The Phycologist

The Newsletter of the British Phycological Society
Editor: Dr Amanda Burson
Homepage: http://www.brphycsoc.org/

68th Annual General Meeting

Manton Prize Winners

Algae identification courses

Number 98- Spring 2020

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2020
British Phycological Society

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Student Representative[6]

Vacant

Editorial

We had another great annual meeting with number 68 hosted by the University of Plymouth! In this issue we have the usual post-meeting highlights: presentation abstracts, general meeting minutes and some re-caps on the events. There's quite a few bursary and internship reports to read as well, including those from some of our first early career bursary recipients! As a personal highlight, there was a chance meeting of the past two *Phycologist* editors, Alison Taylor and Jan Krokowski, and myself! It was nice to swap stories and get some handy tips. Finally, a short but fond farewell to a beacon of the British algal community, Linda Irvine.

Best,

Amanda Burson

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 https://brphycsoc.org/the-phycologist-back-issues/

TABLE OF CONTENTS

Front and back cover drawings by Debby Mason **www.debbymason.com**

The 68th British Phycological Society Meeting 6-9 January 2020

Submitted by Clare Marshall, CPR Plankton Analyst at the MBA and Chair of the BPS Volunteer Committee

January 2020, saw over 130 delegates and speakers from around the world gather in Plymouth, UK for the 68th British Phycological Society Meeting. The Marine Biological Association (MBA), The University of Plymouth and Plymouth Marine Laboratory collaborated to deliver the event. I work at the MBA as a Plankton Analyst with the Continuous Plankton Recorder (CPR) Survey, so I was excited we were hosting the conference here in Plymouth. I had taken the role of Chair of the BPS Volunteer Committee back in September 2019. Together, with a team of nine other volunteers and the university events team, we organised the raffle, the student icebreaker session and a full timetable to assist during the conference itself, ensuring everything ran smoothly (we hope we achieved that).

A drinks reception held at the Marine Biological Association on Monday evening kick-started the week. Those new to Plymouth had the opportunity to appreciate its stunning beauty as the MBA overlooks the striking Plymouth Sound. The MBA membership team were present and many delegates were impressed to see the Continuous Plankton Recorder from the CPR Survey and learn how the plankton samples are collected (both phytoplankton and zooplankton); including on our local route Plymouth to Roscoff, on the Brittainy Ferry.

The University of Plymouth hosted the remainder of the conference. Grégory Beaugrand gave an interesting and informative keynote lecture about phytoplankton responses to climate, using historical data collected by the CPR Survey. A great day of Manton Prize talks, delegate talks and two minute poster pitches followed, with volunteers running around the lecture theatres assisting with question and answer sessions. An enjoyable evening Poster Session ensued, enabling those not giving a talk to network. Many enjoyed the sustainably sourced canapés and some delightful wines. Contacts were made and research shared, hopefully forging into 2020 with some great ideas.

There were many stands displaying new microscope technology, algae cultivation and biotechnology techniques and a local artist, Debby Mason, (who provided the drawings of algae for the BPS conference handbook cover) exhibited her work.

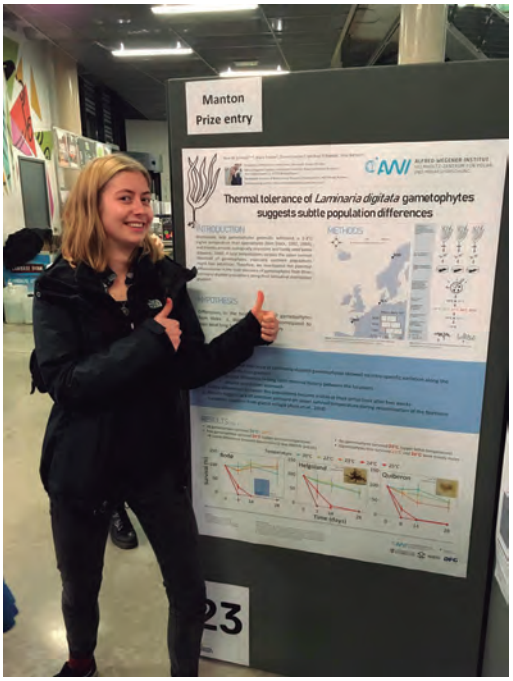
The following day, more Manton Prize talks and Special Sessions took place. Alexandra Campbell joined us from the University of the Sunshine Coast in Australia, giving an insight into seaweed-microbe interactions and seaweed restoration projects, whilst Prof. Graham Underwood, current president of BPS, delivered the Public Lecture "Thin films of life and the challenges of changing environments".

A particular highlight of the week was the evening dinner and Ceilidh. During this, Graham Underwood was given special thanks for his role as president over the past two years. Prof. Jason Hall-Spencer from the University of Plymouth took the baton. The two Manton Prize winners were rewarded for their hard work and research; Daniel Liesner (Alfred Wegener Institute) for the best talk and Nele Schimpf (Alfred Wegener Institute and University of Plymouth) for the best poster. Raffle prizes donated by local businesses were handed out and some of us were given signed copies of "Seaweeds of Britain and Ireland", which I will thoroughly enjoy reading and working with. The Ceilidh band "Fox Amongst the Chickens" then began entertaining us. Amazing and so much fun; everyone enjoyed the musical delights, with most people getting up on the dance floor.

On the final day of the conference, algae talks continued throughout the morning. A few of the remaining delegates had the opportunity of a tour at the University Marine Station, testing their local seaweed identification skills. Whilst on the sunny but windy afternoon, one of the other volunteers and I joined another small group of delegates, for a plankton sampling session on board Wavedancer; the University research vessel.

I would like to say a huge "Thank You" to all of the BPS volunteers and events staff for their enthusiasm and hard work. We certainly did Plymouth algae proud. As a lover of all things algal, it was great to be part of BPS 2020. Looking forward to next year!

Manton Prize
Poster Winner



Nele Schimpf nele.schimpf@students.plymouth
Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Bremerhaven, Germany

Poster Title: Thermal tolerance of *Laminaria digitata* gametophytes suggests subtle population differences

I am an undergraduate student at the University of Plymouth studying for my BSc in Marine Biology and Oceanography. It is a very hands-on degree and I have enjoyed the many laboratory practicals, boat trips and fieldtrips along the south-west coast of the UK. The best parts so far, were the field excursions abroad to Brittany, France and Fiskebäckskil, Sweden, which gave me invaluable and unforgettable impressions, both biological, oceanographical and cultural. While most of my peers were interested in the crabs, snails and starfish, I couldn't help but notice the sheer variety and beauty of seaweeds, especially in Brittany. Since then I have grown more and more fond of seaweeds, doing lots of voluntary work in the laboratory at the University, helping out with maintaining *Ectocarpus* cultures, and later on assisting a PhD student with his work on the production of, and damage caused by, reactive oxygen in *Ulva*, *Chondrus* and *Fucus*.

As part of my degree, I decided to undertake a placement year at the Alfred Wegener Institute (AWI) Bremerhaven, Germany. The AWI is a world-renowned institute for polar and marine research and so I was determined to do my placement there. I was pleased to be accepted into the functional ecology section at the AWI, doing experiments on the upper thermal tolerance of *Laminaria digitata* gametophytes. On the one hand, this has involved many therapeutic hours of counting gametophytes under the microscope, and will involve many more. On the other hand, my placement has unexpectedly also involved two trips abroad. During the third week of my placement I was spontaneously invited to go along on a phycological field trip to Brittany, and was very grateful to be able to explore the beautiful, seaweed-rich rocky shores of Brittany again. The next great news came when my supervisor announced that a group of us would be attending the 68th annual British Phycological Society Conference in January 2020, in Plymouth (of all places!), me included.

So at the start of January, a cohort of five of us from the AWI made our way to a very rainy and foggy Plymouth – what else would you expect? It was my first conference, so I was quite excited and nervous. I was one of the few undergraduates at the conference, so I felt a little out of my depth and intimidated by so many accomplished scientists and phycologists. However, after a very entertaining and fun phycological quiz during the student icebreaker at the MBA on Monday evening, I was much more relaxed and looking forward to the next few days.

The conference was well-organised and well-attended by many local and international phycologists, but still had a very familiar atmosphere. In between the presentation sessions, we had many short, productive breaks with lots of chatting, networking and twittering going on. There was plenty of good food and drinks, and the dinner on Wednesday night was very enjoyable. Especially the ceilidh was great fun, even though I made a mess of it.

I was very impressed with the talks, although some were a bit too complex for me. It was nevertheless very interesting to learn about all the different algae research going on across the world, and overall it proved to be rather thought-provoking as to what kind of work I would like to pursue in the future. The poster session on Tuesday evening was a great success, with lots of interesting posters. I really enjoyed sharing my knowledge with so many interested phycologists and I realised how much I have already learned during the past three months of my placement. Having almost forgotten there was a prize to win and not expecting in the least to win, I was even more surprised and honoured when I was announced the winner of the Manton Prize for best student poster - all those hours of counting gametophytes under the microscope paid off! I could not have done it without the guidance and support of my supervisor, Dr Inka Bartsch, and all the co-authors of the poster. Finally, I would like to thank the organising committee and everyone else involved for making this conference a great experience.

Manton Prize
Presentation Winner

Daniel Liesner daniel.liesner@awi.de
Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Bremerhaven

Talk title: Local differentiation in heat response of *Laminaria digitata* at the range edges

First impressions matter. That makes algae a bit difficult to like initially. If someone encounters smelly chunks of decaying seaweed at the beach, cyanobacteria blooms in their favourite lake, or green mats in their pond at home, algae seem often a nuisance at first glance. However, a closer look reveals a fascinating world of diversity, beauty and global importance.

For me, that insight came quite late. Following school, I enrolled at the University of Rostock to study marine biology at the Baltic Sea, not quite knowing what to expect. Growing up surrounded by maize fields and cows in the German countryside, the ocean seemed inaccessible and mysterious, and I think that played a big role in my rather uninformed decision at the time. I enjoyed the basic courses and especially an exchange year abroad in Romania, but I was never quite sure where it would lead me. It was only in the fifth semester that a topic really drew me in, and that was phycology.

I began my deep dive into algae research guided by Prof. Ulf Karsten at the University of Rostock. He referred me to Dr. Inka Bartsch at the Alfred Wegener Institute (AWI) in Bremerhaven, where I conducted my Bachelor's thesis on the temperature tolerance of one of the most forgiving study organisms an inexperienced student can hope for – Fucus vesiculosus. I stayed in Rostock for my Master's degree, for which I entered the microscopic realm and investigated interactions of marine diatoms and zoosporic parasites with Dr. Bettina Scholz in the north of Iceland. Shortly before I graduated, I heard that my BSc supervisor Inka and Dr. Klaus Valentin were advertising a PhD position on temperature responses of kelp forest key species in a pan-European project. Naturally, I applied.

Now I am approaching the end of my PhD on temperature response plasticity in the kelp *Laminaria digitata*. I researched transgenerational temperature effects between gametophytes and sporophytes, I travelled along L. digitata's entire distribution range to investigate local temperature adaptation, and I performed crossing experiments between populations to assess heredity. It is exciting and challenging, and I am having a great time.

Part of the fun is of course communicating and discussing your hard-earned results. This year, our AWI macroalgae group finally arranged to join a BPS meeting for the first time with three talks and a poster. The meeting was off to a great start with the student icebreaker and a phycological quiz. The next day, Dr. Gerald Boalch brought everyone up to date with a 15-minute summary of the past 300 years of British phycology, which provided a great introduction to the following days. The high quality of presentations from seniors as well as students was astounding, and the familial atmosphere made for pleasurable breaks and chats over tea. The sessions covered a wide range of topics from climate change effects on algae, over marine forest ecology and restoration, to algal interactions, parasitism and holobiosis.

The Manton Prize sessions were a centrepiece of the conference. Because these sessions did not run in parallel, everybody was invited to focus on the early career scientists, which gave us an amazing platform to present our research. The cross-section of recent advances by Master's and PhD students from all over the globe, and the accompanying enthusiasm of the young researchers resulted in inspiring sessions and fruitful discussions. The Irène Manton Prize is a prestigious and highly competitive prize, which became evident in the quality of the presentations. Actually winning the Manton Prize was therefore as honouring as it was surprising to me, and I am extremely grateful for receiving it.

First impressions matter and my first impression of the BPS annual meeting could not be better. Thank you to all the organisers for a great conference full of scientific as well as cultural impressions (now I know what a ceilidh is and that I am terrible at it), and I am looking forward to seeing you at a future meeting!

Annual General Meeting Minutes
British Phycological Society
68th Annual General Meeting
Levinsky Room, Roland Levinsky Building, Plymouth University
17:00 – 18:00 Tuesday 7th January 2020

Present: Christine Campbell, Geoffry A. Codd,Eileen Cox, Maeve Edwards, Elizabeth Y. Haworth, Emily Hutchinson, Anne Jungblut, Hiroshi Kawai, Martin Kelly, Hannah Kemp, Regina Kolzenborg, Jan Krokowski, Keelan Lawlor, Jane Lewis, Adam Lewis, Christine Maggs, Clare Marshall, Linda Medlin, Dónal McGee, Suzanne McGowan, Hilary Redden, Michael Rodríguez, Kate Schoenrock, Teresa Shelly, Nicky Slee, Joe Taylor, Alison Taylor, Seth Thomas, Hennie Thomson, Graham Underwood (GU), Eleanor Wood, Jo Wilbraham, Chris Williamson, Martin Wilkinson, Chris Yesson.

1. Apologies

Andy Davies, Gill Malin.

2. Announcements

None.

3. Minutes of the 67th AGM, January 2019, SAMS, Oban

Proposal to accept these minutes: Juliet Brodie

Seconded: Martin Wilkinson

4. Matters arising

None.

5. Reports from Elected Officers

a. Secretary (Francis Bunker)

519 emails were received in 2019. These included some spam and many from organisations trying to sell their service to the BPS (conference organisers, bid writing advice etc.). Relevant correspondence was forwarded to appropriate members of Council to be dealt with or for advice as to how to deal with them. Selected events were forwarded to the Web Master (Andy Davies) for consideration of posting on the BPS web site.

The BPS insurance was renewed in the secretary's name on 12th November 2019 by the society's treasurer, Maeve Edwards.

b. Treasurer (Maeve Edwards)

BAccounts are not through from accountants but will be emailed to members as soon as they are received. An overview of current financial status was given (and is available on the web site). Subscription increase was discussed.

Payments

Expenditure on the current account has run normally in the last six months, with the majority of requests for payments running on time, with a few exceptions for both members of council and students, for which I apologise for any delays.

Accounts overview: Current balance, 3/1/20
Current a/c: £31,295.94
Savings a/c: £37,613.44
NS&I investment a/c: £97,314.77
WooCommerce (card payment facility linked to web payments): £540.00 (automatic payout to bank due 9/1/20)
Paypal: £4819.34 (manual payout to bank account after membership rush of January).
Total: £171,583.50

Outgoing funds committed but as yet unspent:
Prizes: £250
Travel: £8,396
Small grants: £12,792
Council: £808
Other (administration): £946
Total: £23,193

Accounts preparation

Accounts for 2017 and 2018 have been prepared and sent by the accountants in advance of this AGM, although I apologise for them not being produced earlier to allow for a longer period of reflection/query. I propose that the accounts can be distributed to the membership via email in the next few days and leave a time period of one week for comments before any corrections/explanations are made and submission to the Charity Commission.

The paperwork for the 2019 accounts is being prepared and will be ready by the summer council meeting.

Membership and website administration costs and implications – current and future

Financial capture of memberships appears to be going well, thanks to the systems put in place by Andy. The vast majority of memberships are now rolling over in January, which makes the tracking of society income much more efficient, although there are always those few that join any time during the rest of the year. However, these systems cost money to run, at approximately £1.76 per member after Paypal and WooCommerce fees and upgrades are taken into account, as well as website monthly hosting costs from Jolt. The good news is that this is nearly half as cheap as the financial administration costs in 2017 when we used Paypal and paid for the rental/use of a credit card machine (£3.21 per member).

While we need these online financial mechanisms in a digital age (particularly where over half of our subscription income comes from beyond the borders of the UK), it is still quite costly for us to gather them and I propose the council (and BPS membership) consider a modest increase in membership fee. To this end, I would propose that we discuss this at the summer council meeting and present a new subscription structure at the AGM 2021 that also includes a new category for businesses. We must also outline the clear benefits of the increased membership fee for all, which can then be used as recruiting material for a variety of different targets (e.g. young postgrads, early stage researchers, businesses etc.).

Graham Underwood commented that threats to BPS finances from Open Access is something to watch.

c. Membership Secretary (Hilary Redden)

On, 17th Dec 2019, the active membership of the Society was 376, this includes our 12 Honorary Life Members.

European Journal of Phycology

Of our 376 active members in 2019, 109 (29%) opt to receive the EJP by post. This is up from 59 members in 2018.

Membership breakdown

Membership Plan	No. of active members	% of Total
Honorary Membership	**12**	**3**
Ordinary Membership with Journal	**74**	**20**
Ordinary Membership without Journal	**147**	**39**
Retired Membership with Journal	**16**	**4**
Retired Membership without Journal	**18**	**5**
Student (3 year) Membership without Journal (NEW)	**37**	**10**
Student Membership with Journal	**7**	**2**
Gtv Student membership without Journal	**65**	**17**
Corporate Membership	**0**	**0**
Total Members Active	**376**	

Total membership (Fig 1) although up on 2018 is still nearly 100 members less than the heady days of 2010 (470 members). Why this is I don't know, but perhaps the new 3-year membership for students and the automatic renewals will keep members active as their annual renewal now requires no effort on their part.

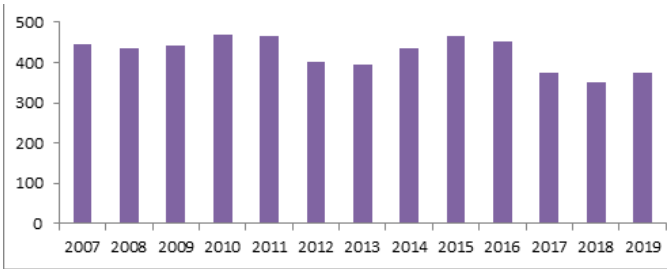


Fig 1. Total membership by year

Membership Country of Origin

Based on the suffix of their email and no other personal identifier, it can be seen that our membership comes from 36 different countries (Fig 2). Unsurprisingly the majority (216, 57 %) are British based email addresses. Of our other most welcome colleagues (43 %), 16 EU countries are represented, and the two largest non-British contingents are from the USA and Germany.

For more graphical information on the country of origin of BPS members please see the Membership report at https://brphycsoc.org/annual-general-meeting/

Database and Renewals

As we have had a full year of the online membership application and payment methods I can report that most but not all membership attempts are successful. There are 8% of which fail or pause. Examination of these usually indicates some problem at the PayPal payment end which is the responsibility of the applicant. These are often an expired payment card or miss-type into an information field and a successful membership application is subsequently made when the flawed attempt is abandoned, and information resubmitted.

Membership attempts		
Successful	Active	376
Flawed (8%)	Cancelled	7
	Expired	8
	Paused	5
	Pending	11
	Total	407

However, if on examining your membership details on the website that you discover you have miss-typed any information e.g. a post code you should be able to edit it yourself or send the correction to the membership secretary (membership@brphycsoc.org) for editing.

d. Student Representative (Amie Parris)

No report submitted.

6. Reports from the Editors and Webmaster (*https://brphycsoc.org/)

A. Joint Editors of the *European Journal of Phycology* and *Applied Phycology* (Chris Maggs and Juliet Brodie)

Editors in Chief, Editorial Assistant and Associate Editors

Christine Maggs and Juliet Brodie have been joint Editors in Chief for the period. Caroline Magill continues as Editorial Assistant.

Associate Editors are unchanged since last year's report but we are very sorry to report the recent sudden death of Prof. Mario Giordano, Ancona, one of EJP's Associate Editors for Biochemistry and Physiology.

General Comments

The last 12 months have been very busy with 148 new submissions to the journal. Adding revised papers coming back to that figure, there was a turnover of 228 papers handled in the last 12 months.

2019

Volume 54 Issue 1 February 2019 (published in Feb) – 128 pp
Volume 54 Issue 2 May 2019 (published in April) – 124 pp
Volume 54 Issue 3 August 2019 (published in August) – 272 pp (larger issue to clear papers)
Special Issue: Abstract booklet for EPC7 – published in August ahead of the conference
Volume 54 Issue 4 November 2019 (published in December) – 124 pp

Manuscripts submitted by author country Jan 1st to Dec 31st

148 submissions from 44 countries.

For more graphical information on the country of origin of submission authors please see the EJP report at https://brphycsoc.org/annual-general-meeting/

Decisions made on manuscripts Jan 1st to Dec 31st

Accept ratio 37:34 (33.3%)

Decision	# of manuscripts
Accept	37
Reject with Transfer	29
Reject	35
Reject-Inappropriate	10

For graphical information on submission to decision times please see the EJP report at https://brphycsoc.org/annual-general-meeting/

Journal Impact Factor

European Journal of Phycology's 2018 Impact Factor increased to 2.562 from its 2017 value of 2.481. It is now at its highest ever level. The *EJP* five-year impact factor has increased from 2.335 to 2.621. However, due to rising IF in other journals *EJP* is still (just) Q1 in Marine & Freshwater Biology and continues to be Q2 in Plant Sciences.

Top cited papers for the 2018 Impact Factor (papers published in 2016 and 2017)

Journal Impact Factor contributing items: Citable items in 2017 and 2016 (78); Citations in 2018 (197)

• *Seaweed production: overview of the global state of exploitation, farming and emerging research activity* Buschmann, Alejandro H.; Tadmor-Shalev, Niva; Critchley, Alan T.; Camus, Carolina; Infante, Javier; et al. (20 citations)

• *A polyphasic approach for the taxonomy of cyanobacteria: principles and applications* Komarek, Jiri (18 citations)

• *The genera Melanothamnus Bornet & Falkenberg and Vertebrata SF Gray constitute well-defined clades of the red algal tribe Polysiphonieae (Rhodomelaceae, Ceramiales)* Diaz-Tapia, Pilar; McIvord, Lynne; Freshwater, D. Wilson; Verbruggen, Heroen; Wynne, Michael J.; et al. (7 citations)

• *Inflated organelle genomes and a circular-mapping mtDNA probably existed at the origin of coloniality in volvocine green algae* Featherston, Jonathan; Arakaki, Yoko; Nozaki, Hisayoshi; Durand, Pierre M.; Smith, David R. (6 citations)

• *Long-term survival of haptophyte and prasinophyte resting stages in marine sediment* Ellegaard, Marianne; Moestrup, Ojvind; Andersen, Thorbjorn Joest; Lundholm, Nina (5 citations)

• *Cellular aggregation in Chlamydomonas (Chlorophyceae) is chimaeric and depends on traits like cell size and motility* Sathe, Santosh; Durand, Pierre M. (5 citations)

• *Cyst-theca relationship and phylogenetic positions of Scrippsiella plana sp nov and S-spinifera (Peridiniales, Dinophyceae)* Luo, Zhaohe; Mertens, Kenneth Neil; Bagheri, Siamak; Aydin, Hilal; Takano, Yoshihito; et al. (5 citations)

For graphical information on impact factor please see the EJP report at https://brphycsoc.org/annual-general-meeting/

B. Editor of *The Phycologist* (Amanda Burson)

A vote of thanks was given to Jan Krokowski for all his years' service as Editor.

Spring 2019- Number 96 Costs:
Printing- £186.40 (35 copies with insert)
Postage- £68.30

Autumn 2019- Number 97 Costs:
Printing- £128.40 (40 copies)
Postage- £39.71

There has been a dramatic decline in the number of requests for printed and mailed copies of *The Phycologist* (down approx. 75% from 2018). I assume this is likely due to the default selection of 'via email' when joining the BPS on the new website. As this keeps printing costs low, future issues will be produced with colour of all images not just covers. Of course, this will be within reason and adjusted to any surges in printed copy requests.

Two requests were made to use material published in *The Phycologist*. One was requested by The Open University of Israel for the use of an illustration of desmids by David Williamson which appeared in issue 94 of The Phycologist. The request was made via Dr. Elizabeth Haworth the curator of the Fritsch Collection of Algal Illustrations of the Freshwater Biological Association where many but not all of Williamson's illustrations are held. Dr. Haworth confirmed with David Williamson that he granted permission for this particular illustration to be used in the textbook. I confirmed with Jan Krokowski (acting editor at time of publication) and we also gave permission for the use of the illustration.

The second request was by the marketing group representing the ioLight field microscope manufacturers. The request was to use Francis Bunker's review of their microscope which appeared in the autumn number 97 issue of *The Phycologist* as promotional material at the BPS 2020 conference. I gave permission for this after checking with Francis that he agreed for his article to be used in this capacity.

C. Webmaster (Andy Davies)

Graham Underwood presented the following report on behalf of Andy Davies.

Main BPS Website

Since the last AGM, we have released the updated the website to reflect the new logo design and undertaken the second automated annual renewal during early January. Overall, this went very well, we had some minor issues with some member renewals that were largely due to their entry of incorrect PayPal account details, expired credit cards and so on. Each of these were handled manually by the webmaster and/or the Membership secretary.

We have had approximately 99.5% uptime on the site, with the longest outage of 5 hours occurring in November 2019 due to an issue at our hosting company. We promptly resolved this issue through communication with their support team.

Visitor numbers for the website are summarised below, currently we have received approximately 32,000 unique visitors to the site, accumulating over 1.7 million hits.

For graphical information on website visits please see the Webmaster's report at https://brphycsoc.org/annual-general-meeting/

BPS Algal Records

The Webmaster was contacted by David John about an outage of the BPS Algal Records site, in discussion with David and Martin Wilkinson, we agreed that the site would be moved to be under BPS Webmaster control. This decision was made to ensure that control of the site and the domain name was not lost. The site and the domain names were moved to our current hosting provider (Jolt.co.uk) in May/June 2019, with thanks to Martin for facilitating this move.

The inaccessibility issue was repaired after some difficulties due to the complexities of the database system used. The site was also updated to use SSL (secure communication between visitors and the website, an internet standard that is now required for a good listing on search engines and to reflect the new logo of the BPS.

Visitor statistics are only available for part of the year, but these numbers seem healthy for a highly targeted website.

For graphical information on the BPS Algal Records website please see the Webmaster's report at https://brphycsoc.org/annual-general-meeting/

7. Elections to Council Membership (Francis Bunker)

Election of Ordinary Member of Council 2020 and other Council changes

On November 26th 2019, BPS Members were informed of the election of an ordinary member of council and asked to vote by secret ballot. Candidates were as follows:

-Donai McGree (AlgaeCytes Ltd.): Proposed by Jo Taylor, seconded by Mahasweta Saha

-Bill Brierley (FBA): Proposed by Jan Krokowski, seconded by Martyn Kelly

-Dan Franklin (Bournemouth University): Proposed by Gill Malin, Seconded Graham Underwood

A total of 45 members voted in the elections, resulting in a win for Dan Franklin who now commences a 3 year term as an ordinary member of council. Council wish to thank all the candidates for standing. Dan is replacing Jo Wilbraham who is stepping down after a 3-year term and a vote of thanks was given to her for her service.

-Jason Hall-Spencer becomes the new President of BPS

-Jayne Lewis becomes the new President Elect

-Graham Underwood is now the Immediate Past President.

-Gill Malin steps down as Immediate Past President.

A vote of thanks was given to Gill for her service over a 6 year term, being President, Immediate Past President and chair of the Awards and Training Committee. Gill remains as chair of the Algal Applications Committee.

Hiroshi Kawi steps down as Overseas President and his place is taken by Mariana Olivera. A vote of thanks was given to Hiroshi Kawai.

BPS is still looking for a student member of council to replace Amy Parris. Council wish to thank her for her work.

8. Subcommittee reports (*https://brphycsoc.org/)

A. Awards and Training Committee (Gill Malin)

The report was presented on behalf of Gill Malin by Graham Underwood.

Gill Malin, Immediate Past President, chaired the Awards and Training Committee 2018-2019 and Graham Underwood takes over this position as of the January 2020 AGM. The BPS Ordinary Members of Council are now involved in judging the applications and are thanked for their work this past year.

In 2019 the nominal budget was £30,000, 28 applications for a total of £58,733 were received and funding of £21,988 was allocated.

There are now 3 funding rounds per year instead of 4: 1st February, 1st June and 1st November.

The BPS Funding Guidelines were revised in Oct 2019 and the Membership advised by email. The aim was to increase clarity to reduce the number of queries and ineligible applications. Summer Undergraduate Project have been renamed Summer Undergraduate Internships and academic and corporate members are eligible for these. A new Early Career research Bursary for up to £500 for attendance at the BPS Annual Meeting was introduced.

