



# **The 74<sup>th</sup> British Phycological Society annual meeting**

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**Aberystwyth, Wales**

**6<sup>th</sup> – 8<sup>th</sup> January 2026**

**AR LANY MÔR**



**ON THE SEASHORE**

## Croeso i Aberystwyth!

Which is to say, Welcome to Aberystwyth. And more specifically, to the 74<sup>th</sup> British Phycological Society annual meeting, the first time this has been held in Aberystwyth. Being west coast, Aberystwyth has a wide range of macroalgae adorning its coast and if the weather is fine there is no better way to spend an afternoon than exploring the rockpools off the coast at low tide... However, as it is January, being inside listening to a set of excellent talks makes a good second-best.

I'm really excited about the range of talks we have at this year's meeting. From microalgae to macroalgae, from genetics to ecology, from seaweed companies to artists, we've got it all. In addition to the presentations, we will have an exhibitor area for our Gold sponsors next to the posters this year, please visit them whilst you are here. Other highlights include Saul Purton's Presidential address, given as a public lecture on Tuesday afternoon – having seen Saul present before this will be highly engaging and not to be missed. We have a ceilidh on the Wednesday following the conference dinner, and a tour of the National plant phenomics centre and AberInnovation for those interested on the Thursday morning. Following the conference, I am delighted that we are hosting and supporting a UK seaweed network workshop led by Emily Kostas, Jen Reed and Aleya Prokudina (UCL) in partnership with Rhianna Rees, CEO of Seaweed Scotland that afternoon; and for those staying in Aberystwyth for an extra night, the pantomime is recommended for Thursday evening, ridiculous and fun entertainment. And throughout the whole conference, a seaweed- and marine-inspired art exhibition in the Art Centre gallery just along the corridor from the lunch, posters and exhibitors.

Whether this is your first visit to Aberystwyth or your regular haunt, I hope you enjoy this annual meeting and leave feeling inspired and ready for another year of phycology.

Cofion cynnes,



Dr Jessica Adams

Conference organiser lead and President elect of the BPS

**We would like to thank the following sponsors for their support:**



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## Special sessions and plenary speakers

### Microalgae physiology and taxonomy



Glen Wheeler

Senior Research Fellow, Marine Biological Association  
**Seaweed Scotland**

Glen's research examines the biology and ecology of marine phytoplankton. Much of Glen's work examines cellular responses to stress to help understand how algae may respond to future environmental change. Glen has a particular interest in the biology of coccolithophores and the mechanisms through which these algae produce their remarkable covering of intricate calcium carbonate plates.

### Applied Phycology



Rhianna Rees

CEO, Scottish Seaweed Industry Association

Rhianna leads the Scottish Seaweed Industry Association, driving innovation, collaboration, and growth across the UK's seaweed sector. With a background in knowledge exchange, regulation, and industry development, she champions seaweed's role in the blue economy, from biostimulants to food systems.

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### Science outreach



Mikey Ross

Head of the Culture Collection of Algae and Protozoa (CCAP)

Dr Mikey Ross is a lecturer in algal biotechnology at the Scottish Association for Marine Science (SAMS) and is head of the Culture Collection of Algae and Protozoa (CCAP). Mikey's research could be described as spanning the Good, the Bad, and the Ugly of algae. This would include exploring algae for high-value products useful across biotechnology, mitigating Harmful Algal Blooms, and bioremediation. He has become increasingly involved with various science communication and outreach activities.

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## Presidential address

### **Microalgae as light-powered cell factories for the bioeconomy**

Public lecture by **Professor Saul**



President of the British Phycological Society

**Purton,**  
Society

Tuesday 6<sup>th</sup> January, 16:00 -17:00

**Location:** C22 Hugh Owen lecture theatre, Penglais campus Aberystwyth University

Saul Purton is Professor of Algal Biotechnology at University College London (UCL), and current President of the British Phycological Society. Formerly, he was Director of Algae-UK: a national network in algal biotechnology and bioenergy funded by the UK Government. He obtained his PhD in plant molecular biology from the University of Cambridge in 1988, and was then awarded a long-term EMBO Research Fellowship to study algal molecular-genetics at the University of Geneva, before joining UCL as a lecturer in 1991.

His research group focusses on various aspects of microalgal biology and evolution, and the exploitation of microalgae and cyanobacteria as phototrophic cell factories for the production of natural or recombinant products. These products include pigments, oils, bioactive metabolites and therapeutic proteins. Major new projects in his group include the reprogramming of the algal chloroplast with a completely synthetic and redesigned genome, and the production of algal-based oral vaccines and antibacterials for combating viral and bacterial pathogens of farmed shrimp and fish. He also has an interest in broader aspects of microalgal biotechnology including areas such as bioremediation and biorecovery, and the use of algae as a teaching resource to help inspire school students to pursue STEM subjects.

In the Presidential Address, he will highlight some of the key discoveries and applications during his research career with a particular focus on how this work might benefit society in the near future.

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## Getting to and around Aberystwyth

### Public transport to Aberystwyth

Trains run direct from Birmingham New Street, taking roughly 3 hours.

The journey from central London is approximately 5 hours. National Express coaches run from London Victoria and take approximately 8-10 hours.

### Public transport to Penglais campus

The Penglais Campus occupies a site of about 32 hectares to the south of the A487 Penglais Road on the northeast side Aberystwyth town.

It is a 20-30 minute walk **uphill** from the main train station.

Buses run roughly every 10 minutes from Aberystwyth bus station to Penglais campus. Check your travel at <https://myunijourney.traveline.cymru/aberystwyth-university/>

**See maps on overleaf**

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# Key locations in Aberystwyth

**Marine Hotel** (blue fronted, on seafront)

**Railway** (mainline) station (yes, Wetherspoons is on the platform)

**Bronglais hospital A&E** (hopefully not needed)

**Penglais campus** (20 minute walk up the hill, beyond National Library)

**C22** (from the Hugh Owen library, take the external route past the Level D entrance. Take the external steps down to Level C side entrance; is C22 on immediate left.)

**Bus stops** (turn right after exiting station)

**National Library** (landmark, no BPS events here)

**International Politics building** (on Penglais campus opposite Arts Centre)

**Arts Centre** (on Penglais campus next to main library and SU)

# Arts Centre: internal maps



Aberystwyth Arts Centre is located on Penglais Campus and is the large building between the Hugh Owen Library and Student Union Building. Access to the main foyer and box office is at ground level, there's a lift up to the theatre foyer and a stair lift down to the lower foyer. Gender neutral toilets are located on Floor 3. For more information visit <https://aberystwythartscentre.co.uk/access/>.

**Level 2**

- Cafe
- Shop
- Lift
- Central Staircase
- Entrance (from car park)

**Level 3**

- Lift
- Cinema
- 2D Room
- Dark Room
- Photography
- Gender Neutral Toilets
- Theatre Bar
- Round Studio

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## Programme

<b>Monday 5 January 2026</b>		
<b>Location: 'Main room'. Interpol Hall, Penglais campus, Aberystwyth University</b>		
13:00-17:00	Registration	Interpol reception (outside hall)
13:00-17:00	Posters pinned up from now	Art centre 'studio' room / adjoining theatre bar area

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<b>Tuesday 6 January 2026</b>		
<b>Location: 'Main room'. Interpol Hall, Penglais campus, Aberystwyth University</b>		
8:00-9:00	Registration	Interpol reception (outside hall)
9:00-9:20	Saul Purton, Jessica Adams	BPS Welcome
9:20-9:30	Angela Hatton, Aberystwyth PVC	Aberystwyth University welcome
9:30-10:00	Glen Wheeler	Plenary for microalgae physiology and taxonomy
10:00-10:15	Break	Interpol reception (outside hall)
<b>Split sessions</b>		
	<b>Main room (Interpol hall)</b>	<b>Art centre cinema</b>
	<b>Microalgae physiology and taxonomy session</b> <b>Chair: Glen Wheeler</b>	<b>General phycology</b> <b>Chair: Puja Kumari</b>

