may useful to increase our understanding on diversity and ecology of diatoms, such as mitochondrial gene. We assembled all available mitochondrial genomes (mtDNA) of diatoms from public DB (10 spp) including three newly determined mtDNAs, such as *Berkeleya fenica* GenBank accession NC_026126 (35,509 bp, 29.7% GC), *Navicula ramosissima* NC_031848 (48,652 bp, 31.7% GC), and *Skeletonema marinoi* JK029 NC_028615 (38,515 bp, 29.7% GC) isolated from the west coast of Korea. 34 CDS of diatoms' mtDNAs were compared for new amplicon primer design. Based on the statistical tests and sequencing results, we selected three candidate markers for diatoms, i.e., cob, cox2, and nad5. We described and discussed new markers' theoretical and practical utilities for quantitative diatoms monitoring based on preliminary results of field samples from Geunsoman mudflat (winter to spring 2017), the west coast of Korea.

(P-GP2) Systematics and Biodiversity: an international peer-reviewed journal

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Systematics and Biodiversity is devoted to whole-organismal biology. Numerous algal papers have been published in the journal. It is an international, peer-reviewed, life science journal, without page charges, which is published by Taylor and Francis for the Natural History Museum. The journal is published six times a year online and two printed copies per year. The criterion for publication is scientific merit. *Systematics and Biodiversity* documents the diversity of organisms in all natural phyla, through taxonomic papers that have a broad context (not single species descriptions), while also addressing topical issues relating to biological collections, and the principles of systematics. It particularly emphasizes the importance and multi-disciplinary significance of systematics, with contributions which address the implications of other fields for systematics. Also, it may advance our understanding of other fields through taxonomic knowledge, especially in relation to the nature, origins, and conservation of biodiversity, at all taxonomic levels. The journal does not publish single species descriptions, monographs or applied research nor alpha species descriptions. Taxonomic manuscripts must include modern methods such as cladistics and/or molecular analysis. The 2016 Impact Factor was 2.127 and the journal is ranked 15/53 or the upper 28% in the category: Biodiversity and Conservation © Thomson Reuters 2013 JCR). The five-year Impact Factor was 2.141.

(P-GP3) Nitrogen uptake by the macro-algae *Cladophora coelothrix* and *Cladophora parriaudii*: influence on growth, nitrogen preference and biochemical compositionMichael E. Ross^{1,2}, Katharine Davis¹, Rory McColl¹, Michele S. Stanley², John G. Day², Andrea J.C. Semião²¹School of Engineering, University of Edinburgh, Edinburgh, EH9 3FB, UK, ²Scottish association for Marine Science (SAMS), Scottish Marine Institute, Oban, Argyll PA37 1QA, UK

Bioremediation using macro-algae has the potential to concomitantly treat polluted waters for re-use and generate exploitable biomass. To test this potential, the influence of different nutrient regimes on growth, bioremediation capacity, and biochemical composition of two species of *Cladophora* was studied. Macro-algae were incubated in medium formulations containing four different nitrogen/phosphorus ratios (N/P) and four N sources, i.e. ammonium (NH₄⁺), nitrite (NO₂⁻), nitrate (NO₃⁻) and urea (CO(NH₂)₂). Additional experiments were performed with dual combinations of these N sources, provided at equimolar concentrations, at two N/P ratios.

When cultivated under a single N source, the daily growth rate (DGR) of *Cladophora parriaudii* (4.75 – 11.2%) was always greater than that of *Cladophora coelothrix* (3.98 – 7.37%), with significance when either NO₂⁻ ($p = 0.025$) or urea ($p = 0.002$) were employed. The amount of N-uptake reflected the corresponding growth, whereupon *C. parriaudii* consistently removed more N than *C. coelothrix*. Significant differences in growth ($p = 0.005$) and N-uptake ($p = 0.001$) were observed intra-specifically when *C. parriaudii* was cultivated in medium containing N source combinations. The results suggest that *C. parriaudii* exhibits a preference towards NH₄⁺ uptake, meanwhile urea is generally removed secondarily. However, incorporating urea into the medium had a threefold effect: it enhanced the uptake of other co-existing nitrogenous forms, increased the DGR and yielded biomass rich in carbohydrates. The protein and carbohydrate composition of *C. parriaudii* biomass ranged from 5-15% and 36-54%, respectively, with the variation dependent upon the N/P ratio of the cultivation medium.

This work indicates that algal strain selection is critical to treating wastewaters with specific nutrient profiles. Moreover, the biochemical composition of the biomass generated is dependent upon the algal species and the N regime. Therefore, on a broader biotechnological viewpoint, nutrient regimes could be tailored to reduce costs and produce biomass with specific commercial attributes.

(P-GP4) The paralytic shellfish toxin profiles and global distribution of the dinoflagellate *Alexandrium minutum* HalimAdam M. Lewis^{1,2}, Lewis Coates², Andrew Turner², Linda Percy¹, Jane Lewis¹¹Faculty of Science and Technology, University of Westminster, 115 New Cavendish Street, London, W1W 6UW, ²Food Safety, Cefas, The Nothe, Barrack Road, Weymouth, DT4 8UB

A comprehensive review was undertaken of the distribution of the toxic dinoflagellate *Alexandrium minutum* Halim. The primary threat to humans caused by *A. minutum* is because of the production of paralytic shellfish toxins (PSTs) which can accumulate in seafood vectors, which if consumed lead to the human condition known as paralytic shellfish poisoning. Within this work it became apparent that the known global spread of this important species has increased, either due to range ex-

pansion, as a consequence of improved or novel investigation, or as a combination of these factors.

Those populations of *A. minutum* capable of producing PSTs display a range of different toxin profiles with differing saxitoxin derivatives or differing proportions of common toxins being present. As yet no genetic basis for these differences in toxin productivity has been isolated although there are currently 4 recognised clades within the *A. minutum* species the two principle clades being the Pacific and the Global. A novel analysis of *A. minutum* toxin profiles was undertaken by applying K means clustering to PST profiles extracted from the literature. This analysis generated 5 distinctive clusters, each relating to a statistically separable toxin profile. Interestingly examples of each of the two major clades had representatives from different toxin profile clusters. This suggests further, currently undetermined genetic separation or relatedness between clades, as the differences in the ITS region of the ribosome upon which the clades are based, does not seem to be coupled to the specifics of the toxin profile. It also raises the possibility that there is an environmental driver for the differing toxin profiles, although profiles clustered geographically in some cases in others they were either cosmopolitan or spatially isolated. This new approach offers an additional tool with which to examine the relationships between populations and target further genetic research.

(P-GP5) Characterisation of *Corallina officinalis* (Corallinales, Rhodophyta) across its geographical distribution

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Coralline algae are critical components of marine ecosystems from tropical to polar regions. They are particularly dominant in shallow water ecosystems and are important ecosystem engineers. In this study, primary production and calcification responses were investigated in *Corallina officinalis*, one of the most common species of coralline alga in the North Atlantic, across its natural distribution. Three sites were selected: Iceland for northern populations, UK for central populations, Spain for southern populations. Physiological measurements of calcification (dark and light), photosynthesis and respiration were performed both *in situ* and in the laboratory using incubation chambers. In the laboratory, physiological measurements were carried out using different irradiance levels. Analyses were repeated in summer and winter in each location.

Incubations in natural environments showed the highest photosynthesis, calcification, respiration and dark calcification rates in Spanish populations in winter. In summer, photosynthesis rates were almost 300% and light calcification rates were 45% higher in UK populations compared to Icelandic populations, with data from Spanish populations still to be acquired. Respiration rates were 4.5 times lower and dark calcification rates were more than 3 times lower in UK populations compared to Icelandic populations.

In the laboratory, experiments under different irradiance levels showed that both photosynthesis and calcification rates in *C. officinalis* are strongly related to irradiance. Under saturated light

conditions the Spanish populations showed the highest oxygen production (249.66 ± 8.77 and 246.57 ± 32.52 mg(O₂)/g FW/h) in winter. Under the same conditions UK populations showed the highest oxygen production in summer (287.81 ± 27.98 and 336.33 ± 27.41 mg(O₂)/g FW/h), with data from Spanish populations still missing.

The data obtained in this study can be used as baseline data for studies of climate change induced effects on this species, which are vital to predict how this important species may be affected by climate change.

(P-GP6) Patterns in growth thermotolerance of non-toxic and toxic marine phytoplankton

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Harmful algal blooms (HABs) and their negative impacts pose a significant challenge to public health and economy. They appear to expand globally, and may be intensified in the future, where their duration, frequency, intensity and toxicity may increase in response to warming and acidification due to climate change. Understanding the growth thermotolerance in non-toxic and toxic microalgae is crucial in predicting the biogeography of harmful bloom-forming species in the context of ocean warming. This present work evaluates the variations in their thermal growth responses and examines the implication of these differences to their biogeography in future climate scenario. Using non-toxic *Prorocentrum micans* and toxic *Prorocentrum lima* as model organisms, growth was estimated along a gradient of temperature (7.1 – 31.4°C) using high-throughput microtiter based culturing and phenotyping approaches. The experimental data was supplemented with published datasets on marine phytoplankton growth rates a thermal gradient. Temperature sensitivity of phytoplankton growth rates could be well described by a Gaussian model. Experimental results showed that the toxic strain have lower max growth rate but have wider thermal niche that may suggest that toxic strain is more thermal generalist. Findings in the analysis of pooled datasets revealed differences in the thermal growth parameters, which may suggest the potential influence of toxicity-related traits to the thermal response that may provide a selective advantage to toxigenic species under future climate scenarios. Furthermore, results showed that the biogeographical distribution of toxic phytoplankton shifts in the warming ocean due to alteration in their thermal tolerance.

(P-GP7) Alien invasion: a looming threat to microalgal culture

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Loss due to invading organisms presents a crucial bottleneck to microalgal culture. Invasive organism includes other microalgal species, which cause loss through competition for resources, and protozoan grazers such as amoebae, ciliates, and flagellates, which cause loss through consumption.

Resource competition and consumption through predation has been extensively studied in the context of marine microbial ecology, but a significant disparity exists between this knowledge and the algal biotechnology sector. This disparity means that many established quantitative methodologies are not utilized in the context of invasive organisms. Additionally, current methodologies used to quantify competitive interactions are limited to monoxenic systems which is problematic as invasion by invasive organisms often includes a multitude of species. Finally, although the scope of invasive organisms is believed to be highly diverse, insufficient focus has been placed on identifying the organisms involved and establishing model species.

This project aims to resolve these issues through the establishment of a model invasive ciliate, which managed to invade an open *Nannochloropsis* system causing its collapse. Initially the focus of the project is to identify the ciliate and quantify factors such as ingestion rates, growth rates, and functional and numerical response utilizing conventional ecological methods thereby bridging the gap between marine microbial ecology and blue biotechnology. Additionally, the project will establish a novel way of quantifying protozoan grazing through the use of time-lapse and image recognition utilizing cell enumeration and tracking pipelines. Although the project will focus on a monoxenic system consisting of the ciliate and *Nannochloropsis*, in the first instance, the follow up stage will employ a dixenic system that includes an unidentified flagellate also isolated from the *Nannochloropsis* pond. Since the flagellate and *Nannochloropsis* are a similar size, fluorescent dyes applied to live cells will be utilized to distinguish between the two species.

(P-GP8) Diatom Collections at the Natural History Museum: Using digitisation to maximise research potential

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The Diatom Collection at the Natural History Museum (BM) contains a wealth of material assembled over 200 years with new specimens continually being added. The collection has a global coverage and represents freshwater, marine and brackish of extant and fossil diatom material. Although the bulk of the collection is comprised of glass microscope slide preparations there are also extensive correlated raw and cleaned samples in bottles and dried on glass, mica and paper as well as diatomite.

Accessing a particular specimen in the main glass slide collection of over 100,000 objects is possible through a card index of species names, each with a roll call of slide numbers for the relevant taxon. This card index comprises c.12,000 taxon cards and contains more than 270,000 species references. This system is sufficient to find an example of a particular species in the collection but for modern research the data on these cards require electronic capture in order to maximise their potential. A good percentage of the specimens in the collection has never been examined since its arrival and represents a vast untapped resource for research into comparative biology, environmental change and, in some cases, ecological time series studies.

We have now started a project to digitise this card index which will provide a framework for further digitisation work and a new way to query our collection. Progress so far from the first c.1200 cards which have been transcribed have revealed a 10% increase in the number of nomenclatural type specimens record-

ed in the collection as well as highlighted several undescribed species and potential research projects. The transcription work will ultimately produce a verified list of names associated with our collections and create a digital framework of records in the Museum's collections management system which will also be made available online.

(P-GP9) CCAP: A NERC National Capability Service and Facility providing algal, cyanobacterial and protozoan strains, and so much more!

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The Culture Collection of Algae and Protozoa (CCAP) facility is well furnished with a unique capability to supply cultures across a wide biodiversity; growth media and other services, such as large volume cultures; molecular, and taxonomy services. Hosted in the Scottish Association for Marine Science (SAMS), the Collection provides a vital platform promoting world leading environmental science and supporting national strategic needs. Training for post-graduate students and scientific staff is provided through hands-on short courses, cultures and advice and day-to-day support.

CCAP is reshaping itself to grow its value and relevance for today and tomorrow's user base, driven by the continuing boom of analytical tools and sequencing technologies. These cutting-edge techniques empower novel environmental and biotechnological research relevant to our user community: they have led to the discovery of unsuspectedly high biodiversity among algae and protists¹, creating a commensurate need for a complete rehaul of algal and protistan taxonomy. We are thus developing unique science and economic resources focused around incorporation of new protistan diversity, especially algal pathogens; biobanking of unique and economically important seaweed cultivars; expanding integration of genomic resources; and embracing the importance of the microbiome in shaping algal physiology, influencing biogeochemical processes, and synthesis of valuable compounds.

(P-GP10) Molecular phylogeny and genetic variability among endosymbiotic green algae of various ciliates revealed by multiple gene analyses and AFLP technique

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Endosymbiotic green algae are widely distributed in ciliates such as *Paramecium bursaria*, *Stentor polymorphus*, *Climacostomum virens*, *Coleps hirtus*, or *Euplotes daidaleos*, and have traditionally been identified as named or unnamed species of *Chlorella* or *Zoochlorella* or referred to as *Chlorella*-like algae or zoochlorellae. We studied several endosymbionts isolated from various hosts and geographical localities using an integrative approach (nuclear encoded small subunit and internal transcribed spacer regions of rRNA gene sequences including their secondary structures, morphology, physiology and virus

sensitivity). Three *Chlorella*-like endosymbionts could be identified in various ciliates: *Chlorella variabilis*, *C. vulgaris*, and *Micractinium conductrix*. The subdivision into species was highly supported by different phylogenetic methods and characteristic compensatory base changes in the secondary structures among the ITS-2 sequences. To detect the genetic variability below the species level, we analyzed the AFLP patterns (Amplified Fragment Length Polymorphism) using two pairs of restriction enzymes (EcoRI+MseI and EcoRI+PstI) and compared them with those of the free-living relatives. Strains with identical ITS sequences showed differences in AFLP pattern, which correlated with their geographical origin.

(P-GP11) Kelp! I need somebody! *Laminaria hyperborea* forests host diverse faunal assemblages at multiple scales

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This project aims to fill in knowledge gaps concerning biodiversity supported by subtidal kelps in the Northeast Atlantic. In contrast to other recent activities in Europe, in Ireland little is known about kelp habitats outside of BIOMAR surveys from the late 1990s. Irish subtidal kelp forests are generally dominated by *Laminaria hyperborea*, but punctuated with four common species: *L. digitata*, *Sacchorhiza polyschides*, *Saccharina latissima*, and *Alaria esculenta*. In this study we characterise seasonal patterns of 1) floral and faunal diversity, 2) *L. hyperborea* stipe and holdfast diversity and 3) fish and invertebrate recruitment to kelp forests at four permanent monitoring sites in western Ireland. Season and phenology of kelps have an effect on presence/absence of some species, especially fish and canopy forming kelps. Results have also revealed strong seasonal patterns of recruitment to these habitats, largely concerning commercial species. The stipes and holdfasts of *L. hyperborea* are also directly of high ecological importance, supporting epiphytic diversity and abundance of species, which increases with age. The results presented here are part of a wider project investigating also kelp productivity and population structure which will provide a baseline for this region and support further kelp forest research in Ireland.