For all schemes the applicants must have been a member of the BPS for at least 3 months before the application date and successful applicants should be prepared to renew their membership where the project or meeting falls in the following calendar year. Applicants for Internships and Project Award from members who do not have an independent position (e.g. a short-term postdoctoral scientist) need to provide a letter from their line manager to assure the BPS Council that the applicant has the time and access to the general facilities and materials required for the project. PhD student members should note that they are not eligible to apply for Summer Undergraduate Internships and Project awards.

BPS members are also reminded that we are an active member of the Federation of European Microbiological Societies and this gives BPS members access to the FEMS funding schemes. https://fems-microbiology.org/fems-activities/

B. Biodiversity and Conservation Committee (Martin Wilkinson)

Three new committee members were announced: Angie Gall, Nick Steward and Chris Yesson.

Field meetings and courses

i. Annual seaweed identification course at MBA, Plymouth, 5-7th May, organised by Francis Bunker

ii. Possible marine field meeting at St.Andrews, 19-22 August 2020, in the new Scottish Oceans Institute which has replaced the Gatty Marine Lab. M.Wilkinson and C. Scanlan have met with Dave Patterson and Emma Defew from St. Andrews who are very enthusiastic and would be happy to co-organise to help keep costs down.

iii. Eileen Cox and Elliot Shubert's Freshwater algae course at Kindrogan could not taker place in 2019 due to renovation swork at the field station. They are not listed as running this course in 2020.

iv. Paula Lightfoot is running a course on biotope mapping at Millport FSC field station from 24th-27th July

2020.

v. Dave's and Brian Whitton's freshwater identification course at Durham ran in summer 2019 with a largely UK contingent. Less easy to run courses now at Durham, so the course may not run in 2020. Possibility of holding it elsewhere, but the location needs to fulfil certain criteria. NHM is a possibility, as is the FBA. Dave John and Jo Wilbraham to look into this.

vi. Martyn Kelly and Dave John had a second joint freshwater field meeting with the Quekett Society at Ennerdale Bridge. Found at least 55 desmid taxa. A plate of the desmids will go into the Quekett magazine. They would like to organise a further meeting at Malham Tarn.

Algal Recording

i. Front page of BPS recording site needs improvement, particularly to encourage freshwater records. Dave John with Liaise with Andrew on this.

ii. BRC recorders meeting in Edinburgh on Saturday 7th March 2020 which it is hoped one or more committee members can attend.to represent BPS.

Publications

i. Freshwater Flora - sales are beginning to drop off, 9 in the past six months. Now £152 per copy.

ii. Desmid posters - sold 3 copies in last 12 months, now about 10 left.

iii. Brown seaweed flora - Juliet now has everything, ca.600pp. Juliet valiantly to continue preparing for publication for which we are really grateful – simplification of nomenclature needed.

iv. Seaweeds book (FB) - no update from publishers.

v. Noted that FSC guide to diatoms is out of date, and Alan Pentecost's freshwater book is out of print and out of date but still useful.

vi. European book on charophytes in progress. 32 charophyte species in the UK. Molecular work needed and is in progress.

Research projects

i. BPS-funded Desmids of Britain & Ireland - checklist & conservation (JW). Going well but a large mis-match between the record cards and the current checklist being resolved. IPAs should be revisited when lists are confirmed, so rare species can be identified. BPS funding has run out, but not necessary for this phase of the project.

ii. Natural England-funded Gongrosira scourfieldii project (DJ) - Found travertine streams on the Jurassic coast with several more sites for G.scourfieldii. No Gongrosira at Malham Tarn. Report submitted to NE in March. Thanks are due to Richard Landsdown at NE for funding.

iii. Diatom project with National Museum of Wales (MK) - BPS funded. The project is proceeding, but slower than planned. Subject to approval from BPS Council, Ingrid has been given 40 days per year for the project for ca.£100 per day from BPS. Unclear who has overall responsibility for the project and its direction. Martyn to discuss with Graham Underwood as he will become chair of the grants committee.

iv. IUCN aquatic plants taxon group/Natural England Aquatic Plants Taxon Group

v. This group deals with all types of aquatic plants (except seaweeds) and has an interest in freshwater algae. Dave John has been attending. Projects might include possible red-listing of *Nostoc* and *Rivularia* and freshwaster *Vaucheria* but there are major problems. Guidelines for SSSIs for algae need to be revisited.

Threats to large brown seaweeds

i. OSPAR Threatened and/or Declining Species & Habitats - proposals to include kelps being discussed. Jo Foden from OSPAR was unable to attend our meeting but sent detailed information to us. It was not clear who exactly has made the assessments so far, and Juliet will follow this up with Jo.

ii. Seaweed harvesting – an online petition circulating in summer 2019 started a scare that the Scottish Government might have reversed its decision in 2018 not to allow destructive mechanical sampling of kelp beds. It turned out that this was an old petition from before the 2018 legislation that was still going round – a danger with online petitions. Martin now receives weekly digests of business from the Scottish Government so we can avoid this in future. Martin will collate the committee's views on seaweed harvesting with a view to having a possible BPS position on this.

C. Outreach and Education Committee (Martyn Kelly)

Martyn Kelly presented his report (below) and explained how the committee will endeavour to facilitate members with outreach.

A new competition for outreach ideas is being put forward and professional press releases will be implemented.

The BPS, along with the Quekett Microscopical Society, held a weekend of algal-themed microscopy in September 2019 in the Lake District. This was the second time that such an event has been held and provided a good opportunity for the BPS to link up with amateur scientists with an interest in the natural world.

During 2020 the Education and Outreach Committee will focus on ways of facilitating outreach amongst members. This may include establishing areas of the website that provide resources for a range of outreach activities

The Education and Outreach Committee is also considering having a BPS presence at the Green Man Festival in the Brecon Beacons in August 2020. Several members have already expressed interest in helping with this event, and the Green Man organisers are enthusiastic about our participation.

D. Algal Applications Committee (Gill Malin)

Gill Malin's report was presented by Graham Underwood.

Remit

(As discussed by AAC 1/6/16 and Council 6/16)

The remit of the Algal Applications Committee covers all aspects of applied phycology from biotechnology through to the use of algae as bioindicators and the production of algal biomass for inter alia biofuels, food, feed, nutritional supplements, and various high value products. The overall aim is to foster stronger connections between the BPS and the commercial companies, public agencies and regulatory bodies that use or consider algae in their work. A particular focus will be inspiring and training the next generation of applied phycologists.

Please note

Re: Corporate Membership – wording needs to be agreed and put on website ASAP. A fee of £250 has been proposed. We would need to set up a 'vetting' committee and members of the AAC could contribute to this. The AAC could also contribute to invitation to companies to join and judging of applications for summer internships from companies.

E. Natural History Museum Representative (Juliet Brodie)

No report delivered by Juliet Brodie spoke briefly on the subject and responsibilities of this post.

9. Federation Reports

A. Federation of European Phycological Societies (FEPS) (Geoff Codd)

Federation of European Phycological Societies (FEPS) Website

In addition to the British Phycological Society, FEPS includes the national phycological societies (or phycological branches of national botanical societies) of: Spain, France, Belgium, Germany, Poland, Italy, Greece, Croatia and Macedonia. For the FEPS website, including announcements of conferences, newsletters etc. (see https://www.facebook.com/FEPSalgae/). A new database on invasive seaweeds in Europe is being developed on the website.

IPC7: the 7th International Phycological Congress, Zagreb, Croatia, 25-30 August, 2019.

A very successful congress was held, which included 432 participants from 48 countries. Student attendance accounted for 35% of the registrants. The largest student contingents were from South Korea and France.

Individual membership of FEPS

The initiative introduced by the current FEPS President (Professor Cecilia Totti, Italy), to enable individuals in countries with no national phycological societies, to join FEPS on a personal basis, is attracting new members.

IPC8: the 8th International Phycological Congress, to be organised by FEPS, will be held in 2022 in Brest, France.

B. Federation of European Microbiological Societies (FEMS) (Anne Jungblut)

Anne Jungblut took over from Paul Hayes as FEMS representative in 2019 and hopes to create awareness of BPS in FEMS and via versa. Anne pointed out that FEMS have good grants which BPS members can access. Next FEMS meeting is 2020 in Split, Croatia in 2020 and Anne wants BPS to put in a topical session on Algae.

Anne D. Jungblut represented BPS at annual member society delegate meeting in Milan, Italy, from 6-8 September 2019. As a new delegate Anne D. Jungblut was invited to introduce her research and BPS. She gave an overview on aims and membership of BPS as well as publications and conferences. She highlighted the publication of well performing and peer-reviewed journals such as the European Journal of Phycology and the new open-access journal Applied Phycology as well as advertised the next annual meeting in Plymouth in January 2020.

Prof Hilary Lappin-Scott was announced as new President of FEMS.

The next FEMS member society council meeting will be in Split Croatia, 4-5 September 2020.

D. Royal Society of Biology (Graham Underwood)

The BPS is a full organisational member of the Royal Society of Biology (RSB). The RSB is a single unified voice for biology: advising Government and influencing policy; advancing education and professional development; and encouraging public interest in the life sciences. This year we have contributed to the work the RSB is doing on learned society publishing activity and income generation, in response to plans to make all publishing open access (plan S). This could have a significant detrimental impact on many Learned Societies, where publishing generates a significant element of the annual income. The BPS is in this category. Is is important that the RSB can represent

their members in this matter. We receive various notifications of events and training, which are passed to Council member and Society members where appropriate. Events are mainly based in London. The BPS will remain a member of the RSB in 2020.

10. Future Annual meetings

69th Annual Meeting will be held in Nottingham in January 2021. Suggestions for 2022 requested.

At the close of the meeting Jason Hall-Spencer (the incoming President) gave a special vote of thanks and presentation to Graham Underwood (the outgoing President).

Minutes by Francis Bunker (Secretary); Reports by individual officers.

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British Phycological Society annual winter meeting, Plymouth, 6-9th 2020

Submitted by Jan Krokowski

There is nothing like a 9hr+ train journey north to south crossing nearly the whole of Great Britain, from Scotland to Plymouth, to sweep away the cobwebs in the new year. But, at least my journey wasn't as bad as for some travelling from Australia or Japan, or the Shetlands or even Aberdeen. Plymouth is a long way away, unless of course you live nearby.

The last time the BPS held its winter meeting in Plymouth was in 2006. I remember that well for a number of reasons - it was my first time as editor of *The Phycologist*, and the conference dinner was held in the National Marine Aquarium, eating fish whilst looking at fish. The (free) tour of the Aquarium was particularly amazing, with the baby seahorses making an impression on me to this day. In 2006 the main focus was on Genomics, we had a Quiz, and a BPS Auction. Fourteen years later and we have progressed with many of the talks including sequence data as standard, and we had a raffle which very nearly resembled an auction. We also had a ceilidh following the conference dinner, but what a disappointment – only 4 dances before the band had to call it a night.

The meeting kicked off with the invited talk from Gregory Beaugrand, on responses of phytoplankton to climate in the North Atlantic Ocean: past, present and future. In fact climate change, global warming and climate crisis were mentioned in a large proportion of the talks – it was hard to have a talk without them mentioned – will it be the same 14 years from now I wonder? Gerald Boalch gave a great talk on the history of Phycology in Plymouth, going back as far as the 1700s; for those that missed it, Gerald wrote a great piece on the early days of the BPS during the 60th anniversary of our Society (*The Phycologist*, 81, autumn 2011). There were many other memorable talks in the special sessions on Hidden forests (marine seaweeds), Algal interactions (pathways to coexistence, internal and external), Impact of climate change

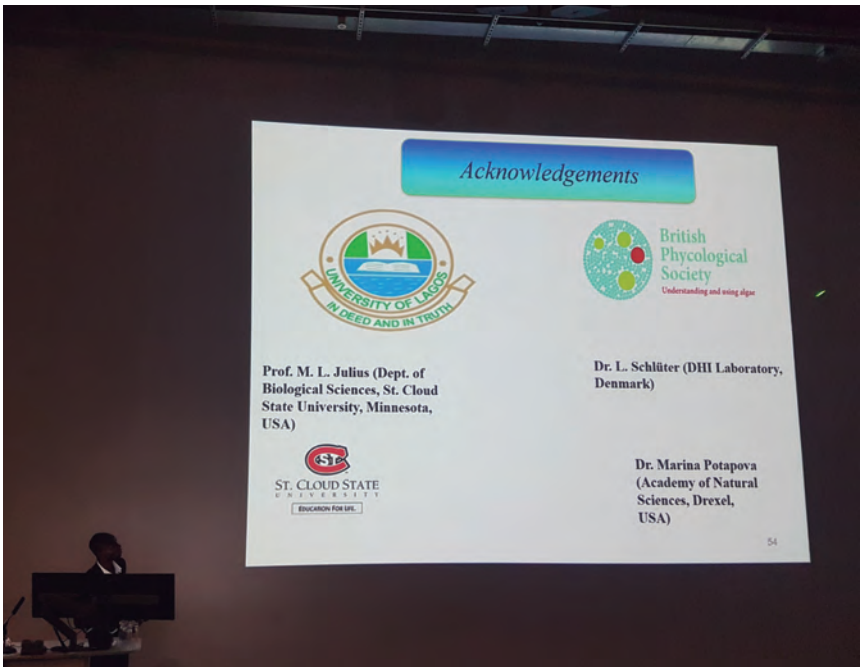
on marine and freshwater algae, Use of algae as biomonitors in freshwater and marine systems, and General phycology (mop up for all other talks). As I mentioned, it was hard pushed not to hear a talk that didn't mention climate change. Everyone had their opinion and data to highlight impacts of climate change. My take home message was that everything will adapt to change – change is coming. But there will be loss of taxa (not just algal) and it seems other taxa will replace what is lost, perhaps to the detriment of the environment. Alexandra Campbell, invited Australian speaker, had a right go at what was and is currently happening in Australia and didn't pull any punches on blaming non-action on the Australian PM; and continued brilliantly when her Mac ran out of juice – who needs powerpoint! Sebastian Hess needed powerpoint in his talk on protoplast feeders – predators and grazers of algae e.g. *Vampyrella*, amoebae and other flagellates. Some of the video action of these, finding, attaching and carrying out their parasitism was amazing! You can see some on YouTube but there aren't as good as what was shown. The Manton talks were split over two days, but as usual there was great quality and clarity from the students, and a well-deserved congratulations to Daniel Liesner and Nele Schimpf. The posters were displayed in a good location in the foyer, close to the food and drinks, and surrounded by really interesting stalls and I must mention the Thames mud flat poster and stalls, with the droplet box – that was a great idea.

Our presidential address was given by Graham Underwood on 'thin films of life and challenges of changing environments'. This was a public lecture with between 30-40 members of the public attending – that's really good - a great turn out and the lecture theatre looked full. I gather everyone enjoyed it, particularly hearing and seeing details about the circadian rhythms of the benthic diatoms in relation to hourly and daily changes in light and tide. I always thought diatoms are clever – this goes to prove it.

Great thanks to everyone from Plymouth for organising the meeting – it's never easy making the conference run smoothly, but Plymouth - you did a great job. Nottingham – over to you. Looking forward to some ceilidh or disco where hopefully we can have more than 4 dances, maybe even a quiz, and maybe even an auction too (just saying for a friend)....

Bursary Reports BPS Conference

Owoyemi Wahab Elegbeleye ***Department of Marine Sciences, Faculty of Science, University of Lagos, Nigeria***
oelegbeleye@unilag.edu.ng



First impressions, they say, last longer. As a first timer, attending the 68th annual meeting of the British Phycological Society in Plymouth was a fascinating and intriguing experience. As a young academic, meeting with great scholars and captains of industry in phycology and related fields at a global forum has always been my goal. While ruminating on how to actualize my highly cherished desire in 2020, the British Phycological Society came to my aid with the maiden edition of Early Career Researcher Bursary Award. With enthusiasm and positive hopes, I quickly applied. It was heartwarming to receive an email from the Bursary committee informing me that my application has been positively considered. Special thanks to the Awards and Training Committee under the chairmanship of Professor Gill Malin. Having secured the BPS travel grant, it was now time to get a UK visa. I applied for a standard visa category which would take fifteen (15) working days to be processed. Sadly, the visa application was in December 2019 and there were a number of public holidays. This caused delay a great deal of delay, such that I did not get my travel document until Tuesday 7 January 2020 for a conference that started the previous day; what an uncertain situation! However, it was interesting that my talk on "Phytoplankton assemblage in a tropical harbour: microscopy versus chemotaxonomy" was scheduled for Thursday 9th January 2020 and so, I felt I could make it. I left Nigeria for the United Kingdom on Wednesday 8 January 2020, went through a lot of stress but, it was worthwhile in the end!

The meeting was attended by enthusiastic scholars and graduate students from almost every part of the world. One could see that in all the faces of the attendees. The January 2020 meeting had a general session and four special sessions but unfortunately, I could only attend the Special Session 4. No regrets however, as I was able to make my presentation and meet with accomplished scholars of phycology who encouraged and positively lifted my passion for algae – the most wonderful organisms on planet earth. I also had a great time reacting to questions from my audience; more interestingly were peculiar questions on how scientists and scientific researches influence government policies in Nigeria. Meeting with Professor Juliet Brodie, whose numerous publications have been important readings for me, was indeed a highlight. With her style, I cannot agree more that "simplicity is a mark of genius". I also listened to some thought-provoking talks from astute authors. These included "Setting nutrient thresholds to achieve Good Ecological Status in surface waters", "Limiting lifestyles – how plankton lifeforms are changing in UK marine waters" and "Using historic samples to uncover Harmful Algal species niche preferences". I engaged myself in cross-fertilizing of ideas with co-participants in the conference and a platform for possible collaborations was established. It was awesome to be part of the Plymouth Sound Phytoplankton sampling aboard a research vessel. Seeing the Plymouth harbour, all I could say was: "Like Lagos, like Plymouth". Gladly, I took some planktonic samples from Plymouth waters along with me back to Nigeria.

My journey to the 68th annual meeting may best be titled "From Lagos to Plymouth: the experience of a resilient phycologist". Smile! All thanks to the organisers and planning committee of the January 2020 meeting of the British Phycological Society. The BPS annual meeting is a place to be and I sincerely hope to participate yearly.

***Carla Greco** Life Sciences Department, Natural History Museum, London School of Biological Sciences, University of Bristol c.greco@nhm.ac.uk*

On the 6th January it was time for another BPS Annual Meeting! I made my way from London to Plymouth for the 68th Annual Meeting hosted at the University of Plymouth. After having attended my first BPS meeting last year I was very excited to give my first talk on my current PhD work "Under the ice: Microbial mats of Lake Untersee, Antarctica" in the Manton Prize session.

The first event of the conference was a reception at the MBA, where a student quiz was organised. My team unfortunately did not win, however we all enjoyed getting creative and sculpting some algae out of playdough. Over the next three days of the conference I attended talks on a breadth of topics, from the kelp forests of Ireland to Arctic diatoms. The second day of the conference included two sessions on "Hidden Forests" and "Algal Interactions". I particularly enjoyed the Manton Prize session that gave students the opportunity to present their research and be judged by a panel. All the talks were of extremely high calibre and showed a range of topics and presentation style. During the coffee breaks between sessions there was plenty to talk with other presenters and attendees, and I really enjoyed getting to know other students at the conference.

Wednesday continued with more talks with a session on the "Impact of Climate Change on Marine and Freshwater Algae" in addition to a general phycology session. A particularly important talk was given by Dr. Alexandra Campbell from the University of the Sunshine Coast, Australia, which highlighted the impact of climate change and climate-mediated diseases on seaweeds in Australia. Prof. Graham Underwood followed this talk with an inspiring lecture on biofilms and their resilience across different environments. A highlight of the conference was the conference dinner and dance where prizes were handed out, and the Manton Prize winners were announced.

The final day of the conference offered a general phycology session and a session on "Algae as Biomonitors in Freshwater and Marine Systems", rounded off by Dr. Chris Yesson with a lecture on methods for monitoring habitat-forming seaweeds. In the afternoon two events were offered – a tour of the Plymouth Marine Station and a trip aboard a research vessel for phytoplankton sampling.

I'd like to thank the organisers of this year's BPS annual meeting and all the speakers and presenters who contributed to this enjoyable meeting. I am extremely grateful to BPS for the financial support that allowed me to attend the conference and present my PhD work.

***Regina Kolzenburg** University of Portsmouth, School of Biological Sciences, Institute of Marine Sciences, Portsmouth, UK regina.kolzenburg@port.ac.uk*

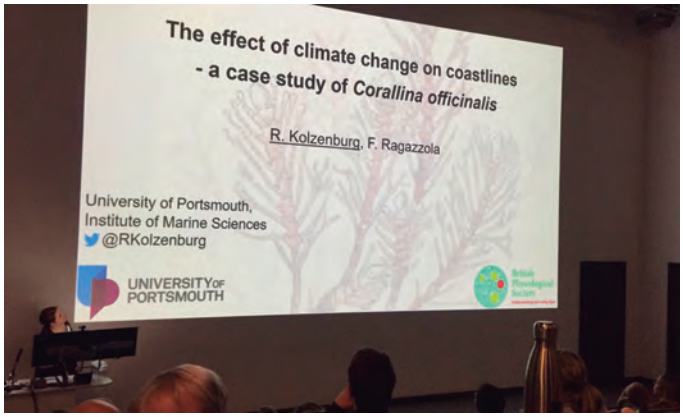
Thanks to the BPS, I was lucky to be part of the Annual Meeting of the British Phycological Society. This year, it was held in Plymouth from the 6th – 9th January 2020. A combined effort of the University of Plymouth (Lina Rasmusson, Jason Hall-Spencer), the MBA (Colin Brownlee, Clare Ostle, Dan Smale, Gerald Boalch) and the PML (Clare Widdicombe, Mike Allen, Mahasweta Saha) made it a great success. Organised by a lovely and helpful committee the annual meeting started with a wine reception and student icebreaker at the MBA, so everyone who had arrived by then could gather and have a first mingle before the session start on Tuesday.

The first full day of the meeting started with a warm welcome of the Director of the Marine Institute, Richard Thompson. After an interesting invited lecture about the past, present and future of the phytoplankton in the North Atlantic by Grégory Beaugrand and the history of phycology in Plymouth by Gerald Boalch, the first session of the Manton Prize student talks began. Very diverse, high quality talks from kelp productivity and miniature marine forests to novel techniques to identify cyanobacteria in phytoplanktonic assemblages were presented. The talks were accompanied by poster presentations on both days which were held in coffee and lunch breaks throughout the meeting. Here delegates had the opportunity to talk to the presenters in more detail and give feedback or develop research ideas together.

After a seaweed inspired lunch, delegates spent the afternoon between two sessions: "Hidden forests" and "Algal interactions". Within these sessions, talks ranged from kelp forest diversity in Ireland and Arctic coralline algae, to cyanobacteria-diatom interactions and antibody production in diatoms. The first day concluded with a Taylor & Francis sponsored wine reception in combination with an extended poster session. It was great to see old and new phycologists exchanging thoughts, forming collaborations and passing on knowledge throughout the evening.

On the second day delegates could choose to listen to talks in the "General phycology" session or the special session on "Algal interactions". Both sessions covered a great variety of interesting talks about bioenergy production, phytoplankton parasites, physiological responses of diatoms to osmotic stress and even on how to get published in BPS journals. The morning continued with the second and last Manton Prize session concluding the competing presentations for the award of the best student oral presentation. 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 the presentations. In addition to the prize for the best oral presentation, throughout the conference, posters were also judged for the

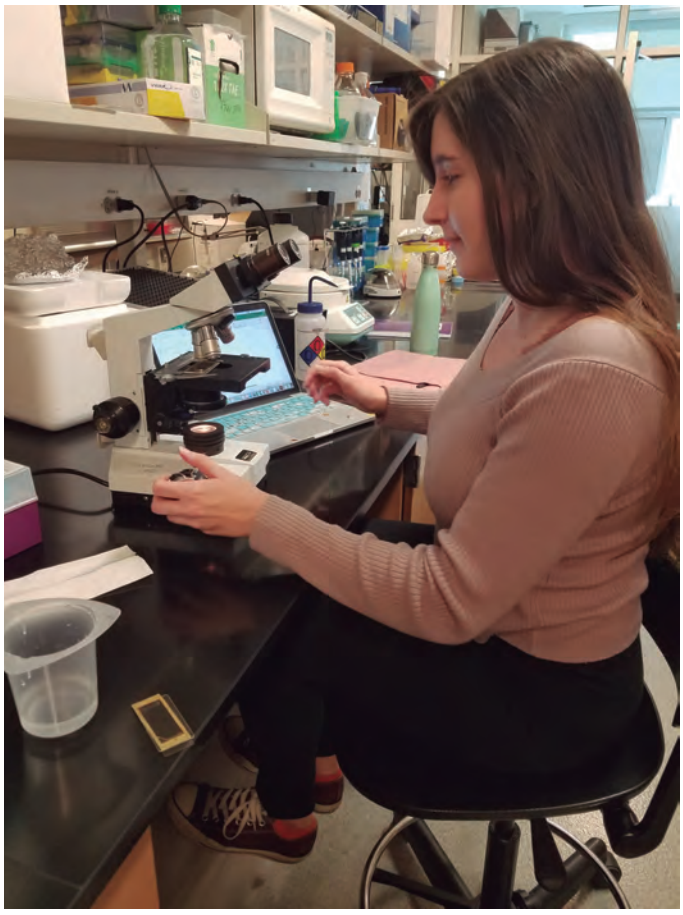
Manton Prize for best student poster. The winner of the best oral presentation Daniel Liesner (Alfred Wegener Institute) gave a brilliant and engaging talk about local differentiation in heat responses of *Laminaria digitata* at the range edges. After an afternoon of whizzing back and forth between lecture theatres (most of the time unable to decide which talk you should listen to as they were all interesting) the second day closed with the highlight of every Annual Meeting: the conference dinner and traditional ceilidh at a beautiful venue overlooking Plymouth harbour. The relaxed atmosphere soon got the majority of participants on the dance floor as well as conversations held late into the evening.



The last day of the meeting attendees could choose between the "General Phycology" and "The use of algae as biomonitors in freshwater and marine systems", and could exchange final thoughts during a last poster session and lunch before making their way home. The overall atmosphere of the meeting was welcoming, familial and convivial with plenty of opportunities to network and or hold casual conversations. I would like to thank the BPS for their financial support that made it possible for me to go to the meeting. I was able to discuss my research with international experts, made new contacts and was even able to form new collaborations for future research opportunities. Overall, it was a great meeting and experience and I am looking forward to next year's 69th Annual Meeting.

Erin Meyer Department of Biology and Marine Biology, University of North Carolina Wilmington emm5468@uncw.edu

The BPS annual meeting began with an evening welcome reception at the Marine Biological Association in Plymouth. The laboratory is situated on Citadel Hill, requiring a scenic walk through Hoe Park, overlooking Plymouth Sound. Many people attended, and combined with a friendly atmosphere, I met a number of fellow phycologists and was able to reconnect with current collaborators and meet their graduate students.



The conference kicked off the next morning at the impressive Roland Levinski Building at the University of Plymouth with an opening welcome from Jerry Roberts, followed by a plenary lecture by Dr. Grégory Beaugrand who discussed phytoplankton phenology, succession, and distribution in the context of climate change. The first round of student Manton Prize talks followed the plenary session. Because the Manton Prize talks were held as sole sessions, it is a great opportunity for students to showcase their research and hear the opinions and feedback of a wide range of experts. There were 13 Manton Prize presentation candidates, with topics ranging from salinity stress in seaweed to understanding Antarctic microbial communities. Congratulations to Daniel Liesner who was awarded the Irene Manton Prize for best student oral presentation on his work exploring kelp distribution in the face of climate change. The BPS annual meeting has a very student-friendly atmosphere that encourages interactions with both fellow students and other academics and professionals in the field. I am glad that I gave my first conference talk at this meeting because of this welcoming environment.