10:15-10:35	<p><b>Matthew Keys</b></p> <p>Diatom phycosphere carbonate chemistry measurements at single cell resolution: from modulation of carbon uptake to effects of flow on the diffusive boundary layer</p>	<p><b>Manus Cunningham</b></p> <p>The way forward: Cultivation of Fucaceae for aquaculture purposes</p>
10:35-10:55	<p><b>Harry Catherall</b></p> <p>Low-cost alternatives for direct measurement of CO<sub>2</sub> fixation by intertidal microphytobenthic soft sediment systems</p>	<p><b>Gregory Rorrer</b></p> <p>A process model for predicting of the effects of aeration rate on biomass productivity, aeration cost, and net CO<sub>2</sub> emissions during tumble-tank cultivation of the red seaweed <i>Devaleraea mollis</i> (Pacific dulse)</p>
10:55-11:15	<p><b>Chris Williamson</b></p> <p>Ubiquitous and expanding glacier algal blooms around the Greenland Ice Sheet</p>	<p><b>Rebecca McKinney</b></p> <p>Temporal Effects of Tailored Light Regimes on Phenolic Content of <i>Fucus serratus</i> (Phaeophyceae)</p>
11:15-11:35	<p><b>Jenny Smith (Manton)</b></p> <p>Using Environmental DNA Techniques to Quantify Microalgal Communities</p>	<p><b>Puja Kumari</b></p> <p>Acquisition and maintenance of environmental stress memory in red seaweed <i>Bangia</i> sp.</p>
11:35-11:55	<p><b>Ingrid Juettner</b></p> <p>Recovery from acidification in streams after long-term liming</p>	<p><b>Giulia Leanza</b></p> <p>How Long Before We Hit the Bottom? Settling Dynamics of <i>Saccharina latissima</i> from in situ and laboratory measurements</p>
11:55-12:15	<p><b>Andrea Highfield</b></p> <p>Insights into the carbon concentrating mechanisms of the diatom <i>Thalassiosira pseudonana</i></p>	<p><b>Reina Veenhof</b></p> <p>Thermal adaptation of <i>A. esculenta</i> gametophytes</p>
12:15-12:35	<p><b>Attila Molnar</b></p> <p>Identification and Characterization of Genomic Safe Harbours for High and Stable Production of High-Value Compounds in <i>Chlamydomonas reinhardtii</i></p>	<p><b>Ben Jennings</b></p> <p>Catalysing global action: An Overview of the Seaweed Breakthrough</p>
<b>Art centre theatre bar area</b>		
12:35-13:15	Lunch	Posters and stalls in adjoining studio

<b>Main room (Interpol hall)</b>		
<b>Manton prize Session 1</b>		
<b>Chair: Jasmine Ramshaw</b>		
13:15-13:30	<b>Tayla Leathers</b>	Temporal and Spatial Variability in <i>Laminaria digitata</i> Populations Across the UK Show Contrasting Dynamics Between Range-Centre and Range-Edge Sites.
13:30-13:45	<b>Anne Margrete Nilsen</b>	Effects of thermal priming on the <i>Saccharina latissima</i> transcriptome response to heat stress
13:45-14:00	<b>Ruby George</b>	Future function of Furoid forests: linking traits to ecological functions along a large-scale latitudinal and climatic gradient
14:00-14:15	<b>Niko Steiner</b>	The effects of thermal priming on heat tolerance in the kelp <i>Saccharina latissima</i> intragenerational and transgenerational responses across age classes
14:15-14:30	<b>Jack Duffy</b>	Experimental investigation into wave attenuation by <i>Laminaria hyperborea</i> using dynamically scaled mimics in a wave tank.
14:30-14:45	Break	Interpol reception. No refreshments
14:45-15:00	<b>Friederike Gronwald</b>	Macrophyte dispersal from Racetrack flume to the Baltic Sea
15:00-15:15	<b>Jack Burton</b>	Fine-scale population structure and genetic diversity of the sugar kelp, <i>Saccharina latissima</i> , in Ireland
15:15-15:30	<b>Ndeye Bineta Dia</b>	Production of the building-block molecule 3-hydroxypropionic acid from seaweed waste
15:30-15:45	<b>Robyn Mastin-Wynne</b>	In-situ experiments to establish the role that UK kelp forests play in attenuating wave energy
15:45-16:00	Break	Interpol reception. With refreshments
<b>C22 Hugh Owen lecture theatre</b>		
16:00-17:00	Prof Saul Purton	Presidential address as a Public lecture

<b>Art centre bar and adjoining studio room</b>		
17:00-19:00	Poster and drinks session	Sponsored by Taylor and Francis
19:00-00:00	Student (PhD, MSc etc) and ECR icebreaker event	Led by BPS student representatives and local ECR conference organisers.  To be held in Aberystwyth town, meet at the end of the poster session to walk down together.



<b>Wednesday 7 January 2026</b>		
<b>Main room (Interpol Hall)</b>		
9:00-9:30	Rhianna Rees	Plenary for Applied phycology
9:30-9:50	Leon Williams	Lessons from the industrialisation of seaweed-based material: Challenges and Opportunities in Scaling Marine Biotechnologies
09:50-10:15	Break	Interpol reception
<b>Split sessions</b>		
	<b>Main room (Interpol hall)</b>	<b>Art centre cinema</b>
	<b>Applied Phycology</b> <b>Chair: Rhianna Rees</b>	<b>General Phycology</b> <b>Chair: Francis Bunker</b>
10:15-10:35	<b>Alla Silkina</b> Green Economy Centre : Translating Algal Biotechnology for a Sustainable Bioeconomy	<b>Graham Underwood</b> Contributions of benthic microalgal biofilms to sediment organic carbon stocks across a salt marsh gradient
10:35-10:55	<b>Yixing Sui</b> Enhancement of Protein Extraction Efficacy from Red Seaweed <i>Palmaria palmata</i> Using Ultrasonication and High-pressure Homogenisation	<b>Juliet Brodie</b> Developing new tools for identification and listing of vulnerable seaweed species

10:55-11:15	<b>Maxine Canvin</b> Kelp Farming and Carbon: A Drop in the Ocean?	<b>Christine Maggs</b> How diverse is <i>Plocamium</i> (Gigartinales, Rhodophyta) in Britain and Ireland?
11:15-11:35	<b>Thierry Tonon</b> Pelagic sargassum events in Jamaica: morphotype abundance, and analysis of the biochemical and elemental composition of the biomass after different drying treatments to inform valorisation pathways	<b>Francis Bunker</b> Some Algal Trends from long term monitoring in Pembrokeshire Marine SAC
11:35-11:55	<b>Jessica Adams</b> Seaweed pilot-scale processing for fucoidan	<b>Svenja Heesch</b> Taxonomy of the Prasiolaceae (Trebouxiophyceae): new insights
<b>Art centre theatre bar area</b>		
12:00-12:45	Lunch	Posters and stalls in adjoining studio
<b>Main room (Interpol hall)</b>		
<b>Manton prize Session 2</b>		
<b>Chair: Ruby George</b>		
12:45-13:00	<b>Ann Mary VB</b>	Chemical ecology and cross talk between cosmopolitan phytoplankton and pathogenic Vibrios
13:00-13:15	<b>Holly Liken</b>	Dealing with biased class sizes in AI-based automatic microalgal classification
13:15-13:30	<b>Frieda Schegel</b>	Orai-like calcium channels and their potential role in coccolithophore calcification
13:30-13:45	<b>Jose Ignacio Gayo Pelaez</b>	A novel, fast and reliable alternative for microalgal growth assessment in scalable cultivation systems
13:45-14:00	<b>Aidan Salter</b>	Characterization of carbohydrate-active enzymes from species of green microalgae
14:00-14:15	<b>Arianwen Herbert</b>	Nutrient controls on plankton communities in the South Atlantic subtropical gyre
14:15-14:30	Break	Interpol reception

14:30-14:45	<b>Ilona Shadrach</b>	Problem or opportunity? Utilising the biostimulant properties of microalgae for plant growth and pest control in hydroponic co-cultivation
14:45-15:00	<b>Adam Dingmann</b>	Variation in Lotic Parameters and its Influence in Structuring Stalk Forming Diatom Communities
15:00-15:15	<b>Jasmine Ramshaw</b>	Quantifying bacterial assemblages associated with both farmed and wild populations of <i>Saccharina latissima</i> across the aquaculture growing season in SW England
15:15-15:30	<b>Catherine Philip</b>	Dimethyl Sulfoniopropionate (DMSP) Metabolism in green tide causing seaweeds
15:30-15:40	Jessica Adams	Outline of evening's events
15:40-16:00	Break	Interpol reception
16:00-17:00	<b>AGM</b>	Interpol hall
<b>Marine hotel, on seafront</b>		
18:30-23:00	Conference dinner and ceilidh	



<b>Thursday 8 January</b>		
<b>Main room (Interpol hall)</b>		
9:00-9:30	<b>Mikey Ross</b>	<b>Plenary for Science outreach</b>
9:30-9:50	<b>Dan Franklin</b>	BPS education and outreach: a session to explore our current activities and plans, and to plot new directions