Applied freshwater research session posters

(P-FW1) Understanding how artificial mixing via bubble plumes influences nutrient and phytoplankton dynamics within a drinking water reservoir.

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Nuisance algal blooms are becoming increasingly common in drinking water reservoirs. Such blooms cause increased utility expenditure in the treatment process and can be linked with customer complaints for taste and odour.

Thermal stratification provides a stable water column which benefits certain species of nuisance cyanobacteria that have physiological features that enable them to maintain their position in the water column. Artificial destratification seeks to

break down and/or prevent the formation of thermal density layers within the water column. As a result, the more turbulent environment is suggested to drive more competition between phytoplankton species.

Blagdon Reservoir, Somerset, is artificially destratified by 7 bubble plumes that operate over the thermal stratification season. Since the installation of the plumes, the frequency and magnitude of high total cell counts has increased, suggesting that bubble plume operation is in fact increasing phytoplankton productivity.

Here, results from a fieldwork campaign at Blagdon Reservoir (Bristol Water) are reviewed to assess the seasonal and spatial variation in nutrient and phytoplankton dynamics within an artificially destratified reservoir. Initial results suggest that thermal stratification persists during warm and dry periods, which alters the spatial distribution of nutrients throughout the reservoir.

(P-FW2) Are the effects of climate change already affecting our reservoirs?

Helen Cantwell¹, Rupert Perkins¹, Thomaz Andrade¹

¹Dwr Cymru Welsh Water

Climate change is predicted to both directly and indirectly modify nutrient dynamics within surface water bodies across the UK. Such modification to the supply and interaction of essential nutrients may deleteriously affect the quality of the water, challenging existing water treatment methods, materials and viability.

Dŵr Cymru Welsh Water (DCWW) historical data for Llandegfedd, spanning 35 years of environmental and water chemistry parameters has been analysed to identify water supply risk. Specifically, changes in abstraction, reducing reservoir volume in summer, at the time of elevated water temperatures have been investigated to determine potential water supply risk resulting from identified patterns in nutrient dynamics and reservoir hydrology. Findings are presented which identify areas for further investigation regarding nitrogen and phosphorus dynamics and impacts on phytoplankton community, including an increasing dominance by cyanobacteria. These findings are presented in the context of potential water supply risks including cyanobacteria toxin production and problem taste and odour metabolites.

(P-FW3) Assessing the impact of aquaculture in the Philippines using palaeolimnology

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In the Philippines, aquaculture in freshwater lakes contributes significantly to its economy, food security and employment. However, intensive aquaculture often leads to degradation in the lake ecosystem integrity because of nutrient fertilisation resulting in harmful algal blooms (HABs), introduction of toxins and invasive species and increased organic inputs causing anoxic waters. This is threatening the ability of freshwater lakes

to continue to provide the vital ecosystem goods and services on which the population relies. The problem can be seen as a need to maintain a delicate balance between a requirement for increased production to aid the country's food security and economic development against the need to conserve and protect fishery resources, in this case freshwater lakes, for long term sustainability. The aim of this research is to quantitatively assess the ecological response of the Seven Lakes of San Pablo, on the island of Luzon, in the Philippines, to aquaculture practices. This will be achieved by the use of a multi-proxy palaeolimnological approach. Sediment cores collected from multiple lakes will be investigated for biological proxies such as chlorophyll and carotenoid pigments to provide evidence on the frequency and/or abundance of HABs and geochemical proxies, specifically, bulk organic stable isotopes ($\delta^{15}\text{N}$, $\delta^{13}\text{C}$) and C/N ratios to link changes in organic matter recycling to the archival record. This will be combined with archival research and Landsat data to accurately correlate changes in the intensity/timing of aquaculture at each lake with proxy changes observed down the core.

Mapping, conserving and sustainably exploiting seaweed genetic resources in blue biotechnology session posters

(P-SW1) Hidden diversity in the oomycete genus *Olpidiopsis* is a worldwide threat to red algal cultivation and conservation

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Emerging diseases are hindering macroalgal cultivation, the fastest-growing of all aquaculture sectors, with an annual growth rate nearing 10 % and a value in excess of \$5bn. The oomycete genus *Olpidiopsis* notably encompasses pathogens of red seaweeds, including the most economically damaging disease of laver farms in Asia. Using microscopy and molecular analysis, we identified in Scotland two novel *Olpidiopsis* pathogens of *Palmaria palmata* and *Porphyra* sp. and describe them as *Olpidiopsis palmariae* and *O. muelleri* spp. nov., respectively. We also report a new variety of *Olpidiopsis porphyrae*, a devas-

tating pathogen previously thought to be restricted to Japanese and Korean farms. To evaluate the extent of *Olpidiopsis* diversity and its biogeography, we created MOULINETTE, a pipeline coupling blastn of metabarcoding datasets, *de novo* OTU discovery and GPS coordinate retrieval, and used it to screen all marine barcoding datasets available on the SRA database. This screen, coupled with precomputed OTUs from large scale metabarcoding campaigns (Tara and Australian Marine Dataset), unveiled 29 OTUs that represent unknown *Olpidiopsis* taxa, with a worldwide distribution. In summary, we demonstrate the worldwide occurrence, and hitherto unsuspected diversity, of a destructive genus of marine oomycetes that is the main cause of economic loss in the Asian seaweed industry. We conclude that the unprecedented growth of algal cultivation, conjugated to the lack of appropriate biosecurity regulation pertaining to international seed trade, lays the ground for potentially grave ecological and economic crises, similar to the ones that have been unfolding in animal aquaculture.

(P-SW2) Building foundations to monitor and conserve Falkland Islands marine forest habitats

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In the Falkland Islands, a Subantarctic archipelago in the South Atlantic comprising 778 separate islands, seaweeds are a vital natural resource. These 'marine forests' contribute substantially to primary productivity and harbour unique biodiversity, in addition to providing spawning habitat for commercially important squid populations. In the face of emerging threats from oil exploration, fishing activities, invasive species and climate change, there is a need for improved baseline knowledge of seaweed communities to facilitate effective monitoring and management of the Falklands marine environment. This project aims to fill gaps in our knowledge of the diversity and distribution of seaweeds in the Falklands by (1) examining species occurrences in historic and contemporary herbarium collections, (2) conducting additional field surveys and specimen collections throughout the Falklands, and (3) using molecular techniques to identify endemic and non-native species. Historical and contemporary species occurrence data, which will be made available through data repositories, will be used to map spatial and temporal variation in species diversity. Species identification training will also be provided to local managers to build capacity for future ecological monitoring. Further, outreach initiatives will raise public awareness of the socio-ecological importance of seaweeds and enable community members to participate in ongoing surveys.

(P-SW3) Biogenic trace gas production by seaweeds: exploring the impacts of worldwide aquaculture expansion

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Previous research has established that micro- and macroalgae can produce a range of trace gases that are important for various global biogeochemical cycles, chemical reactions in the atmosphere and climate. Amongst these, the halogenated 'very short-lived' substances (VSLs) impact on the oxidising capability of the atmosphere, increasing the lifetime of greenhouse gases such as methane.

Dimethyl sulphide (DMS) and isoprene form aerosols in the atmosphere that can also act as cloud condensation nuclei. Aerosols and clouds scatter light back into space and ultimately have a cooling effect on climate. Furthermore, recent modelling work suggests that tropospheric halogens reduce ozone-related radiative forcing by about 15%. This poster outlines the ideas and plans for my PhD research and some early data. The overall aim is to increase understanding of macroalgal production of volatile organic compounds and their ocean to atmosphere fluxes. The important contexts for the project are climate change and global aquaculture expansion. The production of DMS, isoprene and halogenated gases is being measured via gas chromatography (FPD or MS detection). Currently methods are being tested by working with *Porphyra*, *Ulva* and *Fucus* species collected from the Norfolk coast. Various modifications (i.e. incubation time, timing of sodium hydroxide addition for DMSP analysis and incubation media) of the usual methodology for detecting DMS have been trialed. Beyond this, the effect of current and future oceanic conditions, e.g. light, temperature, nutrients and CO₂ on the production of a broad range of trace gases could be tested. We also want to investigate whether the non-volatile organic compounds derived from seaweeds and sea surface microlayer bacteria influence trace gases emissions. Later we hope to also look at how trace gas production differs between monoculture and polyculture scenarios, and whether the bacteria living on seaweed surfaces affect gas production and flux.

(P-SW4) Dietary fucoidan supplementation in black tiger shrimp (*Penaeus monodon*) enhances immune response and resistance against white spot syndrome virus (WSSV) and acute hepatopancreatic necrosis disease- causing *Vibrio parahaemolyticus* (VP AHPND)

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A 30-day feeding experiment was conducted to determine the immune enhancing capability of fucoidan extracted from *Undaria* sp.-supplemented diet (control, 1.0, 2.5 and 5 g kg⁻¹) in black tiger shrimp (*Penaeus monodon*). Different immunological indicators were analyzed including total hemocyte count (THC), differential hemocyte count (DHC), phenoloxidase (PO) activity, plasma total protein (PTP) and plasma agglutination titer (PAT). Also, growth and survival were measured after 30 days. Challenge experiments were then followed to determine the resistance of shrimp fed with fucoidan-supplemented diets against the two of the most economically important shrimp

diseases which include white spot syndrome virus (WSSV) and acute hepatopancreatic necrosis disease-causing *Vibrio parahaemolyticus* (VP_{AHPND}). Results showed that fucoidan-supplemented diets improve the shrimp's immune responses as the concentration of fucoidan increases. In addition, the result of the challenge experiments against WSSV and VP_{AHPND} corroborate with the immune assays results. At 5 g kg⁻¹ fucoidan supplementation, the highest survival rates ($p > 0.05$) in both WSSV and VP_{AHPND} were observed when compared to the lower fucoidan supplementations (1 and 2.5 g kg⁻¹) and the control group. However, no significant differences in terms of weight gain and survival were observed among all treatment diets. Supplementation of fucoidan in the diet activates the shrimp's immune response thereby improving its resistance against pathogens.

(P-SW5) Mapping the correlates of project participation: The case of sea cucumber (*Holothuria scabra*) ranching in Pandaraonan, Guimaras, Philippines)

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This study highlights the gender dimension of the sandfish (*Holothuria scabra*) sea ranching project in the district of Nueva Valencia in the province of Guimaras, Philippines started by the SEAFDEC/Aquaculture Department with support from the Australian Center for International Agricultural Research (ACIAR). The project intends to address the depleting population of *H. scabra* to enhance and sustain the local sandfish population and to provide livelihood support for the communities. The analysis focused on men and women's involvement in fishing, their perceptions on the socio-political conditions in their community, and the factors correlated to their willingness to participate in the project.

Focus group discussions (FGD), mapping workshops and a survey of sixty (60) households were conducted on February to April 2016. The data obtained were gender segregated to identify and understand the gender differences in the utilization and perceptions of the respondents on *H. scabra* collection. Results showed that there were gender differences in men and women's fishing trip duration ($p < 0.05$) as women's activities were tide dependent and were limited in the intertidal zone. Commercially valuable species were mostly targeted (e.g. *Siganus* spp.) but women's catch included more molluscs (e.g. *Strombus* spp.) compared to men's ($p < 0.05$). Correlation analysis of selected variables (e.g. socio-demographic variables, fishing involvement, project awareness and assessment of governance practices/mechanisms) with willingness to participate in the sea ranching project showed that project awareness ($p < 0.00$), perceived project benefits ($p < 0.00$) and governance practices/mechanisms ($p < 0.04$) were correlated with project participation. These results support the premise of the study that women were highly involved in fishing despite the lack of institutional recognition. Meeting community expectations and enhancing local capacities were important drivers of "increased project involvement" and these should be integrated in interventions aimed at enhancing community engagement in projects.

(Abstracts to be continued p. 35)

Anna's dress

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As a family we have a little boat. One of our favourite haunts in this boat is The Naze nature reserve in Walton on the Naze, Essex. Full of watery wildlife, it's a quiet place sightings of seals and tern are not unusual. Going for a coffee after a particularly cold morning on the boat, I notice in the sailing club a drawing of a small clinker boat. Next to it, framed neatly, its' technical counterpart, a blueprint copy of the very same drawing.

This blueprint was produced in exactly the same way as the prints in Anna Atkins' book, *British Algae, Cyanotype Impressions* of 1843. The technique of the blueprint has not changed since Anna Atkins' work.

Combining potassium ferricyanide and ammonium ferric-citrate in equal measures forms a light sensitive liquid. This liquid exposed to sunlight forms a permanent Prussian Blue pigment. In 1842, John Herschel invented this method during his numerous experimentations in photography and chemistry.

John Herschel was a friend of Anna Atkins and her father. Anna's father, John Children was a respected scientist and secretary of the Royal Society. Anna's mother had died as a result of giving birth, so Anna was brought up by her father. As an only child she was exposed to influences otherwise unavailable to a woman. She illustrated her father's translation of Lamarck's *Genera of Shells* (1823) at an early age and John Herschel introduced her to the Cyanotype.

At a time where the whole of society was struggling to adapt to new ways of seeing and thinking, Anna, as an experienced botanical illustrator, embraced the cyanotype. Using it to



Plate from *British Algae, Cyanotype Impressions* 1843

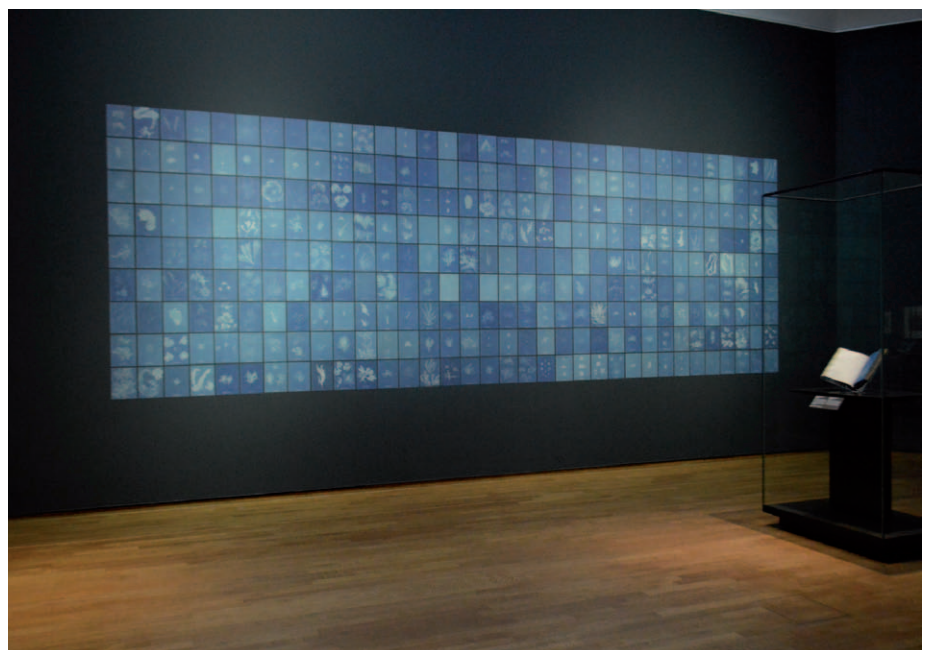
print the first book with photographic plates in 1843. Printing her collection of Algae. She was a photographic pioneer.

Mike Ware cites Atkins in his paper *Cyanomicon*: "The difficulty of making accurate drawings of objects as minute as many of the algae and confervae, has induced me to avail

myself of Sir John Herschel's beautiful process of Cyanotype, to obtain impressions of the plants themselves, which I have much pleasure in offering to my botanical friends." (1)

In 1843 Anna started producing her hand printed publication, *British Algae: Cyanotype Impressions*, which was intended as a guide to the treatise on seaweeds by Hervey. Hervey's book had no illustrations. She printed 12 books between 1843 and 1853, every book containing around 307 images of algae. A demonstration of determination and persistence. The process of collecting and drying seaweeds, preparing the paper, mixing chemistry and waiting for the sun to come out is time consuming.

Her books are now, more than ever, recognised as documents of importance for the development of the art of photography as well as within natural history. No doubt her work was partly forgotten because she was a woman. But it would not be fair to say that was the only reason. Fashion and taste played a role as well. The cyanotype was considered simple, childlike and the intense blue colour too overwhelming for good taste.



Rijksmuseum Amsterdam 'New realities' Anna Atkins book, *British Algae* on display and a mural of 306 algae prints from her book.