The rest of Tuesday's talks were divided between two sessions: hidden forests and algal interactions, which covered topics including Irish kelp forests (Kathryn Schoenrock) and cyanobacterium-diatom interactions (Sandra Lage). The diversity of interesting topics meant I split my time between the two sessions. As someone who is interested in calcifying algae (coccolithophores) and trace metal incorporation, I particularly enjoyed Lina Rasmusson's talk on Arctic coralline

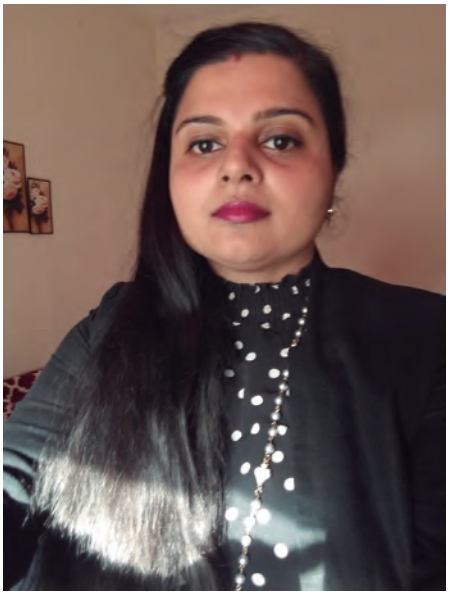
algae. These calcifying algae can potentially provide salinity proxies through the relationship between salinity and elemental composition of their calcified structures. Wednesday had three official sessions: algal interactions, impacts of climate change on marine and freshwater algae, and general phycology. Calcification was also a hot topic on Wednesday, where 4 talks relating to calcification or calcifying organisms were given. It is unusual to have so many calcification and coccolithophore talks during phycology meetings, so I really enjoyed hearing from experts in the field. I was excited to meet the authors of papers I have read throughout writing my thesis. One author, Jessica Walker, gave a talk on biomineralization in Acantharea (radiolarians) which was of particular interest. Acanthareans produce a strontium sulfate skeleton, which is an unusual mineral to produce. Using a range of high-resolution analytical imaging techniques, her work aimed to gain insight into the mineralization process of radiolarians. Her findings indicate incremental crystal growth and the use of biomacromolecules in the crystallization process, which is similar to other biomineralizing systems.

Wednesday night ended with dinner, a raffle, and a ceilidh dance at The Loft in Sutton Harbor. It was my first time seeing a ceilidh dance, and while I did not participate, it was really fun to watch the organizers and dancers work together to produce the choreographed couples line-dance. Thursday morning got a later start, possibly due to the Wednesday night festivities, and marked the last day of the conference. Lectures were split into two sessions: general phycology and the use of algae as biomonitors in freshwater and marine systems. After the talks, attendees had the option to tour the University of Plymouth Marine Station and take part in an algae sampling trip.

Many of my current collaborators work at the MBA, so attending the BPS annual meeting in Plymouth provided me an opportunity to meet with them in person to discuss current projects, manuscripts, and future directions for my thesis. These in-person meetings are more productive and allowed for great conversations in a short amount of time.

I would like to thank BPS for awarding me the student bursary travel award so that I could present my work at the 68th annual meeting. It was a wonderful conference to give my first talk, and it was a great opportunity to discuss my research with fellow experts. Getting this award also allowed me to meet many of my collaborators for the first time, which was both fun and productive!

Roshni Paul ***Birmingham City University, Birmingham, UK Roshni.Paul@bcu.ac.uk***



I am Dr. Roshni Paul currently working as a post-doctoral research associate at Birmingham City University, Birmingham, UK. Recently I attended the 68th Annual meeting and conference for the British Phycological Society (BPS) at the University of Plymouth, on 6-9th of January, 2020.

The conference, on Day 1, was filled with talks from diverse areas including seaweed ecology, morphology, cultivation, preservation and new techniques of imaging using drone and satellite technology. Out of the two parallel sessions which focused on algal interactions and hidden forests, the latter had my full attention. In particular, the talks which presented on the diversity, and resilience of kelp forests in Ireland, and Dan Smale's talk on the climate change impact on the Kelp forest structure. As my PhD centred around Saccharina latissima, I thoroughly enjoyed hearing about the project on environmentally sustainable and commercially viable farmed seaweed by Carly Daniels.

On Day 2 of the conference, I was delighted to present an oral presentation of my research on bioenergy production from the seaweed species Saccharina latissima. The paper demonstrated the feasibility of utilising seaweed as a biomass resource for bioenergy production using a biochemical pathway of anaerobic digestion in the north-western Europe region. The presentation gave me one of the best opportunities I have had in my career so far to review and explain my research ideas in front of a seaweed specialist audience. Furthermore, I could also discuss the possibilities of future collaborations combining the seaweed cultivation and energy production with experts from Plymouth Marine Laboratory and University of Exeter. The other aspect of the conference which I appreciated was the Manton Prize presentation sessions. The students who presented their work were unique, and I was impressed, especially by the work of Carla Greco's research in Antarctica. The conference definitely brought together several spheres of research under one platform and it was a great space to see the energy of like-minded researchers at play.

Day 3 of the conference was also intellectually challenging for me as I was listening to the invited lecture by Dr. Mike Best. Overall, the conference challenged me to think broadly and to adapt to be inclusive of the similar studies conducted in the field of phycology. Freshwater algae, phytoplankton and seaweed among other biotic and abiotic factors are all part of the ecosystem in an intertwined and interdependent manner and I have understood once again the importance of taking care of my earth and my resources in more possible ways. And scientific studies are one step closer to making our earth a better place for all living beings. I wish success to all of the researchers

who attended the conference and believe that they have also engaged and benefitted from the experience.

The conference was also a platform for me to meet my peers and other researchers who have collaborated with me during my PhD research programme including Scottish Association of Marine Sciences. The conference has helped me to sharpen my skills with new ideas and approaches that I believe will make my future work more effective and efficient and to grow as a confident, independent researcher. The conference was a great networking opportunity, and I'm especially thankful to have now joined the editorial board of the upcoming journal Applied Phycology, from Taylor and Francis Group of publications.

I am extremely grateful to have been successful in acquiring one of the BPS Travel Awards for attending this conference and would like to thank all the organisers of the conference. I have new understandings through all of the speakers, greater focus on the developing research in this field, new networking connections, and inspiration to follow my ideas from meeting high profile researchers who attended the conference. All of the presentations and posters were of a high standard and I would definitely recommend my fellow researchers in other societies to attend this conference in the coming years.

Dain Son University of Westminster

I was very excited to receive the email from BPS confirming I was a recipient of the BPS Student Bursary Award. This meant that I would be able to attend my first ever conference and also get to present the "SLIMEWATCH" work that I carried out in the past summer with Professor Jane Lewis and Dr. Susi Arnott, which was also kindly funded by the BPS.

On arrival, I felt the University of Plymouth was a very fitting location for the BPS conference to be held, and being able to visit the Plymouth Marine Laboratory opened my eyes to the diverse array of research areas in phycology. This feeling was furthered by the many talks and poster presentations organized by the BPS.

Alongside being able to attend the amazing talks being given by researchers on various topics, it was wonderful to be able to present my work in the form of a poster and a mini version of our "SLIMEWATCH" exhibition. The "SLIMEWATCH" exhibition had previously been presented to the general public, but not to a scientific audience. Additionally, this was my first poster presentation, so it was a great experience to be able to explain and present my work. I feel that I have gained an important skill that will benefit me greatly in the future.

The most amazing part of being able to attend the BPS annual meeting was the fact that I was surrounded by inspiring researchers who are so passionate about their area of research. Professor Graham Underwood's presidential lecture was a great example of this, as he not only gave a great lecture on diatoms but also demonstrated how just how fascinating microalgae are with so much passion and love for his work. I also had the pleasure of meeting and speaking to many of the attendees of the conference which allowed me to ask questions and learn more about their research. It was truly inspiring to see just how much potential phycology possesses in terms of research and future development.

One of the main themes of many of the talks given during the conference was climate change. This was great to see, especially as a young student where climate change is at the center of many conversations. As long as there are many like-minded people working towards a collective goal, I feel there is hope for humanity.

Overall, being able to attend my first conference as well as travelling to a new city was a wonderful experience. I haven't had many opportunities to explore the UK as an international student based in London, and I would not have been able to afford to attend the conference if it wasn't for the BPS bursary scheme. Attending the conference has made me want to choose a career in research as I was greatly inspired to continue to contribute to science. I have also gained great appreciation for algae and seaweeds and just how important they are to our ecosystem. I would like to thank the BPS for funding my travel costs, allowing me to attend the conference, and again to my supervisor Professor Jane Lewis, who informed me of this opportunity.

***Georgia Ward* Department of Life Sciences, Natural History Museum, London, UK georgia.ward@nhm.ac.uk**

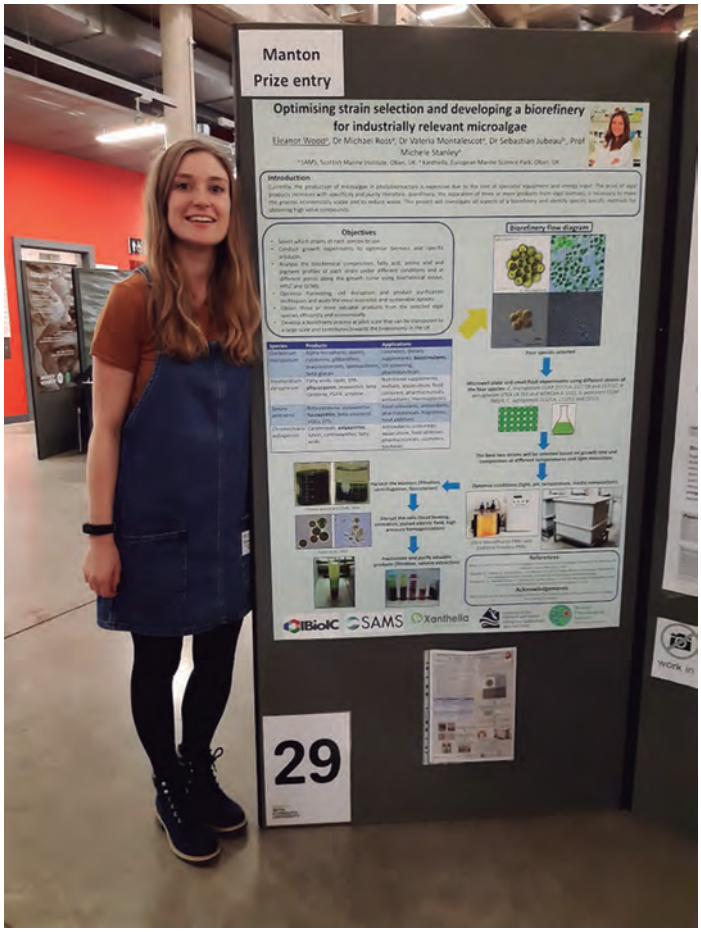
As a recent convert to seaweed research (from invertebrate pathology), the 68th Annual Meeting of the British Phycological Society held in Plymouth was a first for me, and hopefully not the last! I gave an oral presentation, along with my postdoctoral supervisor Prof. Juliet Brodie, presenting my work using *Chondrus crispus* as a model for studying holobiont composition of carrageenophyte red algae. Juliet talked about the prokaryote communities associated with *Chondrus*, and the changes in community composition we observe across host tissues, across seasons (including seasonal bleaching events), and with varying host life-history stage. My own talk focused on the methods we're developing for the study of eukaryote communities associated with macroalgae, including the identification and characterisation of potential pathogens.

This work is part of GlobalSeaweedSTAR, a four-year multidisciplinary project aimed at increasing the research and innovation capacity of developing countries engaged in seaweed farming. Through collaborations with institutions in Malaysia, the Philippines and Tanzania, a key aim of the project is to develop diagnostic tools for detecting pests and disease agents which limit the yields of important cultivated seaweeds, particularly the carrageenophyte eucheumatoid genera *Kappaphycus* and *Eucheuma*, using the tools developed using our *Chondrus* model.

It was really exciting at BPS to see other researchers presenting similar work on microbe-seaweed interactions, and how these interactions are influenced by environmental conditions. It was also great to learn about other projects working towards sustainable seaweed aquaculture, both here in the UK, and Australia, where restorative aquaculture is being used to restore seaweed forests and their associated ecosystems.

Overall this year's BPS annual meeting was a great experience, and I especially enjoyed the high quality of the student talks, and the opportunity to catch up with colleagues, which as always was a useful opportunity to discuss new methods, ideas and future collaborations! I'm grateful to the British Phycological Society for the travel award which allowed me to attend – I'm already looking forward to next year's meeting!

***Eleanor Wood* Scottish Association for Marine Science, Oban eleanor.wood@sams.ac.uk**



I am a first year PhD student from SAMS working with Xanthella as my industrial partner. My project is entitled "Optimising strain selection and developing a biorefinery for industrially relevant microalgae" and the research is funded by IBioIC. The BPS 68th Annual General Meeting was held in Plymouth and I was very grateful to be funded by the BPS to attend. This was the first BPS conference that I have been to, and it was a great opportunity to meet lots of people who love algae!

My conference experience began with a student ice-breaker session in the form of an algae quiz. This was a lot of fun and a good way to meet the masters and PhD students prior to meeting the other researchers. After the quiz we had a wine reception that led to dinner at a Mexican restaurant where around 35 of us filled a previously empty space.

The first full day of the conference started with some welcome and introductory lectures from Jerry Roberts, Gregory Beaugrand and Gerald Boalch. This was followed by the first Manton Prize sessions where PhD students had the opportunity to present their research. Two that particularly intrigued me were by Rachel Parkes and Anna Busch. Rachel discussed her post-stationary phase results about the diatom Stauroneis sp. using different coloured lights to alter quantities of high value compounds. Meanwhile, Anna described her findings of mucilage pigments in Mesotaenium sp. from different geographical locations which are induced by UV-B radiation and the colour altered depending on the pH. After lunch the parallel sessions 'Hidden forests' and 'Algal interactions' took place and I chose to attend the algal interactions sessions. Later, I attended the Annual General Meeting which was a great opportunity to find out about the members of the committee and their roles and to learn about how the society is run. During the breaks and at the end of the day I was pleased to present my first research poster. It was good to talk to people about my ideas for the PhD and hopefully I will

be able to present and discuss some of my results at next year's conference.

The next day began with an invited lecture by Hiroshi Kawai about taxonomy of Ecklonia and Eisenia, then parallel sessions 'Algal interactions' and 'General Phycology' of which I attended general phycology. Afterwards the second Manton Prize session took place. I particularly enjoyed Carla Greco's talk about her Tychonema sp. and Leptolyngbya sp. findings in Lake Untersee, Antarctica, a unique environment. Later that day there were more parallel sessions which included a talk by Donal McGee who discussed the successful and unsuccessful biorefinery methods that the company Algaecytes have trialled. There was also an invited lecture by Alexandra Campbell who discussed the environmental issues in Australia and the damage that is being caused to seaweeds due to the high temperatures and virulence of bacterial infections as well as the work that is taking place to restore under water forests. Subsequently, Professor Graham Underwood, the outgoing president of the BPS, gave a public lecture about his career in biofilms and their presence across a wide array of geographical locations including mud flats and sea ice. That evening we had a dinner and a ceilidh which was fantastic fun!

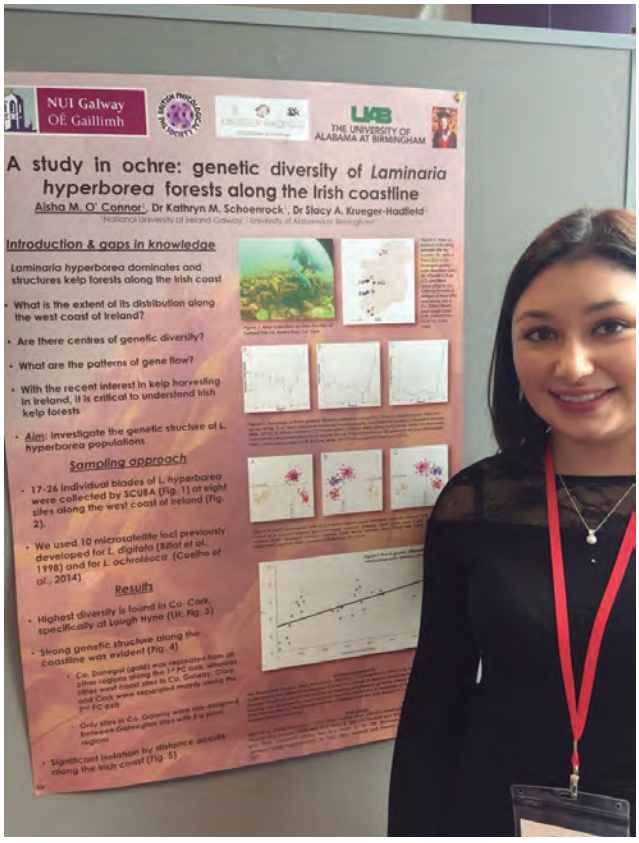
The final day began with a talk from Jacob Searle from Varicon Aqua. It was interesting to see the results of the growth rates of algal strains on chemical media against the company's own formulations. Jo Wilbraham gave an intriguing talk about desmids and their distribution across the UK and Klaus Valentin showed his results of growing Melosira arctica over long term growth trials and showed that this diatom is able to survive in sea ice due to the presence of over 50 antifreeze proteins within its genome.

Overall, it was a really great experience. The talks were engaging, and I met many interesting people that I am keen to stay in contact with and perhaps work with in the future. Again, I would like to thank BPS for this opportunity and look forward to next years meeting!

Aisha O'Connor Department of Botany and Plant Sciences, National University of Ireland Galway aishaoconnor1005@gmail.com***

On January 7th 2019, I began my journey across the Celtic Sea to Oban, Scotland. This was a trip of firsts for me; my first time in Scotland and my first conference, and it was made possible through a student bursary from the British Phycological Society, for which I am truly grateful.

A warm welcome was extended to all attendees of the meeting to kick things off on Tuesday morning. The day proceeded with a series of short talks under the umbrellas of chemical ecology and general phycology, followed by the student Manton Prize talks. I presented a poster on the research project I am currently working on with Dr. Kathryn Schoenrock (National University of Ireland Galway) and Dr. Stacy Krueger-Hadfield (University of Alabama at Birmingham): A study in ochre: genetic diversity of Laminaria hyperborea forests along the Irish coastline. The genetic portion of this research took place at UAB in August 2018 with thanks to the BPS student internship bursary, so it was rewarding to present the research at the BPS meeting now. There was an array of other posters on display, covering many algal-related topics, so not only was I proud to see my work on display but it was interesting to see what other research is being done in phycology, a field which I have come to be so passionate about.



On the second evening of the meeting, all attendees were treated to a meal at the Royal Hotel and a traditional Scottish cèilidh. Though I am Irish, and we have a similar tradition of cèilidhean, this was a new experience for me. The relaxed atmosphere of dinner allowed conversations to flow, giving everyone the chance to connect with each other on a more casual level. The raffle and prize-giving ceremony provided great entertainment and set the mood for the fun that was yet to come. After dinner, the Céilidh Bandidos set up their instruments and launched into playing trad music. I was surprised at the enthusiasm of people getting up to learn each new dance, the steps of which were taught to us by a member of the Bandidos. It was a fun, culture-infused way to dance into the night and complemented the relaxed yet organised vibe of the entire meeting.

The BPS Meeting was a fantastic opportunity for me to meet other like-minded people who were equally interested in studying algae. This made for a positive change to

the usual scenario of being in the company of scientists and researchers from other fields, and was encouraging to see the volume of scientists who are part of the algal community, many of whom I have encountered as authors of papers I have read for my undergrad thesis and current research. The variety of talks and poster topics sparked further interest for me in all things seaweed, and have motivated me to persevere in my studies. I look forward to the possibility of returning to the BPS Annual Meeting, having progressed (I hope!) with my Masters Studies, and give a presentation on my research.

*Unfortunately Aisha's report was not included in last year's Spring newsletter but we hope you can enjoy a little trip down memory lane back to Oban!

Bursary reports International Conferences

Rani Monica Shanmukha Swamy Saggere ***Department of Biology, University of New Brunswick, Canada rani.saggere@unb.ca***

One of the undeniable truths of life is that the magic of experiencing any ecstasy in this world for the first time will always be a special sensation of its own. To rejoice over and revisit it in the memory remains my all-time personal favourite. One such memory to ponder and add to my list of happy nostalgia will be my tour in a bustling cosmopolitan city- Tokyo. The capital city of Japan (The Island Nation), Tokyo is the world's most populous metropolitan area and the centre of Japanese culture. This city was in no way relevant to me a couple of weeks ago but today, as I write this, I have a connection that completely transforms myself to that month, day, time and place.

Yes, it was VOLVOX 2019- The Fifth International Volvox Conference in Tokyo, Japan. It took place at the University of Tokyo campus from July 26th- July 29th 2019. The conference is held once in every two years and brings together international scientists working with Volvox and its relatives. They invite experimentalists and theorists interested in these fascinating organisms. The volvocine algae grow in various freshwater environments worldwide and have important roles in the water ecosystems. Furthermore, these organisms have become an important model system for investigating the evolution of sex and multicellularity, development and cellular differentiation, and have also yielded important insights in fields as diverse as genomics, biological physics, hydrodynamics, and social evolution. This meeting aims at fostering the exchange of ideas and expertise together with aims to initiate new collaborations to expand and strengthen the Volvocales and volvocine algal community.

I originally hail from Bengaluru, South India but currently pursuing my Doctoral degree at University of New Brunswick, Canada under the supervision of Dr. Aurora M. Nedelcu. I began my second year of my Ph.D. in May and this was my first international conference. As my supervisor was unable to make it to the conference due to an unavoidable circumstance, I planned my travel with other post doctoral and a master's students from my university.

I was glad to be a part of this and I decided to give an oral presentation of my research findings that I have been progressing with from the start of my program. At the same time, I was unsure of what to expect as it was my first international conference. The absence of my supervisor added little more anxiety, but despite this July 29th was my presentation day. The conference provided students with 20 minute slots to present their work or research findings. This was the best platform for me to discuss my work with other delegates and eminent scientists in the field. I was introduced by Dr. Stephen Miller to the audience and I presented a part of my PhD work. My talk primarily focussed on understanding a life history trade off gene called RLS1 in Chlamydomonas reinharditii. This forum not only helped me share my ideas but also provided me with valuable feedback and suggestions that I can improve in my research. The questions raised by the audience enhanced my approach, forcing me to clarify things in a much better way. The attainment of knowledge was not merely restricted to this, but I also gathered ideas and novelty from other research and people working on different objectives with the same model organism. The enlightenment of skills that I acquired during this period branches out and provided a wider array of research innovations.

Apart from this the team had arranged several social events. The speciality of Japan: the sushi evening, was the first interesting get-together/ welcome party arranged by Dr. Nozaki and his team. It was undoubtedly a great chance for all of the participants to know each other in person and exchange views over the culinary delight. Also, the post-conference trip to Tsukuba science city allowed people to benefit from each other's time in a comfortable, friendly and unofficial environment. Needless to mention, the coffee/tea and lunch breaks during the entire conference were prime opportunities for people from different countries to come, meet and greet each other by communicating freely with no limitations. As time passed, growing familiarity with the speakers abetted the ease of my nerves. This platform allowed diverse thinkers to come together and aided the networking of people beyond any barriers of age, field and experience.

Personally, I made a lot of new passionate friends at different levels in their scientific career. I found this meeting a very informative one, in all respects, and recommend students to attend the program for self-development and for knowing science and scientists beyond research papers and books. I wish for other students like me to get an opportunity to have countless learning opportunities at conferences and experience the joy of being a part of it. Because I claim it to be an undefinable emotion. I would like to thank the organizers for uniting people working from diverse labs and universities with same curiosity to contribute their part to scientific community at large.

Lastly, I have to mention- to attend or be present at any international meeting like this would be a dream for all the students pursuing research. But to actualise it, it is not as easy as it sounds. Especially, for an international student like me, a lot of constraints arise because of the additional expenses (travel, accommodation, food etc.) that it make it unrealistic for most. Although my university provided a few small grants as a PhD student to help with the expenses, it was not quite sufficient to manage everything. My supervisor's guidance, I became a member of British Phycological Society and applied for a travel grant to supplement my limited available resources. I am very grateful and indebted to the British Phycological Society for providing me the much needed support. I was happy to receive one of the most competitive grants in the field which paved my way to get to the conference. Infinite thanks to everyone who has facilitated me in their own way, for my journey to travel and sail my boat of research.

British Phycological Society
68th Annual General Meeting
6th-9th January 2020

Meeting Abstracts

MP1: Global miniaturisation of temperate marine forests

Albert Pessarrodona Silvestre, Karen Filbee-Dexter, Teresa Alcoverro, Jordi Boada, Colette J. Feehan, Stein Fredriksen, Sean P. Grace, Yohei Nakamura, Carla A. Narvaez, Kjell Magnus Norderhaug, Thomas Wernberg (University of Western Australia)

Accelerating anthropogenic changes to Earth's environment are favouring species with opportunistic life-history characteristics that are highly responsive to change. Existing work has documented how the dominance of opportunists transforms local habitat structure. Yet, the mismatch between local scales of observation and global patterns of environmental change has limited our capacity to understand these ecological changes, which operate across vastly different taxa and stressors. We examined the vegetation structure of marine forests that have experienced a shift towards dominance of opportunistic species during the past half-century, albeit as a result of different anthropogenic pressures. The present structure of those habitats differed across the globe, featuring varying heights, species diversity and being dominated by different algal groups. Importantly, differences among turf reefs dwarfed massively when compared to historical marine forest canopies, revealing a fundamental change in habitat architecture. Variation in the multivariate trait space of contemporary canopies has significantly reduced, converging towards short, small algal forms with numerous but smaller habitable spaces. This transformation has also resulted in a shift in the body size of fauna inhabiting the forests, suggesting that a community-wide miniaturization has occurred. We conclude that the ongoing declines in marine forests and replacement by algal turfs are a generalizable phenomenon occurring across temperate reefs, typified by a loss of habitat size, altered ecological function and a collapse of global seascape diversity.

MP2: Differential responses of *Stauroneis* sp. (Bacillariophyceae) exposed to varying conditions post-stationary phase.

Rachel Parkes, Lorraine Archer, Dónal McGee, Thomas Smyth, Eoin Gillespie, Nicolas Touzet (School of Science; Department of Environmental Science; Centre for Environmental Research, Sustainability and Innovation; Institute of Technology Sligo; Sligo; Ireland)

There has been an increasing drive to better valorise bio-based raw materials and products in the context of the sustainability of bio-based industries and the circular economy. Microalgae hold the ability to accumulate high-value metabolites which are sought after within industrial sectors such as bioenergy, pharmaceuticals, cosmetics or nutrition. Owing to their antioxidant, anti-inflammatory, antimicrobial or antiviral activities, the xanthophyll pigment fucoxanthin and polyunsaturated fatty acid omega-3 EPA have attracted increasing interests as they could be sustainably sourced from microalgae. A key challenge however resides in optimising the yields of these compounds within the microalgal biomass they are retrieved from. The marine diatom *Stauroneis* sp. LACW-24 was batch cultivated into its stationary phase of growth then subjected to varying regimes of light exposure (white, red, blue, green LEDs) and nutritional limitation (silica and nitrate) for 12 days prior to biomass harvest. Proximal analysis of the biochemical composition by ATR-FTIR showed that omitting nitrogen from the medium enhanced the proportions of carbohydrates. The highest EPA yields were obtained with the W-f/2, B-f/2, W-f/2(Si-1) and W-(f/2-1) sets (ranging from 3.8-4.6 mg g-1). The fucoxanthin yield was the highest when cells were subjected to blue LEDs (6.2 mg.g-1), a 2-fold increase compared to the controls. These results indicate that a two-stage approach to the cultivation of diatoms can be used for enhancing the production of the high-value metabolites fucoxanthin and EPA.

MP3: Hyperspectral mapping of *Ascophyllum nodosum* in western Ireland

Tom Rossiter, Tommy Furey, Tim McCarthy, Dagmar Stengel (National University of Ireland Galway)

The mapping of seaweed populations is important from both and ecological and economic perspective and the collection of baseline data will support informed management decision making. This research aimed to develop an integrated remote sensing approach for the assessment of the distribution and biomass of the intertidal brown fucoid, *Ascophyllum nodosum* (Phaeophyceae). The high spatial and spectral resolution of drone-mounted hyperspectral sensors is potentially a useful tool for seaweed mapping, as many intertidal communities are spectral similar and spatially heterogenous. To develop this methodology, a site was chosen in Co. Galway where detailed drone-based remote sensing surveys were conducted. Hyperspectral surveys were conducted using

a pushbroom sensor mounted on a DJI Matrice 600 Pro and supporting RGB surveys were conducted using a DJI Inspire 2. Surveys were conducted under stable light conditions and within a thirty-minute window either side of maximum low tide. Ground control points (GCPs) were collected, using a high precision RTK GPS, to georeference the data and a spectral radiometer was used to build a spectral library of canopy forming seaweeds and non-vegetated surfaces to support classification. High resolution RGB imagery allows for accurate digital delineation of selected cover classes, improving the efficiency and accuracy of both training and reference data collection. Two pixel-based classification approaches were used, Maximum Likelihood (MLC) and Spectral Angle Mapper (SAM). MLC classification results were significantly more accurate than SAM and showed higher levels of accuracy for the eight cover classes that we aimed to identify, including A. nodosum. Accurate data on total extent can now be gathered making this methodology useful for a range of intertidal resource assessment applications.