10:00-10:15	Break	Interpol reception
<b>Split sessions</b>		
<b>Main room (Interpol hall)</b>		<b>Bus to IBERS, Gogerddan</b>
<b>Science outreach</b> <b>Chair: Mikey Ross</b>		<b>Visit to IBERS, Gogerddan campus</b> <b>Lead: Valerie Rodrigues</b>
10:15-10:35	<b>Matthew Julius</b> Fostering Students' Awareness and Attitudes toward River Environments: Development of a Diatom-Based Educational Program	<p>Bus departs on road below Art Centre at 10:15 and returns 12:30.</p> <p>Tour includes visit to the National Plant Phenomics Centre and to AberInnovation where the IBERS Biorefinery facility is based.</p>
10:35-10:55	<b>Susi Arnott</b> What's science outreach for?	
10:55-11:15	<b>Nikolas Kappas</b> SeaKey: an app, webkey and print version to guide the identification of seaweed species of the German North Sea and Baltic Coasts	
11:15-11:35	<b>Kirsti Davies</b> Gwymona, a local community project exploring creating ways of connecting people with seaweed	
11:35-11:55	<b>Andrew Stone and Jon Somerscales</b> Creating an interactive art-science installation with living microalgae	
11:55-12:15	<b>Emma Heathcote</b> An adventure through Wales, the land of seaweed	
12:15-12:35	Beat the queue to lunch/ have (another) look at the Ar Lan y Mor exhibition in Art centre gallery 2	
<b>Art centre theatre bar area</b>		
12:30-13:30	Lunch	Stalls in adjoining studio

<b>UK Seaweed network workshop (Invitation only)</b>		
<b>Main room (Interpol hall)</b>		
13:30- 17:30	<b>Emily Kostas / Rhianna Rees</b>	Workshop
<b>END OF CONFERENCE</b>		

## Posters

### Art centre 'studio' room

Sarah Le Besque*	University of Oxford	The over-looked middle class of phytoplankton: the significance of nano-phytoplankton in the sub-Antarctic region of the eastern Pacific.
Andy Stawowy*	Swansea University	Deciphering community interactions and biotechnological applications of the microalgal microbiome
Hey-Won Wong*	University of Bath/ British Antarctic Survey	Examining the impact of the world's largest icebergs on Southern Ocean phytoplankton communities
Raed Yaseen*	Swansea University	Salinity Adaptation in <i>Nannochloropsis</i> : Cellular, Culture-Level, and Media Chemistry Perspectives
Jenny Smith*	Cardiff University	Using Environmental DNA to Quantify Algae Communities
Jooyoung Ser*	Swansea University	Can microbial interactions enhance red body production in <i>Nannochloropsis oceanica</i> ?
Adam Reeve*	University of Plymouth	Effects of a fermented macroalgal biostimulant on spring wheat ( <i>Triticum aestivum</i> L. cv. KWS Cochise) growth, yield and seed quality.
Anne Margrete Nilsen*	Nord University	Effects of thermal priming on the <i>Saccharina latissima</i> transcriptome response to heat stress
Jessika Banham*	Swansea University	Functional traits of a canopy-forming seaweed vary with wave exposure and latitude.
Charlotte Jennings*	Newcastle University	Modelling the effect of abiotic conditions on algal growth
Jose Gutierrez Higa*	Cardiff University	Plant seedling growth and soil respiration responses to seasonal United Kingdom seaweed wrack extracts
Ethan Quah*	University of Plymouth	The role of kelp-bryozoan symbiosis in the carbon cycle
Abrar Shakil*	Swansea University	Trait linkages reveal seasonal trade-offs between growth and reproduction in fucoid seaweeds along a South Wales coast.

Raye Scottow*	Aberystwyth University	Working towards functional recombinant sulfatases for Ulvan polysaccharide breakdown
Eric Harris-Scott*	University of Portsmouth	Biodiversity enhancement and climate impacts of integrated multi-trophic aquaculture at an offshore location in the southwest UK.
Kiri Belcher*	Alfred-Wegener institute	Enhancing Alginate Yield and Efficiency: Mechanochemical-assisted Extraction from <i>Laminaria digitata</i>
Kate Bowler*	University of York	Characterising the CO <sub>2</sub> Concentrating Mechanism in Brown Macroalgae
Sally Henderson*	Swansea University	Self-cleaning slipways: Harnessing species interactions for sustainable management of coastal infrastructure
Nadia Frontier*	Swansea University	Marine Forests in Flux
Jennifer Griffiths*	Aberystwyth University / NRI	Seaweed on my lunch tray: challenges and opportunities of including macroalgae in Welsh school meals
Francisca Vermeulen	Scottish Association for Marine Sciences	Economic and physiological considerations of using <i>Haematococcus lacustris</i> and <i>Chromochloris zofingiensis</i> for astaxanthin production
Joshua Mutter	Swansea University	Advancing Mapping and Monitoring of Canopy-Forming Brown Macroalgae Using Multispectral Remote Sensing
Madhubalaji Chegu Krishnamurthi	University of Bath	Cavitation Mediated Fucoxanthin Extraction in Methanol Water Solvent Systems
Nikolas Kappas	GEOMAR Helmholtz Centre for Oceanic Research Kiel	Unravelling our knowledge of macroalgae in the German Baltic Sea - a review of monitoring and research in the last decades
Giulia Leanza	Bangor University	How Long Before We Hit the Bottom? Settling Dynamics of <i>Saccharina latissima</i> from in situ and laboratory measurements
Ingrid Juettner	Amgueddfa Cymru - Museum Wales	Recovery from acidification in streams after long-term liming.
Francisca Vermeulen	Scottish Association for Marine Science	Drones and Droids: Are you ready to investigate an algal bloom using marine robots?

Haley Gladitsch	Natural History Museum	Surfacing Data: Digitisation of the Brown Algae Collection at the Natural History Museum
Rob Mrowicki	Natural History Museum	Changes in the microbiome of farmed Kappaphycus species in Malaysia associated with 'ice-ice' disease
Valerie Rodrigues	Aberystwyth University	Characterisation of Ulvan Saccharifying Enzymes from <i>Alteromonas sp. 76-1</i>
Zoe Coombes	Swansea University	Marine Biodiscovery Network Initiative

\* = Manton prize posters

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## Presentation abstracts

### Microalgae and Cyanobacteria Physiology and Ecology

#### Plenary: Unravelling the mysteries of calcification in coccolithophores

Glen Wheeler

Marine Biological Association

Coccolithophores are a major group of marine phytoplankton characterised by the production of calcium carbonate scales known as coccoliths. They play a critical role in the global carbon cycle through their contribution to primary production and in their role as the major calcifying organisms in modern oceans. Despite their global importance to marine ecosystems, many aspects of coccolithophore biology remain poorly understood. Many species cannot be grown in laboratory culture, hindering detailed study of their physiology. Coccolithophores exhibit a haplodiplontic life cycle, characterised by distinct forms of calcification, but the environmental triggers and mechanisms that govern life cycle transitions remain elusive. The mechanisms through which coccoliths are generated and the impact of these processes on wider coccolithophore biology are also poorly understood.

Our research sets out to identify and characterise the mechanisms of coccolith formation in order to understand the unique impact they have on coccolithophore biology. This allows us to better understand how coccolithophores may respond to future environmental change, particularly ocean acidification caused by anthropogenic carbon dioxide emissions, which is predicted to be particularly damaging for calcifying organisms. Calcification in coccolithophores is distinct from most other calcifying organisms because it occurs entirely intracellularly. Coccolith formation therefore require massive fluxes of inorganic ions across cellular membranes. Calcium and inorganic carbon act as substrates for calcite precipitation and precise regulation in intracellular pH is required to remove excess protons generated by this process. We have identified some of the unique aspects of coccolithophore biology that allow them to cope with these extraordinary demands. These novel mechanisms have provided insight in to the environmental sensitivity of coccolithophores and will allow us to better predict how these remarkable organisms may be influenced by future changes in ocean chemistry.