Fair Park Lagoon 1981 -1986



8 metre long boardwalk next to the pond, printed with Phragmites



Tiled tableau with printed plant material. The Othona Coastal Park Essex 2016

How taste can change. In May 2017 The Rijksmuseum in Amsterdam bought one of Anna Atkins' books for a record price of £145,000. That same year her book was given a prominent position in the Exhibition, *New Realities*. In it she was recognised as an early pioneer of photography. 'The images are surprisingly modern looking', writes Johanna Moorhead, reviewing the exhibition in the *Guardian* (2)

The cyanotype is not used to document plant species anymore. As far as I know only Anna Atkins did this. It is also not used as a method of copying technical drawings or plans of boats and buildings anymore. That faded out in the late sixties. Xerox and digital took over.



Anna Atkins 1861 and Anna's dress 2017

Exhibition at the Tower, Walton on the Naze, October 2017

De-commercialised historic processes are often used by contemporary artists. It is however not just the process or the history of the cyanotype that fascinated me. There is a relevance for our contemporary world in Atkins' work worth re-examining.

I saw an approach to documenting the visual world involving a new technology, aesthetic depiction, curiosity and wonder. Structured by diligent documentation. The combination of those disciplines and the complexity of human observation, both poetic and rational, seem to come together in her work.

This approach is very familiar to me. I explore in my work a cross-disciplinary approach between art and environmental science. Trying to use a more holistic approach to the concerns of the Anthropocene. I agree with Phillip Hoare when he writes that a separation of art and science has, 'led us to a point at which experts can be demonised and culture itself discredited as elitist. (3) Within that context Anna as a woman, artist and botanist lives in the back of my head as a source of inspiration. She travels with me.

During my MA study in Essex, I came across work by the artist Patricia Johansson. Johansson was asked to illustrate the botany as it used to be, of a lagoon in Dallas. The lagoon being putrefied was seen as an obstruction and a danger in the city. It stank, a child had drowned. Nature had become a nuisance.

Johansson questioned the illustrating as a sole discipline, she suggested a reintroducing of the past. A regeneration project for the lagoon. Johansson's illustrations of the botanical history of the lagoon were exhibited in the Natural History Museum of Dallas as part of a fundraising effort. With success. A cross-disciplinary team of designers, scientists' artists and engineers was set to work. The result, a park with reintroduced flora and fauna of local species. Walk ways to observe the lagoon. Instead of a smelly lagoon a waterpark. This combination of disciplines is very effective and satisfying.

In 2016 I gained a commission at The Othona Community, a residential community in Bradwell on Sea, redesigning an overgrown pond and pigsty into an educational environmental pond and classroom. This being the ideal opportunity to combine environmental issues and art. Inspired by both Johanson and Atkins I set to work.

After my MA I decided to follow in Anna Atkins footsteps at Walton on the Naze. For a year I collected Seaweeds and printing them. It is time consuming work. Anna Atkins determination and persistence struck me once more. Peering in rock pools and roaming marshes in Victorian attire can't have been easy. I wanted to make her something. Comparing outfits of modern day female field researchers and Victorian ones gave me the idea for Anna's dress.

Family friends have a lot to answer for, or perhaps its human contacts that ultimately changes our world. Graham Underwood and Michael Steinker came as a family friends to this exhibition and I was invited as an Artist to the British Phycological Society 2018 Conference in Southend. I would like to thank them for this opportunity. I would also like to thank Jan Krokowski for asking me to write this article. I really enjoyed my involvement and had an interesting time talking to all. Sitting next to all the scientific posters with those fascinating drawings, graphs and microscopic images I feel it might be time to knock on a laboratory door.

Angenita Hardy-Teekens

1. Anna Atkins, *Photographs of British Algae, Cyanotype Impressions*, Halstead Place, Sevenoaks 1843-53 in Ware, M. 2014
2. Blooming Marvellous, the world's first female photographer and her botanical beauties by Joanna Moorhead, *The Guardian*, 23rd June 201
3. *A sense of wonder*, essay by Phillip Hoare, /www.little-toller.co.uk/the-clearing a journal of nature, landscape and place, February 5th, 2018



Microphytobenthic biofilms session posters

(P-BS1) How can oyster farming affect the microphytobenthic biofilm growth? comparison between and beneath tables

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On the French coastline, *Magallana gigas* is grown into brackish water on culture tables above the sediment. Oyster farming is known to create environmental variations that potentially alter the microphytobenthos (MPB) growth at ecosystem scale. Furthermore, since 2008 an Ostreid Herpes Virus (OsHV-1) caused massive mortalities on oyster spats when the water-temperature exceeds 15,5°C in summer leading to an organic matter and OsHV-1 flux toward the sediment. Because of the table-light-intensity-attenuation and the protective properties of the biofilm, oyster tables represent the perfect shelter for OsHV-1 persistence. During a 41 days period covering spring and neap tide cycle we analysed the sediment and the migrant MPB Chl *a* between and beneath an oyster table at two sampling times (3 hours before low tide and low tide) in the Baie des Veys which is the most productive area of France. We performed Pulse Amplitude Modulated measurements to study the MPB components. Thus we highlighted that epipelagic MPB between tables showed lower mean chl *a* quantity ($46,89 \pm 14,15 \text{ mg/m}^2$) than beneath the table ($66,58 \pm 14,94 \text{ mg/m}^2$) where a maximum of Chl *a* was found ($227,47 \pm 44,34 \text{ mg/m}^2$). The averaged chl *a* concentrations was 1,42 times higher under the table. The averaged MPB Photosynthetic yield (α_{ETR}) was higher beneath the table ($0,436 \pm 0,035$) than between the tables ($0,366 \pm 0,031$). Furthermore, over the sampling period the α_{ETR} showed that between the two sampling times the under-table α_{ETR} was constant while it was decreasing between the tables showing inhibiting conditions. These results show that the oyster table habitat is more benefic for the biofilm development rather than between the tables, in spite of the reduction of light exposure. The variation along 2 spring/neap cycles showed that photosynthetic rates were always high beneath table while they are more variable between tables

(P-BS2) Benthic microalgae in salt marsh restoration

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Microbial colonization and sediment consolidation, which are precursors to saltmarsh development, were investigated in intertidal coastal habitats in the Colne-Blackwater Estuary, Essex, as part of a project with ExoEnvironmental Ltd and Brightlingsea Harbour Commissioners, to re-establish eroded sites that were previously salt marsh in the 1940s, by adding locally dredged sediment into brushwood-enclosed compartments. One compartment was surveyed in Summer 2017 and compared to adjacent mudflats, and to mature salt marshes in the estuary.

Initial surveys of microphytobenthos found a greater diversity and higher biomass (Chl *a*) of larger diatom taxa in the compartments compared to mudflats, and a high cover of visible

biofilms (including filamentous cyanobacteria). This may relate to the lower grazing pressure by the infauna in the compartments. Overall invertebrate densities (mainly *Hediste* and *Dolichopodidae*) were lower on the compartments compared to mudflats, which supported the highest densities of *Hydrobia* (up to $> 60,000 \text{ m}^{-2}$). Sediments in the compartments had higher ash free dry weight values, and lower water content than the adjacent mudflats, though not comparable to sediment in established mature salt marsh sites at Langenhoe, Mersea and Tollesbury. Ecologically the compartments appear to be on a trajectory between mudflat and mature saltmarsh, but the sediments need to significantly dewater and increase sediment shear strength to allow salt marsh plant colonisation.

(P-BS3) The use of the BenthosTorch[®] as a rapid assessment of the ecological status of rivers in Scotland (UK)

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Benthic biofilms are composed of photoautotrophic algae and heterotrophic fungi, bacteria and protozoa contained in an extracellular polymeric matrix. The photoautotrophic community within biofilms has been shown to respond not only to water quality but also to fluctuations in discharge, irradiance and grazing conditions. Benthic algae (or phytobenthos) are considered in the Water Framework Directive (WFD) through the study of the benthic diatom community, which typically involves high degree of taxonomical skills and prolonged laboratory procedures. Although the focus of the WFD has been the analysis of community composition, quantitative estimates of benthic algal biomass can also be very valuable not only supporting traditional community composition assessments, but also providing a rapid assessment of the ecology of rivers and streams.

This preliminary study aims to assess the viability in using the BenthosTorch[®] probe as a rapid assessment technique to estimate algal biomass in freshwater rivers and streams. BenthosTorch is a hand-held portable probe that provides *in situ* estimation of chlorophyll-*a* (chl-*a*) concentrations in benthic biofilms, which is a proxy of algal biomass. The measurement is based on the emission and detection of fluorescence emitted from the pigments (chl-*a*) in algal cells. The intensity of the fluorescence is also used to estimate the separate chl-*a* of green algae, blue-green algae and diatoms. This preliminary study illustrates the spatial and temporal variability of algal biomass in 26 rivers across Scotland (UK). In addition, algal biomass was correlated to chemistry and the Trophic Diatom Index (TDI) to investigate if changes in nutrient concentrations or water quality can be detected using the BenthosTorch.

(P-BS4) Self-shading in cultured microphytobenthos. Tracking production rates, compensation depth and concentration of pigments

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Self-shading is a common phenomena widely described for all of primary producers (e.g. phytoplankton communities), but not addressed in detail for microphytobenthos (MPB). In order to explore the structural changes associated with this process, we developed a microcosm controlled experiment to monitor growth and net production rates (Net Prod, O₂ microsensors), as well as the compensation depth (z_{comp}) and pigment concentrations (chlorophyll a, phaeopigments and the D_{430}/D_{665} index) of an intertidal MPB during 12 days. We assessed the effect of nitrate concentrations (0, 25 and 100 μM) under a low light environment (200-300 $\mu\text{mol m}^{-2} \text{s}^{-1}$). Furthermore, the thickness of the photic layer (z_{phot}) was calculated by the attenuation coefficient of sediment particles ($k_1 \approx 4.5 \text{ mm}^{-1}$) and assuming a standard attenuation coefficient for chlorophyll a ($k_2 \approx 0.02 \text{ m}^2 \text{ mg chl a}^{-1}$). As expected, there was not significant differences in growth rates between nitrate treatments, thus supporting that light was the main limiting resource. During the culture development, production rates (1.5-6 $\text{mmol O}_2 \text{ m}^{-2} \text{ h}^{-1}$) increased from net heterotrophic (0-2 days) to a maximum value in the 6th day, but were decaying thereafter. Light availability was traced by the evolution of z_{comp} (0-0.8 mm), which exhibited an initial increase similar than Net Prod, but a late asymptote parallels to z_{phot} . By assuming that biomass in the photic layer are saturated after 6th day, we worked out analytical expressions to predict both Z_{comp} ($R^2=0.70$, $p<0.001$) and Net Prod ($R^2=0.88$, $p<0.001$) as a function of k_1 and chlorophyll a concentration. Whereas phaeopigment concentration remained constant during the experiment, the D_{430}/D_{665} index decreased from 7.5 (day 0) to 2.0 (days >2), thus suggesting an initial simplification of the community. The complex relationship between chlorophyll a concentration and productivity contributes to explain the lack of linear correlation frequently observed in field studies.

(P-BS5) Biofilms, a lifestyle that defies changes?

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Epilithic photoautotrophic biofilms play an important role in the primary production of the littoral zone of Lake Constance, Germany. These biofilms are composed of communities of algae, fungi and bacteria, that presumably are interacting in these habitats. Recent work has shown that bacteria can induce the biofilm formation of the pennate diatom *Achnanidium minutissimum*. This diatom is producing capsules of extracellular polymeric substances (EPS, consisting mostly of carbohydrates) only in the presence of bacteria, thus under xenic conditions. In complete absence of bacteria (axenic conditions), the diatom cannot form capsules and grows in a suspended mode, not sticking to surfaces. An isolated diatom satellite bacterium, *Bacteroidetes* S32, is known to induce these capsules and thus the biofilm formation by producing unknown soluble, but rather hydrophobic molecules. This interkingdom interaction raises questions about the impact of environmental changes on biofilm formation, and, how such specific communication may affect the resilience of such biofilms to changes of the external conditions. An sterile incubator system for biofilms have been designed for studying the generation of such mixed-species photoautotrophic biofilms. Growth experiments of axenic diatoms, xenic biofilm diatoms and axenic diatoms co-cultivated with *Bacteroidetes* S32, will be monitored using these incubators with different nutrients concentrations, light intensities, and

temperatures to simulate environmental changes occurring in the shallow, littoral zone of aquatic habitats.

(P-BS6) Radiative energy budget in a microbial mat under different irradiances and tidal conditions.

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Irradiance and temperature changes during tidal cycles affect microphytobenthic primary production potentially changing the radiative energy balance in the photosynthetic biofilm between immersion and emersion. To test this hypothesis, we estimated for the first time the radiative energy budget in a photosynthetic microbial mat during immersion and emersion under increasing irradiance (100, 400 and 800 $\mu\text{mol photon m}^{-2} \text{s}^{-1}$) using combined microsensor measurements of O₂, temperature and scalar irradiance. The total light energy flux absorbed by the photosynthetic mat (J_{ABS}) can be either dissipated as heat (J_{H}) or conserved by photosynthesis (J_{PS}). J_{ABS} was higher in immersion than emersion, due to a lower reflectance, however, less than 1 % of the energy absorbed was conserved by photosynthesis under both tidal conditions, while the rest was dissipated as heat ($J_{\text{H}} > 90 \%$). The efficiency of photosynthesis (ϵ_{PS}) and heat dissipation (ϵ_{H}) were 0.026 and 0.974, respectively, for both tidal conditions. During immersion, the upward heat flux was higher than the downward one ($J_{\text{Hup}} > J_{\text{Hdown}}$), whereas during emersion the opposite occurred ($J_{\text{Hup}} < J_{\text{Hdown}}$). At the highest irradiance (800 $\mu\text{mol photon m}^{-2} \text{s}^{-1}$), sediment temperature increased approximately 2.5°C after 2 hours of emersion, without any apparent effect on photosynthetic efficiency. Interestingly, the increase in the incident irradiance and temperature during emersion did not result in an increase of the energy conserved by photosynthesis. Under these conditions most of the absorbed energy was channelled into heat production possibly to avoid photoinhibition or photochemical damage. This means that the absorbed energy photochemically conserved for photosynthesis is similar in immersion and emersion.

(P-BS7) Spatio-temporal trophic significance of the microphytobenthos in intertidal tropical mudflats of French Guiana

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The coastal line of French Guiana is influenced by fluid mud coming from Amazon River. Sediment is transported in west-northwest direction and forms huge mud banks along the coastline from Amazon River mouth to Orinoco River. With alternative phases of accretion and erosion induced by the combination of currents, waves and winds, the coastline is characterized by unstable and continuously changing conditions. Despite mud banks instability, French Guiana mudflats support a vigorous development of microphytobenthos biofilm (MPB) in surficial sediment with a very high-biomass and a low-diversity. MPB supports various communities: an exceptionally high abundance of meiofauna, a remarkably low diversity but relatively high abundance of deposit feeding benthic macrofauna, and a very high abundance and diversity of many species of patrimonial migrating shorebirds, local waterbirds and fish. This study aimed to better understand the functioning of those tropical mudflats in French Guiana by 1) describing, with isotopic analysis, the food web in two contrasted mudflats (estuarine and coastal) over two main seasons (dry and wet) and 2) evaluating the dependence of different components of the food web to MPB as a main food source. The $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$ signatures indicated a direct trophic transfer of MPB to higher trophic levels and a strong marine influence for both mudflats during both seasons.