MP4: A UV-inducible sunscreen pigment found in the extracellular mucilage of aerophytic green algae (Conjugatophyceae)

Anna Busch (University of Cologne)

Terrestrial algae face several stressors including periodic drought and high solar radiation, both of which can be harmful to living cells. Some of these algae synthesise and accumulate light-absorbing substances that shield the cells against harmful radiation (non-photosynthetic pigments). A number of eukaryotic algae deposit such pigments in vacuoles or the cytoplasm, while sunscreen pigments in the extracellular matrix are - until now - only known from prokaryotic algae (Cyanobacteria). In the moist uplands east of Cologne, Germany ('Bergisches Land') we observed mass developments of terrestrial algae belonging to the polyphyletic genus *Mesotaenium* (Conjugatophyceae). These algae formed extensive black crusts covering moss, tree bark and bare soil, and exhibited pigments in their extracellular mucilage. Mesotaenium species with a pigmented mucilage were only rarely documented in the past, lack genetic identity and the function of their extracellular pigment is still unclear. We sampled such algae from diverse terrestrial habitats in Western Germany and North America (Great Smoky Mountains, USA), established several axenic cultures, studied the cell morphology with light microscopy (including confocal laser scanning microscopy), and sequenced the rbcL gene for phylogenetic inferences. The isolated strains showed common morphological characters (e.g. cell shape, plastid morphology), but varied in size and on the genetic level. Due to distinct morphological and genetic differences to the type species of the genus *Mesotaenium* (*M. endlicherianum*), we plan to introduce a new genus for the studied strains. To test whether extracellular pigmentation can be induced under light stress, algal cells were exposed to fluorescent tube lamps emitting photosynthetically active radiation (PAR) and ultraviolet radiation (UV). Cells treated with UV-B secreted blue mucilage and established pigmented capsules. As determined by microspectrophotometry, the pigmented mucilage absorbed in the entire solar spectrum, with two broad absorption maxima at about 300 nm and 580 nm. Both the UV-induced production and the absorption spectrum of pigmented mucilage strongly suggest a sunscreen function. We conclude that the densely coloured mucilaginous capsules may protect the algal cells from harmful solar radiation in their natural habitat.

MP5: Novel fluorescence techniques to discriminate cyanobacteria in mixed phytoplanktonic assemblages

Emilie Courtecuisse, Stefan Simis, Kevin Oxborough, Peter Hunter, Gavin Tilstone, Evangelos Spyrakos (Plymouth Marine Laboratory)

Harmful Algal blooms (HABs) are increasing in frequency and magnitude, enhanced by anthropogenic activities, including climate change (Paerl and Huisman 2008). A number of bloom-forming species produce potent toxins and constitute an actual and future risk to human and animal health and ecosystem functioning. Many cyanobacteria species form HABs (CyanoHABs), mainly found in freshwater bodies (Cronberg et al. 2003). Rapid and precise methods are required to detect, quantify and gauge the physiological state of cyanobacteria in mixed freshwater phytoplanktonic communities. Fluorescence techniques provide accurate and rapid results without disturbing the environment, at relatively low cost. Cyanobacteria possess specific optical properties, exploitable, in theory, for their detection. In laboratory conditions, fluorescence measurements were carried out on individual cultures of a range of phytoplankton groups (chlorophytes, diatoms, and cyanobacteria) under different light conditions (intensity and colour). Mixed phytoplanktonic community fluorescence was numerically modelled from single culture measurements. From these detailed measurements we understand fluorescence patterns of cyanobacteria in mixed communities and we determine which optical characteristics and measurement protocols are exploitable in the detection of cyanobacteria using new in situ sensors. References: Cronberg, G, EJ Carpenter, and WW Carmichael. 2003. 'Taxonomy of Harmful Cyanobacteria'. Manual on Harmful Marine Microalgae. UNESCO Publishing, 523–62. Paerl, H. W., and J. Huisman. 2008. 'CLIMATE: Blooms Like It Hot'. Science 320 (5872): 57–58. https://doi.org/10.1126/science.1155398

MP6: Local differentiation in heat response of *Laminaria digitata* at the range edges

Daniel Liesner, Louise Fouqueau, Myriam Valero, Michael Roleda, Gareth Pearson, Kai Bischof, Klaus Valentin, Inka Bartsch (Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research)

In recent years, kelp populations worldwide have faced decline and extirpation at their equatorward limits, while models predict a poleward shift of kelp ecosystems during climate change. To gain an understanding of local thermal

adaptation and response plasticity in a forest-forming kelp species, we assessed populations of *Laminaria digitata* along its entire European distribution range for their capacity to withstand high temperature stress, and analysed population structure and diversity with microsatellite markers (n=12). We sampled wild meristematic *L. digitata* material (n=30) at six locations ranging from Kongsfjorden, Spitsbergen, to the southernmost distribution limit in Quiberon, France. In a heatwave experiment, we subjected samples from all locations to the same, sublethal temperature treatments (15–23°C for eight days including acclimation) and assessed growth, storage compounds, photosynthetic efficiency and pigment contents as response traits. Recovery was assessed following seven days at 15°C. Microsatellite genotyping revealed all sampled populations to be genetically distinct entities, underlying strong regional structuring between southern and northern clades. Genetic diversity was highest at the southern distribution limit in Quiberon and lowest in the geographically isolated population on the island of Helgoland in the North Sea. The physiological response of *L. digitata* to temperature was similar over the entire distribution range and did not reflect the mean temperature gradient along the latitudinal gradient. However, material from Spitsbergen and Helgoland presented subtle differentiations in their temperature responses, which reflect long-term local temperature histories at these sites. Finally, a heatwave reaching 23°C for five days led to a cessation of growth, from which none of the sampled populations recovered. Our results suggest that the heat stress response of *L. digitata* is generally stable across its distribution range, despite strong genetic structuring of the populations. Slight local differentiation occurred in populations from the most distinct thermal environments, but 23°C posed a growth limit for all populations. This implies that local adaptation in trailing edge populations of *L. digitata* might not alleviate detrimental effects of global warming.

MP7: Idiosyncratic responses to increased salinity stress in populations of *Fucus vesiculosus*

Alexandra Kinnby, Co-authors: Per R Jonsson, Olga Ortega-Martinez, Mats Töpel, Henrik Pavia, Ricardo T Pereyra, Kerstin Johannesson (University of Gothenburg)

Climate change related effects threaten the persistence of species worldwide. Genetic differences among populations of the same species, however, might make the populations react differently to climate-induced stress. In order to understand the responses of a species to climate change we therefore need to analyze the contribution of differences in tolerance among populations that may be particularly pronounced in areas with steep environmental gradients. Here we use a common garden approach to test variation in tolerance to reduced salinity among populations of the marine foundation macroalga *Fucus vesiculosus*. We sampled 6 populations within 100 km at the entrance of the brackish water Baltic Sea (NE Atlantic) where a steep salinity gradient is established (from 10 to 18 practical salinity units, psu). We measured growth, maximum photochemical yield, and phlorotannin content in tissue of the same individuals exposed to both current and future conditions. We found that populations responded very differently to stress under future local salinity, a 4 psu decrease in all populations, as projected for this region by the end of the century. Some maintained growth at the cost of reduced phlorotannin production. One other population was strongly negatively affected while a second population at similar salinity, maintained growth and phlorotannin production when salinity was decreased. Position along the environmental gradient, connectivity and genetic affinity of the populations seemed to play an important role to explain the different abilities to tolerate the simulated salinity decrease.

MP8: Contrasting temperature performance of two co-occurring digitate Arctic kelp species

Kiara Franke, Daniel Liesner, Inka Bartsch (Ifred-Wegener-Institute, Helmholtz Center for Polar and Marine Research)

Understanding the physiological responses of macroalgae to changing temperatures is crucial to predict future ecosystem changes under the threat of climate warming. The two phenotypically similar digitate kelp species, *Laminaria digitata* and *Hedophyllum nigripes*, inhabit overlapping ecological niches in the Arctic, but their southern distribution boundary is dissimilar. This suggests a different adaptation of their life cycle stages towards temperature. We investigated growth, upper temperature limit and photosynthetic characteristic of juvenile sporophytes, and upper temperature survival and gametogenesis of gametophytes of both kelp species along temperature gradients in a full-factorial approach. We thereby add further data for an Arctic *L. digitata* population and present the first ecophysiological investigation for *H. nigripes*, a species formerly partially confused with *L. digitata*. It became evident that both co-occurring species have a fundamentally different temperature performance in both life-cycle stages. Arctic *L. digitata* gametophytes survived 24°C and sporophytes survived 21-22°C, and thereby temperature tolerance was 4°C or 5°C higher than in *H. nigripes* gametophytes and sporophytes, respectively. Recruitment of juvenile sporophytes was similar for both species at 5 and 10°C. Whereas *H. nigripes* had an advantage over *L. digitata* at 0°C, *L. digitata* was the only species recruiting at 15°C. *H. nigripes* showed a much better sporophyte growth performance at 0 and 5°C than *L. digitata*, but photosynthetic parameters (rETR-irradiance curves) suggest that both populations are well adapted to Arctic temperatures. The overall temperature performance of *H. nigripes* shows a true affinity to Arctic to sub-Arctic temperatures, while Arctic *L. digitata* behaves similarly to temperate populations. Data suggest that future increase in Arctic seawater temperatures may hamper the success of *H. nigripes* and favour *L. digitata*. Whether both species take the same or different functional roles in Arctic kelp forest communities, however, remains unresolved.

MP9: Characterising the role of NADPH oxidase in ma-

rine diatoms

Jack Dickenson, Glen Wheeler, Mark Moore, Colin Brownlee (Marine Biological Association of the UK)

Tight control of cellular redox state is important for healthy cell homeostasis. Imbalance in the production or removal of reactive oxygen species (ROS) can cause oxidative stress damage to cells. However, controlled production of ROS can be harnessed by cells for signalling or other aspects of metabolism. NADPH oxidase (NO_X) proteins function primarily to produce extracellular ROS, channelling intracellular electrons to react with extracellular oxygen. NO_X derived ROS production has well-characterised roles in defence in mammalian cells. However, NO_X proteins are diverse and widespread, being present in plants, algae, fungi and bacteria, and produce extracellular ROS for functions other than defence. Understanding of the roles of NO_X proteins outside of mammalian and plant cells remains limited. We focused upon characterising roles of NO_X proteins in marine diatoms. We explored the involvement of NO_X proteins in relation to photosynthesis regulation in the model diatom *Phaeodactylum tricornutum* using a range of techniques. These included molecular techniques such as genetic transformation. We explored the effect of chemical inhibition of NO_X to cellular physiology through assays measuring extracellular ROS production and photosynthetic performance. *P. tricornutum* showed a clear link between increased extracellular ROS production and increased light intensity. Furthermore, chemical inhibition of diatom NO_X proteins dramatically affects photosynthetic output, leading to changes in cellular redox status and compromised cellular physiology, particularly to photosynthetic machinery. We suggest diatom NO_X proteins are crucial to healthy cellular physiology by acting to alleviate excess electron stress by removing excess reductant generated during photosynthesis to balance the redox state of NADPH. This adds to growing evidence showing how diatoms are capable of metabolic coupling to reduce electron pressure, helping explain diatoms remarkable tolerance to high light intensities.

MP10: The effect of climate change on coastlines, a case study of *Corallina officinalis*

Regina Kolzenburg, Federica Ragazzola (University of Portsmouth)

With increasing severity of climatic implications on, for instance, socio-economy, health and ecosystems due to anthropogenically induced global climate change, the necessity to research the complex interactions and impacts of these changes on organisms is urgent. At present, the impacts of climatic changes on marine coastal ecosystems are poorly understood. As critical components of global marine shallow water ecosystems, habitat builders and indicator species for climatic impacts, coralline algae are alarmingly effected. The species focussed on in this study and representing the majority of traits of coralline algae, is *Corallina officinalis*. We aimed at a laboratory experimental approach to assess the impacts of climate change across the species distribution in the NE Atlantic ranging from the northern boundary in Iceland to the southern boundary in Spain. Physiological and structural measurements were performed to determine thermal and chemistry-induced stress responses. These were compared between origins of populations and a distinct vulnerability of the southern marginal populations to increasing temperatures and changing carbonate chemistry were identified. Physiological rates such as respiration, primary production and calcification changed negatively in both southern populations indicating a great amount of stress, but showed an increase in central and northern populations. Structural parameters such as cell wall thickness or linear growth were greatest in northern populations. Central and southern populations, however, showed a reduction in both under climate change conditions leading to increased fragility. In addition to compromised resilience in southern marginal populations, northern marginal populations showed a great resilience and adaptation potential to future oceanic conditions. Based on these findings, the generally assumed Centre-to-Margin hypothesis regarding abundance as well as adaptation and resilience potential is not observed in *C. officinalis* and is suggested to be modified into a North-to-South gradient for this species. Overall, this study demonstrates that coralline algae (Rhodophyta, Corallinaceae) are vulnerable to ocean warming and ocean acidification. However, predicting the extent of their susceptibility to these changes is complex as it must be considered together with additional environmental and ecological factors. This study highlights the importance of ecological interactions in determining species responses to environmental change.

MP11: Sensitivities of key freshwater species to environmentally relevant exposures of microcystin LR

Oloyede Adekolurejo, Chris Hassall; Paul Kay (University of Leeds)

The worldwide expansion of microcystin-producing cyanobacterial blooms and the release of toxic microcystins in water potentially threaten human health, aquatic biodiversity and ecosystem integrity in freshwater systems. It is however unknown how individual species across different trophic levels in the freshwater food web may respond to microcystin exposures during toxic blooms. To test the hypothesis that species will differ in their sensitivities to environmentally relevant concentrations of microcystins, we conducted a battery of 72-hour algal growth inhibition test on the phytoplankton species, *Scenedesmus quadricauda*, 48-hour acute toxicity test on the zooplankton grazer, *Daphnia magna*, and 96-hour acute toxicity on two species of amphipod shredders, *Gammarus pulex* (native spp), and *Dikerogammarus villosus* (invasive) using pure MC LR and crude cyanobacterial extract treatments. Relative the control, pure MC LR treatments strongly inhibited the growth of *S. quadricauda*, while the photosynthetic pigments were not affected by both pure MC LR and the crude extract treatments. Survival of D. magna neonates was significantly reduced by Microcystis extract. However, neither pure MC LR nor extract treatments affected

the survival of both native and invasive amphipods. Our results suggest that the toxic effects of microcystin on freshwater organisms depend on the species involved and that microcystin alone is not likely to be primarily responsible for the observed negative effects on organism during toxic freshwater blooms.

MP12: Sr in coccoliths of *S.apsteinii*: partitioning behavior and role in coccolith morphogenesis

Erin Meyer, Gerald Langer, Glen Wheeler, Colin Brownlee, and Alison Taylor (University of North Carolina Wilmington)

Coccolithophores are important contributors to global calcium carbonate through their species-specific production of calcite coccoliths. Nannofossil coccolith calcite remains an important tool for paleoreconstructions through geochemical analysis of isotopic and trace element incorporation, including Sr, which is a potential indicator of past surface ocean temperature and productivity. *Scyphosphaera apsteinii* (Zygodiscales) exhibits an unusually high Sr/Ca ratio and correspondingly high partitioning coefficient (DSr) in their two morphologically distinct types of coccoliths. Whether or not this reflects mechanistic differences in calcification compared to other coccolithophores is unknown. We therefore examined the possible role of Sr in *S. apsteinii* calcification by growing cells in deplete, ambient, and higher than ambient Sr conditions (between 0.33 - 140 mmol/mol Sr/Ca). The effects on growth, quantum efficiency of photosystem II (Fv/Fm), coccolith morphology, and calcite DSr were evaluated. Reducing the Sr/Ca from ambient (9 mmol/mol) did not significantly alter the frequency of malformed and aberrant muroliths and lopadoliths, but at higher than ambient Sr/Ca conditions coccolith morphology was significantly disrupted. This implies that Sr is not a critical determining factor in normal coccolith calcite morphology in this dimorphic species. Interestingly, muroliths had significantly lower Sr/Ca than lopadoliths at ambient and elevated [Sr], and lopadolith tips had lower Sr than bases in ambient conditions. In summary, the Sr fractionation behavior of *S. apsteinii* is unusual because of an overall high DSr, and an inter- and intra-coccolith variability in Sr/Ca. We hypothesize that differential Sr-and Ca-binding capacity of coccolith associated polysaccharides may account for the unusual Sr fractionation of this species which can explain all observations made in this study.

MP13: Under the ice: Microbial mats of Lake Untersee, Antarctica

Carla Greco, Marian Yallop, Gary Barker, Anne D Jungblut (Natural History Museum London and University of Bristol)

Cyanobacteria have shaped biogeochemical ecosystems on Earth since their evolution approximately 2.5 billion years ago and are particularly successful at surviving in extreme environments. Whilst the presence of cyanobacterial mats in the polar regions has been recorded historically, from nineteenth century exploration expeditions, the emergence of next generation sequencing techniques enables a more in-depth study of cyanobacterial diversity and community structure in perennially cold environments. Under low disturbance environments, cyanobacterial mats are able to form complex 3D structures that are laminated through seasonal growth and incorporation of sediment. A fascinating example of these structures comes from Lake Untersee, East Antarctica, where unique cone shaped structures and pinnacles have been reported. These structures are of particular geological interest as they are modern day analogues of Archean stromatolite fossils. It has been suggested that the microbial community can influence the morphology of the mats and understanding the ecology and the microbial interactions of modern mat formation may aid in interpreting the formation of Archean fossils. Analysis of 16S rRNA sequencing data demonstrated that the biofilm mats of Lake Untersee consist of diverse microbial communities. Consistent with other Antarctic freshwater ecosystems, Lake Untersee was dominated by cyanobacterial benthic mats that additionally included prevalent phyla including Proteobacteria, Verrucomicrobia, Planctomycetes and Actinobacteria. The cyanobacterial taxa were composed largely of *Tychonema*, but also included *Leptolynbya* and *Pseudanabaena* in all samples. These genera have been found in other Antarctic lakes, such as Lake Vanda, suggesting that these genera are ideal candidates for further research on the adaptation of cyanobacteria to cold environments.

Special Session 1: Hidden Forests

SS1.Invited Speaker: Seagrass meadows – sensitive but mighty sentinels in a changing world

Irene Olivé (University of Glasgow)

Seagrasses refer to the group of flowering plants readapted to live in seawater. Despite the relatively limited number of species belonging to this group, seagrasses colonize coastal areas all over the world playing a key ecological role in the functioning of coastal marine ecosystems. The high productivity and complex physical structure associated with seagrass meadows support high biodiversity and provide ecosystem services that rank among the highest on Earth. In the recent years a growing scientific effort has been devoted to understanding the functioning of these communities, particularly since large decreases in seagrass cover were reported globally a few decades ago. Seagrasses are considered globally threatened and early indicators of anthropogenic pressures. Nevertheless, recent studies highlight that seagrasses may play a key role in counterbalancing global climate change and creating refugee areas for associated sensitive species. The clonal nature of seagrasses makes them particularly suitable for studying how these organisms adjust to environmental gradients and cope with changes at different temporal scales, from short-term acclimation to long-term adapta-

tion. The use of seagrasses as model species in climate change research not only contributes to our understanding of seagrass' biology and capacity to cope with climate change but may also shed light on the functioning of other marine macrophyte communities.

SS1.Invited Speaker: The structure, function and threats to UK and Chilean kelp forests

Pippa Moore, Nathan King, Mathilde Bue, Albert Pessarrodona, Harry Teagle, Mike Burrows, Anna Yunnie, Tom Vance, Ally Evans, Alejandro Perez-Matus, Adam Gouraguine & Dan Smale (Aberystwyth University)

Kelp forests extend along 25% of the global coastline, where they provide a 3-dimensional habitat that supports elevated levels of primary and secondary production as well as providing a range of goods and services to human society. At the same time these vital ecosystems are subjected to a range of anthropogenic stressors from direct exploitation to the impacts of climate change. Some of the early pioneering work on the ecology, distribution and standing stock of kelp was undertaken in the UK, but from the 1980s onwards attitudes and regulations towards scientific diving has meant that the UK has lagged behind other countries in our ecological understanding of kelp forests. Here I will present research undertaken over the last five years where we have undertaken large-scale (across 9° of latitude) mensurative experiments to better understand how the structure of kelp and kelp associated assemblages vary across natural gradients. Using space-for-time substitutions and experimental manipulations I will also outline the likely responses of kelp to future climate warming and what this might mean for the structure, functioning and ecosystem services kelp forests provide. Finally, I will outline research into the impact of commercial kelp harvesting on Chilean kelp forests and the drivers that may promote resilience.

SS1.2: Kelp forests of Ireland: distribution, diversity, productivity and resilience to change

Kathryn Schoenrock, Kenan M. Chan, Stacy A. Krueger-Hadfield, Jessica Adams, Aaron Golden, Tony O'Callaghan, Rory O'Callaghan, Julie B. Schram, Natalie Thompson, Aisha M. O'Connor, Jessica J. Ratcliff, Dagmar B. Stengel, and Anne Marie Power (National University of Ireland Galway)

Kelp forest monitoring along the west coast of Ireland has been on-going since winter 2017, shedding light on the diversity and productivity of these systems. The subtidal kelp forests dominated by *Laminaria hyperborea* host higher diversity than other nearshore habitats including maerl beds, *Serpula vermicularis* reefs, and tidal loughs across all seasons. Further, these forests produce up to 11 kg m-2 biomass in shallower habitats during summer, and continually regenerate themselves after disturbances throughout the year, making them highly productive ecosystems. Unlike other kelp species worldwide, *L. hyperborea* is negatively buoyant and though it can be exported to adjacent habitats, such as maerl beds, the shore, and deep sea, dispersal is generally limited, especially for spores. Populations exhibit isolation by distance, and the highest genetic diversity (i.e., allelic richness, expected heterozygosity) lies in the populations along the south coast of Ireland (Co. Cork), a predicted glacial refugium. Current studies are exploring the eco-evolutionary aspects of resilience in *L. hyperborea* forests as well as monitoring tools which will help track distribution shifts in comparison to historical records.

SS1.3: Functional alpha- and beta-diversity of seaweeds across the rocky intertidal elevation gradient

Laura Cappelatti, Alizée R. L. Mauffrey, John N. Griffin (Swansea University)

How the functional diversity of marine foundation species responds to environmental stress gradients remains poorly understood. Here we tackle this question by revisiting the textbook case of seaweed community changes across the rocky intertidal stress gradient from low to high shore. We surveyed seaweed assemblages across shore heights at sites in south Wales (UK), and investigated multiple aspects of functional diversity at large (entire zones) and small (1 x 1m quadrat) scales. Seaweed species were positioned in a multidimensional functional space and clustered into emergent groups to investigate patterns of redundancy. Null models were used to ascertain whether observed measures of functional α- and β-diversity differed from expected given observed species richness across zones. The overall seaweed trait-space showed signs of 'over-redundancy' with an uneven distribution of species across emergent groups. Species loss with shore height eroded redundancy and led to a contraction of functional richness - the total functional space occupied - in line with null model expectations at large and small scales. Functional dispersion - a metric that indicates trait complementarity of dominant species - was greater-than-expected across all zones at the large scale and in the low zone at the small scale. These results show: 1) Seaweed functional structure is vulnerable to species loss as redundancy is concentrated within a few groups and depleted under environmental stress; 2) Seaweed communities higher on the shore have a smaller range of trait values and, potentially, contribute a smaller suite of ecosystem functions; 3) Trait complementarity of abundant species may be an important mechanism promoting species coexistence and functioning among marine foundation species such as seaweeds.

SS1.3: The structure, function and threats to UK and Chilean kelp forests

Pippa Moore, Nathan King, Mathilde Bue, Albert Pessarrodona, Harry Teagle, Mike Burrows, Anna Yunnie, Tom Vance, Ally Evans, Alejandro Perez-Matus, Adam Goura-

guine & Dan Smale, (Aberystwyth University)

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SS1.4: The Clones/Magheraveely Lakes - how water quality decline is reflected in charophyte lakes.

Nick Stewart, Yvonne McElarney, Frances Lucey, Joerg Arnscheidt, Sara Meehan, Darren Garland & Raymond Wilson

The Clones/Magheraveely Lakes are a group of small kettle-hole marl lakes straddling the national border in Ireland. In the late 1980s all had extensive charophyte communities but this has declined due to nutrient enrichment in all of the lakes in the 30 years since. This study has shown a clear pattern of decline within the lakes which is influenced by the adajcent land management. This matches the patterns seen in similar declining sites elsewhere. The study also looked at the how these changes are reflected in the standard lake monitoring methods and found them to be unsatisfactory.

SS1.5: The colour dynamics and photosynthetic performance of the brown alga *Cystoseira tamariscifolia*

Barry Pettifor, Supervised by - Rasmusson, Lina M.; Hall-Spencer, Jason M. (Plymouth University)

Structural colours are seen when nanoscale anatomical features interfere with incident light at particular wavelengths which are then reflected. Iridescence occurs when changes in viewing angle alter the colour perceived. This has evolved biological uses in signalling (e.g. in plants, insects, birds) and light harvesting (angiosperms). In some marine algae colour is created by extracellular multilayer structures or intracellular, tightly packed nanospheres. Recent research on the brown seaweed *Cystoseira tamariscifolia* revealed the opalescent photonic crystal (OPC) anatomy responsible for this species' blue colouration and showed that its colour intensity responds to light and dark. Biophysical modelling led to speculation that OPCs have a role in photosynthesis. To investigate this further we explored colour responses in *C. tamariscifolia* using time lapse photography and a range of light treatments. The most intense blue colouration occurred in the dark and reduced rapidly in light, even at very low irradiance levels. The response was not light spectrum dependent, such as might occur in response to immersion. Chlorophyll fluorometry showed that the maximum quantum efficiency of photosystem II was higher in conditions in which strong blue colouration was evident (just after dark) but reduced over a 90 minute period of illumination. Dynamic nanostructures may modulate the transmission of light to chloroplasts in response to different irradiance levels. In terms of practical applications, static nanostructures have already been shown to enhance the efficiency of photovoltaic cells. A deeper understanding of the sensing and motor processes used to manipulate light transmission in seaweeds could inform solar cell design through incorporation of self-tuning mechanisms.

Special Session 2: Algal Interactions

SS2.Invited Speaker: First insights into the molecular mechanisms involved in the perforation of algal cell walls by microbial 'protoplast feeders'

Sebastian Hess (University of Cologne)

Trophic interactions of heterotrophic microbes with algae are diverse, and range from predation (or grazing) to highly specialised parasitism. This spectrum also contains so-called 'protoplast feeders', single-celled eukaryotes that perforate foreign cell walls to specifically consume the cell content of other eukaryotes by phagocytosis. With that, protoplast feeders are able to feed on microalgae with tough cell walls, which are otherwise hard to consume for other microscopic predators, and may play important roles in microbial food webs. Nowadays we know that there is a wealth of phylogenetically diverse protoplast feeders inhabiting marine, freshwater and soil ecosystems, e.g. the vampyrellid amoebae and viridiraptorid flagellates. However, the molecular mechanisms underpinning the intricate feeding behaviour of such life forms, especially the perforation of chemically diverse algal cell walls, are still unknown. In this talk, I will give an overview about known protoplast feeders from several evolutionary lineages and show how we study their interactions with microalgae. The viridiraptorid flagellates, in particular, are well-suited laboratory models to shed light on cell biological and biochemical processes taking place at the interface of attacking protoplast feeders and algal cell walls. Comparative transcriptomics of such flagellates in different life history stages and biochemical assays re-

veal the potential roles of carbohydrate-active enzymes (CAZYmes) during prey cell recognition and cell wall dissolution. Some of the protein families found are well known from plant-microbe interactions and raise interesting evolutionary questions that will be experimentally addressed in future.

SS2.Invited Speaker: Plankton Photosymbiosis

Fabrice Not (CNRS STation Biologique de Roscoff)

Photosymbiosis is a symbiotic relationship between two or more organisms, one of which is capable of photosynthesis. Like other forms of symbiosis, photosymbioses can involve the full spectrum of trophic interactions from mutualism to parasitism. As in marine benthic environments (e.g. coral reef ecosystems), photosymbiotic associations are frequently encountered among plankton in marine pelagic environments and can involve various combinations of microalgae with bacteria, protists, or metazoans. After a brief overview of current knowledge on the diversity of the organisms involved in mutualistic pelagic photosymbioses, I will focus on Radiolaria (Rhizaria) a poorly studied yet significant plankton group in oceanic ecosystems. Evolutionary relationships based on single cell morpho-molecular approaches for main radiolarian groups and their microalgal symbionts emphasize the necessity to re-evaluate traditional classification structures. Those molecular phylogenies using universal taxonomic marker genes (e.g. 18S rDNA) also provide references sequences that are critically required to appropriately annotate environmental meta-barcoding datasets and explore specific ecological patterns in relation to contextual parameters. In order to investigate further the functioning of photosymbiotic relationships between protists, I'll present a comparative genomic approach based on reference transcriptomes and dedicated bioinformatics tools such as similarity sequence networks. Identification of gene sets involved specifically in photosymbiosis will contribute to a better understanding of symbiotic relationships. Following this strategy we believe that genomic functional traits can be characterized and help decipher the distribution of targeted biological functions in the environment but also be valuable to conduct evolutionary studies.