#### **Diatom phycosphere carbonate chemistry measurements at single cell resolution: from modulation of carbon uptake to effects of flow on the diffusive boundary layer.**

Matthew Keys<sup>1</sup>

Andrea Highfield<sup>1</sup>, Abdul Chrachri<sup>2</sup>, Brad J. Gemmel<sup>3</sup>, Colin Brownlee<sup>1</sup>, Kevin T. Du Clos<sup>4</sup>, Lee Karp-Boss<sup>5</sup>, Glen L. Wheeler<sup>1</sup>

1The Marine Biological Association of the UK

2University of Exeter

3University of South Florida

4Louisiana Universities Marine Consortium

5University of Maine

All phytoplankton are surrounded by a thin stagnant seawater film that adheres to and moves together with the cell. This boundary layer, where transport processes occur via molecular diffusion, interfaces between the cell surface and the surrounding bulk seawater. Often referred to as the phycosphere, this chemical microenvironment is dependent on the diffusive boundary layer (DBL) thickness, the diffusion coefficients of the chemical species within and the chemical/biological uptake activity across the cell membrane. Diatoms utilise multiple mechanisms of dissolved inorganic carbon (DIC) uptake to maintain CO<sub>2</sub> supply to Rubisco, but how these different pathways are coordinated in response to rapid changes in their environment remains unclear. By directly measuring dynamic changes in phycosphere carbonate chemistry around single cells of large centric diatoms using a triple-microelectrode approach, we show that DIC uptake is rapidly modulated. Additionally, recent observations have demonstrated unsteady sinking behaviour in diatom cells occurring over timescales of milliseconds. It has been hypothesized that this sink-stop-sink behaviour may be a strategy to enhance nutrient fluxes via thinning of the DBL. Using a custom microfluidic channel combined with pH and oxygen microelectrodes, we measured flow effects on the pH DBL of a large centric diatom in steady and unsteady flows, simulating flow velocities of the same magnitude observed during unsteady sinking behaviour. Our DIC uptake measurements reveal that dynamic modulation of CO<sub>2</sub> and HCO<sub>3</sub><sup>-</sup> uptake allows diatoms to rapidly respond to changes in CO<sub>2</sub> supply and demand. Our flow simulations on the DBL reveal that steady sinking velocities significantly reduce the boundary layer, which re-establishes when sinking stops (sink-stop). In contrast, sustained unsteady sinking behaviour (sink-stop-sink') results in a continuous thinning of the DBL, suggesting a strategy to enhance nutrient flux while increasing residence time in the photic zone.

### **Low-cost alternatives for direct measurement of CO<sub>2</sub> fixation by intertidal microphytobenthic soft sediment systems**

Harry Catherall

University of Hull

Restoration of temperate soft-sediment intertidal ecosystems is underway in many countries to replace areas lost to port and harbour development and to compensate for coastal squeeze as sea levels rise. Key questions concern the function of newly restored sites - do these areas offer the same levels of ecosystem services, and carbon storage in particular, as natural sites? The REWRITE team are working on methods and models to quantify the productivity of microphytobenthos dominated sites across Europe. Existing methods for primary production either measure gas exchange and are typically high-cost (>10,000), or use in-situ measurements of chlorophyll fluorescence, also at high cost, and involving complex calculations to derive carbon fixation. Here, we describe a low-cost gas exchange method to rapidly assess rates of primary production for any type of intertidal soft sediment system. The cost of pCO<sub>2</sub>sensors has decreased greatly in recent years since the global pandemic as interest in measurements of air quality in confined spaces has grown. Trials of low-cost, Bluetooth-enabled sensors such as the

Aranet-4 Home (logging pCO<sub>2</sub>, temperature, relative humidity, air pressure) have been done on soft sediment systems including microphytobenthic biofilms in the Westerschelde and Humber estuaries. The low-cost system consists of a 30l volume hemispherical plexiglass dome, pCO<sub>2</sub> logger, PAR logger and small fan. Blackout curtain material is used for dark incubations. Hobo temperature/light loggers record values inside and outside the dome, with a total equipment cost of < 400. Rates of primary production and respiration from the low-cost system were very similar to those obtained from an equivalent commercially available scientific instrument (EGM-5 portable gas analyser) using multiple, paired, 15-30 min incubations on the same sediment surface for a wide range of sediment types. Development of low-cost methane detectors as well as vegetation-index cameras will further expand the range of possible measurements, and description of a common set of guidelines will allow large-scale measurement of carbon drawdown to be made, leading to improved models of intertidal ecosystem function.

### **Ubiquitous and expanding glacier algal blooms around the Greenland Ice Sheet**

Chris Williamson

University of Bristol

Glacier algal blooms occupying the melting surface of the Greenland Ice Sheet (GrIS) support diverse and active microbial communities and amplify ice melt through positive albedo feedback. Knowledge about the distribution and magnitude of these blooms has been limited to isolated field surveys or regional remote sensing and modelling studies to-date. Here, we present the first Greenland-wide simulation of glacier algal blooms over the past two decades (2010–2022) using a Quasi Monte Carlo (QMC) ensemble approach. We show how conditions conducive for glacier algal growth are present around the entirety of the GrIS margins in every year of our study regardless of the magnitude of the melt season. Spatiotemporal heterogeneity in accumulated biomass exists across the ablation zone, between ice sheet sectors and relative to inter-annual variability in melt. Bloom magnitude maps to the availability of ablation zone area in each year and we identify northern sectors of the GrIS as potential harbingers of expansive glacier algal blooms that remain to be sampled as well as an increasing trend in total bloom extent (3724 km<sup>2</sup> yr<sup>-1</sup>) between 2000 and 2022, supporting the likelihood of future bloom expansion as more of the ice sheet is unlocked by warming.

### **Using Environmental DNA to Quantify Algae Communities**

Jenny Smith

Cardiff University

In drinking water supply reservoirs, microalgae and cyanobacteria, form a key component of the water system but under the various conditions can have significant negative consequences for water quality and risks for end users. Issues include algal blooms, the release of both toxic chemicals and foul tasting (non-toxic) metabolites into water bodies. To anticipate these issues, water companies need to monitor algal communities in reservoirs. Current practices involve manual identification using traditional microscopy, however, this is time consuming, labour intensive and can be biased by a phycologist's level of taxonomic expertise. Furthermore, these analyses tend to identify microalgae to genus level only, which may not provide the resolution

needed for informing water quality management and predictive modelling. As part of the Ofwat-funded Artificial Intelligence (AI) for Algal Monitoring project in conjunction with Bristol University and water companies from across the UK, Jenny's PhD project involves using environmental DNA (eDNA) to quantify and monitor algal communities in reservoirs. The genetic information will be used to ground-truth Bristol University's AI community to determine if the AI tool is sufficient for industry needs. In addition to ground-truthing the AI data, this project aims to use network analyses and investigations into coevolution between algae taxa, to identify ecological associations between species that could reveal indicator taxa of water quality risks.

### **Recovery from acidification in streams after long-term liming.**

Ingrid Jüttner<sup>1</sup>,

Oliwia Franczak<sup>1,3</sup>, Martyn Kelly<sup>2</sup>, Ian Vaughan<sup>3</sup>, Steve Ormerod<sup>3</sup>, Haydn Probert<sup>4</sup>, Louis Macdonald-Ames<sup>4</sup>, Simon Evans<sup>4</sup>

1 Amgueddfa Cymru – Museum Wales, Department of Natural Sciences

2 Bowburn Consultancy

3 School of Biosciences, Cardiff University

4 The Wye and Usk Foundation

We studied the effects of long-term liming on stream diatoms during three projects between 2003-2025 in the upper River Wye catchment, Wales. The streams, located in base-poor upland areas, are affected by acidification as a result of deposition of air pollutants and forestry practices. Variations in water chemistry, diatom species composition and diversity, and in the index Diatom Acidification Metric (DAM) were compared between different types of land cover and flow conditions. Streams located in conifer plantations had low pH and very low species richness, and were treated with lime. Of the two methods tested, catchment and in-stream liming, the latter proved most successful and has been used annually since 2007. Electrofishing was carried out for several years before and after liming to monitor the recovery of salmon populations. Diatom species composition changed after liming with species tolerant of low pH, in particular *Eunotia exigua* (Br ex Kütz.) Rabenh., becoming less abundant and being replaced by acid-sensitive species, predominantly *Achnanthes minutissimum* (Kütz.) Czarn. In 2013, DAM index values and ecological quality ratios (EQR), which were both lower in conifer and acid grassland areas before liming than elsewhere, had improved after liming, and in many areas the ecological status class of limed streams had become good or high. A change to diatom assemblages with predominantly acid-sensitive species after liming correlated with increasing numbers of juvenile salmon which had migrated upstream to sites that lacked fish prior to liming. To investigate long-term effects of liming and potential effects by climate warming, we reinvestigated all streams in 2024/25 during low and high flow conditions. We report changes in diatoms in streams limed annually since 2013 and compare those with long-term changes in untreated acidified streams in a neighbouring catchment, and with changes observed in untreated reference streams that are unaffected by acidification.