(P-BS8) Microbial mats of salt marshes of Atlantic coast in France: importance of MPB and resources of biomolecules of biotechnological interest

Christine Cagnon¹, Cristiana Cravo-Laureau¹, H el ene Agogu e², Robert Duran¹, Sophie Sabl e², Isabelle Lanneluc², Corentin Herv e², Ingrid Fruitier-Arnaudin², [Christine Dupuy](#)²

¹ Universit e de Pau et des Pays de l'Adour, Equipe Environnement et Microbiologie, IPREM UMR CNRS 5254 (Institut des sciences analytiques et de physico-chimie pour l'environnement et les mat eriaux), b atiment IBEAS BP 1155, 64013 Pau cedex

² UMR LIENSs (Littoral Environnement et Soci etes), CNRS-Universit e de La Rochelle, 2 rue Olympe de Gouges, 17000 La Rochelle

Along coastlines, in many locations around the world from estuaries to hypersaline ponds, highly productive photosynthetic microbial mats (included microphytobenthos) develop at the water-sediment interface. They consist in laminated structures where microorganisms are organized according to microgradients of oxygen, sulfur species, redox potential and light. It is now admitted that microbial mats have influenced Earth's evolution, at the origin of the oxygenation event and Eukaryote colonization. Nowadays, modern microbial mats provide important ecosystem services including oxygen production, sulfide depletion, sediment stabilisation and carbon sinks. The high microbial diversity also represents biological resources (i.e. metabolites, enzymes and microbial strains) yet unexplored. The exploration of the microbial mats can also reveal metabolic capabilities with high biotechnological potential. The aim of the study was to describe the biodiversity of microbial mats functioning including the bioproduction of biotechnological poten-

tial molecules. Our study characterizes the microbial molecular biodiversity of microbial mats developing on the Atlantic coast and describes the main predators, larger organisms such as the meiofauna (nematodes, copepods). A search for biomolecules of biotechnological interest has been carried out as a result of eco-extractions of different bioactive molecules: antimicrobial activities (culture screening on different pathogenic microorganisms), antioxidant, and bioadhesive and biosurfactant activities (molecular and cellular). Microbial mats constitute an original biological matrix model, including microphytobenthos, where complex microbial metabolisms are favored.

(P-BS9) Overview of biofilm-related studies on intertidal mudflats in the Bay of Fundy, Canada

[Myriam A. Barbeau](#)¹, Diana J. Hamilton², Sarah G. Neima², Travis G. Gerwing¹, Jenna T. Quinn², David Drolet^{1,2}

¹ Department of Biology, University of New Brunswick, Fredericton, NB, E3B 5A3, Canada

² Biology Department, Mount Allison University, Sackville, NB, E4L 1G7, Canada.

The upper Bay of Fundy has the highest tides in the world, exposing vast mudflats at low tide. These mudflats typically have average sediment particle sizes of 15–80 μm , and are covered with a diatom biofilm. A previous study conducted on 2 mudflats in 1 summer reported densities of live diatom cells between 5–25 $\times 10^4$ per g wet sediment, and that the main functional group was tychoplankton (the other groups being epipelonal and epipsammon). We have measured chlorophyll *a* concentration, an index of diatom abundance, in the top 2 mm of sediment at different temporal (minutes to years) and spatial scales (metres to kilometres). Chl *a* concentration varied between 1–5 mg m^{-2} in winter (when ice effects are substantial) and 10–60 mg m^{-2} in summer, with most spatial variability being among patches (metres) and mudflats (8 mudflats). Within a low tide period, chl *a* concentration did not vary significantly. In community studies, biofilm abundance (a bottom-up factor) significantly correlated with infaunal community structure (*Corophium volutator* amphipods, polychaetes, *Macoma* clams, *Tritia obsoleta* snails, Harpacticoid copepods, ostracods), but only accounted for ~1% of the variation in community structure and did not transmit beyond a single trophic link (i.e., no trophic cascades were detected). Shorebirds, in particular Semipalmated Sandpipers (*Calidris pusilla*), use Bay of Fundy mudflats as an important foraging site during their annual southward migration. In the past, sandpipers were reported to primarily feed on *C. volutator*, but our recent morphological, behavioural and dietary studies indicate that the birds have a broad diet that includes biofilm. Using scanning electron microscopy, we identified hair-like structures on the tongues of Semipalmated Sandpipers that may facilitate biofilm consumption. We have identified “skimming” as a common foraging behaviour at night, similar to grazing used by other bird species when feeding on biofilm. Using stable isotope analyses of bird blood plasma and potential prey items, as well as molecular scatology, we have determined that bird diet broadly tracks prey availability, and biofilm is a regular part of the diet. Given this, we examined fatty acid composition in biofilm relative to other food items. We found that biofilm has a fatty acid profile (rich in polyunsaturated fatty acids, PUFAs) similar to *C. volutator*, suggesting that when taken in sufficient quantities, biofilm should facilitate the birds' physiological preparation for migration. We now need to better understand

biofilm dynamics. An original study conducted in 1979–80 at 1 mudflat estimated peaks in microphytobenthic production up to 700–800 g carbon m⁻² d⁻¹ in the summer, and an annual rate of 60–80 g carbon m⁻² y⁻¹, but we do not know how this varies spatially, temporally and in association with various communities.

(P-BS10) Subtidal microphytobenthos: a « secret garden » stimulated by the engineer species *Crepidula fornicata*

Androuin Thibault¹, Dubois F. Stanislas¹, Decottignies Priscilla², Polerecky Lubos³, Marzloff Martin¹, Hubas Cedric⁴, Dupuy Christine⁵, Caisey Xavier¹, Legall Erwan⁶, Carlier Antoine¹.

¹ IFREMER, DYNECO, LEBCO, Technopole Brest Iroise, BP70, F-29280 Plouzané, France

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³ University of Utrecht, Department of Earth Sciences, Utrecht, Netherlands

⁴ UMR BOREA 7208 , CNRS/MNHN/IRD, Muséum National d'Histoire Naturelle, Station de Concarneau, Place de la Croix, 29900 Concarneau, France

⁵ Littoral, Environnement et Sociétés (LIENSs) UMR 7266 CNRS, University de La Rochelle, 2 rue Olympe de Gouges, 17000 La Rochelle, France

⁶ IFREMER, DYNECO, PELAGOS, Technopole Brest Iroise, BP70, F-29280 Plouzané, France

The slipper limpet *Crepidula fornicata* is an emblematic invasive species spreading along the northeast Atlantic coast. This gregarious species lives in stacks of several individuals, forms

extended beds in shallow subtidal areas and is able to modify the surrounding environment. As a result, *C. fornicata* is considered as an ecosystem engineer. In particular, this suspension-feeding animal produces large amount of biodeposits, leading to organic enrichment and high biogeochemical fluxes at the sediment-water interface. It also provides hard substrate within soft sedimentary systems. Therefore, *Crepidula* beds seem to provide favorable conditions towards microphytobenthos (MPB) biofilm development.

Using *Crepidula fornicata* as a model, we tested the « gardening » hypothesis with a mesocosm approach coupled to hyperspectral imagery. Our experiment was designed to compare both the physical (*i.e.*, presence of hard substrate) and the biological (*i.e.*, biodeposition) engineering effect of the species. The use of hyperspectral imaging allowed us to map chlorophyll *a* biomass over time and over different regions of interest (ROIs): outer bed sediment, inner bed sediment and shells. The growth rate of MPB was compared among treatments and ROIs, using linear mixed effect models. Our results showed that *C. fornicata* was able to promote MPB growth rate, both within and outside *C. fornicata* beds, hence confirming the gardening effect hypothesis. They also suggest a more pronounced effect of the biological activity compared with the single physical effect of the species. The underlying stimulation processes are probably directly linked to the excretion and indirectly through the biomineralisation of the *C. fornicata*'s biodeposits. Our findings highlight that the promoting effect on MPB already demonstrated for several intertidal molluscs species (*e.g.* mussels, oysters) may also be true for shallow subtidal benthic species. In the case of *Crepidula fornicata* habitat, our results provide clues about the respective trophic roles of pelagic vs benthic microalgae in the trophic functioning of benthic communities.

The British Psychological Society

Statement of Financial Activities for the Year ended 30th September 2015

	Note	Unrestricted General	Designated S.M.F.	Restricted Manton	Total 2015	Total 2014
		£	£	£	£	£
INCOME AND EXPENDITURE						
Incoming Resources						
Subscriptions 2015		7,850.00	-	-	7,850.00	6,909.50
Conference		1,112.26	-	-	1,112.26	-
Journal profit share 2013		-	-	-	-	12,173.03
Journal profit share 2014		12,511.88	-	-	12,511.88	37,535.63
Journal profit share 2015		51,926.63	-	-	51,926.63	-
Interest		890.46	-	-	890.46	905.03
Annual meeting 2014		-	-	-	-	7,500.00
EJPMC		2,818.91	-	-	2,818.91	2,791.00
Total Incoming Resources		77,110.14	-	-	77,110.14	67,814.19
Resources Expended						
Grants, studentships & awards	2	8,019.32	12,342.53	250.00	20,611.85	17,965.07
Publications expenditure	3	30,662.87	-	-	30,662.87	22,445.44
Meetings & Committee Expenses	4	3,604.72	-	-	3,604.72	9,028.48
Administration Costs	5	9,630.60	-	-	9,630.60	9,692.36
		51,917.51	12,342.53	250.00	64,510.04	59,131.35
Net Incoming (Outgoing) Resources for the Year		25,192.63	(12,342.53)	(250.00)	12,600.10	8,682.84
Fund at 1st October 2014		123,209.84	25,000.00	3,444.09	151,653.93	142,971.09
Transfer (General to SMF)		(12,342.53)	12,342.53	-	-	-
Fund at 30th September 2015		136,059.94	25,000.00	3,194.09	164,254.03	151,653.93

The British Psychological Society

Balance Sheet as at 30th September 2015

	Note	2015 £	2014 £
Current Assets			
Debtors	7	41,408.83	18,231.59
Short term deposits		130,820.27	139,940.29
Cash at bank		17,645.94	15,055.78
		<u>189,875.04</u>	<u>173,227.66</u>
Liabilities: amounts falling due within one year	8	25,621.01	21,573.73
Net Assets		<u>164,254.03</u>	<u>151,653.93</u>
Funds			
Unrestricted	9	136,059.94	123,209.84
Restricted		3,194.09	3,444.09
Designated		25,000.00	25,000.00
		<u>164,254.03</u>	<u>151,653.93</u>

Signed on behalf of the British Psychological Society

Dr Maeve Edwards
Treasurer

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The British Psychological Society

Notes to the Accounts for the Year 30th September 2015

1 Accounting Policies

The accounts have been prepared in accordance with applicable Accounting Standards and the SORP - Accounting and Reporting by Charities issued in March 2005. A summary of the more important policies, which have been applied consistently, is set out below:

Basis of Accounting

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

Subscriptions

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

Funds

Restricted funds comprise unexpended balances of donations and interest to be applied for specific purposes. At 30th September 2015, the Society's only restricted fund was the Manton Fund.

Designated funds are those set aside out of unrestricted funds for specific purposes. At 30th September 2015, the designated fund of the Society was the Scientific Meetings Fund ("S.M.F.").

Income

Income is recognised where there is an entitlement to the funds, any performance conditions attached to the item have been met, it is probable that the income will be received and the amount can be measured reliably.

Cash Flow Statement

The Society has taken advantage of the exemptions provided in FRS 102 'The Financial Reporting Standard applicable in the UK and Republic of Ireland' from including a cash flow statement.

	Unrestricted General £	Designated S.M.F. £	Restricted Manton £	Total 2015 £	Total 2014 £
2 Grants, Studentships & Awards					
Travel awards for Winter Meeting	-	12,342.53	-	12,342.53	2,087.68
Awards for courses, travel, Summer Bursary	1,913.90	-	-	1,913.90	5,375.53
Poster prize at Winter Meeting	-	-	250.00	250.00	150.00
Small Grants	5,100.00	-	-	5,100.00	3,660.00
Hilda Canter-Lund award	-	-	-	-	250.00
Summer studentships	-	-	-	-	3,253.00
Algaebase Sponsorship	-	-	-	-	2,595.64
Diatom Group	1,005.42	-	-	1,005.42	593.22
	8,019.32	12,342.53	250.00	20,611.85	17,965.07
3 Publications Expenditure					
Journal	4,684.50	-	-	4,684.50	5,015.25
EJP Editors expenses	16,954.41	-	-	16,954.41	11,250.00
EJP Management Committee	952.28	-	-	952.28	168.77
The Psychologist	8,071.68	-	-	8,071.68	6,011.42
	30,662.87	-	-	30,662.87	22,445.44
4 Meetings & Committee Expenses					
Council Meeting 2014	-	-	-	-	1,649.68
Council Meeting 2015	1,957.42	-	-	1,957.42	-
Biodiversity Committee expenses	631.77	-	-	631.77	480.90
Society of Biology expenses	37.80	-	-	37.80	-
General expenses (Sec/Tres/mem sec)	243.42	-	-	243.42	-
Annual Meeting 2014	804.96	-	-	804.96	3,204.17
Annual meeting 2014 speaker expenses	-	-	-	-	404.96
Annual meeting 2014 Expenditure refund	(920.65)	-	-	(920.65)	959.55
Annual meeting 2014 Conference Facilities Sponsorship	850.00	-	-	850.00	2,329.22
	3,604.72	-	-	3,604.72	9,028.48
5 Administration Costs					
Public liability insurance	556.50	-	-	556.50	530.00
Independent Examiner's Fee	1,440.00	-	-	1,440.00	1,440.00
Credit Card Charges	533.02	-	-	533.02	552.36
Bank charges	606.59	-	-	606.59	258.71
Executive Honoraria (2014)	4,250.00	-	-	4,250.00	3,000.00
Honorarium 13/14 M Saunders	-	-	-	-	1,250.00
Society of Biology Subscription	-	-	-	-	58.50
FEMS subscription	566.74	-	-	566.74	415.64
FEMS expenses	516.46	-	-	516.46	-
FEPS subscription	-	-	-	-	468.98
FEPS expenses	488.09	-	-	488.09	850.30
Website Maintenance	673.20	-	-	673.20	867.87
Miscellaneous	-	-	-	-	-
	9,630.60	-	-	9,630.60	9,692.36
	51,917.51	12,342.53	250.00	64,510.04	59,131.35

The British Psychological Society

Notes to the Accounts for the Year ended 30th September 2015 (cont.)

6 Reimbursement of Council members' expenses

Ten (2014: ten) Council members received £1,947,42 (2014: £1,649.68) as reimbursement of travel and overnight accommodation for expenditures incurred during the year on Society business. No monies were paid to any Council member in respect of subsistence.

7 Debtors	2015 £	2014 £
Trade Debtors	21,926.63	7,535.63
Interest receivable	706.44	695.96
EPC6 loan	10,000.00	10,000.00
Paypal - subscriptions	7,663.50	
University conference	1,112.26	-
	<u>41,408.83</u>	<u>18,231.59</u>

8 Liabilities: Amounts falling due within one year

Accruals & deferred income	15,121.01	11,073.73
Provisions for the Journal and the Phycologist	10,500.00	10,500.00
	<u>25,621.01</u>	<u>21,573.73</u>

9 Analysis of Net Assets between Funds

	Unrestricted Funds £	Designated Funds £	Restricted Funds £	Total Funds £
Fund balances as at 30th September 2015 are represented by				
Current assets	161,680.95	25,000.00	3,194.09	189,875.04
Current liabilities	(25,621.01)	-	-	(25,621.01)
Total Net Assets	<u>136,059.94</u>	<u>25,000.00</u>	<u>3,194.09</u>	<u>164,254.03</u>

164254.0296

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

We report on the accounts of the Society for the year ended 30th September 2015, which are set out on pages 1 to 4.

Respective responsibilities of trustees and examiner:

The Council Members are responsible for the preparation of the accounts. The Council Members consider that an audit is not required for this year (under section 144 of the Charities Act 2011 and that an independent examination is needed).

It is our responsibility to:

- * examine the accounts (under section 145 of the Charities Act);
- * to follow the procedures laid down in the General Directions given by the Charity Commissioners (under section 145(5)(b) of the Charities Act); and
- * to state whether particular matters have come to our attention.

Basis of independent examiner's report:

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

Independent examiner's statement:

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

- * to keep accounting records in accordance with section 130 of the Charities Act and;
- * to prepare accounts which accord with the accounting records and comply with the accounting requirements of the Charities Act;

have not been met.

FEB Chartered Accountants
Chartered Accountants and Registered Auditors
Belfast, Northern Ireland

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The British Phycological Society Trustees Annual Report (2014/2015)

Introduction

This is the first Trustees Annual Report of The British Phycological Society presented by Dr. Maeve Edwards after taking over as Treasurer from Dr. Michelle Tobin in March 2015. It is made in this form to meet the requirements of the FRS 102 Statements of Recommended Practice (SORP), issued by the Charity Commission and serves as an annual record of the resources entrusted to the Society and the activities it has undertaken. It covers the financial year 1st October 2014 to 30th September 2015, and was approved by trustees at a council meeting held in Bangor University, Wales on the 11th January 2017.