SS2.1: Utilization of municipal wastewater and flue gas for cultivation of microalgae for biofuel production

Sandra Lage, Francesco Gentili (Stockholm University)

Society faces major challenges in the production of sufficient amounts of biomass for energy and material production. Biomass from microalgae that are rich in oil has great potential as a complement to biomass from forests and agriculture. The success of microalgae as feedstock depends on achieving high yield with minimum energy input. The coupling of microalgae for phyco-remediation of wastewater, CO_2 recycling and biomass production for sustainable biofuels production is a feasible option. This study investigates the effect of algal species composition variability between ponds and through the season on the biomass biochemical composition and nutrient removal on municipal wastewater supplemented with flue gases containing circa 10% of CO_2. The local microalgae consortium was cultured during the 2017 summer season in open raceway ponds, with a surface area of 19.14 m^2, outdoors and inside a greenhouse in Umeå, northern Sweden. The results from the ponds suggest that the microalgae consortium can simultaneously remove dissolved nitrogen and phosphorus to low levels and sequester CO_2 independently of the dominant green-algae species, while generating a feedstock potentially useful for biofuels production.

SS2.2: Optimization of recombinant antibody production in the diatom *Phaeodactylum tricornutum*

Félix Cicéron, Michael J. Allen, Paul Rooks, Tracey A. Beacham (Plymouth Marine Laboratory)

Diatoms are one of the most prominent groups of phytoplankton in oceans, having diverse and peculiar metabolisms. Notably, it has been shown that the model species *Phaeodactylum tricornutum* is able to produce and secrete recombinant human monoclonal antibodies. Thus, it can now be considered as a new interesting platform for antibody production, since it is recognized as safe, cannot be contaminated by mammalian-type virus, and grows on inexpensive medium. However, its production yield is currently too low to be competitive. Until now, antibody genes have been inserted in *Phaeodactylum* using the biolistic (gene gun) methods. This technique limits the possibility of genetic circuit optimization since the DNA vectors breaks and inserts randomly in the genome. An alternative transformation method has been developed recently, using bacterial conjugation to deliver a self-replicating plasmid. This "soft" transformation allows maintaining the integrity of both the foreign genetic circuit, and the diatom's original genome. This project consists in enhancing the yield and practicability of recombinant protein production in *P. tricornutum*. It will rely on the optimization of the currently available replicative plasmid, combined with the establishment of a pilot scale process for the culture and purification. Various key DNA sequences will be tested independently and these bio bricks will then be combined in a final backbone vector. A major part of the project will be dedicated to scaling-up cultures from the classic 300 ml research laboratory volumes to pre industrial pilot scale (50 – 100L), and optimizing the downstream process of cell clarification, supernatant concentration, and protein purification. The product will be characterized in term of yield, affinity, and post-translational modification. This last attribute will be analyzed in collaboration with the University of Normandy. A previously produced anti-Hepatitis B antibody will be used as a reference, in order to compare with the results that were

firstly obtained from biolistic transformation. By combining genetic and process optimization approaches, we aim to move from the current "proof of concept" stage, to a streamed line process that allows going from the cloning of a foreign gene to a pilot scale culture in less than three months.

SS2.3: Evidence supporting the 'healthy herd hypothesis' in a marine protist-diatom interaction

Davis Laundon, Nathan Chrismas, Glen Wheeler, Michael Cunliffe (The Marine Biological Association)

Protist-protist interactions are ubiquitous, yet poorly understood, ecological processes that regulate the structure and function of microbial communities. Of these interactions, parasitism of marine diatoms has major implications on global biogeochemical cycling due to their essential role as primary producers. Environmental DNA sequencing studies have indicated that such interactions are widespread across the global oceans, however, our understanding of the underpinning physiology of protist-diatom parasitism is limited because of the relatively few cultured examples of these systems. Culture-based experiments are therefore vital in gaining a comprehensive understanding of trophic ecology and the impact on biogeochemical cycles in marine systems. Here, we present the isolation, stable co-culture and characterisation of a widespread thraustochytrid symbiont (herein designated 'ThrauL4') of the ecologically important diatom *Chaetoceros*, including the development of an experimentally tractable model system. Our physiological experiments characterise the ThrauL4-*Chaetoceros* interaction cycle and show that ThrauL4 preferentially targets senescent and 'unhealthy' diatom cells in a manner indicative of a necrotrophic parasite. We show that the selective targeting of 'unhealthy' diatoms manipulates the overall diatom population to be healthier, revealing the complexities of protist parasitism on marine phytoplankton communities. This study provides support for the 'healthy herd hypothesis' in a protist-protist symbiosis, a phenomenon typically associated with animal predators and their prey, highlighting the unanticipated ecological complexity that can be revealed from culture-based experimentation in protist-protist interactions. Taken together, our isolation of a stable thraustochytrid-diatom symbiosis is an important step forward in characterising the complexity of marine microbe-microbe interactions and sheds light on the ecophysiological and biogeochemical implications of phytoplankton parasitism.

SS2.4: Establishing environmentally and commercially sustainable techniques for farming seaweed

Carly Daniels, Ian Ashton, Ross Brown, Mike Allen (The University of Exeter)

Worldwide demand for seaweed is rapidly growing, as is the interest in its cultivation. Leading seaweed producing countries include China, Indonesia and the Philippines, though unsurprisingly, interest in its cultivation is fast emerging across Europe. Nutrient-rich temperate waters and a large coastline make the UK, a prime location for seaweed cultivation. Through a collaborative research and development project, the University of Exeter (along with project partners the Cornish Seaweed Company) are investigating sustainable seaweed cultivation in Cornwall. The project aims to address three key elements of seaweed cultivation namely the practical how to, the environmental implications and the market potential of seaweed. This project will practically trial rope-grown cultivation of Sugar Kelp, *Saccharina latissima*, by integrating its culture into shellfish farming activities. Investigating practical seeding methods as part of a pilot scale farming operation the research program will also analyse the hydrodynamic loads on seaweed infrastructure, giving valuable evidence of the costs and practicalities of seaweed cultivation. In Situ environmental monitoring including observations of temperature, Dissolved Oxygen, Salinity, light, nutrients, chlorophyll, plankton community profiling and wave and current profiling will be used to assess the marine environment. This data will help to understand environmental drivers of production success through biomass monitoring and determine the environmental implications of seaweed cultivation. In particular, how seaweed may reduce harmful algal blooms (HABs), how it may enhance other aquaculture activities; and model and physical influences on the water body around the site. This project will also look into alternative uses for seaweed that can diversify market potential of the harvested product. Seaweed provides a versatile biomass that has diverse qualities, by investigating a selection of these qualities, including the lipid and carbohydrate concentration, we will start to uncover alternative market potential. This project presents one of a growing number of studies that looks to bring macroalgal culture to the South West of England and shows vast potential.

SS2.5: Bioenergy production from *Saccharina latissima* through anaerobic digestion

Roshni Paul, Prof. Lynsey Melville, Dr. Sri Suhartini, and Dr. Michael Sulu (Birmingham City University)

This research aims to compare the feasibility of using wild and cultivated brown macroalgae species *Sacchairna latissima* as a novel feedstock for co-digestion with agricultural crop waste residues including wheat residues, grass and maize silage, sugar beet-vegetable mix, pig manure and brewery spent grain. Anaerobic digestion of macroalgae has been an increasingly important area of research in recent years however co-digestion of macroalgae biomass with other traditional waste biomass is still a developing research area. Wild and cultivated *Saccharina latissima* samples was obtained from Northern Irish Coast, UK. Biochemical methane potential tests were carried out on the samples as a mono digestion and co-digestion feedstock. The results indicated that seaweed

offered potential as a co-digestion feedstock enhancing the overall methane production. The co-digestion of wheat and *Saccharina latissima* had the highest specific methane production and pig manure showed the least specific methane production for both wild and cultivated biomass. This is possibly because seaweed has lower cellulose, no lignin and high carbohydrate content which aids better digestion performance. Comparisons were made in the biochemical properties of the wild and cultivated biomass indicating significant difference. The wild *Saccharina latissima* had a specific methane production of 0.249 l CH4 Kg-1VS and the cultivated biomass had a specific methane production of 0.393 l CH4 Kg-1VS. Results showed that cultivated biomass performed better than their wild counter parts. This is favourable for promoting utilisation of cultivated biomass than wild because it is unsustainable on a larger scale posing potential threats to the natural ecosystem. Macroalgae biomass cultivated in a marine environment also do not compete with agricultural land or potable water which makes it an attractive biofuel feedstock. However there are challenges involved for continuous AD operations including large scale cultivation and supply of seaweed, seasonal variability affecting the biochemical composition of the biomass, and thereby affecting the optimum carbon to nitrogen for co-digestion using macroalgae biomass.

SS2.6: Towards understanding the prokaryote microbiome composition and impact on carrageenophyte red algae

Juliet Brodie, Georgia Ward, Stuart Ross, Grant Stentiford, David Bass (Natural History Museum, London, UK)

Seaweeds are known to coexist with an associated community of prokaryotic and eukaryotic co-localised and co-evolving taxa, including bacteria, protists, fungi and other algae. This holobiont is increasingly recognised as influencing host health status, particularly bacteria which can be beneficial, modifying the host's interaction with grazers, epiphytes and abiotic factors. Other members can be pests (endobionts and epibionts, including other seaweeds) and pathogens (bacteria and micro-eukaryotes). Little is known about the interactions between these taxa and how they are influenced by environmental conditions and host, or how the composition of these communities vary over time, holobiont health status and host life-stage. Global seaweed aquaculture is a rapidly expanding industry, with the majority of production based in Asia (including countries such as China, Indonesia, the Philippines and the Republic of Korea). Eucheumatoid red algae (*Kappaphycus* and *Eucheuma* spp.) are of particular importance as they are commercially exploited as a source of carrageenan, a polysaccharide used for thickening foods and in other industrial processes, e.g. cosmetic and pharmaceutical production. However, the yield of these crops is limited by outbreaks of disease and pests, in particular outbreaks of epiphytic algae, and a diseased state known as 'ice-ice', which causes bleaching of the thallus. 'Ice-ice' is thought to be caused by opportunistic bacterial infection, though the identity of disease-causing taxa, and their interactions with abiotic factors, other holobiont components and the host remain unknown. Understanding these interactions is critical for minimising the impact of disease outbreaks on commercial seaweeds. *Chondrus crispus*, a traditional North Atlantic source of carrageenan, is a potential model by which to study carrageenophyte microbiome composition and variation. High-throughput 16S sequencing, paired with light microscopy, are being used to study composition of prokaryotic communities across seasons in individual host tissues of life stages of *C. crispus* collected in Dorset, UK.

SS2.7: Exploring eukaryotic diversity associated with Carrageenophyte red algae: A study of *Chondrus crispus*

Georgia Ward, Additional authors: Stuart Ross, David Bass, Grant Stentiford, Juliet Brodie (Natural History Museum)

The red alga *Chondrus crispus*, known as Irish moss, is common along shorelines in Europe where it is a traditional source of carrageenan, a thickening agent used in foods, cosmetics and pharmaceuticals. Like all seaweeds, *C. crispus* exists with an associated community of bacteria, protists, fungi and other algae, with these organisms together comprising the holobiont. While the importance of the composition of this holobiont in influencing the development and health status of the host is becoming increasingly apparent, the majority of studies focus on the role of bacteria in modifying the host's interactions with grazers, epiphytes and abiotic factors. The identity of eukaryotic pathogens and symbionts and their interactions with their host remain largely unexplored. In this study we use 18S-targeted high-throughput sequencing, PCR screens targeted at known pathogen groups, and light microscopy to investigate the incidence and identity of eukaryotes associated with *C. crispus* tissues collected in Dorset, UK, and how this varies across seasons, individual host tissues and life history stages. We also discuss the importance of the methods used for understanding the role of the holobiont in influencing the health and disease of carrageenophyte algae.

SS2.8: Ecological stoichiometry of phytoplankton parasites

Dedmer Van de Waal, Kai Cheng, Thijs Frenken & Alena Gsell (Netherlands Institute of Ecology)

All life on Earth consists of a basic set of elements, notably including carbon (C), nitrogen (N), and phosphorus (P). Ecological Stoichiometry studies the balance of these elements, and as such provides a mechanistic framework based on first principles to understand ecological interactions. Generally, primary producers have flexible elemental demands and therefore a high stoichiometric plastic-

ity, while consumers tend to have more strict nutritional demands and are stoichiometrically homeostatic. As a consequence, strong elemental imbalances at the base of the food-web may limit consumers and lead to trophic bottle-necks. The elemental demands as well as the extent of homeostasis is expected to be particularly high in parasites, such as viruses and fungi, as they lack complex cellular machinery. In a series of experiments, we tested how nutrient limitation of phytoplankton shifted infection dynamics of viruses and fungal parasites (chytrids) in harmful freshwater cyanobacteria. We showed that viruses are more strongly impacted by host P limitation, while parasitic fungi are more sensitive to N limitation. Thus, although an imbalanced nutrient supply will limit phytoplankton growth, it may more strongly limit their parasites, and as such ultimately provide the host with a stoichiometric refuge from diseases.

Special Session 3: Impact of Climate Change on Marine and Freshwater Algae

SS3.Invited Speaker: Climate change and diseases of seaweeds, microbiome manipulations and restorative aquaculture

Alexandra Campbell, Peter D Steinberg, Ezequiel M Marzinelli, Adriana Verges, Torsten Thomas, Sharon Longford, Suhelen Egan, Nicholas Paul (University of the Sunshine Coast)

Like most marine organisms, seaweeds persist in a 'microbial soup' with millions of microorganisms occurring planktonically in each millilitre of seawater and forming complex biofilms on all living surfaces, including seaweeds. These microbiomes and their seaweed hosts interact in many diverse and complex ways and we are now beginning to understand the very fundamental interdependence of marine holobionts. I have studied how environmental change influences seaweed-microbe interactions and what the consequences are for the host and the coastal ecosystems they underpin. I will present data on climate-mediated diseases from three of the dominant habitat-forming species from around Australia – the country with the highest seaweed diversity and endemism in the world - with a particular focus on interactions at the molecular and cellular levels. Because climate mediated diseases are often implicated in seaweed declines, I have also worked on a long-term seaweed restoration project, affectionately named 'Operation Crayweed', which I will briefly describe. My current projects on the Sunshine Coast, focus on 'restorative aquaculture' and aim to make the restoration of seaweeds and other organisms economically feasible on ecologically relevant scales (i.e. hundreds or thousands of kilometres), which is the scale at which seaweed forests are currently declining in Australia each decade.

SS3.1: Temperature sensing in diatoms: cold shock and Ca^{2+} signalling

Friedrich Kleiner, Katherine Helliwell, Glen Wheeler, Colin Brownlee (Marine Biological Association of the UK)

Diatoms are a diverse collection of photosynthetically active microalgae with exceptional ecological importance. Temperatures lower than the optimum for growth or even survival can easily occur in the oceans due to seasonal changes or in coastal areas due to the impact of riverine inputs or tidal flows. As diatoms exhibit a global distribution, a big variety in cold tolerance is to be expected and partially already observed. Yet, nothing is known about the specific signal perception and transduction pathways, changes in transcription and activity of cold-stress related proteins in diatoms. This talk aims to present findings regarding the first two aspects, namely how the model diatom *Phaeodactylum tricornutum* senses drops in temperature employing the most versatile intracellular signalling system: Calcium signalling. We examined the occurance of Ca^{2+} signalling in response to cold-shock employing a P. tricornutum strain with a genetically encoded fluorescence based Ca^{2+} biosensor using microscopy. Putative underlying ion channels and signal transduction pathways will be briefly discussed in frames of in silico based screening. Simple growth experiments assessing the survival in cold conditions will be presented as well. *Phaeodactylum tricornutum* portrays an easily reproducable influx of Ca^{2+} ions into the cytosol which correlates with strength and duration of the cold stimulus. The purpose as well as underlying ion channels of this cold response remain unknown. Ca^{2+} signalling is employed by bacteria as well as single- and multicelled eukaryotes for a broad range of stress responses – including cold shock. Here we present promising evidence that it is the case for diatoms as well, though the exact mode of action and consequence for the cells are not completely understood yet.

SS3.2: Impact of increased ice-sheet melt on the phytoplankton community within Greenland's fjords

Amanda Burson, Suzanne McGowan (University of Nottingham)

Arctic fjords are a major site of interface between ice-sheet derived freshwater and ocean marine water. This study seeks to understand the to-date unstudied impacts of increasing GrIS melt-water on phytoplankton communities found in Arctic fjord systems. Phytoplankton are the base of the marine food web and play a determinant role in the overall productivity of the fjord system, including economically important fisheries. In the last 20 years, the Arctic has warmed twice as fast as the global average. As a result, Greenland ice-sheet (GrIS) melting currently exports over 400 km3 of freshwater annually and is expected to increase with further warming. In the summer of 2019, record breaking ice loss occurred with reciprocal increases in meltwater entering the fjord system. Two investigative surveys were conducted along the 160 km

Kangerlussuaq fjord system in western Greenland. The first survey was conducted in July of 2018, when summer GrIS melt fell within normal ranges for recent decades. The second survey was conducted in August of 2019, after the exceptionally high summer meltwater period. By comparing community composition of the phytoplankton alongside auxiliary water parameters between these differing years we can begin to forecast how a future fjord system may look. Analysis of the impact of increased GrIS meltwater on the nutrient regime, including the relative stoichiometry of major dissolved inorganic nutrients, may also give an indication of future impacts on limitation to growth and nutritional value of future fjord phytoplankton.

SS3.3: Salinity and time can alter epibacterial communities of an invasive seaweed

Mahasweta Saha, Robert M.W. Ferguson, Shawn Dove, Sven Künzel, Rafael Meichssner, Sven Neulinger, Finn Ole Petersen, Florian Weinberger (Plymouth Marine Laboratory)

The establishment of epibacterial communities is fundamental to seaweed health and fitness, in modulating ecological interactions and may also facilitate adaptation to new environments. Abiotic factors like salinity can determine bacterial abundance, growth and community composition. However, influence of the regional stressor i.e. salinity as a driver of epibacterial community composition (until species level) has not been investigated for seaweeds and especially under long time scales. We also do not know how abiotic stressors may influence the 'core' bacterial species of seaweeds. Following an initial (immediately after field collection) sampling of epibacterial community of an invasive red seaweed Agarophyton vermicullophylum, we conducted a long term mesocosm experiment for 5 months, to examine the influence of three different salinities (low, medium and high) at two different time points (3 months after start of experiment and 5 months i.e. at the end of experiment) on the epibacterial community richness and composition of Agarophyton. Metagenomic sequencing showed that epibacterial communities changed significantly according to salinity and time points sampled. Epibacterial richness was significantly different between low and high salinities at both time points. Epibacterial richness also varied significantly between 3 months (after start of experiment) and 5 months (end of experiment) within low, medium and high salinity level. Irrespective of salinity levels and time points sampled 727 taxa consistently appeared in all Agarophyton samples hinting at the presence of core bacterial species on the surface of the alga. Our results indicate that both salinity and time can be major driving forces in structuring epibacterial communities of seaweeds with respect to richness and β-diversity. We highlight the necessity of conducting long term experiments allowing us to detect and understand epibacterial succession over time on seaweeds.

SS3.4: Life cycle phase specific responses of *Coccolithus braarudii* to light intensity and nutrient limitation

Gerald Langer, Vun Wen Jie, Dorothee Kottmeier, Serena Flori, Alison Taylor, Colin Brownlee, Glen Wheeler (Marine Biological Association of the UK)

Coccolithophores feature a haplo-diplontic life cycle comprised of diploid cells producing heterococcoliths and haploid cells producing morphologically different holococcoliths. In the field hetero- as well as holococcolithophore communities are present. These communities have distinct distributions in space and time. While heterococcolithophores tend to prefer winter and greater depths in the water column, holococcolithophores are often relatively dominant in summer and higher up in the water column. These distribution patterns strongly suggest that both life cycle stages occupy their own ecological niches, with the holococcolithophore being more tolerant to high light and temperature and low nutrient concentrations. In order to understand coccolithophore ecology and evolution it is necessary to understand the differential ecophysiology of hetero- and holococcolithophores. Culture experiments are an indispensable means to this end. In this study we performed two sets of culture experiments using the prolific coccolithophore *Coccolithus braarudii*. In the first experiment we compared haploid and diploid *C. braarudii* with respect to their responses to light intensity changes. We found the holococcolithophore to be more high light tolerant than the heterococcolithophore. We observed for the first time light stress induced malformations in coccolith crystal morphology. These malformations, however, were confined to the heterococcolithophore. In the second experiment we subjected a haploid and a diploid strain of *C. braarudii* separately to nitrogen and phosphorus limitation and analysed, inter alia, crystal morphology and growth rate. We conclude that the holococcolithophore copes better with phosphorus limitation than the heterococcolithophore. Responses to nitrogen limitation were life cycle stage specific too, but not with respect to all analysed parameters. Notably coccolith crystal morphology was affected in the heterococcolithophore only (both N- and P-limitation). Normally developed coccolith crystals are essential for coccosphere architecture. Given that the coccosphere is instrumental in the ecological success of coccolithophores and that the holococcosphere is insensitive to environmental stressors that severely affect the heterococcosphere, one significant advantage of the holococcolithophore life cycle stage could be its insensitive morphogenesis. This novel aspect of coccolithophore biology opens up a new perspective on coccolithophore eco-physiology.

SS3.5: Algal photophysiology drives darkening and melt of the Greenland Ice Sheet

Christopher Williamson, The Black and Bloom team (University of Bristol)

On the surfaces of glaciers and ice sheets, specialised species of 'glacier algae' belonging to the Zygnematophyceae are able to establish wide-spread algal blooms during summer melt seasons, with significant consequences for the physical (melt) and chemical (carbon and nutrient cycling) ice surface environment. To achieve this feat, glacier algae must balance their requirements for photosynthesis and growth with the exceptional stresses experienced, including extremes in temperature, desiccation, visible and UV radiation. Here, we report the first quantification of the photophysiological mechanisms that allow glacier algae to thrive on the bare ice surface. Significant secondary pigmentation is shown to enable tolerance of extreme irradiance whilst simultaneously repurposing captured UV and short-wave radiation for melt generation, with total cellular absorption increased ~50-fold by secondary pigmentation. In contrast, glacier algal chloroplasts positioned beneath shading pigments remain low light adapted and dependent on typical non-photochemical quenching mechanisms for photoregulation. On the Greenland Ice Sheet (GrIS) glacier algae direct only ~ 1% of incident energy to photochemistry versus 40 – 65% to ice surface melting, contributing an additional ~1.86 cm water equivalent surface melt per day in patches of high algal abundance (~10^4 cells ml-1). Our findings are critical for the incorporation of biological feedbacks into predictive models of GrIS surface mass balance and provide unique insight into how photoautotrophic life excels within icy environments.

Special Session 4: Algae as Biomarkers

SS4.Invited Speaker: Limiting lifestyles – how plankton lifeforms are changing in UK marine waters

Mike Best (Environment Agency)

Assessment tools developed under the Water framework Directive from 2007 onwards have enabled us to classify estuaries and coasts based on phytoplankton biomass (chlorophyll-a), taxa cell counts and seasonal succession of functional groups. However recent developments under the Marine Strategy Framework Directive and UK Marine Strategy by the UK Pelagic group has allowed us to look at our data in a different way. One of the key shifts has been the inclusion of the lifeforms concept and state space of pairs of ecologically relevant lifeforms. This allows some integration across organisations, methods and sea areas. Measurement of the shape of change in plankton communities provides new information on the state of our near- and offshore phytoplankton communities. Results suggest that the phytoplankton community may be changing in ways that correlate to changes in nutrients and nutrient ratios in inshore waters and possibly climate change further offshore. These impacts may ripple further up the food chain. These views provide a compelling case to review our current thinking in both coastal and marine waters.

SS4.Invited Speaker: Setting nutrient thresholds to achieve good ecological status in surface waters

Martyn Kelly, Geoff Phillips, Heliana Teixeira, Sandra Poikane, Fuensanata Salas (Bowburn Consultancy)

Member States of the European Union currently use a wide range of nutrient criteria to support good ecological status in surface waters. National thresholds are set using a number of approaches; however, those countries that used expert judgement had significantly higher thresholds than those that used data-driven approaches. In order to facilitate the development of robust thresholds, the European Commission supported research into appropriate statistical approaches to setting nutrient thresholds and a summary of that work will be presented in this talk. In brief, regression-based approaches are the preferred approach but the relationship between pressure and biological response is often too weak for this to yield thresholds that are robust enough to drive management actions. Where nutrients are one of a number of pressures influencing the biota, then conventional regression leads to underestimates of thresholds and, potentially, very stringent regulatory regimes. In such cases, quantile regression can be employed, but this yields non-precautionary targets. Significant uncertainty remains even after accounting for significant co-variables and, therefore, the process of setting nutrient thresholds cannot be divorced from the management regimes that will enforce these targets. More esoteric statistical approaches have also been advocated and whilst these might have applications, those concerned with the development of environmental standards which could potentially affect utility bills and the profitability of businesses also need to ensure that the reasoning.

SS4.Invited Speaker: Methods for monitoring habitat-forming seaweeds

Chris Yesson (Zoological Society of London)

Habitat-forming species, such as kelp forests or coralline reefs, are important environmental indicators. Declines in these species will directly impact the habitats they create. Multiple anthropogenic stresses such as climate change, pollution and fishing are threatening a wide variety of marine species, which has led to a greater emphasis on monitoring for impact assessment and conservation planning. Although direct surveys remain the gold standard, they are time-consuming, expensive and often spatially limited. Using examples from our work, this talk will review methods of monitoring based on real-world examples such as: maximising the use of historical data, remote surveys from boat-based systems such as towed cameras and acoustic sensors, aerial imagery from drones

and satellites, and even diversity monitoring using population genetics. There are many monitoring methods, each with their own benefits and disadvantages, and selecting the right method depends on many factors. Novel methods have the potential to widen our monitoring capacity and extend our knowledge of the distribution and abundance of macroalgae and other keystone marine species.

SS4.1: Conservation challenges for a microscopic world: Documenting desmids

Joanna Wilbraham (Natural History Museum, London)

Freshwaters are amongst the most threatened habitats in the world. Many waters in the UK have irreversibly changed or disappeared and those that remain are under immense pressure largely due to habitat loss, pollution, recreation, abstraction and the introduction of non-native species. Climate change is also becoming a major concern for freshwater life. The conservation of biodiversity associated with freshwaters has for obvious reasons focused on the larger animal and plant species, however, microorganisms such as the algae play a fundamental role in these ecosystems and constitute rich assemblages which are also threatened. Desmids are a diverse group of freshwater microalgae which dominate the algal flora of nutrient poor, lentic waters and are particularly diverse in such oligotrophic habitats as moorland pools and shallow lakes. They are ecologically highly sensitive, acting as useful indicators of water quality. The conservation of microscopic organisms poses many difficulties due to taxonomic impediments and lack of knowledge of ecology and distribution. To gain a better understanding of desmid distribution patterns across the UK and Ireland this project has undertaken the digitisation of 50 years worth of biological recording data collated by desmid expert David Williamson. Reliable datasets of species occurrence are essential to biodiversity research and conservation so these data, in conjunction with published literature, will provide a basis for developing a more robust checklist of verified desmid taxa known to occur in the UK and Ireland and provide distribution information for these taxa. Furthermore, this will enable us to review the conservation status of the desmid flora and provide data of practical use in the designation and management of protected freshwater habitats.