### **Insights into the carbon concentrating mechanisms of the diatom *Thalassiosira pseudonana***

Andrea Highfield<sup>1</sup>

Matt Keys<sup>1</sup>, Amanda Hopes<sup>2</sup>, Thomas Mock<sup>2</sup>, Glen Wheeler<sup>1</sup>

1 The Marine Biological Association  
School of Environmental Sciences, University of East Anglia

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Understanding how phytoplankton overcome carbon limitation in the ocean to maintain photosynthesis has been the focus of much research, with most phytoplankton having evolved carbon concentrating mechanisms (CCM) that act to increase the concentration of CO<sub>2</sub> at the site of the CO<sub>2</sub>-fixing enzyme, Rubisco. External carbonic anhydrase (eCA)-mediated DIC uptake is an important CCM in a range of marine algae, including diatoms such as *Thalassiosira pseudonana*. This species has been demonstrated to use eCA, with its activity primarily induced by low CO<sub>2</sub> availability. Short-term inhibition experiments of eCA in this species, however, has little impact on photosynthetic O<sub>2</sub> evolution indicating alternate CCM pathways are at play, such as direct transport of HCO<sub>3</sub><sup>-</sup> across the plasma membrane. Tp ZCA1 belongs to the zeta-class of carbonic anhydrases and has previously been localised to the cell periphery in *T. pseudonana*. In this study we generated Tp ZCA1 knock-out mutants using CRISPR-Cas9 gene editing and confirmed a reduction in eCA activity in mutant lines compared to wildtype. This was coupled with a severe defect in growth rate even at ambient CO<sub>2</sub> that could be partially rescued under high CO<sub>2</sub>. A proteomic analysis of the Tp ZCA1 mutant and wildtype was undertaken across a range of CO<sub>2</sub> conditions and has revealed further insights into the CCM of *T. pseudonana*. This study highlights how short-term responses to eCA inhibition over time scales of minutes can differ to long-term effects resulting from loss of gene function and this will have an impact on our understanding of CCMs.

### **Identification and Characterization of Genomic Safe Harbours for High and Stable Production of High-Value Compounds in *Chlamydomonas reinhardtii***

Attila Molnar

Marie Dannay, Antoine Hoguein, Cristina Ponce-Lilly, Roman Zhou

University of Edinburgh

The microalga *Chlamydomonas reinhardtii* is rapidly gaining attention as a promising and sustainable platform for producing high-value compounds, supported by its metabolic versatility, well-annotated haploid genome, and compatibility with modern genome editing tools. Despite these advantages, a major bottleneck persists: strong endogenous gene silencing mechanisms frequently interfere with transgene expression. This silencing leads to low, unstable, or completely lost expression over time, which remains a key challenge for reliable genetic engineering in *C. reinhardtii*. To address this limitation, we aimed to identify and characterise Genomic Safe Harbours (GSHs) - specific genomic loci that permit high, stable, and long-term transgene expression without compromising cellular fitness. We applied a random integration approach using the fluorescent reporter gene mVenus in two distinct genetic backgrounds. We successfully identified and characterised six candidate GSHs. These loci not only demonstrate high and stable expression but also appear to be compatible with CRISPR-Cas-mediated targeted integration, making them strong candidates for precise and predictable genome engineering. The characterisation of these GSHs provides a critical foundation for developing efficient and standardised genetic tools, ultimately advancing *C. reinhardtii* as a reliable chassis for industrial biotechnology applications as well as academic research.

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# General Phycology Session 1

## **The way forward: Cultivation of Fucaeeae for aquaculture purposes**

Manus Cunningham

Queen's University Belfast

Macroalgae from the family Fucaeeae are traditionally wild harvested in the UK and Ireland for a range of markets including agricultural fertilisers, cosmetics, and nutraceuticals. This is largely due to their bioactive compounds including phlorotannins, fucoidan, and fucoxanthin which contribute towards the antimicrobial properties of various *Fucus* spp. While wild harvesting is the standard approach for producing *Fucus* biomass, demand is increasing, with potentially negative implications for marine conservation and market sustainability. Recent research both from Baltic and Irish Seas has investigated the potential for producing aquaculture grown biomass to supplement future demand for *Fucus* spp., which is currently estimated at ~15,000 tonnes per annum in the UK and Ireland. However, the slow growth of many *Fucus* spp. and a lack of methods for scaling biomass production pose substantial barriers to successful cultivation. In overcoming these barriers, we may find inspiration elsewhere in the order Fucales, such as the family Sargassaceae, which are successfully cultivated for aquaculture and restoration purposes in Asia and the Mediterranean. In this study, we explored methodologies based on that used for the widely cultivated genera *Sargassum* and *Cystoseira*, including various cultivation environments from nursery to field settings, different substrata, and methods of growth from zygote development to vegetative propagation, with the aim of highlighting a potential way forward for Fucaeeae cultivation. We found that cultivation of zygotes under both nursery and field settings is the most effective way of producing biomass and can be applied to various *Fucus* spp.; however, considerations of both cost and time are likely to be major factors for successful cultivation.

## **A process model for predicting of the effects of aeration rate on biomass productivity, aeration cost, and net CO<sub>2</sub> emissions during tumble-tank cultivation of the red seaweed *Devaleraea mollis* (Pacific dulse)**

Gregory Rorrer

Oregon State University

The red seaweed *Devaleraea mollis*, commonly known as Pacific dulse, is presently cultivated for food, food ingredients, and aquaculture feed. To intensify land-based aquaculture of *D. mollis*, a fundamental understanding of the aeration processes in tumble tank cultivation is needed to scale production and lower costs. This study describes the development and validation of a process model for predicting the effects of aeration rate on biomass productivity, aeration cost,

and net CO<sub>2</sub> emissions during tumble-tank cultivation of the red seaweed *D. mollis*, where CO<sub>2</sub> in the aeration gas is the sole source of carbon for biomass production. The rated-based model coupled the gas-liquid mass transfer of CO<sub>2</sub> to photosynthetic CO<sub>2</sub> assimilation for biomass production, enabling the asymptotic prediction of biomass productivity from CO<sub>2</sub>-limited to CO<sub>2</sub>-replete growth conditions as the aeration rate was increased from 0.073 to 0.73 L air/L liquid /min. The extended model coupled biomass growth rate to aeration power requirements to estimate the energy cost for biomass production, and the CO<sub>2</sub> emissions associated with electricity consumption by the air compressor. The model analysis showed that aeration energy cost must be balanced against target areal biomass productivity. Furthermore, the sustainability of land-based tumble tank cultivation of red seaweeds with respect to life cycle CO<sub>2</sub> emissions depends on a source of electricity used for powering the aeration process, and the availability of waste CO<sub>2</sub> resources. Although validated for *D. mollis*, the model is generally applicable for all clonally-propagated red seaweeds cultivated in aerated tumble tanks.

### **Temporal Effects of Tailored Light Regimes on Phenolic Content of *Fucus serratus* (Phaeophyceae)**

Rebecca McKinney

Queen's University Belfast

Seaweed nurseries are increasingly interested in producing higher value biomass with stable biochemical compositions for applications in pharmacy, cosmetic, food and feed industries. Light, both spectral composition and intensity, is an abiotic variable that has the potential to be tightly controlled and tailored to upregulate the biosynthesis of specific, valuable biochemical compounds. This study builds used a bespoke photobioreactor to determine the effects of two light spectra within 400-700 nm (pure: blue shifted; warm: red shifted) and three intensities (300, 550, 800  $\mu\text{mol m}^{-2} \text{s}^{-1}$ ) on a 12:12 hr light:dark photoperiod on *Fucus serratus* over time. Treatment lengths were set at 3, 5, 7, 10, 15 and 21 days, to determine the duration required for *F. serratus* phenolic content to peak and subsequently decline under photobioreactor treatments. Controls were maintained at ambient nursery light (30  $\mu\text{mol m}^{-2} \text{s}^{-1}$ ) and a baseline TPC recorded using samples frozen at the time of collection for each timepoint, allowing for a normalised baseline for comparison. Our findings revealed a temporal effect on phenolics, with total phenolic content (TPC) significantly affected by wavelength and intensity; the greatest response amplitude was recorded under the red shifted spectrum at all intensities. TPC increased by ~76% from baseline under warm spectrum high intensity, peaking at 15 days, then declined by ~74% after 21 days under the same conditions. These results highlight the potential of tailored light regimes to enhance biochemical composition and bioactive quality of cultivated seaweeds.