Reference and Administrative Details

The only registered name of the charity is The British Phycological Society (Charity No. 246707), with a principal office address at The Natural History Museum, Cromwell Road, London, SW7 5BD. The charity's trustee on the date that this report was approved was Dr. Maeve Edwards.

Funds held as Custodian Trustee on behalf of others

Not applicable.

Exemptions from Disclosure

Not applicable.

Structure, Governance and Management

The British Phycological Society is an unincorporated association governed by a constitution¹, last amended in 2012. The constitution states that the membership of the society will be open to 'anyone interested in any aspect of the study of algae' and is managed by a council committee that are elected by ballot² of the society members. The BPS council consisted of the following officers in 2015:

President: Prof. Christine Maggs

President Elect: Dr. Gill Malin

Immediate Past President: Prof. Paul Hayes

Vice President Overseas: Prof. Charles Amsler

Secretary: Dr. Jane Pottas

Treasurer: Dr. Michelle Tobin/Maeve Edwards

Membership Secretary: Dr. Sara Marsham

Editor (Joint) of the European Journal of Phycology: Profs. Christine Maggs and Juliet Brodie

Webmaster: Prof. Mike Guiry

Student Representative: Chris Williamson

Federation of European Phycological Societies (FEPS) Representative: Prof. Geoffrey Codd

Ordinary Members: Dr. Gary Caldwell, Dr. Saul Purton, Dr. Anne Jungblut, Dr. Claire Gachon, Dr. Martyn Kelly, Dr. Clare Scanlan

Objectives and Activities

¹ The British Phycological Society Constitution, 2012. <http://www.brphycsoc.org/constitution.lasso>

² Except the immediate past-President, the Webmaster, the FEPS Council Representative and the European Journal of Phycology Editors.

The British Phycological Society Trustees Annual Report (2014/2015)

The aims as per paragraph 2 of The British Phycological Society constitution (2012) are as follows:

“The aims of the Society shall be to advance research and education by the encouragement and pursuit of all aspects of the study of algae and to publish the results of this research in a journal, and also in other publications which shall from time to time appear desirable, provided that all publications of the Society shall be available to the general public. In furtherance of those aims, but not otherwise, the Society shall also aim to increase public awareness of the importance and applications of algae, and to contribute to public debate on issues involving algae.”

In addition, the constitution states that:

“All funds acquired by the Society shall be devoted to the aims detailed in paragraph 2 above or to such associated charitable projects as may from time to time further these aims.”

Achievements and Performance

To this end, the BPS has continued to give financial support to activities that promote phycological research, disseminate phycological knowledge at all levels from governmental advice to community projects, in particular by assisting young phycologists to present their findings at scientific meetings nationally and internationally.

The 2015 annual meeting was held in London (23-28th August 2015) in conjunction with the 6th European Phycological Congress (EPC6) and was hosted by the University of Westminster and the Natural History Museum. Our thanks go to local organisers Drs. Jane Lewis and Elliot Schubert and their team for organising a very successful and varied meeting. The Manton Session was particularly well attended this year, and congratulations go to Sohail Keegan Pinto whose excellent presentation earned him the Manton Prize. To facilitate a greater number of students attending the joint BPS/EPC6 meeting, an additional travel awards were made available. 22 students received support (£12343) to attend this meeting and other meetings from the Scientific Meetings Fund (SMF; £2087.68 in 2014), with many international students applying for the travel award to come to London. The Hilda Canter Lund award for photography was presented to Günter Försterra. The Society continued to receive an encouraging number of applications for funding in this financial year and was able to support a good number of student members to develop and present their phycological knowledge both in the UK and abroad by attending conferences, meeting and courses. The small grant/project award received a high number of applications and 2 awards were made (£5100). In addition, during January 2015, the council approved the funding of a new project to produce an open-access educational resource, A Diatom Flora of Britain and Ireland. The project is due to run between 2015 and 2018 and to cost not more than £19517 to the Society.

The Society journal, European Journal of Phycology (EJP) continued to have a productive year, with 4 issues produced as part of Volume 50, although it was disappointing that the May issue of EJP was not out in time for the AGM. However, the August issue was out on time following the appointment of two new Assistant Editors: Steve Dudgeon (CSUN) for Macroalgal Ecology and Giovanni Furnari (Sicily) as Nomenclatural Advisor. There was a big drive to reduce the time from submission to acceptance of papers under the editorship of Profs. Christine Maggs and

The British Psychological Society Trustees Annual Report (2014/2015)

Juliet Brodie in order to improve the efficiency of the journal and the long-term goals of increasing the journal impact factor. The changing nature of the BPS is reflected in the increasingly applied nature of research papers received. The acceptance rate is currently running at around 45%, the main reasons for rejection being linguistic problems or incorrect formatting. Overall, the status of the journal is very encouraging - the Impact Factor remains stable at around 1.9, it has remained at 68/197 in Plant Sciences, and the journal's five-year Impact Factor has grown to over 2. The importance of citing papers was stressed and supervisors were reminded to encourage students and post docs to increase citations across the field.

Financial Review

A full statement of financial activities of The British Psychological Society for year ending 30th September 2015 are presented in addition to this annual trustees report. The financial statement has been prepared by Dr. Maeve Edwards and independently examined by Mr. Adrian Bannon of Flannigan Edmonds Bannon (Pearl Assurance House, 2 Donegall Square East, Belfast, BT1 5HB).

BPS income for 2015 was £76220, with the greatest majority of this amount coming from the Society's journal profit share from publishers Taylor and Francis (£64439). In addition, subscriptions from members made up £7859 of this total. The remainder of the income for 2015 came from a contribution to editorial expenses (also from Taylor and Francis) and profit from the annual meeting.

Total Society expenditure for 2015 amounted to £64510, broken down into four categories which included: 1) Grants, studentships and awards (£20612; see some specific details in *Achievements and Performance* above), 2) Publication expenditure (£30663), 3) Meetings and Committee expenses (£3567) and 4) Administration costs (£9669).

Publication expenditure costs can be further broken down into production and publication/distribution costs for the European Journal of Psychology, as well as for the Society newsletter, *The Psychologist*. EJP cost £4685 in distribution, with editorial expenses at £16954 to coordinate authors, reviewers, sub-editors and publisher to produce 4 issues of the journal annually. The remainder of EJP costs (£952) include management committee costs travel expenses for an annual trip for up to four members to discuss EJP/publisher developments with Taylor and Francis. *The Psychologist* was produced and distributed for £8072.

Meetings and Committee expenses were modest, with reimbursement for travel and overnight accommodation to allow council members attend one council meeting costing £1957. The second council meeting is not reimbursed as it is organized to coincide with the annual conference at which Society (and therefore committee) members generally attend as a matter of course. Annual meeting costs, general expenses and sponsorship made up the remainder of the £3567 spent.

Finally, administration costs (£9669) to run the Society for 2015 included charges for website maintenance, banking, public liability insurance, the independent examiners of the accounts, subscriptions to the Federation of European Microbiological Societies and Federation of European Psychological Societies. Honoraria were awarded to the following council members: the Membership Secretary, Secretary and the Editor of *The Psychologist* each received £1000,

The British Phycological Society Trustees Annual Report (2014/2015)

the Treasurer received £1250 (split between Drs. Michelle Tobin and Maeve Edwards as part of the handover process).

Net income for the BPS after expenditure in 2015 was £12600. After including funds brought forward (held in reserve as savings) of £151654, the total Society funds carried forward at the end of financial year 2015 is £164254. Therefore, the Society's financial situation remains very healthy and this has allowed the continued support of a wide range of projects and awards dedicated to algal research. The Society does not currently have a reserves policy in place, however work is in progress to develop one for approval by the trustees for the future.

In conclusion, I would like to thank all Council and Society members for their cooperation and support during this financial year. In particular, I would like to thank Dr. Michelle Tobin for her years of contribution to the Society as Treasurer and for her patience and support in the handover of the Treasurer's role.

Signed by

A handwritten signature in black ink that reads "Maeve Edwards". The signature is written in a cursive style with a horizontal line under the first name.

Dr. Maeve Edwards
Treasurer
11 January 2017

Manton Prize Winner

Willem Stock, Willem.Stock@UGent.be

I am Willem, a 27 year old, Belgian microbiologist.

I didn't consider doing research on algae. In my studies, I had a course on algae and, although it was interesting to learn about their diversity and evolutionary history, it ended up being the worst exams of my bachelors. As my studies progressed, I became increasingly fascinated by the ecology of microorganisms as I started to appreciate their importance and their versatility. For my master thesis, I started growing diatoms, at that time, just as a food source for my copepods. This did give me the chance to get to know these organisms and, by the end of the thesis, I was more fond of my algae than my copepods. I was of course excited when I could continue working on them as a PhD candidate.

A PhD on the interactions between diatoms and bacteria in intertidal mudflats, without a doubt one of the most fascinating ecosystems (although I might be biased). Tidal flats are highly dynamic and stressful environments due to daily flooding. And yet, the flats are amongst the most valuable and productive ecosystems, supporting a wide array of organisms.

With every experiment I have been doing on these systems, it dawns on me how truly complex these systems are. The mudflat system being shaped by the interactions between organisms living there and the environmental conditions imposed on it. At the same time, all this seems to be in a constant flux as not only the environment constantly changes but also interactions change over time.

This was also the main message I wanted to bring at BPS. Fortunately, I was able to present my work at the Manton Prize session. From all the wonderful talks given in this session,



I ended up, for some bizarre reason, with the Manton Prize.

Although I'm in the final year of my PhD, this was the first British Phycological Society Meeting I attended. Despite the fact that Ghent (Belgium) isn't far from the UK, previous conferences seemed to have escaped my attention. This year's annual BPS was brought to my attention by my supervisor and, since it was jointly organised with the Third Microphytobenthic Biofilm Symposium, I was keen on attending it. Fortunately, I did!

Even before the conference started, I had a very nice evening thanks to the pub quiz organised by Amie Parris and Philipp Siegel. The team I was in, lost horribly, mostly due a lack of knowledge on the Royals (I didn't even know the Queen had 2 birthdays!) but that didn't spoil the fun.

The conference itself went very smooth, thanks to the efforts of the organisers, with plenty of talks and enough time in between to chat to the other attendees. What stroke me most at this conference was the amount of interactions going on between the participants, both during the sessions and between them. Every talk was followed by an interesting discussion, which often had to be cut short due to time restrictions. During lunches and coffee breaks, I had many interesting talks with some of participants as well.

To conclude, I would like to express my gratitude to both the organisers of this year's BPS and Microphytobenthic Biofilm Symposium and everyone involved for making this a very memorable and interesting event. I would also like to express my appreciation for my supervisor, Koen Sabbe, for getting me hooked on diatoms, his guidance and enthusiasm, of which, I am sure by now, a fair amount rubbed off on me, have been a great help during my work.

Poster Prize Winner



Sara Haro Paez, sara.haro@uca.es

This year the British Phycological Society annual meeting took place in Southend, United Kingdom, from the 8th to 11th January 2018. This year the conference coincided with the 3rd Microphytobenthic Symposium. The conference was divided into four sessions: general phycology, applied freshwater research, mapping, conserving and sustainably exploiting seaweed genetic resources in blue biotechnology and microphytobenthic biofilms. More than 100 participants joined the conference to present some 50 oral communications and 30 posters. I am PhD student at the Microbial Ecology and Biogeochemistry Laboratory of the Biology Department at University of Cádiz, in Spain (<http://www2.uca.es/grup-invest/microbentos>). The 66th BPS meeting was my first international conference. The work presented

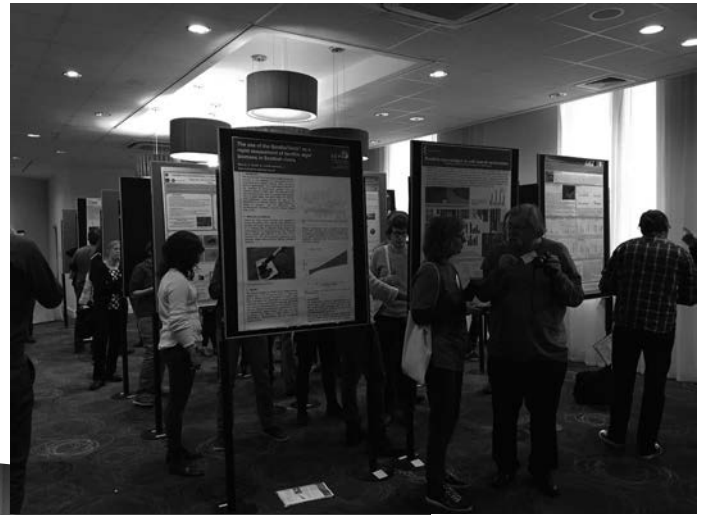


as a poster, “Radiative energy budget in a microbial under different irradiance and tidal conditions”, was carried out in the Marine Biology Laboratory of Helsingør at University of Copenhagen in Denmark where I stayed for 3 months. The question considered in the poster was “Does tidal state affect how much light energy is conserved by photosynthesis?”. To answer this, we estimated the radiative energy budget in a photosynthetic microbial mat during immersion and emersion under increasing irradiance (400 and 800 $\mu\text{mol photon m}^{-2} \text{s}^{-1}$) using combined microsensors measurements of O_2 , temperature and scalar irradiance. The results suggest that the photosynthetic flux was similar in immersion and emersion. Less than 1% of the absorbed incident light energy reaching the sediment was conserved via photosynthesis by microphytobenthos, while the majority of absorbed light energy was dissipated as heat in the sediment. It is expected that these results will be published soon.

I would like to congratulate the organizing committee of the 66th BPS for the organization and the quality of this conference. The feedback I gained during the poster presentation was very interesting. The conference allowed me to extend my network, in a pleasant atmosphere, especially during the conference dinner which I enjoyed a lot. Finally, I would like to thank the British Phycological Society for awarding me the prize for the best student poster. That was the cherry on the cake! Without a doubt, a great experience overall.



Manton Prize speakers



Posters presentation



Southend pier



Blue dress exhibition



President in blue dress



Disco fever chicks!

Student Bursary Reports

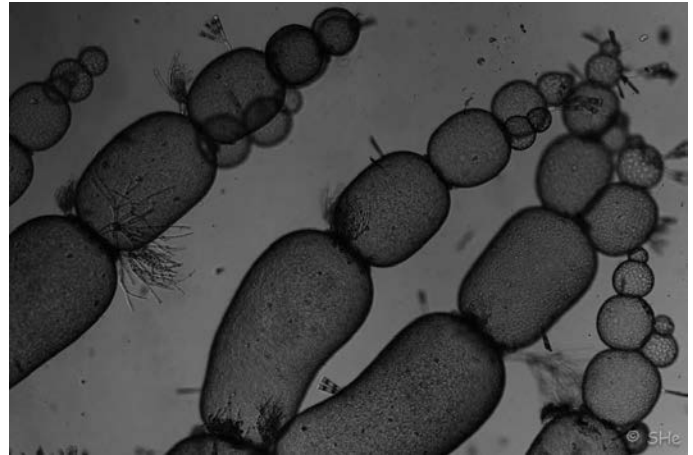
Phycology, Crepés and Rain. Expertise in Flora - Phycology Class in Roscoff (France); 17th – 30th of July 2017.

Sabrina Heiser, heiser@uab.edu.

One of my first fieldwork experiences when I took the BSc in Marine Biology course at Plymouth University was a field trip to the small town of Roscoff. Who would have guessed that 7 years later I would find myself in Roscoff again for two weeks packed full of seaweed fun! This time not with my old university but with the Station Biologique Roscoff. I am currently pursuing a PhD in chemical ecology of red seaweeds with Dr. Chuck Amsler at the University of Alabama at Birmingham. For merely €50 (+ travel, room and board) I ventured back to the little town in Brittany in the hope to refresh my knowledge on algal lifecycles, systematics and taxonomy. Thank you to British Phycological Society for sponsoring this trip including additional expenses!

On a Monday morning, in mid-July a mixed group of early career scientists found themselves in a classroom together. And we were mixed on so many levels (apologies in advance if I leave anyone out). Whilst some were taking or finishing their undergraduate degrees, other were in their master degrees or in their PhD programs. We even had a couple of professionals with us who were teachers or working in a full-time job. Countries of origin included India, Chile, France, Spain, Italy, Russia and Germany. Yet, our goal to learn more about algae united us all. The pencils were sharpened, notebooks ready and none of us was quite sure how to assimilate all the knowledge in those intense two weeks.