SS4.2: Phytoplankton assemblage in a tropical harbour: Microscopy versus chemotaxonomy

Owoyemi Elegbeleye, Ikenna Charles Onyema (University of Lagos, Nigeria)

Investigations into phytoplankton community structures in Nigerian waters have always been carried out using conventional microscopy. Microscopic methods are not sufficient because very small-sized phytoplankton species are easily missed out from sample processing and examinations. At present, there is a dearth of literature on pigment-derived phytoplankton assemblage in Nigerian waters. The aim of this study was to assess the phytoplankton spectrum of the Lagos harbour using a combination of microscopic and chemotaxonomic methods. Phytoplankton diversity and variations in water quality indices were investigated for twelve months from May 2015 to April 2016 following standard methods. Scanning electron microscopic (SEM) images of phytoplankton species were taken with a JEOL JSM 5310 using between 12 and 15 kV accelerating voltage. Chemotaxonomic assessment of phytoplankton was done using a C8 reverse-phase High Performance Liquid Chromatography (HPLC) pigment-labeling technique. All water quality parameters investigated, with the exception of reactive phosphorus, fell within Federal Ministry of Environment (FMEnv.) permissible limits. A total of 96 phytoplankton species belonging to five classes were recorded from microscopic observations. Bacillariophyceae (diatoms) comprised 72 species, Chlorophyceae (green algae) had 2 species, Cyanophyceae (blue-green algae) was represented by 11 species, Dictyochophyceae (silicoflagellates) had 1 species and Dinophyceae (dinoflagellates) comprised 10 species. The results from HPLC pigment-labeling technique validated microscopic observations for diatoms, dinoflagellates, blue-green and green algae. However, there were detections of coccolithophores and cryptophytes by HPLC which were not seen under the microscopes. From this study, *Achnanthes eureka*, *Hyalosynedra laevigata*, *Mastogloia cuneata*, *Mastogloia emarginata*, *Navicula formenterae* and *Palmerina hardmaniana* are new records of diatoms in Nigerian waters. Nutrient stoichiometry showed a clear nitrate limitation in the wet months which could be attributed to excessive supply of phosphorus from allochthonous and human-induced autochthonous inputs. The dominance of tychoplanktonic taxa, which are tolerant to wide fluctuations in salinity and dissolved solids, suggests that the Lagos harbour is experiencing dramatic run-off from terrestrial systems. This study documented a pioneering effort at chemotaxonomic assessment in Nigeria, leading to identification and quantification of nineteen phytopigments.

SS4.3: Using historic samples to uncover Harmful Algal species niche preferences.

Rowena Stern, Vera Trainer, Stephanie Moore, Clare Marshall, Jessica Clarke, Martin Edwards (CPR survey, Marine Biological Association)

Harmful algae are an increasing problem globally through toxin poisoning events to humans and marine life to deoxygenation and overgrowth. Despite many studies, their response to environmental drivers remain enigmatic. At the same time, prediction of harmful algae events is vital for food security, to mitigate against climate change effects and are a key monitoring target for Marine Strategy Framework Directive. Population sub structuring and a lack of species-level data for many harmful algae thwarts

useful indicator development. The Continuous Plankton Recorder Survey has sampled plankton over 6 million miles in the Atlantic since 1930, and a physical record exists from 1960s. Although preserved in formalin, a DNA-damaging agent, it is now possible to obtain techniques opening up long-term evaluation of harmful algae species at climate-change relevant scales. Here we discuss our findings on spatial partitioning of *Pseudo-nitzschia* and other key harmful algae species.

General Phycology Session

GP.1: Physiological responses of marine diatoms to osmotic stress

Glen Wheeler, Katherine Helliwell, Friedrich Kleiner, Serena Flori, Colin Brownlee (Marine Biological Association)

Diatoms are globally important phytoplankton that dominate many marine ecosystems. In order to thrive in these environments diatoms must be able to sense and respond to diverse environmental stimuli. Diatom communities, in particular those in estuarine and or sea-ice environments, may experience significant fluctuations in light, salinity and temperature over short time scales, necessitating cellular mechanisms that enable a rapid response. We have examined the signalling mechanisms that diatoms use to respond to these stimuli using the model diatom *Phaeodactylum tricornutum*. We find that a calcium-dependent signalling pathway is essential for survival of *P. tricornutum* in response to hypo-osmotic stress. Exposure to hypo-osmotic conditions results in cell swelling and triggers exhibit cytosolic calcium elevations that initiate in the apical regions and spread to the rest of the cell. This suggests that the stress is perceived locally in the apical region, but the propagating calcium wave enables a response at the whole cell level. We also find that *distinct P. tricornutum* morphotypes exhibit different osmotic-signalling sensitivities, suggesting that a pleomorphic lifestyle confers ecological resilience to osmotic stress in this species. Inhibition of calcium signalling by removal of external calcium results in excessive cell swelling and cell bursting in severe hypo-osmotic stress. The calcium-dependent signalling pathway is therefore essential for osmotic adjustment and likely contributes to the ecological success of diatoms in diverse environments that experience significant fluctuations in salinity.

GP.2: Phagocytosis and the digestive vacuole of diploid calcifying coccolithophores

Alison Taylor, Elizabeth Stone, Madeline Liberti, Madison Cox, Emily Fox (University of North Carolina Wilmington)

Mixotrophy is widespread in unicellular marine algae with smaller size groups obtaining up to 25% of their biomass via bactivory (Zubkov, M.V. et al. 2008 Nature 455, 224-248). Photosynthetic dinoflagellates in particular exhibit a variety of nutritional strategies, often combining phagotrophy with autotrophy. The heterotrophic and mixotrophic origins of the haptophytes are also well recognized, and genomic studies of haploid and diploid (calcifying) stages of coccolithophores suggest they possess the molecular machinery and capability to phagocytose and enzymatically degrade potential prey particles (Houdan, A., et al. 2006 Aquat. Microb. Ecol. 44, 291-301, Rokitta, S.D., et al. 2011 J. Phycol. 47, 829- 838). Using fluorescently labeled pH sensitive prey and confocal microscopy, we demonstrate phagocytosis and the development of a well-defined acidic digestive vacuole (DV) in the 2N non-motile calcifying stages of *Scyphosphaera apsteinii*. Experiments with fluorescently labeled particles revealed *S. apsteinii* ingested and accumulated beads up to 2 microns in diameter in the DV. This implies larger coccolithophores may not be limited to bactivory, and could potentially consume larger picoeukaryote prey. We present evidence that the DV may be multifunctional in nature. Overall, our data supports mixotrophy through phagocytosis and degradation via a DV pathway in some calcifying heterococcolith- bearing coccolithophores. This has important implications for understanding nutritional strategies in these globally important marine protists.

GP.3: A novel Ca^{2+} signalling pathway co-ordinates environmental phosphorus sensing and nitrogen metabolism in marine diatoms

Katherine Helliwell, Ellen Harrison, Joseph Christie-Oleza, Andrew Rees, Joshua Downe, Maria Aguilo-Ferretjans, Lisa Al-Moosawi, Colin Brownlee, Glen Wheeler (Marine Biological Association of the UK and University of Exeter)

Phosphorus is a critical nutrient controlling phytoplankton growth. Availability of this limiting factor can vary significantly in space and time, particularly in dynamic aquatic ecosystems. Diatoms are important eukaryotic phytoplankton that thrive in regions of pulsed phosphate supply, yet little is known of the sensory mechanisms enabling them to detect and rapidly respond to phosphorus availability. Here we show that phosphorus-starved diatoms utilise a novel Ca^{2+}-dependent signalling pathway to sense and regulate cellular recovery following phosphorus resupply. This pathway, which has not previously been described in eukaryotes, is sensitive to sub-micromolar concentrations of phosphate, alongside a range of environmentally relevant phosphorus forms. Using comparative proteomics, we have characterised early adaptations governing diatom cellular recovery from phosphorus limitation. Strikingly, the dominant response was substantial enhancement of nitrogen assimilation proteins. This led to 12-fold increases in absolute nitrate uptake rates, relative to phosphorus-starved cells. Moreover, we find that the novel phosphorus-Ca^{2+} signalling pathway controls this primary recovery response. Our findings highlight that fundamental cross-talk between the essential nutrients phosphorus and nitrogen drive diatom recovery from phosphorus limitation. Moreover, a specific Ca^{2+}-

dependent phosphorus signalling pathway governs such ecological acclimation responses, and is thus likely critical to the success of diatoms in regions of episodic nutrient supply.

GP.4: Wavelength-dependency of photosynthesis on coastal seas: insights for chromatic light climate change

Mónica Michel-Rodríguez, Sébastien LEFEBVRE and Fabrice LIZON. (Univ. Lille, CNRS, Univ. Littoral Côte d'Opale, UMR 8187, LOG (Laboratoire d'Océanologie et de Géosciences, F 62930 Wimereux, France)

Epicontinental temperate ecosystems are highly impacted by hydrodynamics and continental outputs which induce important quantity and quality light variations. In a climate change context, the decrease of water clarity due to turbidity increase by suspended particulate material (SPM) and colored organic materials (CDOM) at different scales of time and space, could have significant consequences on phytoplankton photosynthesis. Prior studies of microalgae photosynthesis have been based on blue light absorption capacity only. However, taking into account variations in pigment composition of cells in link with available chromatic light field and then subsequent photosynthesis activity is crucial. Here, we have realized some ex situ measurements of photosynthetic parameters spectral dependency for different light quality waters across the English Channel focusing on coastal, offshore and estuarine waters. We used for the first time at our knowledge a new generation fluorometer, the MultiColor-PAM (Schreiber 2012), on natural phytoplankton communities to produce high quality measures of light absorption capacity, the functional absorption cross section of PSII independently from the chlorophyll concentration (SigmaλPSII), at 5 different wavelengths. Results show first that SigmaλPSII and relative photosynthetic parameters present strong spectral dependency consistent with photosynthesis assumptions. The clear SigmaλPSII decreasing values from 440 to 625 nm is mainly controlled by light quality and biomass concentration variations. Secondly, absolute photosynthetic parameters (related to light absorption of PSII) still exhibit great variability with the spectrum and also between the samples which indicate high and reactive photoacclimation processes to changes in light environment. Variance partitioning analyses show that abiotic (as light quality and daily light dose) and biotic parameters (as phytoplankton community structure) controlled only 33.2 and 10 % respectively of photosynthetic parameters spectral variations. These results can be explained by changes in complex energy regulation processes in cells and highlight the great capacity and plasticity of natural phytoplankton communities for chromatic light utilization. Finally, our results suggest that natural phytoplankton communities could acclimate to changes in light quality of relative magnitude in relation to environmental changes.

GP.5: An accurate long-read genome and transcriptome of *Emiliania huxleyi*

Alastair Skeffington, Axel Fischer, André Scheffel (Max-Planck-Institut für molekulare Pflanzenphysiologie)

Algal genomes are providing ever greater understanding of the diversity of cellular and metabolic processes within the Eukarya, and have considerable potential for discoveries that could be harnessed in biotechnology. There is likely to be a great expansion in the genomic information available for algae with upcoming programmes such as the Darwin Tree of Life Project anticipated to generated thousands of new algal genomes. However the discovery of novel cellular functions within the genomes of these algae is dependent not only on the quality of the genomes, but also the quality of the gene models. De novo gene prediction algorithms often perform poorly on non-model organisms without good training data sets, and short-read sequencing data can only partially solve this issue because isoforms cannot be resolved, resulting in considerable uncertainty in the final protein sequences predicted. Thus long-read sequencing technologies, which can provide full length sequences of mRNAs, should be an essential part of modern genome annotation pipelines. We have used single molecule real time sequencing (SMRT, PacBio) to generate a new, high quality genome and transcriptome of a diploid, calcifying strain of the microalga *Emiliania huxleyi* (recently renamed Gephyrocapsa huxleyi). *E. huxleyi* is the most numerically abundant coccolithophore in the modern oceans, and modulates geochemical cycles through photosynthesis, production of calcified scales (coccoliths) and DMSP production. Although the original genome of *E. huxleyi* has driven much important research, it suffers from poor gene models and some genes are missing from the assembly. We show that our new genome and transcriptome is more complete than the original, and allows us to identify transcript isoforms and thus make an accurate predicted proteome. We describe a pipeline for achieving this analysis despite the complexities of working with a diploid organism with high heterozygosity. We validate our new gene models with proteomic data and show that we can identify proteins associated with calcification in *E. huxleyi* that were not part of the predicted proteome from the original genome. In addition, our new data allows an independent evaluation of the 'pan genome hypothesis' put forward by the original genome paper.

GP.6: Reanalysis of the Theriot et al. (2015) 7 gene data set using multiple outgroups

Linda Medlin, Yves Desdevies (Marine Biological Association of the UK)

A previous study of available diatom sequences tested the value of multiple outgroups in analyses of the 18S rRNA gene in recovering the three diatom Classes (Coscinodiscophyceae, Mediophyceae, Bacillariophyceae) as monophyletic groups (Medlin 2014). When certain outgroups

were used (haptophytes ciliates, prasinophytes and chlorophytes), these classes were recovered with strong bootstrap 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 all of the V4 region of the 18S RNA gene or bases beyond position 1200. 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 entire 18S RNA gene including the V4 region. Analyses were performed by sequentially adding more outgroups using 1) evolutionary models with parameters relaxed across genes and codon positions for coding sequences (codon partition scheme = CP) and 2) without any partitions or evolutionary models (NCP). The CP analysis recovered a monophyletic mediophycean and bacillariophycean clade and three coscinodiscophycean clades: sequentially adding more outgroups did not change the topology of the clades but dramatically increased bootstrap support. NCP analyses recovered a monophyletic Coscinodiscophyceae and Bacillariophyceae and a Mediophyceae with 3 clades, each with strong bootstrap support. Finally to perform a total evidence analysis, morphological data was added to the molecular data set and weighted so that the few morphological data, which are logically coded by more than seven genes, could contribute equally to the data set as one of the seven genes. This addition produced a monophyletic Coscinodiscophyceae but the Bacillariophyceae was imbedded in the Mediophyceae in the CP analysis but not in the NCP analysis.

GP.7: Challenges and opportunities in developing a sustainable algal biorefinery

Donal McGee, Authors: Dean Johnson, Yueming Wang, Peter Koronaios, Avtar Matharu, Frederik Zitzmann, John Dodd, John Macdonald, Yat-Keung Lee (AlgaeCytes Ltd.)

Algae biotechnology offers an opportunity to deal with the concerns facing society's rapidly expanding populations in terms of health, food, and energy security. Algal biomass represents a sustainable resource of high-value bioactives including for example Omega-3 poly-unsaturated fatty acids (PUFAs), carotenoids, polysaccarides and proteins. These are of commercial interest for a wide range of industries including healthcare, personal care, sport health formulators and nutritional therapeutics. AlgaeCytes Ltd is a UK SME that is currently operating a commercial 12,000L pilot scale facilities at Discovery Park in Kent to manufacture Omega-3 PUFAs and other high-value metabolites from microalgae. AlgaeCytes is currently evaluating potential industrial-scale production sites with the aim of achieving a circular economic business model by developing a sustainable zero-waste biorefinery process. The biorefining and chemical valorisation of algal biomass presents an opportunity to maximise the full potential through the commercialisation of a range of high-value metabolites, in addition to value-added co-products from the spent biomass. Although algal biomass offers numerous opportunities for developing a sustainable multi-product biorefinery, multiple challenges exist in purifying the high-value metabolite of interest. These include for example, the partitioning the non-active components during bioactivity screening and removal of chlorophyll from the algal Omega-3 enriched oil. AlgaeCytes has undertaken extensive research to establish the most innovative and sustainable downstream processes for the extraction and purification of eicosapentaenoic acid (EPA) (20:5, n-3) from microalgae. These green extraction processes include "algal milking" using non-ionic liquids, super critical CO2 PUFA extraction and EPA purification using counter current chromatography (CCC) or molecular distillation. Each process contains its own inherit challenges in successful extraction and purification using these technologies. Recent collaboration with the University of York, Green Chemistry Centre of Excellence (GCCE), has led to the successful characterisation of the polar and non-polar constituents of AlgaeCytes microalgal strain providing the key process performance indicators for the extraction and purification of EPA, proteins and value-added co-products (biopolymers, biochar, biofuels) from algal biomass. Developing a biorefinery employing multiple algal species could lead to new commercial opportunities for the co-formulation of multiple bioactives with applications in the healthcare, sports recovery biotherapeutic markets.

GP.8: Drivers of biodiversity in phototrophic microbial mats and bacterioplankton in Antarctic freshwaters

Anne D. Jungblut, Josep Ramoneda, Ian Hawes (Natural History Museum)

Freshwater systems in continental Antarctica are particularly important hosts of inland biodiversity, with primary productivity and biomass generation relying on phototrophic microbial communities. To understand the implications of changing conditions on biodiversity and ecosystem function in these lakes and streams, it is important to investigate which environmental and ecological factors drive the local distribution and diversity of these microbial communities, as a prerequisite for predicting their responses to environmental change. Apart from adaptations to local abiotic conditions, a critical feature that determines the distribution of microbial taxa in time and space is connectivity, such as the physical continuity of the landscape that allows for the exchange of individu-

als across habitats. This connectivity may be particularly important where new habitat is being created through lake level rise, since the ability of organisms to colonise may play a role in community assembly. In this study, we sequenced the V4 region of the 16S rRNA gene to describe the spatial distribution of benthic cyanobacterial mat and planktonic bacterial communities across habitat units such as the proglacial Lake Brownworth, the Onyx River and the perennially ice-covered Lake Vanda in the McMurdo Wright Dry Valley, Antarctica. Our findings suggest strong compositional differences between the mat and water environments with Actinobacteria dominating water compared to Cyanobacteria and Proteobacteria, which dominated the mats. Differences between the composition of the mat and water environments were even stronger at the Cyanobacterial genus level. Filamentous taxa such as Phormidium, Tychonema and Leptolyngbya dominated the microbial mats, whereas unicellular Chamaesiphon represented most of the Cyanobacterial taxa in water. Geographical differences in cyanobacteria and bacteria composition were also observed. However microbial mats and planktonic communities from the seasonally ice-free moat environments from different habitats tended to be more similar than communities from the deeper parts of Lake Vanda. There was also a correlation between community assembly and the history and stratification of the Lake Vanda. In summary, the study suggests that benthic phototrophic mat and planktonic communities are shaped by a combination of abiotic variables and different degrees of connectivity across habitat types in the Wright Valley, Antarctica.

GP.9: Limits of short and long term acclimation in the Arctic diatom *Melosira arctica*

Klaus Valentin, Mirta Jacobs, Lin Jiang, Anique Stecher, Madlen Franze, and Erika Allhusen (Alfred Wegener Institute)

Melosira arctica is currently perhaps the most productive diatom in the ice-covered Arctic Ocean and can contribute up to 80% to carbon export into the deep see. However, we see a significant reduction in Arctic ice cover which will increase in the near future. A significant increase in SST is also expected until the end of the century. In our study we determined growth limits of *Melosira* in short- and long-term experiments of up to 15 months and found that this diatom is already fully adapted to polar conditions and life at sea ice. Temperatures of 8°C or higher light intensities are lethal after 2-3 months. Even more so *Melosira* shows adaptation to live inside sea ice as it contains in its nuclear genome two large gene families of anti freeze protein (AFP) genes typical of sea ice diatoms. One of the AFP families is novel for diatoms and has not been found in any eucaryotic genome. From our data we conclude that *Melosira arctica* will suffer from expected warming and reduction of sea ice cover which likely will decrease its primary productivity and carbon export contribution to the Arctic Ocean.

Invited/Public Lectures

Responses of phytoplankton to climate in the North Atlantic Ocean: past, present and future

Gregory Beaugrand, Loick Kléparski, Guillaume Signoret, Mariarita Caracciolo (Université de Lille)

Climate change is having a discernible influence on marine biological systems of the ocean. Among biological components of marine ecosystems, phytoplankton are especially important because they are at the basis of the oceanic food chain, they contribute to the biological carbon pump, and last but not the least they are very sensitive to climate-induced environmental alterations. We will review expected changes in phytoplankton from the species to the community level looking at processes such as phenology, annual phytoplankton succession and spatial distribution. We will try to identify biological processes at work and will propose a way to understand and anticipate the effect of climate change on phytoplankton using a unifying theory called the MacroEcological Theory on the Arrangement of Life (METAL).

Taxonomic study of Japanese *Ecklonia* and *Eisenia* (Laminariales, Phaeophyceae)

Hiroshi Kawai, Shingo Akita, Kazuki Hashimoto, Takeaki Hanyuda (Kobe University Research Center for Inland Seas)

In a multigene molecular phylogeny based on mitochondrial cox1, cox3 genes and the atp8–16S rDNA region, as well as the plastid atpB, psaA, psbA and rbcL genes, *Ecklonia* spp. formed a monophyletic clade supported by high statistical values, and *Eisenia* spp. showed monophyly depending on analytical methods. The Japanese *Eisenia* species that used to be identified as *Eisenia arborea* (*E. arborea* sensu Arasaki) was shown to be genetically distant from *E. arborea* from the NE Pacific and *E. bicyclis* from Japan. *Eisenia* spp. were morphologically distinct in having a split meristematic zone in the mature thallus forming a dorsi-ventral blade with false branches. Therefore, we propose reinstatement of *Eisenia* as an independent genus and describe a new species, *Eisenia nipponica* from Japan. *E. nipponica* is distributed on the Pacific Coast of central Honshu, having a separate geographical range from *E. bicyclis*. In the genus *Ecklonia* s.s. four species (morphospecies) *E. cava*, *E. kurome*, *E. radicosa* and *E. stolonifera* have been distinguished in the northeastern Asia. However, due to their remarkable morphological plasticity and very close genetic relationships, their species boundary was not clear. Monophyly of *E. radicosa* was supported by the molecular phylogeny using concatenated DNA sequences of mitochondrial atp8–16S rDNA and cox3 genes, but the independence of other

three morphospecies were not supported. Instead, they formed three genetic groups having separate distributional ranges along Japanese coast. In the analyses using microsatellite markers, occurrences of the genetic exchange were detected in the contact areas of their geographical distributions.

Thin films of life and the challenges of changing environments

Graham Underwood (University of Essex)

Have you ever slipped on a wet rock, or seen gold and green sheens on mud or sand? Then you have experienced an algal biofilm. Almost any wet surface will be covered with a mixed film of algae and other microbes, embedded in a matrix of slime. Biofilms are everywhere. They are exposed to extreme conditions: Damaging levels of light and ultra-violet radiation; temperature; wetting and desiccation; various pollutants. Despite this, the biological activity of biofilms is very high, and they make significant contributions to nutrient cycling and food chains in many freshwater and marine ecosystems. Drawing on examples from tropical, temperate and polar regions, Professor Underwood, President of the British Phycological Society, will show how our understanding of the chemistry, biology and ecology of diatoms, the major algal component of biofilms, has developed. The secrets of their success are due to high species diversity, metabolic, and behavioural flexibility. This provides the resilience for biofilms to face the challenges of their changing environments.

Poster Session

PS.1: A microalga and its microbiome: Diversity, variability and not just a question of B12?

Georgina Andrews (Algaecytes LTD)

Microalgae are a diverse group of phototrophic organisms, that have potential to produce a wide range of products important in creating a sustainable future. Microalgae have been seen to have associated bacterial populations and often grow poorly without this interaction. This may be due to many factors including the transfer of products such as cobalamin (B12), carbon sources and nitrogen sources. AlgaeCytes' proprietary microalgae ALG01 (Eustigmatophyceae), which produces Eicosapentaenoic acid (EPA), an important omega-3 oil, needed by many living things for growth and repair. ALG01 is grown phototrophically and with its associated microflora. The aim of this study was to investigate whether ALG01 could be grown axenically and to gain an insight into the role of the associated microflora. In the present study, axenic ALG01 had impaired growth, like many other documented axenic strains. The addition of B12, tryptone and glucose improved the growth of axenic cultures (approx. 50% increase) but did not return growth to normal levels when compared to non-axenic cultures. Eighty-three morphologically different bacteria were successfully isolated from an ALG01 culture through agar isolation. The strains were tested against the axenic ALG01 culture on agar where 65 showed a positive interaction, 18 showed no effect and none showed a detrimental effect. Addition to liquid cultures was not statistically significant when cultivated to early stationary phase of growth within a small-scale system. Ten strains with the most significant effect were sequenced and were identified as *Pseudomonas*, *Pimelobacter*, *Brevundimonas*, *Microbacterium*, *Comamonas* and *Sphingopyxis* spp. Genomic analysis of these strains showed them to have a plethora of possible products that may underpin any interaction with ALG01 i.e. B12 production and denitrification. The microbiome of ALG01 has been shown to be more significant than initially thought. More investigation is needed into the dynamics of all the species within ALG01 cultures and our study reflects that of other microbiome studies where there are complex interactions that are beneficial to growth, but their precise function is unknown. This has large implications in the industrial use of microalgae through culture management practices, increases in product production and an indicator of culture health and performance.

PS.2: The effect of temperature on competition between *Laminaria* kelp species

Alissa Bass (The Marine Biological Association and University of Plymouth)

Climate change driven increases in sea surface temperature are impacting marine species globally. In addition, the more frequent and intense extreme climatic events, such as marine heatwaves, are exacerbating the heat stress on these organisms. Temperature is a key driver of population structure and community composition, affecting abundances and distributions of species, as well as the interactions between one another. Here, we will investigate the effect of temperature on competition between kelp juveniles of three important Laminaria species found in the South West UK. Kelp are important foundation species of cold water and temperate habitats, supporting a high level of biodiversity, as well as having high economic value. Understanding how these species interactions shift with temperature will help us predict how they may change in the future and consequently how the structure and function of ecosystems may be impacted.

PS.3: My seaweed looks weird: The web portal to report diseased algae

Janina Brakel, M. Strittmatter, M.M. Perrineau, P. Arce, J. Brakel, P. Murua, C.M.M. Gachon (Scottish Association for Marine Science)

Diseased algae have always been around, but finding one of them in the wild is mostly a chance encounter. Often, the eye of beach-walkers is drawn by seaweeds with

an unusual aspect (deformed growth, discolouration, galls, holes or rot symptoms, etc.), but such encounters usually go unreported. "My seaweed looks weird", as part of the GENIALG and GlobalSeaweedSTAR projects, is an online portal where anyone can contribute weird-, or sad-looking seaweeds to accelerate research. We are encouraging scientists, seaweed professionals or members of the public to report and submit samples of potentially diseased algae. Using a combination of microscopy and potentially, DNA analysis, we shall endeavor to send back a diagnosis in-kind for all samples received. Our goal is to accelerate the description of algal diseases worldwide. We will use the data to identify and map diseases, as well as describe novel or emerging issues. With the marine environment undergoing very rapid changes worldwide, and in particular cultivation growing rapidly, the collected data will represent a baseline of what diseases occur where, both in the wild and in seaweed farms, in order to be able to detect and monitor any changes. With time, we will make the results of this work available through Open Access publications and a (yet-to-be-built) digital online atlas of algal diseases. We hope this tool will be a valuable source of information for seaweed farmers and researchers in the future.

PS.4: Diatom-bacteria interactions: deciphering impacts on algal bloom regulation and toxicity

Laura Branscombe, Michael Cunliffe, Willie Wilson, Katherine Helliwell (Marine Biological Association)

Diatoms are widely distributed marine phytoplankton which contribute up to 40 % of marine primary productivity. These important marine algae can form large blooms which have large-scale impacts on global carbon cycles, and heavily influence phytoplankton ecology. Some bloom-forming diatoms can also release harmful toxins, thus negatively affecting marine ecosystems and fisheries. Gaining a clearer understanding of the molecular mechanisms regulating diatom growth and toxicity is therefore vital for understanding the drivers of bloom dynamics. The importance of biotic interactions in shaping diatom growth and productivity has become increasingly recognized. Further to this, evidence suggests that diatom interactions with other microbes can impact toxin production of toxic diatoms such as *Pseudo-nitzschia*, and thus likely influence the global impact of diatoms in marine ecosystems. Despite the important influence of such interactions on diatom cell biology and metabolism, many of the processes that enable diatoms to regulate acclimation responses to biotic factors remain poorly understood. In this project we aim to combine laboratory and field based approaches to characterize signaling mechanisms mediating interactions between diatoms and bacteria. In particular, using the model diatom *Phaeodactylum tricornutum*, we aim to isolate algicidal bacteria using samples collected from the Western English Channel. We will then employ a novel molecular toolkit that we have developed for *P. tricornutum* that will allow us to characterize the early signalling responses of diatoms to bacteria and/or associated info-chemicals in real time. The longer-term aims of this project are to develop such novel molecular tools for the ecologically abundant, toxic bloom forming diatom *Pseudo-nitzschia*, in order to gain a deeper insight into the biotic drivers of algal population dynamics and toxicity of bloom-forming diatoms.

PS.5: The Culture Collection of Algae Protozoa (CCAP): Supporting future algal research and biotechnology.

Christine Campbell, Cecilia Rad-Menéndez and Rachel J. Saxon (Scottish Association for Marine Science)

The Culture Collection of Algae and Protozoa (CCAP) is a unique protistan Biological Resource Centre comprising a wide range of biodiversity, from Prokaryotic cyanobacteria to strains from most Eukaryotic lineages. In terms of environmental biodiversity, CCAP strains have been collected from rivers, lakes, oceans and soil; and geographically speaking the strains are equally diverse, collected from every continent from Antarctica to the Arctic regions, from Argyll to the Zambezi. The Collection comprises more than 2500 strains in the public domain of which 345 are Type strains, 967 marine algae, 1299 freshwater algae, and 296 protozoa. CCAP specialises in the isolation, maintenance, identification and distribution of cultures and their associated data, as well as the molecular identification and taxonomic revision of strains. CCAP is also involved in many aspects of protistan science. With protists believed to be making up most of the genetic complexity of our planet's ecosystems, CCAP offers an excellent resource to investigate this diverse and extremely relevant group of organisms.In addition, CCAP is actively involved in algal research and biotechnology. CCAP participates in the GENIALG project by isolating and bio-banking economically important seaweed cultivars, ensuring that the strains and their associated data will be publically available for biotechnological and further research purposes. With the aim of supporting the development of disease management and biosecurity in micro- and macro-algal production facilities, CCAP is developing protocols to isolate, maintain and cryopreserve pathogens of commercially important algae. This effort is enabling considerable improvement in the taxonomy, life cycle and physiology of these poorly known pathogens; accordingly, it supports the design of control methods to eradicate diseases in algal farms. CCAP has focused on the isolation of extreme environment organisms with a collection of polar diatoms and, recently has contributed to a project looking into sea-ice diatom biomarkers.