### **Acquisition and maintenance of environmental stress memory in red seaweed *Bangia* sp.**

Puja Kumari<sup>1,2</sup>

Koji Mikami<sup>1,3</sup>

1 Faculty of Fisheries Sciences, Hokkaido University

2 Scottish Association of Marine Science

Seaweeds often acquire species-specific and stress stimuli-dependent acclimatory responses to survive in the marine environment. Understanding the acquisition and maintenance of such tolerance mechanism may provide pertinent tool for building environmental resilience. The ability of seaweeds to memorize their past experiences to better acclimate to the changing environment is not much studied. Generally, higher plants acquire a memory after exposure to external stimulus that enable the plants to react to subsequent stress events with a faster and a stronger defense. This memory persist as a primed state even if the stimulus no longer exist. However, the understanding of such priming or stress memory concept is limited in seaweeds. *Bangia* species is a filamentous red seaweed belonging to Bangiales cultivated commercially in South-East Asia. *Bangia* sp. acquire thermotolerance based on heat stress memory, but the memory is transient and highly variable among different *Bangia* species. In this study, we investigated the role of stress memory in conferring tolerance to the dilution of seawater that causes hyposalinity, hypoosmotic and low nutrient stress simultaneously. *Bangia* sp. ESS1 gametophytes primed with different diluted seawater concentrations for one week showed faster and stronger stress memory responses to recurrent dilution of seawater during triggering stress, which lasted for two weeks. The primed algae showed higher cell viability accompanied with low levels of floridosides and most of the central carbon metabolites during exposure to diluted seawater. This indicated that *Bangia* sp. ESS1 may memorize past stress responses to acclimatize to fluctuating seawater conditions in the marine environment.

### **How Long Before We Hit the Bottom? Settling Dynamics of *Saccharina latissima* from in situ and laboratory measurements**

Giulia Leanza

Martyn Emyr Roberts

Bangor University

Kelp forests are among the most productive marine ecosystems, playing a crucial role in global carbon cycling through both their biomass and detritus. Despite growing recognition of macroalgae as a significant carbon source, knowledge remains limited regarding the degradation rates of detached kelp material and its potential for offshore transport. This study investigated the degradation dynamics of *Saccharina latissima* detritus over eight weeks at two contrasting sites (subtidal and intertidal) in North Wales. We quantified fresh weight loss, assessed key environmental and biological drivers, and tracked changes in settling velocity. We hypothesised that degradation would accelerate over time, differ between sites due to environmental and faunal variability, and influence particle sinking behaviour. Our results confirmed that kelp detritus degraded progressively, with fresh weight loss increasing over time. Degradation patterns varied significantly between sites, driven primarily by abiotic factors (light and temperature) at Menai Bridge and by benthic community composition at Plas Newydd. Notably, sinking velocities increased with degradation, suggesting that particle fragmentation and waterlogging enhance the potential for both long-distance transport and benthic export. These findings demonstrate that *S. latissima* detritus undergoes rapid decomposition under natural conditions, with significant implications for carbon fate in coastal ecosystems. The interplay between local environmental conditions and biological activity indicates that assumptions of long-term kelp carbon storage

may be overly simplistic. This research underscores the need to incorporate decomposition rates and site-specific processes into blue carbon accounting frameworks to refine estimates of kelp's contribution to oceanic carbon sequestration.

### **Thermal adaptation of *A. esculenta* gametophytes**

Reina Veenhof

Scottish Association for Marine Science

The kelp *Alaria esculenta* is ecologically and economically important, supporting both biodiverse kelp forests in the North Atlantic and the seaweed aquaculture industry through cultivation. As a cold-affiliated species, *A. esculenta* is particularly under threat of ocean warming, and accurately forecasting range restrictions can assist decisions on where to concentrate conservation efforts. Concurrently, strategies for increasing thermal resilience are needed to support both ongoing cultivation and restoration into a warmer future. *A. esculenta* has a typical Laminarian life cycle where the microscopic gametophyte alternates with the adult sporophyte. The gametophyte stage may be leveraged during early growth in the nursery phase to improve thermal resilience in subsequent generations. Experimentally establishing thermal limits of early life stages of separate populations of *A. esculenta*, as well as testing the influence of culture temperature on the thermal resilience and whether this carries over to the sporophyte stages, will provide a strong base on which to improve cultivation and restoration techniques. Here, we find that cold acclimation increases thermal thresholds for fertility in *A. esculenta* gametophytes, while the warm-acclimated treatment resulted in more abundant but smaller sporophytes. Cold-adapted sporophytes were also more resilient to autumn heatwave conditions. This work is ongoing to include multiple populations and underlying genetic basis for this thermal reaction, resulting in fine scale population-specific thermal response data. This will be used to predict future range shifts in *A. esculenta* and identify locations that are likely to support successful cultivation and restoration of this ecologically and economically important species of kelp.

### **Catalysing global action: An Overview of the Seaweed Breakthrough**

Ben Jennings<sup>1</sup>, Juliet Brodie<sup>1</sup>, Elizabeth J. Cottier-Cook<sup>2,3</sup>, Phaik Eem Lim<sup>4</sup>,

1 Natural History Museum, Research, Cromwell Road, London SW7 5BD, UK

2 Scottish Association for Marine Science (SAMS), Oban, PA37 1QA, UK

3 University of the Highlands and Islands, SAMS, Oban, PA37 1QA, UK

4 Institute of Ocean and Earth Sciences, University of Malaya, Kuala Lumpur, Malaysia

The Seaweed Breakthrough is an initiative through the United Nations Framework Convention on Climate Change (UNFCCC) High Level Climate Champions 2030 Breakthrough Agenda to mobilise global action to accelerate a comprehensive and coordinated approach to seaweed conservation. It includes a set of high-level ambitious Breakthrough targets to halt the loss of seaweeds, protect and restore them, and to secure sustainable livelihoods and financial investment by 2030. This Breakthrough marks one of the most significant and timely chances to unite the global community in a concerted effort to protect and restore seaweed habitats in a bid to safeguard the vital functions they provide for people and planet. The presentation will provide an overview of the Seaweed Breakthrough and insights into the preliminary results of workshops

where an expert panel have contributed their knowledge to the development of the targets. It will also consider how to catalyse the global community into action and how to develop meaningful global seaweed conservation targets in the absence of comprehensive biological reference points, when losses and gains are highly region specific and the limited availability of restoration techniques for most species. The talk will also explore key lessons from successful global conservation initiatives, such as reducing deforestation rates of rainforests and mangroves, establishment of crop resilience centres and developing gene banks ‘highlighting how these approaches and technologies are critical to advancing the Breakthrough initiative.

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## Manton Prize: Macroalgae

### **Temporal and Spatial Variability in *Laminaria digitata* Populations Across the UK Show Contrasting Dynamics Between Range-Centre and Range-Edge Sites.**

Tayla Leathers

University of Plymouth

Kelps function as key foundation species that form diverse and productive forests, which are distributed along ~25% of the world’s coastlines. These vital marine ecosystems are increasingly vulnerable to climate change, particularly ocean warming, which is predicted to intensify in the coming decades. Understanding how species respond to environmental variability across their geographic range is essential for predicting future distributional shifts under climate change. Populations found towards the range edge are generally more responsive to warming compared with range centre populations, experiencing range shifts when temperatures exceed their thermal niche. Assessing variability of marine foundation species across spatial and temporal scales in response to environmental change can be useful tools for management and conservation efforts. Here, we investigated the population dynamics of the native UK kelp species, *Laminaria digitata* (Hudson) J.V. Lamouroux located towards the trailing range-edge populations (south-west England) and range-centre populations (west Scotland). By integrating historical quantitative survey data from the 1940s with contemporary field surveys conducted in 2025, we assess how population structure, abundance and range limits may have shifted over an eighty-year period. In accordance to anecdotal evidence and projection models, we hypothesise that *Laminaria digitata* populations in the South-west England will have declined since the 1940s, indicating the contraction of the species southern distribution limit, whereas range-centre populations in Scotland will remain relatively stable. This study will highlight the differential vulnerability of *Laminaria digitata* populations and demonstrate the importance of long term monitoring data for forecasting future populations dynamics under ongoing climate change.

### **Effects of thermal priming on the *Saccharina latissima* transcriptome response to heat stress**

Anne Margrete Nilsen

Anne M. L. Nilsen<sup>1</sup>, Niko Steiner<sup>2</sup>, Inka Bartsch<sup>2</sup>, J. Mark Cock<sup>3</sup>, Alexander O. Jueterbock<sup>1</sup>

1 Faculty of Biosciences and Aquaculture, Nord University, Universitetsalléen 11, 8026 Bodø, Norway

2 Alfred Wegener Institute, Helmholtz-Centre for Polar- and Marine Research, Bremerhaven, Germany

3 Algal Genetics Group, CNRS, Sorbonne Université, UMR 8227, Station Biologique de Roscoff, Roscoff, France

*Saccharina latissima* (sugar kelp) is a brown macroalgae of high ecological importance, forming the basis of kelp forests providing essential ecosystem services. Across the North Atlantic, kelp aquaculture is expanding, leading to increased economic interest in the kelp as part of a sustainable blue bioeconomy. However, rising sea temperatures and frequent marine heatwaves now threaten both wild populations and production security. Strategies to enhance kelp growth and resilience will be of high importance for both restoration and aquaculture. Priming, a technique common in agriculture, involves pre-exposing early life stages to moderate stress to induce a molecular priming memory, enhancing performance during later stress exposures. This study investigates the effects of warm priming in *S. latissima*, where gametophytes were exposed to 20°C for three weeks prior to sporophyte formation. Young sporophytes derived from primed (20°C) and naive gametophytes (10°C) were grown at 10°C and then subjected to heat stress (21.5°C for 48h) followed by recovery at 10 °C. Transcriptomic profiles and photosynthetic performance (Fv/Fm, Plabs) were analyzed to investigate priming induced changes in thermal stress resilience. Primed sporophytes showed an earlier and stronger transcriptomic response during heat exposure, with 1,419 differentially expressed genes (DEGs) compared to 564 in controls, while controls showed delayed substantial downregulation after the exposure (2,027 DEGs). Principal component analysis indicated differential recovery in primed kelps. Gene ontology enrichment analysis highlighted upregulation of pathways related to protein phosphorylation, chloroplast function, and post-transcriptional regulation by ncRNA in primed sporophytes during recovery, linking priming to altered regulation of stress responses. Our findings suggest that warm priming of *S. latissima* gametophytes induces a molecular memory persisting through meiosis, leading to modified stress responses in the sporophyte generation. We propose thermal priming as a promising strategy to strengthen kelp resilience for aquaculture and restoration, while supporting the preservation of genetic diversity.