We had the privilege to be taught by an array of amazing scientists. Nathalie Simon and Christophe Destombe were the official organizers of the class. We also had Christophe Six (also from Station Biologique Roscoff, France), Bruno de Reviers (from MNHN Paris, France) and Conxi Rodriguez (from University Girona, Spain) instructing us. The course included a minimal amount of classroom lectures but a lot of hands on experience doing cross sections and looking at the various cytological features of the described groups of algae. All this was topped off with a variety of field trips to different types of shores. At the end of the two weeks, we were able to demonstrate our acquired knowledge during a final exam and by handing in our final project for which we had collected and identified four individuals in a group of algae of our choice from pontoons at the nearby leisure harbour. Some of us even managed to find some spare time to start or expand our personal herbarium. For myself, the course went by far too quickly and I could have easily stayed for at least another two weeks to explore more of the beautiful flora on the shores around Roscoff. Thank you for a great class and lots of good memories, despite the rain.



The 11th International Phycological Congress, IPC11, August 2017



Keelan Lawlor, Keelan.Lawlor@sams.ac.uk *Plenary Speakers*

IPC 2017 saw 460 delegates from 43 countries gathering for an exciting week in Szczecin, Poland.

Opening the conference IPS president Prof. Juliet Brodie highlighted the stability of the IPC format, the stability of *Phycologica* and the importance of this stability taking the IPS/IPC forward. She also reiterated the importance of algae, stressing the importance of 'blue-sky' research, while also acknowledging the role applied research plays in the field. Prof. Włodarczyk, University Rector, chose themes of communication, all the more important in this 'post-truth' world and the difficulties of scale, in particular looking for the relevance of small scale lab results in the wider more global approach. This set the scene for what was to be a fantastic week of fascinating talks, lively discussion and a diverse program.

This conference also embraced applied phycology with an invited symposium on bioprospecting, a contributed session on biotechnology and poster sessions for both.

My research focusses on identifying compounds derived from marine microalgae which may have use as food additives in order to provide a new sustainable source of some of these essential compounds. Hence, I was particularly enthusiastic to attend these sessions and had the chance to participate in the poster sessions with my poster "Marine microalgae as sources of phospholipids and sterols for use as encapsulation agents in food"

Delegates were treated to four excellent plenaries. Highlights included Georg Pohnert discussing the use of comparative metabolomics and microalgal co-culture to investigate microalgal symbiosis and bacteria-microalgal interaction. Included was some especially striking video of diatoms showing how the presence of silica or pheromones results in their purposeful movement as well as their ability to prioritize reproduction or feeding depending on cell state. Zoe Finkel strove to illustrate the role phylogenetics has to play in the slight deviations of microalgae's macromolecular composition from the classical Redfield ratio. Nils Kröger discussed the role that diatom silica-associated biomolecules play in their ability to create intricate nano-structures. Christine Maggs treated us to a highly entertaining walk-through of taxonomy, from complex polynomial naming, to Linnaeus's implementation of the binomial system still in use today to modern advanced molecular techniques and how in the age of big data we can continue to tease apart the remaining taxonomic enigmas.

Bioprospecting

The bioprospecting symposium saw talks by Michele Barbier, Gerardo Toledo, Maike Lorenz and A. Tzvetkova which collectively sought to remind us of the role that the UNCLOS law of the sea and the Nagoya convention play in collection of algae for commercial purposes. As bioprospecting for commercial use is regulated by do-

mestic and international law, it is key to set up algal collection strategies within the current legal and regulatory framework. We were introduced to the concept of access and benefit sharing. An online resource (ABS clearing house) was introduced which aims to provide potential bioprospectors with information on a country to country basis and provide options for the first point of contact, in most cases the relevant government group or department that are charged with ensuring compliance.

Biotechnology

The biotechnology contributed session hosted a number of excellent presentations.

William Barclay made the case for a 'biorational approach to bioprospecting' as there is some difficulty reconciling the huge diversity (~72,500) species of algae with the very few strains, often from culture collections that almost all companies use. These strains/species have undergone no selection processes and much time money and effort is spent trying to make these species work in the system, rather than using a targeted approach to bioprospecting. With a carefully planned integrated selection process suitable novel strains can be identified extremely quickly, saving lengthy optimisation methodologies.

While Ferran Garcia-Pichel introduced the idea of seeding anthropogenically degraded biological soil crusts (BSC) and incorporating biogeography with carefully tailored mixes of microalgal species in the correct proportions providing inoculum to assist in the recovery of BSCs. We learned how BSCs are important for protection from soil erosion, primarily wind in the desert and that their recovery acts to slow the onset of desertification and reduce the size and severity of dust storms.

For many of us, experiments don't always provide the results we might expect. This was illustrated in Thomas Dempster's talk on the potentials of pulsed field electricity (PFE). Initially

studied for removing neutral lipid bodies from cultured microalgae by disruption of the membrane, it soon became clear that it only works on species without particularly robust cell walls. An unexpected benefit of this technology was that application of low voltages increased productivity and reduced the predator and bacterial load in the culture.

Excursions/ALFF

A number of excursions and activities were held on Wednesday with delegates visiting wetlands and islands, a historic Viking village and kayaking for those looking for some exercise!

Wednesday also saw the Algal Microbiome Friends and Foes (ALFF) workshop which provided an eye-opening insight into the great work on the challenging topic of algae-bacteria interactions being carried out by a cohort of talented PhD students and researchers.

Delegates got two opportunities during the conference to attend organised dinners. On Wednesday evening the weather cleared up in time for the bonfire party, a nice addition to the schedule which gave delegates a chance to test their BBQing skills, a demonstration of traditional dance and a chance to enjoy the beautiful countryside, while on Friday evening there was the conference gala dinner.

Algae – bacteria interactions

The complex interactions between microalgae/ macroalgae and bacteria was a continuing theme throughout the conference. Not only was there extensive and fascinating discussion during the ALFF workshop, but it permeated many of the talks. There was talk of how they were good... highlights including learning of the symbioses which occur from Georg Pohnert's fascinating plenary described earlier, Shailesh Kumar Patidar's discussion on using bacteria for growth promotion of selected microalgae and control of unwanted microalgae species. How they could be controlled in a commercial setting... Thomas Dempster's discussion on controlling the bacterial load by PFE and the use of acetate toxicity to modify the bacterial community and reduce bacterial counts in mixotrophic cultures (Eneko Ganuza).

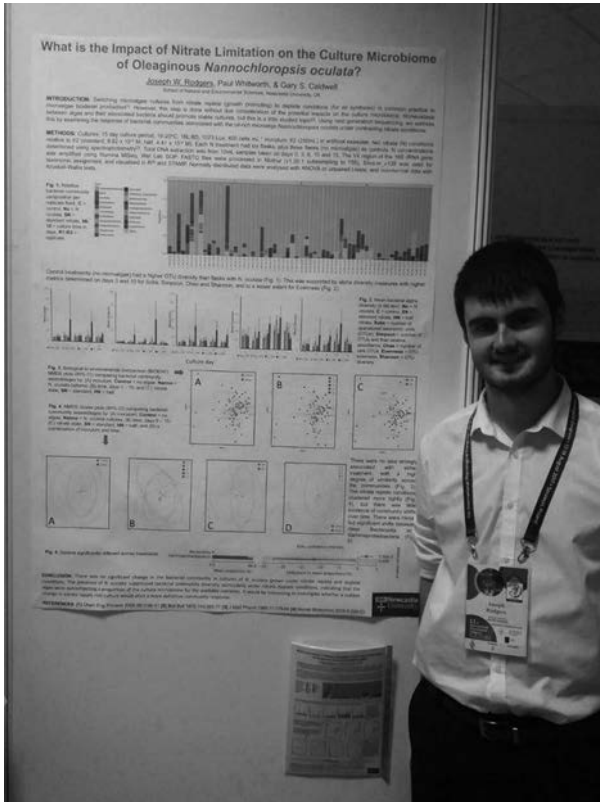
Above all, the talks illustrated the complexity involved in these interspecies interactions exemplified by Assaf Vardi's talk about the complex interaction in blooms as DMSP production modifies the microalgae's susceptibility to both grazers and bacteria.



Final Comments

I think I can speak for all delegates when I congratulate the IPS president Prof. Juliet Brodie, convener Prof. David Mann, Prof. Andrzej Witkowski and the international and local organising committees for a fantastic week of talks, posters, excursions and lively discussions. Hopefully everyone has left Szczecin with a renewed sense of enthusiasm and a real sense of excitement at being part of such a vibrant and productive research group and are already looking forward to IPC 2021 in Chile. Finally, I must acknowledge and thank the invaluable support from BPS for facilitating my attendance at this conference.

The 11th International Phycological Congress, IPC11, August 2017



**Joseph Rodgers, Newcastle University, United Kingdom,
J.W.Rodgers1@newcastle.ac.uk**

The International Phycological Congress occurs every four years, first taking place in 1982, gathering together phycologists from over 40 countries to present their research into every area of phycology, from bioprospecting and biotechnology to the effect of climate change on algal population structures to new breakthroughs in taxonomy and the identification of algae. The 11th IPC took place this year from the 13th to the 19th August in Szczecin, Poland, around 10 miles from the German border.

Sunday evening brought about introductory talks from the President of the International Phycological Society, Professor Juliet Brodie, and the Rector of the University of Szczecin, Professor Edward Włodarczyk. After their warm welcome a more casual atmosphere descended on the gathered delegates as colleagues caught up with each other and new acquaintances were made. The intimidating

atmosphere I felt upon arrival soon disappeared as professors and undergraduates alike opened up and conversed.

Monday opened the five days of talks and posters with an exciting plenary delivered by Professor Georg Pohnert from the University of Jena in Germany about “Chemical communication in microalgae – how unicellular organisms shape and perceive their environment”. I thoroughly enjoyed this talk as it was delivered in a very accessible and engaging manner and certainly set the precedent for the rest of the week. Spending the rest of the day attending talks into various aspects of algal and microalgal biotechnology was great because I became so much more aware of how broad algal biotechnology is and quite how much it encompasses.

Proceedings on Tuesday, Thursday and Friday followed the same outline as Monday, with plenary talks followed by symposia on a variety of topics. Talks that were of particular interest to me revolved around microalgal culture control, such as Thomas Dempster’s talk on “Predator control for large-scale cultivation using pulsed electric field technology”, as during my research I read a lot of literature surrounding large-scale cultures and the problems that were encountered in maintaining the culture and it was interesting to see real world solutions to these problems.

The conference wasn’t all business however, as Wednesday provided a welcome break with local excursions. My group started the day off with wine tasting followed by a trip to a local church that was formally a monastery. It was nice to get out and see the local area as there was a wonderful park nearby that we were able to explore. The day was wrapped up with a barbecue at a local venue and it was nice to unwind and enjoy a performance from traditional Polish dancers.

This was my first conference, attended shortly after graduating from my undergraduate studies. I am currently an MSc student of Biotechnology at Newcastle University and feel very lucky to have been able to present a poster on the microbiomes associated with oleaginous microalgal cultures at such an early stage in my academic life. I would like to thank the BPS for offering to fund my experience and thoroughly look forward to my next conference.

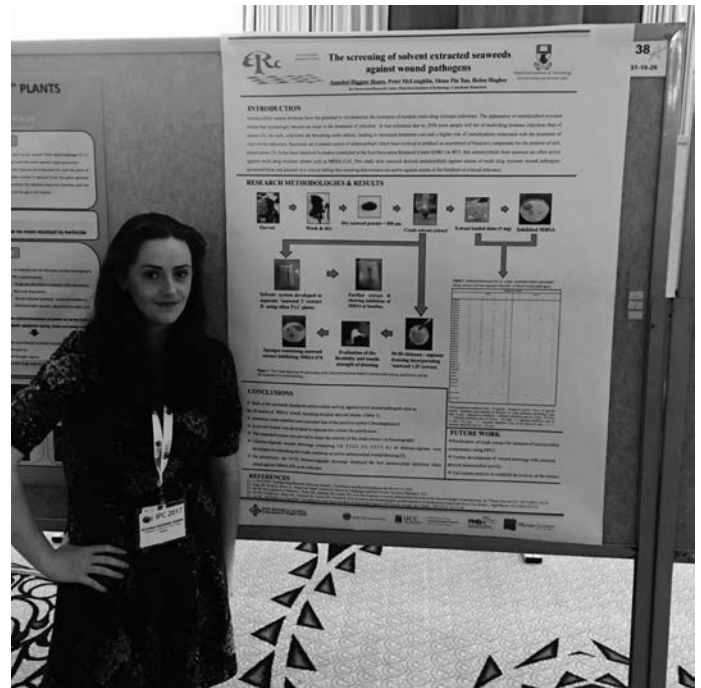
14th International Phytotechnologies Conference

Annabel Higgins Hoare, Waterford Institute of Technology, Department of Science, Waterford, Ireland.
annabel.higginshoare@postgrad.wit.ie

On the 23rd of September, the 14th International Phytotechnologies Conference had begun in Montréal, Quebec, Canada, a conference which was established by the international phytotechnologies society 14 years ago. The international phytotechnologies society is based upon the strategic use of plants and seaweeds to remediate contaminated and polluted natural resources to restore ecosystems. This extends to finding new ways of dealing with waste and adding market value to local ecology (such as with the extraction of bioactives) with the intent of simultaneously promoting the many benefits which plants and seaweeds have to offer such as: habitats for local species, livability, emotional connection/stress reduction and property value increase.

As you can imagine, this was an exciting space in which I could share my research which is based on the extraction of antimicrobial compounds from seaweeds and the incorporation of these compounds into wound dressings. The opening meeting began with a warm welcome into Montréal by Prof. Michel Labrecque who organised the conference, followed by an exciting keynote presentation by Prof. Dr. Barbara Zeeb, a well established expert in the area of phytoremediation. Prof. Zeeb who is based in the Royal Military College of Canada leads much work based on the use of Cucurbitales among other genus to phytoextract pollutants such as hydrocarbons, TNT's and DNT's from contaminated soil. Soil contamination is a huge issue across the US as, there has been many oil spills associated with the extraction of oil and via military negligence during the cold war. As such, the growing of plants on the land to extract these contaminants from the soil is an efficient and ecologically beneficial way of removing pollutants, while giving the added bonus of creating habitats for animals. This process can also be used with seaweed in the extraction of heavy metals from waterways. This version of phytoremediation could possibly give rise to higher concentrations of bioactive secondary metabolites found in stressed systems.

Networking is obviously a huge part of these conferences, and I got an ideal opportunity to make contacts both at an introductory cocktail meeting, and a IPS dinner meeting. I've made friends and contacts who I intend to keep in touch with, as it gives an opportunity for future collaborations between like minded labs and myself. There were

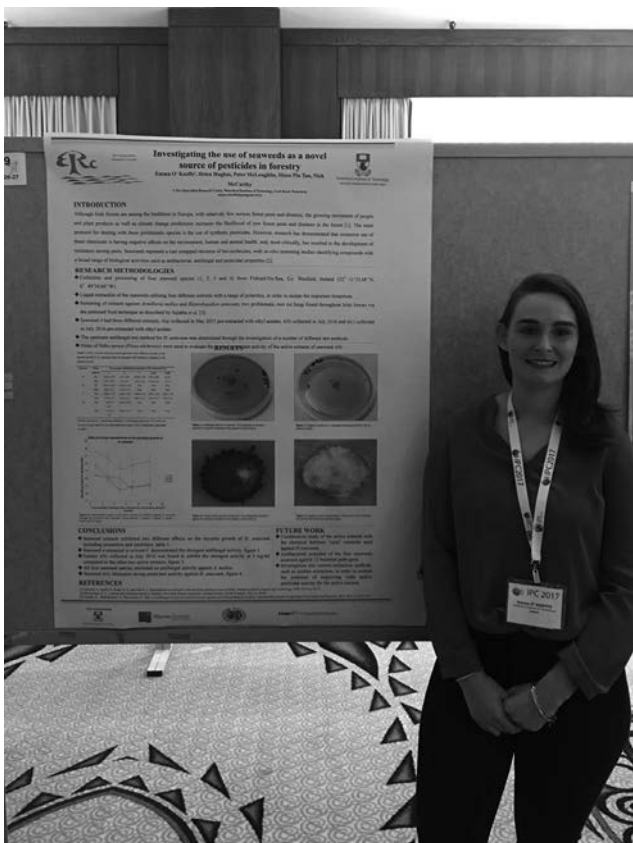


over 50 posters presented, which I got a chance to view, as part of this, I cherry picked the most similar and interesting projects compared to my own and on more than one occasion, asked the author about specific methods that were used as part of their study. As this was an international conference with over 350 delegates, there were five different talk sessions being carried out simultaneously, which led to more than a few difficult decisions!