PS.6: The diversity and resilience of kelp ecosystems in Ireland

Kenan Chan, Kathryn M. Schoenrock*, Aisha M. O'Connor, Stacy A. Krueger-Hadfield, Aaron Golden, Tony

O'Callaghan, Rory O'Callaghan, and Anne Marie Power (NUI Galway)

Kelp ecosystems are changing worldwide via distribution shifts, phase shifts with herbivores or ephemeral algae, or by complete disappearance in response to various climate pressures. The northeast Atlantic is a unique habitat buffeted by an energetic climate system throughout the year and provides a rich seascape for marine communities. European kelp forests are dominated by stipitate Laminariales, specifically *Laminaria hyperborea* from the Mer d'Irioise northwards. We are only just beginning to understand the complex dynamics of these diverse and productive Irish kelp ecosystems in a time in which they are likely undergoing great change. In order to better understand the diversity and resilience within the Irish populations of *L. hyperborea* this project describes i) the historical to present day distribution of subtidal kelp forests along Ireland's coastline, ii) the genetic diversity in populations from the south east of Ireland (hypothesized glacial refugia) to the north (Co. Donegal – Antrim), iii) the presence of kelp propagules in the benthic micro-communities ('spore banks'), and iv) new monitoring tools for continued mapping or reporting for kelp forest communities and phase shifts. These data are important from an academic perspective but are also critical to conservation, regulation or commercial interests.

PS.7: Phosphorus dynamics in the Barents Sea

Patrick Downes, Jo Dixon, Claire Widdicombe, Karen Tait (PML / University of Bristol)

The Barents Sea is considered a warming hotspot in the Arctic; elevated sea surface temperatures have been accompanied with increased inflow of Atlantic water to the shelf sea. Such hydrodynamic changes and concomitant reduction of sea ice coverage enables a prolonged phytoplankton growing season, which will inevitably affect nutrient stoichiometry and the controls on primary production. During the 2018 ChAOS cruise to the Barents Sea, we investigated the role of phosphorus in mediating primary production. As its most bioavailable form, dissolved inorganic phosphorus (DIP), had an average turnover time of 12.6 ±7.4 days. The most southern station (B3) accounted for both the highest rates of primary production (654.75 mg C m2 d-1) and 33P-DIP uptake, where Emiliania huxleyi (E.hux) was the dominant phytoplankton species. The fraction of DIP released as dissolved organic phosphorus (DOP) at this station was <4% compared to an average of 27% at all other stations. Station B3 also showed high alkaline phosphatase activity, E.hux are known to synthesise hydrolytic enzymes, utilising the DOP pool when P is limiting. These results suggest warmer waters with prolonged summer coccolithophore blooms could lead to seasonal P limitation which could eventually dominate conditions in the Barents Sea.

PS.8: Importance of freshwater microalgae and macrophytes in ecotoxicology; use of microbiotests format.

Emily Eagles, Rachel Benstead, Susan MacDonald, Richard Handy & Thomas H. Hutchinson (University of Plymouth)

Research into the freshwater toxicity of chemicals, particularly those of emerging concern, is often dominated by vertebrate studies. To consider the risk of contaminants to the entire ecosystem it is vital to consider all trophic levels, including the primary producers. Zearalenone is a natural toxin formed by fungi of the genus *Fusarium*. As a known endocrine inhibitor recently detected in numerous freshwater studies it is considered a chemical of emerging concern. Freshwater toxicity data for fungal toxins such as zearalenone exist primarily regarding zebrafish, with several investigations into *Lemna* species but very rarely in concern to microalgae. Here we investigate the sensitivity of two primary producers, the microalgae *Pseudokirchneriella subcapitata* and macrophyte *Lemna minor*, to zearalenone using basic growth endpoints and measures of photosynthetic activity. For both test organisms OECD guidelines exist for standardised testing and these were performed in a scaled down microbiotests format. Both the microalgae and the macrophyte demonstrated growth inhibition in the presence of ZON. However the algal species, previously not considered in zearalenone toxicity studies, was 30 times more sensitive than *Lemna*; and when comparing the growth LOEC of the microalgae (230 ug/L at 72 h) to a reported sub lethal LOEC for zebrafish embryos (250 ug/L at 72 h) it demonstrates a similar effect level. As toxic dose is time dependant and varies between species, data for numerous organisms is essential to fully assess potential toxicity to ecosystems. The ability to perform microalgae and *Lemna* sp. tests in a smaller microbiotests format, with commercial kits also available to reduce the cost and time associated with maintaining cultures, offers a relatively easy way to generate commonly overlooked plant toxicity data. Mechanistic toxicity data are also important in understanding the impacts of toxins, with the addition of measures of photosynthetic performance at the end of both tests able to provide the first step in understanding potential sub lethal effects. In the case of this study chlorophyll fluorescence parameters suggested *Lemna* as a potential organism to investigate further with indications of zearalenone inducing electron transport inhibition in PSII of the macrophyte.

PS.9: Diatoms dominate and alter marine food-webs when CO_2 rises

Jason Hall-Spencer, Ben P. Harvey, Sylvain Agostini, Koetsu Ko, Shigeki Wada (Universities of Plymouth (UK) and Tsukuba (Japan))

Diatoms are so important in ocean food-webs that any human induced changes in their abundance could have major effects on the ecology of our seas. The large chain-forming diatom Biddulphia biddulphiana greatly increases in abundance as pCO_2 increases along natural seawater

CO_2 gradients in the north Pacific Ocean. In areas with reference levels of pCO_2 it was hard to find, but as seawater carbon dioxide levels rose it replaced seaweeds and became the main habitat-forming species on the seabed. This diatom algal turf supported a marine invertebrate community that was much less diverse and completely differed from the benthic communities found at present-day levels of pCO_2. Seawater CO_2 enrichment stimulated the growth and photosynthetic efficiency of benthic diatoms but it reduced the abundance of calcified grazers, such as gastropods and sea urchins. These observations suggest that ocean acidification will shift photic zone community composition so that coastal food-web structure and ecosystem function are homogenised, simplified and more strongly affected by seasonal algal blooms.

PS.10: Characterising marine phytoplankton cells by flow cytometry assays

David Hartnell, Adam Lewis, Andrew Turner (Cefas)

Marine phytoplankton account for almost half of global net production, feeding our fisheries and molluscan aquaculture. Numerous species produce potent toxins which have negative human health impacts when bioaccumulated in bivalve shellfish and subsequently harvested for human consumption. Biotoxins in shellfish can take many forms including, paralytic, amnesic and lipophilic (diarrhetic) shellfish poisons; produced by numerous phytoplankton taxa, such as *Alexandrium* (saxitoxins, spirolides), *Pseudo-nitzschia* (domoic acid), *Gonyaulax* (yessotoxins), *Dinophysis* & *Prorocentrum* (okadaic acid) amongst others. Consequently, phytoplankton are monitored under European Union food safety legislation (Reg. (EU)2017/625), data are predominantly used as an early warning mechanism to inform toxin testing of shellfish flesh. In the United Kingdom, routine phytoplankton monitoring is undertaken by light microscopy to identify and enumerate cells, following traditional methodologies. Monitoring programmes require skilled taxonomists, are resource intensive and, importantly, morphologically similar species can be toxic or non-toxic; potentially distorting relationships between cell counts and sample toxicity. The development of rapid, targeted methods such as, flow cytometry, flow cams and molecular techniques, that enable identification, enumeration and toxicity would be beneficial to monitoring programmes. Additionally, greater appreciation of phytoplankton physiology, life cycles and toxin production will enhance broader ecological understanding of the role of phytoplankton and their toxins in marine environments. The aim of this study is to develop expertise in flow cytometry (Cytoflex, Becker Coulter) as a tool for the rapid, robust enumeration and speciation of phytoplankton. Work is underway to analyse and characterise those cultures already held at Cefas. Here, data from these strains differentiated by size, auto-florescence and staining to assess cell densities, growth rates and cell life stages are presented. Strains where sequence data are available or gathered will be analysed with the objective of selecting nucleic acid sequences for species and toxicity discrimination. This will be used for the development of a fluorescence in situ hybridization (FISH) flow cytometric assay for key species within the monitoring framework.

PS.11: Development of gene editing technologies within the haptophyte algae

Andrea Highfield, Rowena Stern, Cecilia Balestreri, Jade Hunt, Colin Brownlee and Glen Wheeler (The Marine Biological Association of the U.K.)

The haptophytes are a globally distributed group of phytoplankton and are major contributors to primary production and biogeochemical cycles in the oceans. Our understanding of the physiological processes within the haptophytes, such as calcification, is limited due to a lack of robust genetic tools, with only a few reports of genetic transformation in a limited number of species. In this project we have sought to develop a genetic toolbox for key members of this group, including Isochrysis galbana, *Pleurochrysis carterae* and *Emiliania huxleyi*, using a range of different approaches. Nuclear transformation using antibiotic-resistant vectors driven by various endogenous promoters have been designed and tested along with different DNA delivery methods. A protocol for CRISPR-Cas9 mediated gene editing is also being attempted using a 'DNA-free' method recently shown to be successful in *Phaeodactylum tricornutum*. Progress made using these methods will be presented.

PS.12: Blooming blanket weed: Managing nuisance algae in National Trust water bodies

Hannah Kemp, Suzanne McGowan, Alexandra Zieritz, Stephen C. Maberly, Carl Hawke, Martyn Kelly, Stewart Clarke (School of Geography, University of Nottingham, Nottingham, UK; Lake Ecosystems Group; UK Centre for Ecology & Hydrology; Lancaster Environment Centre, Lancaster University)

Across the UK, many freshwater ecosystems are experiencing more frequent and widespread blooms of filamentous macroalgae, particularly genera such as *Cladophora*, *Ulva*, *Hydrodictyon* and *Spirogyra*. Currently the extent, cause and consequences of these blooms are largely unknown. The prolific blooms are thought to be associated with increased nutrient concentrations in UK freshwaters from both point source sewage treatment works and diffuse agricultural run-off. However, little is understood about other controls on algae biomass such as interspecies competition, trophic interaction and climate change. The formation of thick mats at the lake surface has the potential to cause major ecological damage by harbouring pathogens, depleting lake water of oxygen and decreasing aquatic plant life. In addition, blanket weed blooms can reduce the amenity value of freshwater bodies by looking unsightly, preventing water-based activities and negative-

ly impacting important conservation work. The National Trust has over 450 lakes on their properties across the UK. Many receive large loads of nutrients from the surrounding land and experience macroalgal blooms which decreases their amenity value for visitors. The lake at National Trust's Clumber Park, Nottinghamshire, will provide a case study site for this project. Routine limnological monitoring and experiments will provide evidence for the main environmental drivers of filamentous macroalgae blooms, and highlight factors causing temporal and interannual variability. In addition, simple water quality data and questionnaire surveys gathered from National Trust and other shallow lake sites across the UK, will formulate a better understanding of the extent of the filamentous macroalgae problem. This project is in the early stages of a PhD and has identified gaps in knowledge areas through a detailed literature review. The results obtained from the proposed research aim to inform effective and sustainable techniques for future management and restoration of UK waters with filamentous macroalgae blooms, using the lake at Clumber Park as a model for application elsewhere.

PS.13: *Corallina officinalis* on our coastlines, a characterisation.

Regina Kolzenburg, Federica Ragazzola (University of Portsmouth)

Coralline algae are critical components of global marine shallow water ecosystems where they function as important ecosystem engineers. Understanding their physiology is crucial in order to predict future impacts on and potential changes in coastal ecosystems. However, no studies attempted to elucidate the structure of one of the most important members of this order, *Corallina officinalis* (Corallinales, Rhodophyta). By means of a combined approach of field and laboratory analysis, we characterised populations of *C. officinalis* across its geographic distribution in the NE Atlantic from the northern margin, Iceland, to the southern margin, Spain. Structural analysis included tensile strength tests, Laster ablation inductively coupled plasma mass spectrometry, scanning electron microscopy and field transplants. In this way, tensile strength, elasticity, growth rates, cell wall thickness and skeletal Mg/Ca trace elemental ratio measurements were performed. Combining the results of these parameters disentangles the structural integrity of this species and enables predictions of potential future changes as a result of anthropogenic effects such as climatic changes or mechanical stress like trampling. Results showed an elevated cell wall thickness with lower within variability as well as a potential increased elasticity due to lower Mg/Ca ration in northern margin populations compared to central and southern populations. Additionally, northern populations showed to be able to withstand higher forced and strain before rupture compared to more southern populations. Populations in the centre of the distribution were able to withstand the comparatively lowest forces, southern populations showed the highest deficit in deformation resistance. The observed increased strength and differences in elemental composition of northern populations may be due to local adaptation to harsh environments. Based on these findings, the generally assumed Centre-to-Margin hypothesis regarding abundance as well as adaptation and resilience potential is not observed in structural integrity of *C. officinalis* and is suggested to be modified into a North-to-South gradient for this species. With changing future climatic conditions, central and southern populations might not be able to withstand an increase in extreme weather events. Overall, this study demonstrates that coralline algae (Rhodophyta, Corallinaceae) are vulnerable to potential future climatic changes.

PS.14: Differences in acid-base regulation of haploid and diploid life-cycle stages of *Coccolithus braarudii*

Dorothee Kottmeier, Abdesslam Chrachri, Gerald Langer, Glen Wheeler, Colin Brownlee (Marine Biological Association)

Coccolithophores are calcifying microalgae that carry characteristic calcite platelets (coccoliths) on their surfaces. Most coccolithophore species exhibit diploid and haploid life cycle stages, each adjusted to different environmental conditions. Diploid life cycle stages are often heavily calcifying, thereby producing excess amounts of H+. Haploid life-cycle stages are often weakly calcifying, generating significantly less H+. We show how these different cellular "H+ burdens" require substantially different physiological molecular strategies to regulate intracellular pH under changing environmental conditions. We combine physiological measurements with molecular and pharmacological approaches, allowing for the identification and characterisation of membrane proteins involved in pH homeostasis. We also present why the different mechanisms for acid-base regulation result in a more pronounced sensitivity towards ocean acidification in the heavily calcifying diploid life-cycle stage.

PS.15: Metabolomic and physiological interactions between a cyanobacterium and a diatom: What regulates a co-existence?

Sandra Lage, Hanna Mazur-Marzec; Elena Gorokhova (Stockholm University)

Nodularia spumigena is a toxic, bloom-forming, and nitrogen-fixing filamentous cyanobacteria occurring in brackish waters worldwide. *N. spumigena* produces several classes of non-ribosomal peptides (NRPs), including hepatotoxic nodularins, that play important roles in shaping plankton communities, although their modes of action are poorly understood. Here, we evaluated whether the interspecific interactions between *N. spumigena* and the diatom *Phaeodactylum tricornutum* affect NRPs production by the cyanobacterium. Using a novel approach that combines culture technique (mono- and co-culturing of

the test species) and liquid chromatography-tandem mass spectrometry for NRPs analysis, we quantified internal and external NRPs produced by *N. spumigena*. Additionally, we evaluated growth and photosynthetic activity of both species under mono- and co-culture conditions. In line with previous studies, growth of *P. tricornutum* and the nodularin production by *N. spumigena* were not affected by co-culturing of the diatom and cyanobacterium. However, production of spumigins, another NRP group, was significantly affected under co-culture conditions. In addition, the photosynthetic activity, i.e. effective quantum yield of photosystem II in *P. tricornutum* and *N. spumigena* increased under co-culture conditions compared to the monocultures. As spumigins are potent inhibitors of serine proteases, which contribute to functioning of photosynthetic apparatus, it is possible that these NRPs are involved in interspecific competitive interactions via photosynthesis regulation.

PS.16: Pre-emptively assessing HAB risk, can we anticipate impacts from climate driven invasions?

Adam Lewis, Andrew Turner, Linda Percy, Jane Lewis (Cefas/University of Westminster)

Climate change is facilitating changes in the distribution of many species globally, including microalgae. Harmful marine microalgae can have a range of impacts on ecosystems and human health as a result of toxin production, creation of hypoxic conditions and mechanical damage to other marine organisms. Due to these deleterious impacts harmful taxa are of great interest although they constitute a comparatively small proportion of the known microalgal species. Monitoring efforts and, in some cases, mitigation strategies have been implemented in many regions where harmful species are known to occur. These efforts are designed to limit the impact of the locally relevant harmful species but are often so targeted in nature that they do not offer protection against threats or impacts from unexpected harmful species. Within the UK a robust monitoring programme is established to determine the presence of toxin producing microalgal species as well as to quantify the presence of toxins within bivalve shellfish destined for human consumption. This monitoring effort targets five groups of toxins regulated within the EU. However, with shifting environmental conditions and a globally connected ocean this targeted monitoring will need to adapt to changes in risk, or damage to public health and the environment is likely to occur without warning. The occurrence of a new harmful microalgal species in the UK could be determined by quantifying the impact of such an introduction after it has taken place. In order to achieve this, new methods may need to be established for the determination of toxin presence or species identification with a consequent delay in management. Alternatively, it may be possible to assess the likelihood of a species introduction or range expansion and to prepare ahead of an event. In the spirit of this approach, work is underway to assess the risk posed by over 120 harmful species from sources worldwide but not yet known from UK shores. Here we present a methodology for evaluating risk as well as exploring possible routes of introduction, future ocean climate projections and challenges associated with certain harmful taxa.

PS.17: Insights into phytoplankton assemblages using Mesolens microscopy

Deirdre McLachlan, Serena Flori, Katherine Helliwell, Glen Wheeler & Colin Brownlee (The Marine Biological Association)

Most investigations of unicellular algae are limited to a specific scale - we can examine population level responses and single cell responses, but not at the same time. Studies of single cells are carried out with high magnification microscopes that allow detailed imaging of only a few cells. Until recently, simultaneous imaging of large numbers of cells in a population has required a trade-off between wide field of view, obtained with a low magnification objective, and optical resolution, or the ability to see fine detail in the image. This major limitation has recently been overcome through a novel concept in optical imaging that allows wide-field imaging with exceptionally high resolution. The Mesolens uniquely combines wide-field, low magnification (x4) with high resolution (n.a. = 0.5), aberration-free images, representing a revolution in optical imaging, providing sub-micron lateral resolution wide-field (up to 6mm diameter) images. This allows us to simultaneously examine stimulus-induced responses in a population of tens of thousands of cells, and also the individual responses of the cells within that population. Using *Phaeodactylum tricornutum* transformed with the calcium sensor R-GECO, we have examined calcium dynamics at the population level and also the responses of the individual cells within that population. We also demonstrate the utility of this approach for studying physiological properties of single cells in natural mixed phytoplankton populations.

PS.18: High resolution pocket microscope with display on mobile phone

Andrew Monk (ioLight magnificent Mobile Microscopes)

The State of New York has approximately 1,200 lakes, managed by 300 Lake Associations. These are made up of residents living on the shores of the lake who have a strong interest in maintaining the health of their lake. Changes in climate and farming methods have led to an increase in toxic Harmful Algal Blooms (HAB). Suspect algal blooms must be reported to the Environmental Protection Agency, which issues a 303(d) status of impaired water notice, closing the lake to recreational activities. Prof. Greg Boyer of SUNY Environmental Science and Forestry says that many of these blooms are in fact harmless, but diagnosis requires a microscope. Lake Association members often

drive long distances to Prof. Boyer's Lab in Syracuse NY to have their samples checked so that their lake can be re-opened. The ESF team is trialling the ioLight portable microscope, a pocket sizes instrument that allows Lake Associations to capture high-resolution microscope images of the algae on their mobile phones and instantly send them to ESF for analysis. ioLight is presenting demonstrations of its Magnificent Mobile Microscope in the British Phycological Society Conference and invites you to see how you can capture and share beautiful images of algae directly from the water's edge. We hope that Lake Associations in New York State can now spend their weekends on the lake rather than driving to Syracuse and back. [Note: our presentation is a demonstration, not a poster. Following a discussion with Prof Jason Hall-Spencer, we would like a 3-minute slot to promote the demonstration]

PS.19: The colour dynamics and photosynthetic performance of the brown alga Cystoseira tamariscifolia

Barry Pettifor, Lina M. Rasmusson, Jason M. Hall-Spencer (Plymouth University)

Structural colours are seen when nanoscale anatomical features interfere with incident light at particular wavelengths which are then reflected. Iridescence occurs when changes in viewing angle alter the colour perceived. This has evolved biological uses in signalling (e.g. in plants, insects, birds) and light harvesting (angiosperms). In some marine algae colour is created by extracellular multilayer structures or intracellular, tightly packed nanospheres. Recent research on the brown seaweed *Cystoseira tamariscifolia* revealed the opalescent photonic crystal (OPC) anatomy responsible for this species' blue colouration and showed that its colour intensity responds to light and dark. Biophysical modelling led to speculation that OPCs have a role in photosynthesis. To investigate this further we explored colour responses in *C. tamariscifolia* using time lapse photography and a range of light treatments. The most intense blue colouration occurred in the dark and reduced rapidly in light, even at very low irradiance levels. The response was not light spectrum dependent, such as might occur in response to immersion. Chlorophyll fluorometry showed that the maximum quantum efficiency of photosystem II was higher in conditions in which strong blue colouration was evident (just after dark) but reduced over a 90 minute period of illumination. Dynamic nanostructures may modulate the transmission of light to chloroplasts in response to different irradiance levels. In terms of practical applications, static nanostructures have already been shown to enhance the efficiency of photovoltaic cells. A deeper understanding of the sensing and motor processes used to manipulate light transmission in seaweeds could inform solar cell design through incorporation of self-tuning mechanisms.

PS.20 Drivers and drainers of oxygen consumption in the temperate seagrass *Zostera marina*.

Lina Rasmusson, Martin Gullström, Mats Björk (University of Gotheburg)

The seagrass *Zostera marina* creates highly important habitats in temperate coastal areas offering several ecosystem services essential for a thriving ocean. Through their high photosynthetic efficiency vast amounts of carbon dioxide are taken up and at the same time partially respired back to the water column; therefore seagrass productivity might impose a great impact on coastal carbon- and oxygen fluxes. Photosynthesis is well studied in *Z. marina*, however, respiration has been given less attention. In earlier studies, respiratory rates have been obtained in darkness and used as a constant over the day, a consensus that we have found misleading. Here, we present a comprehensive assessment of the factors involved in affecting respiration rates. The results showed that light seems to have a suppressive action on the respiratory machinery as we found a high reduction in respiratory rates in light. Furthermore, the dark respiration rates appear to be highly fluctuating on a diel basis, with peaks during mid-day when productivity is at its highest level and at night. Moreover, the temperature was shown to have a major impact on seagrass respiration (confirming earlier research). Finally, as many ecological climate models use a Q10 of two for metabolic processes, we wanted to test if this was accurate for seagrass respiration and photosynthesis. Values fluctuated greatly depending on initial temperatures and depending on the temperature range chosen, indicating that a constant Q10 of two is not precise. These findings clearly show that to make accurate assessments of oxygen- and carbon fluctuations in shallow coastal seagrass areas, a variety of factors needs to be taken into account.

PS.21: *Macrocystis pyrifera* in a warming ocean – a lab experiment in Chile

Nora Salland, Martín Munizaga Kappes, Martin Thiel, Mark Lenz (Marine Biological Association)

In northern-central Chile, natural variability in ocean temperature is driven by the El Nino Southern Oscillation (ENSO). The frequency and intensity of ENSO events and resulting heat waves may increase in future due to anthropogenic climate change. Kelps are important primary producers in coastal temperate ecosystems. They serve as a food source for many marine invertebrates and, as ecosystem engineers, provide habitat, nursery and foraging grounds for a wealth of associated fauna. *Macrocystis pyrifera*, the giant kelp, is a cold-adapted species abundant along the Chilean coast where it plays a critical role in the food web and acts as a habitat former in the coastal ecosystem. In laboratory microcosms, we examined the influence of ocean warming on young *M. pyrifera* sporophytes (121 ± 23 mm blade length). The performance of the alga was assessed across a range of temperatures from the present day annual mean temperature in Coquimbo, Chile (14°C) to the predicted average temperature in

the year 2100 (22°C; IPCC 2014). In a simultaneous two-factorial experiment we measured kelp growth at temperature intervals and under grazing pressure by the red sea urchin Loxechinus albus and the black sea urchin *Tetrapygus niger*. Algal growth rates were a unimodal function of temperature, with maximal growth rates of 2.14 mm/day at 17°C. This temperature for optimal performance is below the present day average summer temperature in the Coquimbo region (18°C). At 20°C the young *M. pyrifera* sporophytes showed no significant reduction of growth. This is contrary to the literature, where growth of large sporophytes is limited at this temperature. At 21°C and 22°C we observed tissue loss and mortality in some sporophytes. Results of the two-factorial experiment showed no significant interaction effect between temperature and grazing pressure by sea urchins on elongation of *M. pyrifera*, which suggests that the kelp shows no compensatory growth due to herbivory grazing. Based on our findings, we predict that near-future summer temperatures and heat stress caused by ENSO will have detrimental effects on *M. pyrifera*, with consequences for associated biodiversity and communities, since the temperature of maximal growth is already commonly exceeded during the austral summer.

PS.22: Thermal tolerance of *Laminaria digitata* gametophytes suggest subtle population differences

Nele Schimpf, Kiara Franke, Daniel Liesner, Michael Roleda, Inka Bartsch (University of Plymouth and Alfred-Wegener-Institute)

Kelps form highly productive and structurally complex marine forests along rocky coastlines in the North Atlantic, but globally they are at risk of decline at their trailing edges due to climate change. The majority of studies have focused on the ecology and thermal responses of the macroscopic sporophyte phase of kelps. In *Laminaria digitata*, the microscopic gametophytes generally withstand a 2-3°C higher temperature than sporophytes. Thereby, they provide ecologically important and hardy seed banks. If local temperatures surpass the upper survival threshold of gametophytes, for example at southern locations, populations might face extinction. We hypothesized that local differentiation in the gametophyte heat tolerance of *L. digitata* corresponds to the long-term local temperature history. Therefore, we performed a full-factorial temperature experiment on gametophytes sampled along a latitudinal gradient, from Quiberon, France (southern geographical and temperature limit), Helgoland, Germany (temperature limit) and Bodø, Norway (cold-temperate location). Vegetatively grown gametophytes were derived from spores released by multiple parental sporophytes, and were exposed to a temperature gradient (20-25°C) for two weeks and post-cultivated at 15 or 20°C for further two weeks. Cell pigmentation and presence of growing cells were used as a proxy for survival. Change in gametophyte density and the ratio of male to female gametophytes were analysed. Gametophytes from all populations were able to survive 15- 23°C, subtle differences were apparent at 24°C, and 25°C was lethal for all. In the Bodø population, 24°C was lethal after two weeks. In the Helgoland population, 7.6 % gametophytes survived 24°C for two weeks, but were dead after two weeks of post-cultivation. In the Quiberon population, 2.3 % gametophytes survived 24°C for two weeks and survival rate remained the same during post-cultivation. Interestingly, long-term post-cultivation (6-12 weeks) revealed that a few gametophytes were able to regenerate. In general, considerably more males than females survived with increasing temperature. Current sea surface temperatures at the studied locations generally do not reach the lethal limit of the gametophytes tested in this study. Nonetheless, we found indications for subtle local adaptation in the lethal upper temperature limit following the latitudinal gradient.

PS.23: Exploring the microphytobenthos in the intertidal Thames

Dain Son, Susi Arnott, Jane Lewis (University of Westminster)

Developing a science art partnership, aspects of the changes observable in a Thames mudflat were investigated. The variation of colour on mudflats over two tidal cycles in June were observed and recorded using time lapse filming. Alongside this the microphytobenthos was sampled and analysed by light microscopy to determine the principal components of the community which were diatoms and euglenids. These were counted and their volumes determined. Euglenids dominated diatoms in terms of numbers and volumes on both sampling days, although the proportions varied for the different days. Colour analysis of film segments related to the sampling sites showed that colour make up was very similar across the sampling points but 'hue' was related to the proportion of euglenids in the community. It is possible that within one site, limited detailed microsopical analysis, combined with filming might be an effective method of scaling up observations of these habitats which can be otherwise challenging to document.