### **Future function of Furoid forests: linking traits to ecological functions along a large-scale latitudinal and climatic gradient**

Ruby George

Swansea University

Large brown seaweeds such as *Fucus serratus* form the foundation of temperate marine forests, supporting biodiversity, nutrient cycling, and blue carbon storage. However, rising temperatures threaten their performance and ecological function. This study investigates how traits and physiological performance of *F. serratus* vary along a ~20° latitudinal gradient from northern Portugal to Orkney, encompassing a ~5 °C difference in mean sea surface temperature. At each region, 10 individuals were sampled from 3 shores to assess morphological traits (specific thallus

area, frond thickness, dry matter content) and growth, alongside controlled metabolic trials measuring photosynthetic and respiratory responses to temperature. Preliminary results indicate a shift toward more acquisitive morphologies and elevated metabolic rates at warmer sites, consistent with a transition toward 'fast' traits. These findings provide early evidence that warming may drive functional change in intertidal forests before population decline occurs, with implications for carbon storage and habitat provision. This work is funded by the British Phycological Society project award and forms part of a collaborative effort between Swansea University and CIIMAR aiming to understanding how environmental gradients shape the resilience and functioning of habitat-forming macroalgae.

### **The effects of thermal priming on heat tolerance in the kelp *Saccharina latissima* 'intragenerational and transgenerational responses across age classes**

Niko Steiner

Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research

Rising ocean temperatures threaten kelp populations and the expanding European kelp aquaculture industry. Ensuring sustainable seaweed production under future climate scenarios requires resilient kelp strains capable of withstanding thermal stress. Priming, introducing moderate stress to enhance subsequent performance, provides a rapid short-term alternative to breeding. We hypothesized that thermal priming of *Saccharina latissima* would induce a physiological stress memory that enhances heat tolerance within and across generations. Gametophytes were primed for three weeks at 0, 10, and 20°C, and the heat tolerance of subsequent sporophytes was assessed in different age classes to identify transgenerational effects: survival of microscopic sporophytes under heat stress (20-23°C), quantum yield and regrowth of juvenile sporophytes during and after a heatwave (10-24°C, 14 days), and quantum yield of adult sporophytes grown in mariculture under heat stress (20-23°C). Warm priming induced measurable transgenerational effects: survival of microscopic sporophytes increased significantly after one week of heat exposure, although this effect was transient and not detectable in adults. Juvenile sporophytes showed only a trend towards improved regrowth after the heatwave when derived from warm-primed gametophytes. Furthermore, adult sporophytes were subjected to a one-day priming trigger at 21.5°C, with or without prior heatwave exposure, to evaluate intragenerational responses to heat stress (20-25°C). Priming had pronounced effects on intragenerational responses: brief exposure of adult sporophytes to 21.5°C significantly enhanced thermal tolerance. When priming followed a heatwave, subtle positive effects were observed compared to priming alone. Our findings demonstrate that warm priming can improve heat tolerance in *S. latissima*, though effects vary in magnitude, duration, and life stage. These results highlight the potential of priming as a tool to enhance kelp resilience but also emphasize the need for further research into the mechanisms, stability, and practical applications of priming for kelp aquaculture and restoration under warming oceans.

### **Experimental investigation into wave attenuation by *Laminaria hyperborea* using dynamically scaled mimics in a wave tank.**

Jack Duffy

Newcastle University

The use of natural habitats for coastal protection, so called nature-based solutions (NBS), is increasing in prevalence globally. Kelp forests, and the complex three-dimensional habitats they form, are promising candidates for NBS. Forests of *Laminaria hyperborea*, through their large biomass and surface area, are believed to generate considerable drag on waves propagating over them, potentially resulting in a significant reduction in wave energy reaching kelp dominated shorelines, leading to reduced coastal erosion. However, evidence supporting this ecosystem service is limited and further research is required to justify the use of kelp forests as an NBS for coastal protection. Hydrodynamically-scaled artificial kelp mimics in laboratory wave tanks can provide unique insights into the role of kelp forests in attenuating wave energy. The degree of environmental control and experimental replication that wave tanks and mimics provide offers opportunities not afforded by field studies. This presentation describes wave tank experiments on scaled mimic kelp that have been designed using geometric and dynamic similarity to ensure their behaviour is consistent with their natural counterparts under wave conditions. First the design and fabrication process for the mimics is outlined, then a series of wave attenuation experiments using the mimics in a flume tank are described. We report on the influence of water depth and kelp forest density on wave attenuation for a range of wave conditions.

### **Macrophyte dispersal from Racetrack flume to the Baltic Sea**

Friederike Gronwald<sup>1</sup>

Lara Schmittmann<sup>1</sup>, Rolf Karez<sup>2</sup>, Florian Weinberger<sup>1</sup>

1 GEOMAR Helmholtz-Centre for Ocean Research, Kiel/Germany

2 State Agency for the Environment, Flintbek/Germany

Large accumulations of drifting macrophytes are a common phenomenon observed along coastlines worldwide. Detachment of fragments or entire thalli may occur due to seasonal physiological changes, hydrodynamic forces during storm events, or grazing activity. Despite their ubiquity, the processes occurring between dislodgement and beaching remain poorly understood. To address this gap, we investigated 1. the influence of hydrodynamic and aerodynamic factors, such as current velocity, wind, and waves on the drift of morphologically diverse macrophyte species in a Racetrack flume; 2. the duration and growth response of macrophytes drifting at different positions in the water column (focusing on *Fucus vesiculosus*, one of the main habitat-forming species in the Baltic Sea); and 3. the potential dispersal of *F. vesiculosus* within the Baltic Sea. Experiments showed differences in the reduction of drift velocity between positively and negatively buoyant macrophyte species in relation to water velocity. Utilizing data from the Racetrack flume experiments, equations were developed to describe the sedimentation and drift velocities of morphologically diverse macrophytes based on shape and density. In-situ experiments showed that decomposition is not a given for detached *F. vesiculosus*, which is able to drift for extended periods of time both at the surface and along the bottom. A novel Lagrangian drift modelling approach incorporating macrophyte specific drag was applied to determine the potential dispersal of *F. vesiculosus* within the Baltic Sea.

### **Fine-scale population structure and genetic diversity of the sugar kelp, *Saccharina latissima*, in Ireland**

Jack Burton

Queen's University Belfast

Assessing genetic resources is essential for the conservation of species with both economic and ecological importance. Genetic assessments provide valuable insights into a population's adaptive potential and its ability to persist under changing environmental conditions. High genetic diversity increases resilience by providing the variability needed to tolerate a broader range of abiotic stressors. Kelps are foundational species in temperate and cold-water coastal ecosystems. In Europe, kelp forests are dominated by *Saccharina* and *Laminaria* species, which deliver key ecosystem services supporting coastal communities and the wider marine environment. These services include nutrient removal in eutrophic areas, absorption of pCO<sub>2</sub> that helps mitigate ocean acidification and warming, and the provision of nursery grounds for fish stocks. Although global kelp decline is moderate, significant regional losses highlight the importance of local factors in determining kelp resilience to environmental change. Abiotic factors, including temperature, salinity, wave exposure, nutrient availability, pH, and pCO<sub>2</sub>, strongly influence kelp distribution and survival. Since the 1990s, European kelp populations have experienced substantial declines driven by ocean warming, eutrophication, pollution, grazing pressure, and the spread of invasive species. This study builds on previous research investigating the genetic diversity of sugar kelp (*Saccharina latissima*) populations along the coastlines of Northern Ireland and the Donegal region. Using a fine-scale sampling approach and newly developed species-specific microsatellite markers, it provides a baseline population structure and connectivity in the region. These results will contribute to establishing a genetic baseline for future monitoring and inform biosecurity policies aimed at reducing the risk of genetic translocation along the coastline.