As part of my own poster presentation, I was to give a form in which to disseminate and defend my own research. I cannot stress how important these skills are, as, without the proper share of knowledge and ideas, it's hard for your research to benefit anyone. I do feel like people were genuinely interested in my research, as well as in the fact that it was on seaweed and not plants, as most of the other posters. In this way, I think that we, as phycologists can raise interest and encourage more people to engage with the sea, a fact which will in turn help lead to a thriving maritime economy and healthier marine ecosystems.

I am so grateful that I could attend such a prestigious conference with the help of the British Phycological Society, and I would like to thank BPS for helping me to have such a great experience, which will benefit my career.

14th International Phytotechnologies Conference: New Sustainable Solutions for Environmental Challenges



Emma O'Keeffe, Waterford Institute of Technology, Cork Road, Waterford, Ireland, emma.okeeffe@postgrad.wit.ie

On Monday the 25th September was the start of the 14th International Phytotechnologies Conference held in Montréal, Canada. Time was spent exploring this fabulous city and the sights it had to offer including the Mount Royal summit which displays spectacular views of the city skyline.

In the evening participants met for registration and ice-breaker cocktails in the exhibition room of the OMNI Mont-Royal hotel. The room filled quickly with both old and new colleagues, eager to discuss their views on phytotechnology. The 14th International Phytotechnologies Conference was officially opened at 8.30 on 26 September 2017 by Ms Chantal Rouleau, a Montréal councillor. Followed by a key note speech by Professor Barbara Zeeb under the theme of phytoremediation in Canada: from theory to teaching to practical applications. This talk demonstrated the importance of getting students actively

involved and the vast number of projects she has been involved in which consisted mainly of phytotechnological studies to remediate metal-, organochlorine-, petroleum hydrocarbon, and salt-impacted sites in collaboration with government agencies and contaminated site owners.

Oral presentations ran from Tuesday to Thursday morning with five different sessions running in parallel meaning there was a large variety of research projects including phytoremediation of soil contaminated with minerals or trace metals and phytotechnologies for control and treatment of waste water, surface water, groundwater, indoor and outdoor air. The poster presentations were run over a two-day period (26th and 27th September) with my poster scheduled for the second poster session. This year there was over 150 posters on display and was evaluated by at least three different evaluators on the basis of presentation of scientific content, ability to explain project and respond to questions.

A student dinner was organized for Tuesday evening in downtown Montréal which gave us the opportunity to network with other students leading to interesting and inspiring conversations.

Thursday afternoon, consisted of the final key note speaker by Dr. Michel Labreque who gave a very interesting presentation on willows and why they are the number one tool for phytotechnology. He not only talked about willows effectiveness in remediating soils contaminated with hydrocarbons but also willows ability to absorb pesticide residues from soils.

The closing ceremony consisted of thanking everyone who helped in the organization of such a successful conference followed by the awards for the best student oral presentation and poster. A trip was then made to visit the Montréal Botanical Garden which is a living museum of plants from all over the world as well as a light show that took place in the evening. Friday consisted of a field tour where we got the opportunity to see the use of phytotechnology in the field such as the use of constructed wetlands that could treat ground water contaminated with organic compounds.

However, I could not have participated in the 14th International Phytotechnologies Conference without this student funding. It was a great opportunity for me to discuss my research and to establish new contacts potentially leading to collaborations in the future. Therefore I sincerely thank the BPS for their financial support.

AlgaEurope Conference

Serena Lima, serena.lima@unipa.it.

The AlgaEurope Conference happens every year and I had the pleasure to attend the last edition in Berlin, from 5th to 7th December 2017 in Berlin, Germany. The three-day conference is an opportunity for the exchange between academia and industry in the field of Industrial Algae. The aim of the conference is to create an environment for the discussion of the evolution of the Algae Biomass sector worldwide and to understand the role of the main European Players. The conference was attended from more than 230 participants coming from all over the World. The program was quite intense; in fact more than 60 speakers were invited to talk. There was also a good poster session with more than 50 posters. The talks were informative and good quality and the keynotes were by experts in the academia or industry. They resulted inspiring to enlarge my vision of possible applications in the microalgal fields. I found a very diverse range of topics in the talks. There were academics in several fields as well as companies, both presenting high-quality scientific results. It was one occasion in which the companies of producers,

the one of manufacturers and researchers had a direct discussion in order to focus on the communal objectives for the future. I found also interesting to discover how many European projects are funded in the fields of Industrial microalgae and of course to discover innovative applications in the field that were new for me.

Thanks to the organizing committee had the pleasure to present my work in a 20-minute oral presentation, and this helped me to find new partners for my research, which was certainly a good outcome of the conference. It was a great growth experience under a professional point of view. In the same time, I had the pleasure to meet people from several research institutes and from companies during the several social opportunities we had, such as coffee breaks and a pleasant social dinner in an Italian restaurant. I would like to thank the conference organizing committee for organizing this excellent conference, which resulted in a great experience under several points of view. I am grateful to the British Phycological Society for allowing me to attend and present my work during this nice experience.



Freshwater Algal Flora of the British Isles - Update 6

David M John and Brian A. Whitton
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The current update takes account of nomenclatural/
taxonomic changes and taxa recorded from Britain and
Ireland since publication of the 2nd edition of *The Fresh-
water Algal Flora of the British Isles* (John *et al.* 2011)
and not mentioned in earlier updates. Further informa-
tion on many of the changes is given in the continuously
up-dated AlgaeBase (Guiry & Guiry 2018) website along
with additional references.

Nomenclatural Changes (to March 2018)

Acutodesmus acuminatus (Lagerheim) Tsarenko now
regarded as a taxonomic synonym of *Tetradesmus*
lagerheimii (Lagerheim) M.J.Wynne et M.D.Guiry (non
Tetradesmus acuminatus C.-C.Jao et Z.-Y.Hu)

Acutodesmus dimorphus Turpin now *Tetradesmus dimor-
phus* (Turpin) M.J.Wynne

Acutodesmus obliquus (Turpin) Tsarenko now *Tetrades-
mus obliquus* (Turpin) M.J.Wynne

Acutodesmus pectinatus (Meyen) Tsarenko now
Pectinodesmus pectinatus (Meyen) E.Hegewald, M.Wolf,
Al.Keller, Friedl et Krienitz

Acutodesmus pectinatus (Meyen) Tsarenko var. *bernar-
dii* (G.M.Smith) Tsarenko now *Tetradesmus bernardii*
(G.M.Smith) M.J.Wynne

Acutodesmus wisconsinensis (G.M.Smith) Tsarenko now
Tetradesmus wisconsinensis G.M.Smith

Batrachospermum atrum (Hudson) Harvey now *Atro-
phycus ater* (Hudson) Necchi et Rossignolo

Cosmarium variolatum P.Lundell var. *skujae* Croasdale,
nom. inval. now *Cosmarium hostensiense* Štastný et
Kouwets

Štastný & Kouwets (2012) renamed and changed the
status of this taxon since originally described without a
Latin diagnosis.

Dilabifilum arthopyreniae (Vischer et Klement) Tschermak-Woess now *Pseudendoclonium arthopyreniae*
(Vischer et Klement) Darienko et Pröschold

Dilabifilum printzii (Vischer) Tschermak-Woess now
Ctenocladus printzii (Vischer) Darienko et Pröschold

Gymnodinium aeruginosum F.Stein now *Nusuttodinium*
aeruginosum (F.Stein) Y.Takano et T.Horiguchi

Micrasteria fimbriata Ralfs *pro parte* now *M. compere-
ana* Neustupa, Štastný et Škaloud

Neustupa *et al.* (2014) undertook a genomic investiga-
tion of *M. fimbriata* and recognized two clearly delimit-
ed monophyletic clades and created the above species.

Oocystella solitaria (Wittrock) Hidák now regarded as a
synonym of *Neglectella solitaria* (Wittrock) Stenclová et
Kastovsky

Penium spirostriolatum J.Barker var. *amplificatum*
M.Schmidt now *Penium amplificatum* (M.Schmid) Van
Westen et Coesel

Pseudendoclonium basiliense Vischer now *Hazenien*
basiliensis (Vischer) Škaloud, Nedbalová, Elster et J.Komárek

Darienko & Pröschold (2018) transferred *Pseudeno-
clonium basiliense* to the genus *Chamaetrichon* so creat-
ing the combination *C. basiliense* (Vischer) Darienko
et Pröschold. Originally they intended transferring it to
Hazenien but believed this genus had not been validly
published, but Škaloud & Leliaert (2018) reinstated
Hazenien on discovering the type culture had been per-
manently preserved and therefore proposed the above
combination.

Pseudendoclonium basiliense Vischer var. *brandii sensu*
Tupa now *Vischerioclodium submersum* Darienko et
Pröschold

Spirogyra grevilleana (Hassall) Kützing now *Spirogyra*
weberi Kützing var. *grevilleana* (Hassall) O.Kirchner

New Desmid Records

Several new records discovered in samples from Kelly
Hall Tarn (SD 288699), Long Moss Tarn (SD 291936),
School Knott Tarn (SD 428972) and habitats on Loughrigg
Fell (NY 364040) collected in September 2017 during the
joint BPS/Quekett Microscopical Club field weekend in
the English Lake District.

Those new desmids identified by David Williamson are
indicated by a single asterisk and those by Marien van
Westen have two asterisks.

Actinotaenium trachypolum (West et G.S.West) Teiling**
Pond ('lily pond') on Loughrigg Fell.

Closterium acerosum Ehrenberg ex Ralfs var. *borgei*
(Borge) Willi Krieger*
School Knott Tarn.

Cosmarium difficiloides Kouwets**

Long Moss Tarn, School Knott Tarn and Loughrigg Fell
According to Kouwets (2001), it is similar to *C. difficile*
but smaller in size and has easily overlooked minute
pores so might have been easily mistakenly identified for
it.

Cosmarium discrepans Štastný et Kouwets

According to Štastný & Kouwets (2012), this species has been mistakenly reported as *C. punctulatum* Brébisson var. *subpunctulatum* (Nordstedt) Børgesen (synonym *C. punctulatum*) in the Shetlands (Williamson 1992, figs 19, 4) and probably by West & West (1897, pl. 6, fig. 19) in the South of England.

Cosmarium medioretusum Coesel**

Long Moss, Kelly Hall Tarn and School Knott Tarn.

Closterium pseudocostatum Štastný et Kouwets

According to Štastný & Kouwets (2012), the illustration of material from the west of Ireland recorded as "*Cosmarium costatum* var. *erectum*" by John & Williamson (2009, p. 32, pl. 4a) is probably this species.

Cosmarium subochthodes Schmidle var. *maius* Schmidle*

Long Moss Tarn.

Euastrum luetkemuelleri Ducellier var. *carniolicum*

(Lütke Müller) Willi Krieger**

Variety recorded in a small stream and 'black mire' pool on Loughrigg Fell.

Euastrum pseudotuddalense Messikommer**

Puddle on Loughrigg Fell and easily overlooked because of its small size according Marien van Westen (*pers. comm.*).

Micrasterias truncata Ralfs var. *quadrata* Bulnheim**

Small stream on Loughrigg Fell.

Spirotaenia beijerinckii Coesel**

Small stream on Loughrigg Fell.

Staurastrum brachioides Coesel et Van Westen**

A puddle and in two "mire pools" on Loughrigg Fell. According to Marien van Westen (*pers. comm.*), this is a very distinctive species that is smaller than *S. brachiatum* Ralfs and its ends are less pronounced.

Staurastrum forficulatum P.Lundell var. *verrucosum*

Grönblad**

Recorded from "Lily Tarn" on Loughrigg Fell.

Staurastrum simonyi Heimerl. var. *semicirculare* Coesel**

Small stream on Loughrigg Fell.

Staurastrum productum (West et G.S.West) Coesel et

Meesters*

Kelly Hall Tarn.

David Williamson (*pers. comm.*) mentions that it is easily mistaken for other morphologically similar taxa with this the most appropriate name for material from this tarn because having distinctively flattened verrucae.

Staurodesmus convergens (Ehrenberg) Teiling var. *wollei*

Teiling*

School Knott Tarn

Staurodesmus extensus Teiling var. *rectus* (B.Eichler et

Raciborski) Coesel et Meesters**

Small stream on Loughrigg Fell.

Xanthidium antilopaeum Kützing var. *minneapolisense*

Wolle**

Small stream on Loughrigg Fell.

Other new records

Chara virgata Kützing var. *barbata* (U.Ganterer) J.A.C.van Raam

Collected in Yardley Chase, Northamptonshire by C.R.Carter in August 2015 and identified by N.F.Stewart.

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Acknowledgements

Many thanks to David B.Williamson and Marien van Westen who provided the new desmid records, Dr Christopher J. Carter for other records and some information on nomenclatural changes, Prof. Michael D.Guiry for assistance with literature and nomenclature; special thanks to Dr Martyn Kelly who organized the thel BPS/Quekett weekend in the English Lake District that resulted in the new desmid records.

Joint BPS/Quekett Microscopical Club field meeting, Windermere, September 2017

On a Friday afternoon back in September, a small convoy of vehicles made its way from the Freshwater Biological Association, on the west side of Windermere, via Hawkshead and Coniston, to two small tarns known to be rich in desmids. The dozen or so people in those vehicles were the advance guard from a BPS and Quekett Microscopical Club field weekend, collecting our first batch of samples with guidance from Dave John.

Readers of *The Phycologist* will be aware that a number of excursions have been organised in recent years in search of seaweeds. Field meetings such as these were a feature of the BPS in the past but had dropped off the agenda in recent years. The success of the marine field meetings encouraged a few of us to extend the exercise to freshwaters. Keen, too, to fulfil the BPS' commitment to education and outreach, we approached the Quekett Microscopical Club, a long-established society for amateur microscopists. The result was a fruitful symbiosis between expertise (see Dave Johns, ... and David Williamson's account elsewhere in this issue) and enthusiasm, all set against the backdrop of Windermere on an unseasonably warm September weekend.

Desmids are a great group to study on a weekend such as this. Not only does the Lake District have many sites known to be rich in desmids but they are very beautiful to look at whilst their relatively large size makes them easy to view. Samples from five tarns provided more than enough material to keep fifteen people happy for an entire weekend.

You can read more about the weekend by following these links:

<https://microscopesandmonsters.wordpress.com/2017/09/17/desmid-masterclass/>

<https://microscopesandmonsters.wordpress.com/2017/09/21/lessons->



Dave John demonstrating how to collect desmids by squeezing Sphagnum at Long Moss Tarn, Cumbria, September 2017.

Participants at the British Phycological Society / Quekett Microscopical Club field weekend at the Freshwater Biological Association, September 2017. Scale bar: one metre (= roughly 2,000 desmids).

from-school-knott-tarn/

<https://microscopesandmonsters.wordpress.com/2017/09/23/different-tarn-different-desmids/>

<https://microscopesandmonsters.wordpress.com/2017/09/28/taking-desmids-to-the-next-dimension/>

Having re-established the principle of freshwater field meetings, and made friends with Quekett members, we are now looking towards the next trip, probably to Ennerdale Water and its environs in autumn 2019.

Martyn Kelly

Analysis of the Desmids collected during the BPS/Quekett Microscopical Club weekend in the English Lake District

Background

Four out of the six European Important Plant Areas (IPAs) for desmids in the UK are within the English Lake District (John & Williamson, 2006) and qualify for this designation under various criteria, including desmid diversity (>70 spp.) and having several potential UK Red List and European Red List taxa. Two of the three tarns sampled (Kelly Hall, Long Moss) during the BPS/Quekett Microscopical Club field excursion in September 2017 have been designated IPAs of European importance for desmids. A similar conservation status was given to Loughrigg Fell (NY364040) where many desmid-rich, slightly 'acidic', oligotrophic aquatic habitats (e.g., puddles, pools, Lily Tarn, small streams) contain a number of suggested UK Red List desmids (see John & Williamson, *op. cit.*) and at least 10 European Red List desmids. One of us (MVW) stayed on after the weekend of the field excursion and sampled nine desmid-rich habitats on Loughrigg Fell and resampled Kelly Hall and Long Moss tarns but not School Knott Tarn, the third tarn studied.