PS.24: Investigation of a spring potamoplankton bloom using light microscopy and flow cytometry

Peter Vaughan (University College London)

Phytoplankton growth in lake ecosystems has been extensively studied and is relatively well understood. In contrast phytoplankton growth in rivers (potamoplankton) has received less attention and the factors which drive it, in particular seasonal succession, are less elucidated. This study investigated the dynamics of the 2019 Spring phytoplankton bloom in the River Thames using weekly flow cytometry (FCM) and light microscopy (LM) analysis to identify and quantify the types of phytoplankton present, together with measurements of chlorophyll-a and

physicochemical parameters. This was the first time that FCM and LM methods had been used together to study a potamoplankton bloom, and provided a more complete picture of changes in the phytoplankton community composition than had previously been achieved using either method individually. The study also enabled a comparison of the utility of the two methods. LM analysis identified individual phytoplankton groups based on their detailed morphology. It indicated that the 2019 Spring bloom was dominated by centric diatoms, as found for previous studies of phytoplankton blooms in rivers, but also revealed a major euglenophyte component, which had not been previously reported. There were also large numbers of cryptophyte cells and, after the centric diatoms had declined, successive peaks in chlorophytes and dinoflagellates. FCM analysis identified phytoplankton groups based on their size and fluorescence (pigment) properties. It had a lower taxonomic resolution than LM but, as an automated system, was much quicker and required less operator training. FCM was also able to detect cells below the effective lower size limit for LM analysis. Such cells, i.e. pico- and nano-chlorophytes, greatly outnumbered the cells counted by LM, both during and after the peak bloom. There were some linkages observed between the population dynamics of individual phytoplankton groups and some of the physiochemical factors measured, but the post-peak decline in the 2019 phytoplankton bloom did not appear to be related to changes in any of these parameters, including water temperature, river flow-rate, sunshine hours or nutrient concentrations. The factors limiting potamoplankton blooms are not well understood and future research might look at the potential role of biotic influences such as predation and viral-induced mortality.

PS.25: Haplo-diplontic life cycle enables niche expansion in coccolithophores

Joost de Vries, Fanny Monteiro, Glen Wheeler, Colin Brownlee (University of Bristol, Marine Biological Association)

Coccolithophores are most recognizable for their production of intricate calcium carbonate platelets, called 'coccoliths', which lead them to play an important role in the carbon cycle. The production of coccoliths is however not their only striking trait. As haplo-diplotonic organisms, coccolithophores are able to reproduce asexually in two different life phases (the 'haploid' and 'diploid' phase). This is in contrast to most phytoplankton, which can reproduce asexually in only the haploid or diploid phase. The haploid and diploid phases of the same coccolithophore species can differ significantly in size, calcification status, and abundance. The two cell forms may furthermore inhabit different niches, which has proposed to enable niche expansion. To date research has however primarily focused on the diploid life phases, and relatively little is known in regards to the biogeography of the haploid life phase, or how much this phase contributes to coccolithophore abundance and niche space. Through a synthesis of coccolithophore abundance data and literature review, we have investigated the difference in biogeography of the life cycle phases, quantified their relative contributions to global coccolithophore abundance, and determined the contribution of each phase to coccolithophore niche space. Our results show that the two life cycle phases have different environmental preferences and thus inhabit different niches, which allows coccolithophores to expand their niche volume and subsequently increases their total abundance. This research highlights the need to include the haploid life cycle phase in coccolithophore ecology, physiology and climate research, and will pave the way for further studies examining the physiology and ecology of coccolithophore life phases.

PS.26: Using herbarium collections to improve our understanding of an important group of red algae

Georgia Ward, Janina Brakel, Juliet Brodie (Natural History Museum)

Eucheumatoid red algae (*Kappaphycus* and *Eucheuma* spp.) are among the most valuable of cultivated seaweeds, and are commercially exploited for their high carrageenan content. Much of this production is in Southeast Asia, in particular Indonesia, the Philippines and Malaysia, and eucheumatoid cultivation is becoming increasingly economically important in East Africa, specifically Tanzania. Despite their economic significance, the taxonomy of the group remains poorly resolved. There are currently 30 valid eucheumatoid species across four genera (*Eucheuma*, *Eucheumatopsis*, *Kappaphycus* and *Betaphycus*), however the majority of available sequence data are for a small handful of commercially cultivated species and varieties, or are otherwise from taxa within this same geographical region, where there is dedicated research effort and expertise. Natural history collections and herbaria are increasingly being seen as valuable resources for taxonomy studies and have the potential to act as an extensive source of molecular, phenotypic and biogeographic data for specimens across broad temporal and spatial ranges. In order to further our understanding of eucheumatoid taxonomy, and provide the most complete phylogeny of the group to date, we sequenced the mitochondrial Cox 2-3 spacer region and regions of the plastid rbcL gene from specimens held at the Natural History Museum in London, UK, including 17 purported species (eight of which previously had no available sequence data), from 17 countries across the Americas, Asia and Africa.

PS.27 Innovative approaches to seaweed cultivation: optimising species selection and culture strategies

Catherine Wilding (Marine Biological Association of the UK)

The cultivation of macroalgae is an emerging field in the UK and across Europe. Cultivated biomass of the kelp *Saccharina latissima* has value as a human food, animal

feed, and bioremediator, as well as potential for carbon sequestration and biofuel production. A recently developed 'bio-binder' glue allows for direct seeding of algal gametophytes onto cultivation lines, bypassing the need for a costly hatchery grow-out period necessitated by traditional 'twining' methods. However, the most effective technique for application of binder solution has yet to be optimised, particularly for deployment at sea under high-energy, dynamic conditions. Further research is also needed to optimise seeding density, species selection, seeding technique, and harvest time to maximise yield and economic feasibility. Here we trialled two different direct seeding techniques with three densities of *Saccharina latissima* gametophyte suspension. A one-stage technique involved mixing gametophytes and binder solution together prior to application onto cultivation lines, while a two-stage technique involved application of gametophytes to lines prior to coating with binder solution. Gametophytes were applied at three density concentrations by diluting a cultured gametophyte suspension with seawater, to produce high (4.9 mL m-1), standard (2.45 mL m-1), and low (1.23 mL m-1) density treatments. Seeded cultivation lines were deployed in at sea and cultured in the laboratory: 10m long vertical dropper lines were deployed at a seaweed farm in Porthallow, Cornwall; 80cm lines were cultured in tanks in Plymouth. Following deployment during November 2019 lines will be monitored for sporophyte growth rate, density, biomass and biofouling. Species diversification will also be explored through trial culture and economic feasibility assessment of two new species: the Golden kelp *Laminaria ochroleuca* and Furbelows *Saccorhiza polyschides*.

PS.28: Potential impact of combined environmental stressors on UK intertidal macroalgae

Gracie Wilson, Andrew Blight, Michael Burrows, David Paterson (University of St. Andrews)

Intertidal macroalgae are ecologically important primary producers. They are also key indicators of how climate change will impact costal zones. Under current climate change predictions, macroalgal species will have to either adapt to the new conditions, change their distribution, or face extinction. In order to predict what may happen to the UK's most dominant intertidal macroalgae species, this project will investigate the single and combined effects that selected environmental stressors, in various orders and combinations, may have. The stressors of interest to this project include but are not limited to increasing sea temperature, eutrophication, and ocean acidification. Dominant species of interest include intertidal red, green and brown macroalgae from across the intertidal zones. Special interest will be given to species which are currently being harvested within the UK. Using the new state of the art facilities within the Scottish Oceans Institute at St. Andrews University, the laboratory experiments will consist of a tidal system where independent mesocosms will be manipulated to investigate the impact of the defined stressors. This impact will be examined by monitoring growth rates, photosynthetic activity, chlorophyll content and recording both wet and dry weight. The laboratory experiments will establish the species that are most sensitive and the combination of stressors that have the greatest effects. This work will then be used to consider the impact of stressors on these algae under natural conditions.

PS.29: Optimising strain selection and developing a biorefinery for industrially relevant microalgae

Eleanor Wood (SAMS)

Production of algal biomass for specific products is a costly procedure that often leads to waste in the form of disrupted biomass or water. The larger components of the algal biomass such as proteins, lipids, and carbohydrates tend to hold less value than the specific amino acids, fatty acids or polysaccharides that they are composed of. To make algal production more feasible biorefinery; the production of three or more products from the algal biomass, is necessary to maximise value from the cultivation process. This project aims to identify the highest value products within the cells of different algal species under varying conditions using analytical techniques such as GCMS and HPLC. Following this, high value components such as pigments, peptides or fatty acids, that can be used for pharmaceuticals or cosmetics, will be separated from the rest of the biomass using cell disruption and purification techniques. Remaining biomass will be used for further products such as feed or fertilisers. Photobioreactors from 1L to 1000L with submersible LED technology from Xanthella will be used so that successful small scale experiments can be upscaled to a commercial level.

PS.30: Sequestration of carbon from *Laminaria* kelp forests may be diminished in a warmer climate

Luka Wright, Andy Foggo (University of Plymouth/Marine Biological Association)

Among the services provided by kelp forests, their contribution to blue carbon sinks is currently of utmost relevance. Detritus from these fast-growing plants, together with assimilated carbon, is sequestered into sediments. Along the Northeast Atlantic coast, the predominant kelps are of the genus *Laminaria*. While the cold-adapted *L. digitata* (Ld) and *L. hyperborea* (Lh) are shifting northward, the warm-adapted *L. ochroleuca* (Lo) is currently expanding its range due to climate change. This study aimed to compare photosynthetic performance and decomposition between the three *Laminaria* spp. in order to better understand whether the contribution of kelp forests to carbon sequestration is altered in a warmer climate. Detritus from all species was aged in a litter bag field experiment. Weight, chlorophyll fluorescence, respiration and net primary productivity were measured before deployment and after 25 and 32 days at sea. Moreover, lamina

discolouration was quantified using imaging software. First, Lo detritus lost biomass at a faster rate than that of cold-adapted species. Second, operating efficiency of PSII declined in all species after 32 days, being highest in Lh and lowest in Lo. Third, gross primary productivity remained constant over time in the northern species, while it decreased in Lo, which was net respiring after 32 days. Fourth, detritus of Lo had a larger proportion of lamina discolouration than the two cold-adapted species after 32 days. The faster decomposition of Lo detritus and its lower photosynthetic performance suggest a decreased carbon export and sequestration potential. Considering that in the near future Lo will become the dominant kelp in the Northeast Atlantic, climate change will likely reduce the carbon sequestration function of temperate kelp forests – a vicious circle, which further exacerbates the effect of anthropogenic carbon emissions. This study hopes to inform climate mitigation strategies and emphasises the need to protect cold-adapted kelps as they are driven north with rising temperatures.

PS.31: Chloroplast genome variability of *Corallina officinalis*

Chris Yesson, Xueni Bian, Chris Williamson, Juliet Brodie (Zoological Society of London)

Corallina officinalis is a calcifying red algae, common in tide pools in the North Atlantic. It is an important habitat forming algae, providing shelter and substrate to many other organisms. There are few published genomes for this group. This study reports the first four published plastomes for this species, along with 3 new mitogenomes from samples in UK, Spain and Iceland. The plastome is 178kbp and shows 99.9% of bases are identical for all samples. The mitogenome is more variable than the plastome. Structure and length of both genomes is consistent with other published *Corallina* genomes.

PS.32: The comeback of Rhodophyta to the Gulf of Gdańsk (southern Baltic Sea)

Aleksandra Zgrundo, Ilona Złoch (University of Gdańsk)

The Gulf of Gdansk has been significantly degraded as a result of extensive exploitation of marketable species (plants and fish) from 1960 to 1980 and strong eutrophication limiting the growth of marine organisms. Despite this, it is still considered as a region of exceptional environmental values and high biodiversity in comparison with adjacent regions. In 2004, a Natura 2000 site was created in the Puck Bay and actions were taken to protect endangered habitats and species. Concurrently, projects were started to restore the species of plants considered extinct and endangered, for example, *Fucus vesiculosus* L and *Zostera marina*. In August and September 2019, intensive field studies were conducted in the Puck Bay on flora (micro- and macroalgae and flowering plants) to assess biodiversity and habitats resources. The material was collected for qualitative and quantitative analysis according to recommendations of Helcom Combine (Part C, Annex C9). This allowed observation of species that have not been reported since the 70s, i.e. *Furcellaria lumbricalis* (Hudson) J.V.Lamouroux and *Coccotylus brodiei* (Turner) Kützing. The identification of *C. brodiei* still requires confirmation because specimens from brackish gulf waters morphologically do not fully exhibit features of the forms developing in the saline waters, and there is a lack of reference material in local collections. Both species were present in the form of free-flowing thalluses in areas where the bottom was covered with 100% flora. This free-flowing form of growth was characteristic for populations observed up to the 60s and they were usually observed together. This imposes a question – whether the observations indicate improvement in the environment quality due to declining human pressure or observations were the result of the extensive studies. The last intensive flora studies have been performed in the early 2000s. Currently, the national monitoring of macroalgae and flowering plants in the Puck Bay is being conducted on a short transect located at the opposite end of the bay. In the presentation, we will expand on issues related to the the indicative potential of naturally recovering populations considered to be extinct.

BPS Field Course "Collecting and Identifying Seaweeds" March 18th-22nd 2019

Submitted by Katrin Schertenleib, Trinity College Dublin

Recipe for a really good week:

1) Welcome the day by admiring Plymouth Sound seen from the MBA.

2) Go to a stunning shore site at low tide, climb over rocks, explore rock pools and the shallow water, "find" and collect things – in this case intertidal seaweeds.

3) Have lunch at the beach and feel the sun.

4) Dedicate the afternoon to exploring your collected specimens in detail, surrounded and supported by expertise.

5) Have a massive, extremely delicious 5-course meal in versatile, inspiring company.

6) Repeat.

Every now and then, throw in a lecture for more background information on algae, and listen to the latest news in green algae taxonomy!

This is exactly how the participants of this year's PBS field course on macroalgal identification had the pleasure of spending their third week in March. It was the week around the equinox (March 20), revealing the maximum range of the intertidal at low tide – perfect to go to the shore, learn and explore!

During that week, the course leaders Francis Bunker and Prof. Christine Maggs, together with their team (John Archer-Thomspon, Ignacio Bárbara, Juliet Brodie, and Anne Bunker), did a great job in sharing their general ecological knowledge, experience and specific expertise according to their backgrounds and research interests. We participants obtained (or broadened) a sound species knowledge on common macroalgae species found in the intertidal or rockpools – mainly large, charismatic brown algae such as sugar kelp (Saccharina latissima), Oarweed (*Laminaria digitata*), or Thong Weed (*Himanthalia elongata*), but also delicate, beautiful, and sometimes quite tricky to identify red seaweeds like Irish Moss (*Chondrus crispus*), Sea Beech (*Delesseria sanguinea*), or Bunny Ears (*Lomentaria articulata*). We were offered extensive training opportunities in the lab to develop an eye for general and, especially, microscopic identification features in, e.g., *Cladophora*, *Ceramium* or *Polysiphonia* species. Some seaweeds can exhibit different morphologies depending on the environmental conditions they grow in, so having true expertise eliminating identification doubts and giving information on what features to pay attention to was immensely helpful.

Identification work in the field and in the lab was complemented by lectures on topics such as shore zonation, seaweed reproduction, the importance of correct naming, and iridescence. Additionally, we were given introductions to the identification of filamentous brown and green algae, or encrusting red algae. The impressive display of the MBA her-

barium collection by Dr. Gerald Boalch and learning how to press seaweeds ourselves were very enjoyable. We even were lucky enough to hear about the very latest news in green algae research thanks to Prof. Christine Maggs: those who thought they recognised *Ulva lactuca* in the field will need to update their knowledge, because specimens found at the shore are most likely *Ulva fenestrata*, unless collected in the (sub-)tropics. Molecular analyses revealed that Linnaeus' type specimen happened to be sent to him from elsewhere, and was not collected at in Europe.

This year's course layout of having two introductory days first, followed by three days with focus on more advanced groups of algae, attracted a huge variety of ocean lovers: interested individuals with non-marine professional backgrounds, artists, environmental consultants, PhD students, scientists, and aquaculture farmers. Some of them had participated in the course once or several times during the previous years and quite a few of us are considering attending it again. You never stop learning, right?

You could probably read it between the lines, but to conclude, I would like to send a huge THANK YOU to the course leaders and their team for the very well organised programme and the excellent supervision, and to the MBA for providing great facilities and delicious food! Even the weather was in favour of us, we couldn't have asked for more.

A study in ochre: genetic diversity of *Laminaria hyperborea* forests along the Irish coastline

Submitted by Aisha O'Connor

I completed a BSc (HONs) in Marine Science with distinction at the National University of Ireland, Galway in May 2018. During my thesis project, I investigated the floral diversity of algal drift habitats on the west coast of Ireland and the fauna that this niche habitat supports under the supervision of Dr Kathryn Schoenrock (NUIG). It was this project that awoke my passion for algal research! Directly before submission of my thesis, I was delighted to learn that I had been awarded BPS funding to take part in a collaborative research project on the population genetic structure of Laminaria hyperborea forests along the west coast of Ireland. The collaboration would include Dr Schoenrock and Dr Stacy Krueger-Hadfield (University of Alabama at Birmingham) and would take place, in part, at UAB. I had never travelled to the US before so this would be my first trip outside of Europe and to people I had yet to meet. Nerves didn't enter my realm of excitement as I completed my thesis and final exams and dove into the literature to begin background research.

The summer began with a final few trips for field work, in which I collected kelp samples with Dr Schoenrock for this research project (see Figure 1). It continued with me working as a bursar for the next 11 weeks in the Aquaculture sector of the Marine Institute, Oranmore, Galway. This was an entirely different field to that of my upcoming research, however it was interesting to experience another area of marine science and to finally apply some of the theory I had learned throughout my undergraduate degree. Since I was working in aquaculture it turns out that I wasn't all too distant from algae. Part of the project I worked on while I was there involved the cultivation of the green alga *Ulva* sp. to monitor its growth through biomass measurements at the research site, which featured fish and lobsters growing together. We, then, compared growth rates of *Ulva* sp. to the control site where only lobsters were growing. I gained invaluable field skills from this work and though I found it interesting, I was eager to shine a light again on algae as the main focus.

Two days after finishing work in the Marine Institute, I jetted off to Birmingham, Alabama. Eventually, after several delays in New York and a sprint through Atlanta, I arrived to a steamy, nighttime Birmingham. In my first week, I had the help of both supervisors to settle me in, show me the area, introduce me to the professors and graduate students of the Department of Biology, and ease me into lab work. Having never done genetic bench work before, this is when the nerves kicked in. There were multiple PCR plates laid out on the bench, pipettes of all sizes, and endless pipette tips on the shelf above me which I was sure I would accidentally knock down at some stage (see Figure 2a). From the second week onwards, I worked alongside Dr Krueger-Hadfield running PCRs on all our individual DNA

Figure 1. Picture of the *Laminaria hyperborea* canopy at Zetland Pier, Bantry Bay, Co. Cork. One of seven kelp collection sites along the west coast of Ireland for this project. Samples were brought to UAB for genetic analysis.

samples, which I helped extract (Figure 2b&c). As the days progressed so too did my pipetting skills. It was satisfying to clearly see the advancement I had made, that I had been learning from observing Dr Krueger-Hadfield and as a result of her patient teaching manner. In addition to lab work, I continued sifting through the literature on the use of microsatellites to study kelp population genetics, which proved to be a relatively modest collection of papers.

Regular term-time resumed during my third week at UAB, which meant lectures started up again. I was fortunate enough to be allowed sit in on Dr Krueger-Hadfield's Conservation Genetics lectures. It was like a cartoon lightbulb moment as Dr Krueger-Hadfield began explaining the theory of population genetics and the various parameters used to quantify differences between populations. At last, the papers I had been slogging through were clicking into place and I was starting to understand their relevance to our work.

This trip has certainly not been all work and no play, however. The graduate students have welcomed me with open arms into their small community where I have been included in every event from daily lunches, dinners out, and twice-weekly step class. I have embraced swims at the 'Rec center', shopping at the outlets, a trip to the Civil Rights Museum, the Vulcan, and BBQ. I feel I have been fully immersed in the southern culture and the diverse ways of life the graduate students have here.

My experience over the past five weeks has inspired me to consider a Master's degree at UAB. With thanks to the BPS for funding, I would not have otherwise had the chance to travel to the US for a research project like this at such an early stage in my career. The opportunity for this project stemmed from my undergraduate thesis supervisor Dr Schoenrock who alongside Dr Krueger-Hadfield I wish to express my sincere gratitude to for their continuous encouragement and belief in me. I will continue to work alongside both supervisors as the first author on a paper describing the results of this project and to present the work at the BPS meeting in Oban.

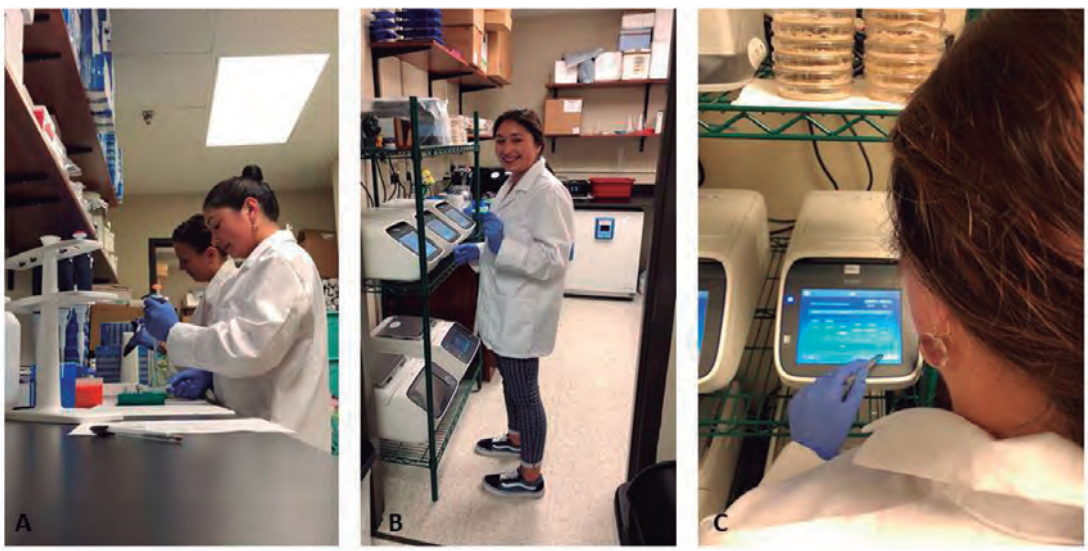

Figure 2. a) bench work for PCR plate preparation, b) plates are put in the thermocyclers for PCR reactions, c) PCR programmes were tailored for the primers used in the Krueger-Hadfield Laboratory, UAB.

SEAWEED FIELD MEETING
St. Andrews on the east coast of Scotland
Wednesday 19th to Saturday 22nd August 2020

This is an area with a rich seaweed flora and a good recorded history which we can explore from excellent facilities and a new laboratory at the new Scottish Oceans Institute at the University of St. Andrews. The BPS seaweed field meetings bring seaweed collectors together visiting a different shore each day followed by laboratory workup to produce full species lists for an area, which we can compare with past records. This is not a formal training course but students and less experienced workers are welcome and can enhance their skills by sharing with more experienced workers. Accommodation is available to participants at a discount in University residences in this ancient, historic town. St. Andrews is a popular destination with extensive rocky shores on the open North Sea coast and in the Firth of Forth. The Edinburgh International Festival and Festival Fringe, on the other side of the Firth of Forth, also take place in August so why not combine with the field meeting for a Scottish visit! If you would like to know more about this field meeting or to book a place please email Martin Wilkinson at m.wilkinson@hw.ac.uk

LONDON FRESHWATER ALGAL IDENTIFICATION COURSE
The Natural History Museum, London, UK
Monday 14th to Friday 18th September 2020

We are pleased to offer a five-day course to train staff of environmental and other agencies, utility companies, consultancies, museums, universities and research students in the identification of the major groups of ecologically-important freshwater algae. Special consideration will be given to harmful and nuisance algae, recognition of algae responsible for "incidents" and the use of freshwater algae for ecological assessment. It is designed to be an introduction for those with limited experience of freshwater algae but, nonetheless, every effort will be made to cater for those who wish to enhance their existing taxonomic expertise and identification skills.

Course Tutors: Prof. David John (NHM), Dr Martyn Kelly (Bowburn Consultancy, co-organiser), Prof. Brian Whitton (Durham), Dr David Williams (NHM, guest lecturer)

Where: The course will be held at The Angela Marmont Centre for UK Biodiversity in the Darwin Centre of the Natural History Museum, Cromwell Road, South Kensington, London: with some lectures in the Sir Neil Chalmers seminar room.

Programme: The daily programme of lectures and practicals begins at 12.30 on Monday 14 September and at 0900 on all other days. The programme runs each day to 1730 except on Friday 18 September when the course finishes after lunch at 1400.

Costs: The course fee of £450 (excl. VAT) covers all tuition, loan of all material including the 2011 edition of The Freshwater Algal Flora of the British Isles. All those attending receive a folder, a manual, and a data pen with supporting materials. Students who have been members of the British Phycological Society for at least three months may apply directly to the Society for some financial support. Details are posted on the BPS website (https://brphycsoc.org/awards_training/), with the next closing date for applications 1 May.

Accommodation: Participants will need to make their own arrangements for accommodation. A list of accommodation in the London area will be sent to registrants well in advance of the course.

How to Apply: Reservations for one of the 12 available places on the course should be made to Martyn Kelly (see below). A full refund will be made to anyone paying in advance if cancelling before 31 July, while 50% refund will be made to anyone cancelling between then and 1 September. All fees will be refunded in full in the unlikely event of cancellation due to the Covid-19 (coronavirus) epidemic. We are, however, unable to refund travel and accommodation costs and therefore recommend participants take out travel insurance.

Further Information: Martyn G. Kelly, Bowburn Consultancy, 11 Monteigne Drive, Bowburn Durham DH6 5QB, UK MGKelly@bowburn-consultancy.co.uk mobile 07711419495

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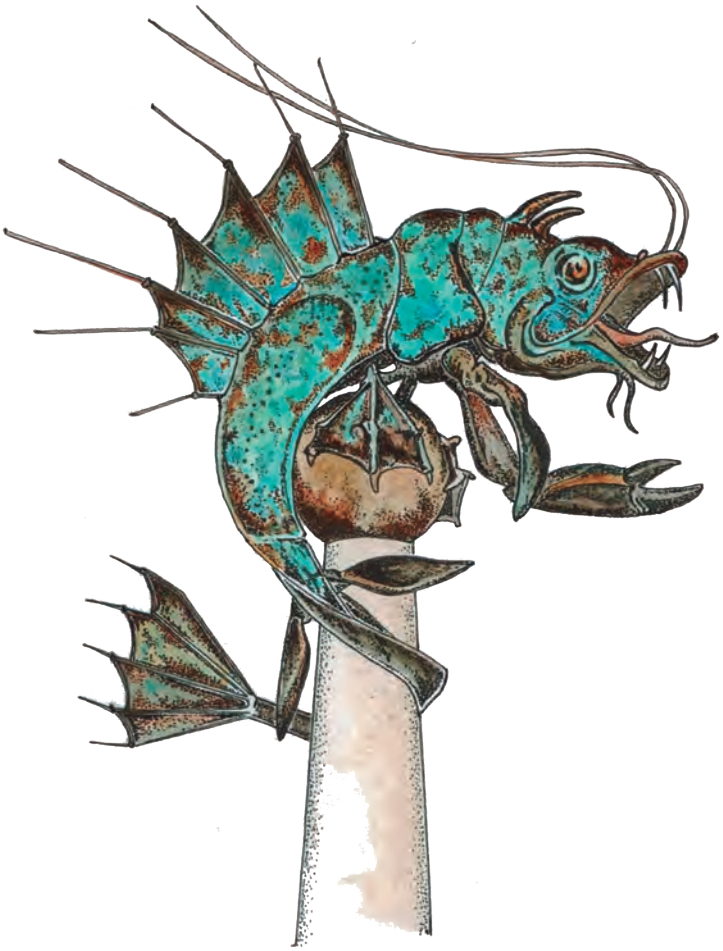
Linda Mary Irvine (1928-2020)

It is with great sadness that we report that Linda Irvine died on 25th February 2020. Linda joined the Natural History Museum in London in 1949 as a phycologist in the Marine Algal Section of the Botany Department with responsibility for both research and curation. She spent some years in the United States but subsequently returned to the museum in 1964 and worked in the algal section until her retirement in 1988. Since then she held the position of Scientific Associate in the department. Professionally, Linda is best known for her work on the coralline algae, a challenging group in which she gained international recognition as an expert authority. Amongst her many achievements she co-authored four volumes of the Seaweeds of the British Isles flora series and was an honorary member of the British Phycological Society.

INSTRUCTIONS FOR CONTRIBUTORS



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

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

Submission of Copy and Deadlines

Copy should be submitted to:

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