The English Lake District lived up to its reputation as one of the most desmid-diverse areas in the British Isles with over 300 taxa recorded in just a

few days. The excursion provided not only an opportunity to add to the existing body of information on important desmid-rich sites, but enabled us to compare our findings with earlier ones and further supported the conservation status of these sites. Most of the samples were collected by squeezing floating mats of the moss *Sphagnum*, occasionally the bladderwort *Utricularia minor* and submergent aquatics. Identified separately were sets of samples collected by Dr Frans Kouwets and one of us (MVW) who also photographed many of the desmids. Other samples were pooled and identified and drawn by another of the authors (DBW). The separate desmid collections were compared to determine whether a few samples from the same small lake are sufficient to be really representative of the desmid flora.

Results

The findings in Table 1 show a high desmid-diversity in all three tarns, including School Knott Tarn whose desmid numbers were relatively low in pre-2000 surveys and was one of the reasons the tarn was not one of the designated desmid IPA. As a result of the present study, the desmid flora of this tarn stands at 111 although only

10% of those discovered in September 2017 were recorded in earlier surveys extending back to the 1970s. What was also surprising was the low number of desmids in common when our different sets of samples were compared despite having been collected in the same tarn on the same occasion or within just a few days. These differences probably relate to several factors, including chance and different microhabitats existing along the shoreline of a water body the size of a tarn. Unless such a water body is thoroughly sampled at numerous points, then it is probably unsafe to conclude that a previously recorded species is no longer present.

The conservation status of Kelly Hall Tarn, Long Moss Tarn and School Knott Tarn is further supported by their high desmid diversity thanks to the addition of a further 26, 57 and 23 taxa respectively. The conservation status of these tarns is also enhanced by the fact that some of the new records are of desmids recorded for the first time in the UK and therefore are of potential UK Red List taxa. The following are new UK records: *Closterium acerosum* Ehrenberg ex Ralfs var. *borgei* (Borge) Willi Krieger (School Knott Tarn), *Cosmarium diffractoides* Kouwets (Long Moss Tarn,

Table 1. An analysis of the desmids identified by two of us (DBW, MVE) from the three tarns collected in September 2017 and a comparison with earlier records.

TARNS	KELLY HALL	LONG MOSS	SCHOOL KNOTT
Grid ref.	SD28893	SD291936	SD428967
MVW records	78	108	47
DBW records	60	48	55
Total number	111	137	88
% similar	22.5	45	19
Pre-2000 records	67	119	33
Pre-and post-2000 taxa in common (%)	31	30	10
TOTAL ALL RECORDS	137	194	111

LONG MOSS TARN

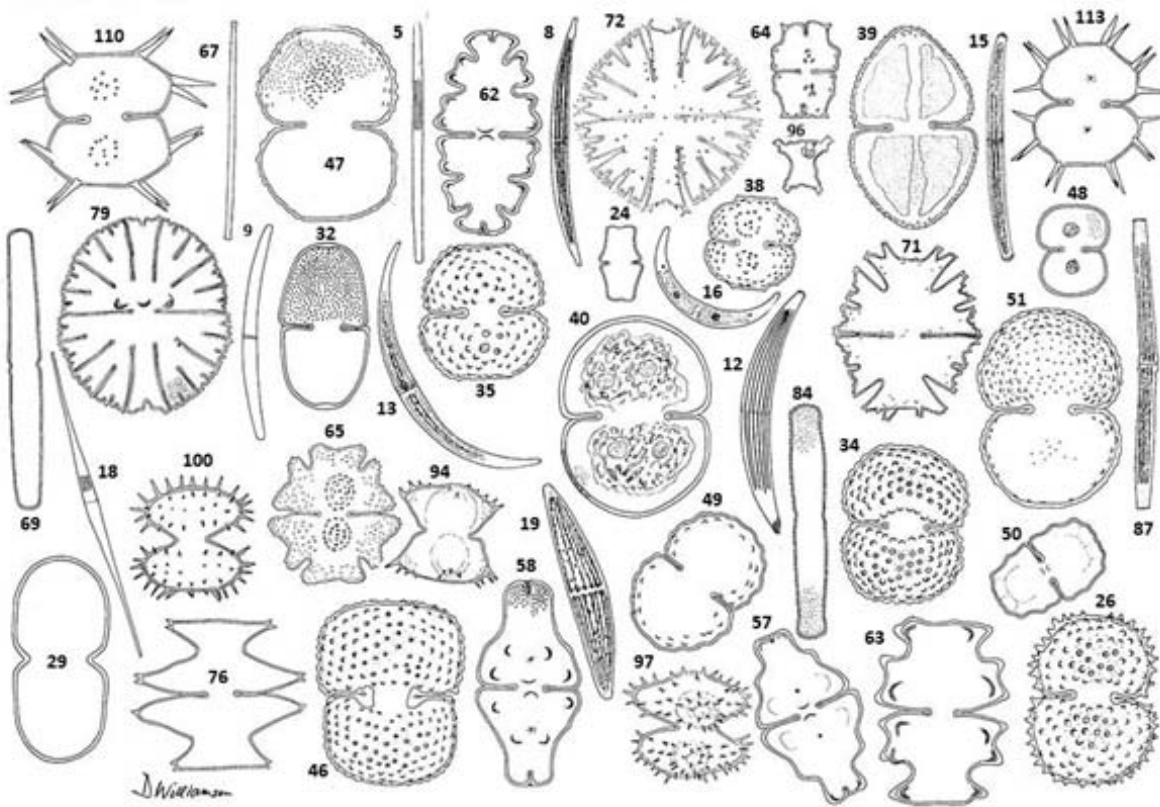


Fig. 1. Collage of desmids identified and drawn by one of us (DBW) from Long Moss Tarn, one of three collages with others dealing with the two other tarns. Drawn at different scales to roughly balance the arrangement on the collage, sizes adjusted so important details are visible, no details of the chloroplasts since all samples were formalin-preserved, and not all desmids are included especially very long ones.

5-*Closterium angustatum*; 8-*Closterium attenuatum*; 9-*Closterium baillyanum* var. *alpinum*; 12-*Closterium costatum*; 13-*Closterium diana* var. *arcuatum*; 15-*Closterium didymotocum*; 16-*Closterium incurvum*; 18-*Closterium kuetzingii*; 19-*Closterium lunula*; 26-*Cosmarium brebissonii*; 32-*Cosmarium hostensiense*; 34-*Cosmarium margaritatum*; 35-*Cosmarium margaritiferrum*; 38-*Cosmarium ornatum*; 39-*Cosmarium ovale*; 40-*Cosmarium pachydermum*; 46-*Cosmarium quadrum*; 47-*Cosmarium subochthodes* var. *majus*; 48-*Cosmarium subtumidum* var. *groenbladii*; 49-*Cosmarium subundulatum*; 50-*Cosmarium tetragonum* var. *ornatum*; 51-*Cosmarium tetraophthalmum*; 57-*Euastrum ampullaceum*; 58-*Euastrum ansatum*; 63-*Euastrum pectinatum*; 64-*Euastrum pulchellum*; 65-*Euastrum verrucosum*; 67-*Gonatozygon brebissonii*; 69-*Haplotaenium minutum*; 71- *Micrasterias americana* var. *boldtii*; 72-*Micrasterias compereana*; 76-*Micrasterias pinnatifida*; 79-*Micrasterias thomasiana*; 84-*Pleurotaenium exiguum*; 87-*Pleurotaenium ehrenbergii*; 94-*Staurastrum cristatum*; 96-*Staurastrum inconspicuum*; 97-*Staurastrum kouwetsii*; 100-*Staurastrum polytrichum*; 110- *Xanthidium antilopaeum*; 112-*Xanthidium antilopaeum* var. *polymazum*; 113-*Xanthidium cristatum*.

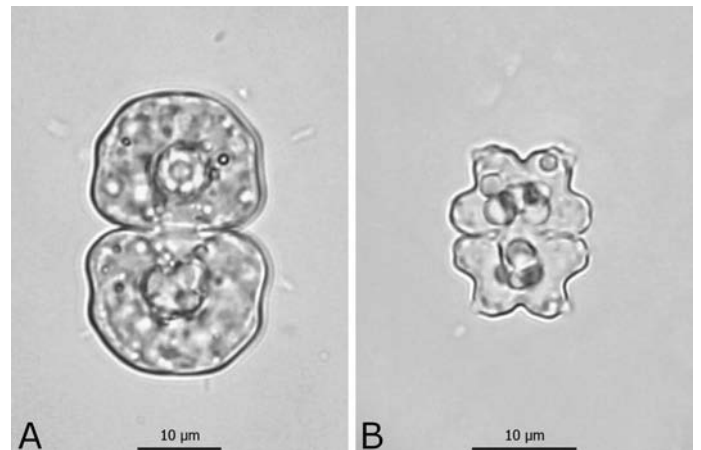


Fig. 2. *Cosmarium difficiloides* and *Euastrum pseudotuddalense*, with the former collected from a small stream and the latter from a puddle on Loughrigg Fell - one of several desmids newly recorded from the British Isles. Photos by Marien van Westen.

School Knott Tarn), *Cosmarium medioretusum* Coesel (Long Moss Tarn, Kelly Hall Tarn, School Knott Tarn), *Cosmarium subochthodes* Schmidle var. *maius* Schmidle (Long Moss Tarn), *Staurastrum productum* (West et G.S.West) Coesel et Meesters (Kelly Hall Tarn) and *Staurodesmus*

convergens (Ehrenberg) Teiling var. *wollei* Teiling (School Knott Tarn). The discovery in School Knott Tarn of seven taxa in European Red Lists (three originally suggested UK Red List desmids) and increase in desmid diversity to 110 taxa makes it eligible to be considered a European IPA for

desmids. The conservation status of the other two tarns is given further support through the discovery of additional possible UK Red List desmids (about six) and a further seven in each tarn that are in European Red Lists.

The desmids records from nine desmid-rich habitats on Loughrigg Fell by one of us (MVW) are difficult to compare with earlier lists. The new records from the Fell have increased the desmid flora to over 200 taxa of which almost 30 are suggested UK Red List taxa, eight are in European Red Lists and the following 10 are new UK records: *Actinotaenium trachypolum* (West et G.S.West) Teiling, *Cosmarium difficiloides* Kouwets (Fig. 2A), *Euas-trum pseudotuddalense* Messikommer (Fig. 2B), *Micras-terias truncata* Ralfs var. *quadrata* Bulnheim, *Spirotaenia beijerinckii* Coesel, *Staurastrum brachiatoides* Coesel et Van Westen, *Staurastrum forficulatum* P.Lundell var. *ver-rucosum* Grönblad, *Staurastrum simonyi* Heimerl. var. *semicirculare* Coesel, *Staurodesmus extensus* Teiling var. *rectus* (B.Eichler et Raciborski) Coesel et Meesters, *Xan-thidium antilopaeum* Kützing var. *minneapolisense* Wolle.

The desmid method developed by Coesel (1998) for evaluating the conservation value of waterbodies in Europe has been applied to desmid lists from the tarns. In the method every desmid species in a sample is given a 'rarity' value and another value for how indicative is a species of a specific environment ('symptomatic'), with values ranging from 0-3 for each attribute (3 for very rare and 3 for very symptomatic). The Nature Conservation Value (NVC) is calculated by summing all values and takes account number of species in determining a NVC value for between 0 and 10. Despite the limitation because rarity values are different for some taxa between Europe and the UK all tarns had high NVC values of 8 and above therefore further supporting the status of these tarns. Several of these rare species in Europe are also rare in the UK.

All the site-specific records associated with the field weekend will be entered into the BPS algal recording portal and some will be accompanied by photomicrographs contributed by one of us (MVW) and Dr Christopher Carter. Some photomicrographs of new additions to the desmid flora of the British Isles will be placed on the AlgaeVision website (Carter *et al.*, 2018).

Acknowledgements

Many thanks to Dr Martyn Kelly, who organized the very successful first joint BPS/ Quekett Microscopical Club field weekend in the English Lake District.

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A fertile find in Wales

Francis Bunker, BPS Secretary, secretary@brphysoc.org

The red alga *Bostrychia scorpioides* occurs all around Britain and Ireland (Maggs and Hommersand, 1993). It lives at the top of the shore, primarily in estuaries, where it grows in amongst saltmarsh plants but also on sheltered rocky shores, often shaded by overhanging trees. On rock, it is often found with the red alga *Catanelia caespitosa*.

Prud'homme Van Reine and Sluiman (1980) and Maggs and Hommersand (1993) reported how reproductive structures are rarely seen in Britain, with all records to date occurring in the south coast of England between 1882 and 1888 (Prud'homme Van Reine and Sluiman, 1980). Studies of *B. scorpioides* in culture by Prud'homme Van Reine and Sluiman (1980) suggest that prolonged high summer temperatures are required for the formation of tetrasporangial stichidia.

Of the hundreds of samples of *Bostrychia scorpioides* examined by Prud'homme Van Reine and Sluiman (1980) only four bore cystocarps and these were on specimens collected at Portland and Weymouth between 1884 and 1888. Since then there have been no published records from Britain and Ireland.

A plant was found with cystocarps in various stages of development at Lawrenny Quay in the Milford Haven Waterway, West Wales. The find was made in September 2015 while undertaking rocky shore monitoring in the Pembrokeshire Marine SAC for Natural Resources Wales. The site is west-facing rock, in the mid-section of the Dauceddau estuary and is fairly well shaded by oak woodland backing the shore.



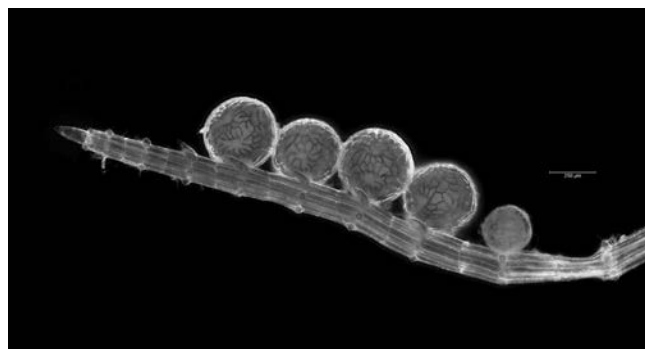
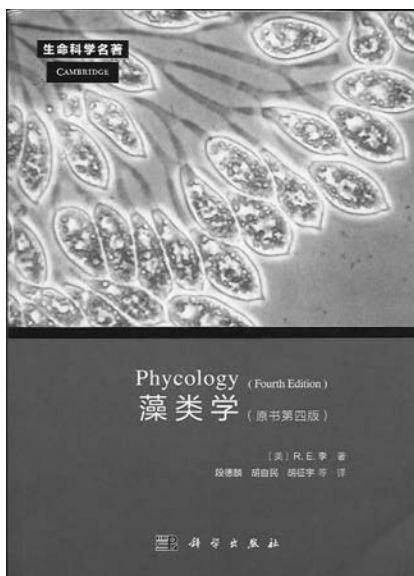
Figure 1. *Bostrychia scorpioides* by a saltmarsh creek



Figure 2. Cystocarps from Lawrenny Quay specimen. Width of cystocarp approximately 500 μ m in diameter.

Advert

A Chinese language edition of the fourth edition of *Phycology* by Robert Edward Lee has been published by the National Academy of Sciences of China. It can be purchased from Amazon.cn for Y380.



Chara antheridia – by Chris Carter, candr.carter@gmail.com, from The Lizard, Cornwall UK. Collected by Paul Gainey. This was one of the short-listed entries for The Tinmes photographic competition in 2017 on the theme of 'The Hidden World', <https://www.rsb.org.uk/get-involved/rsb-competitions/photography-competition/2017-winners>

This is a line of antheridia on a male branch of the stonewort '*Chara fragifera*', one of the algae. Each sphere has a closely-knit set of 'shield cells' with a black outline that give a dramatic setting to the red colouration. This *Chara* is rare (probably Cornwall only) in a few wetland areas and is not always fertile or in peak condition for photography. Even if found it would take some effort to see this and reveal the structure in a communicable way. In a short while the shield cell will burst open to release yet another hidden world inside:- tight coils of cells holding the motile antherzoids.

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