### **Production of the building-block molecule 3-hydroxypropionic acid from seaweed waste**

Ndeye Bineta DIA

University of East Anglia

Microorganisms, leveraging organic resources such as agricultural products and waste, present promising opportunities for sustainable production, provided that efficient processes are established and optimized. This study proposes a greener method for producing 3-hydroxypropionic acid (3-HP) using seaweeds. 3-HP is a building block molecule of significant interest serving in the manufacture of various materials. To reduce the environmental impact of its production, its synthesis from algal waste stands as an interesting alternative. Seaweeds can be exploited to produce various commercially valuable constituents, but none of the current applications utilizes dimethylsulfoniopropionate (DMSP), which can be present up to millimolar amounts per gram of dry cell weight. Thus, producing 3-HP from DMSP-rich algal waste supports the transition to a circular economy, where resources are utilized more efficiently, waste is minimized, and added value is maximized. We firstly identified *Ulva fenestrata* (previously *lactuca*) as the highest DMSP producer, then determined the most cost-effective method to extract it, and finally developed a cellular tool that enables the conversion of DMSP into 3-HP while eliminating its undesirable co-product dimethyl sulfate (DMS) from the cultivation media. Our findings indicate that the 3-HP producing enzyme, expressed in *E. coli* using the pET16 vector, yielded 24 % 3-HP relative to the initial DMSP concentration. In contrast, *Labrys* with the pLMB509 vector achieved a higher yield of 80 %, directly excreting 3-HP into the medium. These

results show that, once optimized, this approach could significantly enhance the sustainability of 3-HP production processes.

### **In-situ experiments to establish the role that UK kelp forests play in attenuating wave energy**

Robyn Mastin-Wynne

Newcastle University

There is an increasing threat of erosion and flooding along coastlines globally. Traditional, "hard" engineered structures like seawalls are becoming unsustainable both environmentally and economically. Consequently, there's growing interest in natural habitats for coastal protection. Kelp forests, for example, enhance coastal resilience by promoting water shallowing, sediment deposition, increased bed friction and the building of vertical biomass. These factors contribute to wave attenuation, thereby mitigating coastal erosion. However, the extent of wave energy attenuation provided by these habitats remains a topic of debate, influenced by variables such as habitat width, height, and density. To address this knowledge gap, this research will quantify wave attenuation, provided by kelp forests in various environmental contexts, highlighting the critical role of natural habitats in stabilizing coastlines in the face of climate change. In addition, the study will evaluate the practicality of using low-cost monitoring devices to capture these processes effectively. Method development and preliminary results will be presented.

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# Applied Phycology

## **Plenary: Latest Trends in Applied Seaweed in the UK**

Rhianna Rees

Seaweed Scotland

The UK applied seaweed sector has undergone significant shifts in recent years, marked by both promising developments and considerable challenges. This talk presents a policy and sector analysis of current trends, drawing on observations from across the industry.

Notable progress includes the emergence of a Canadian-UK cosmetics cluster, with companies collaborating on extraction technologies including supercritical CO<sub>2</sub>, full biomass utilisation strategies, and pigment development. SeaDyes, a Seaweed Scotland member, exemplifies innovation in this space. Biostimulant applications have seen growth, while food-focused enterprises have largely disappeared from the landscape.

The sector faces substantial headwinds. The seaweed farming boom has given way to bust conditions, with financing difficulties, insufficient evidence bases for nature-based solutions claims, and weak market pull creating an uncertain environment.

However, there are grounds for cautious optimism. The UK Seaweed project, a collaboration involving UCL, WWF-UK, the UK Agri-Tech Centre, and the Fishmongers' Company, is establishing a UK-wide network to strengthen the sector, food safety initiatives are addressing key regulatory barriers. These developments suggest a maturing industry beginning to build the infrastructure and evidence base necessary for sustainable growth.

## **Lessons from the industrialisation of seaweed-based material: Challenges and Opportunities in Scaling Marine Biotechnologies**

Leon Williams

PlantSea Ltd

PlantSea is turning the tide on plastic pollution, utilising endemic seaweed to produce new biomaterials and displace petroleum-derived polymers. PlantSea's innovative water soluble film offers a drop-in alternative to PVA/PVOH films for laundry detergent and dish washer capsules. Other bio-based polymer innovations are unable to withstand the chemistry of liquid detergents, giving inadequate shelf-life and mechanical performance, or do not fit the supply chain, being unable to vacuum form or heat seal. The PlantSea polymer system bridges these performance gaps as a solution for PVOH detergent packaging. The innovation's core lies in a proprietary biorefining process that transforms sustainably farmed seaweed into a high-performance wet polymer. In the coming years you will see PlantSea address the final technical barriers to market adoption: fine-tuning performance to customer specifications and developing a stable, transportable dry format that maintains these properties at scale, without

compromising on cost or carbon expenditure. This presentation will examine the scaling journey so far and remaining hurdles to commercialisation. Critical to PlantSea's mission is price parity with the current dominant technology, permitting market adoption by brands large and small. Key drivers to this impact include readily accessible raw materials and an economical production line which will need to be built from the ground up due to the current bottlenecks in the UK innovation and pilot landscape. Current models confirm this achievement is within reach. With major FMCG brands under increasing regulatory and consumer pressure to eliminate microplastics, PlantSea's bio-based technology arrives at the right moment to transform the water-soluble films industry while positioning the UK at the forefront of the global bioeconomy.

### **Green Economy Centre : Translating Algal Biotechnology for a Sustainable Bioeconomy**

Alla Silkina

Swansea University

The Green Economy Centre Biohub advances applied phycology by translating algal biotechnology research into practical, scalable solutions that support the transition to a sustainable bioeconomy. Through close collaboration between academia, industry, and regional innovation partners, the Biohub focuses on developing algae-based technologies with direct application across agriculture, environmental management, biotechnology, and low-carbon sectors. Current research is addressing key sustainability challenges, including the development of algal biostimulants and biofertilisers to improve soil health and crop productivity while reducing reliance on synthetic chemical inputs. These efforts include strain screening, optimisation of cultivation systems, and evaluation of bioactive compounds to support sustainable agricultural practices. Complementary work explores algal extracts and co-cultivation approaches for biological pest management, contributing to integrated pest control strategies that reduce environmental impact and support ecological resilience. The Biohub is also pioneering bio-based carbon capture and utilisation systems. For example, a demonstration project at Bluestone Brewery's facilities captures CO<sup>2</sup> emissions from fermentation using microalgae, generating valuable biomass and showcasing circular economy principles in a commercial setting. Additional interdisciplinary research integrates materials science and applied phycology to develop carbon-rich algal biomaterials for sustainable battery technologies, addressing the increasing global demand for renewable energy storage solutions. Further work focuses on the optimisation of pigment production in cyanobacteria for nutraceutical and functional food applications, including enhancing cultivation performance and refining extraction processes to improve yield and product quality. Across these research streams, the Biohub undertakes strain selection, scale-up, and process translation to ensure industrial feasibility and commercial readiness. Supported by UKRI, the Green Economy Centre Biohub demonstrates how targeted academia-industry collaboration can accelerate the development of low-carbon technologies, strengthen regional bioeconomies, and promote sustainable solutions to global environmental challenges.

### **Enhancement of Protein Extraction Efficacy from Red Seaweed *Palmaria palmata* Using Ultrasonication and High-pressure Homogenisation**

Yixing Sui

University of Greenwich

Seaweeds are significant sources of sustainable protein where red seaweeds, although species dependent, contain relatively high protein content. The effects of particle size (unground, 500  $\mu\text{m}$ , 210  $\mu\text{m}$ , 150  $\mu\text{m}$ ), ultrasonication, and high-pressure homogenisation were evaluated for enhancing protein content and yield from red seaweed *Palmaria palmata*. Scanning electron microscopy (SEM) was used to assess the morphology of extracted protein pellets. Particle size significantly affected protein yield, with 500  $\mu\text{m}$  producing the highest at 1.92%. Ultrasonication further improved yields to 4.82% and 5.91%, while high-pressure homogenisation achieved the maximum yield of 10.85%. Protein content increased from 17.21% (500  $\mu\text{m}$ ) to 27.67% and 28.90% with ultrasonication and homogenisation, respectively. SEM images revealed that smaller particle sizes, ultrasonication, and homogenisation caused pellet fragmentation. Overall, ultrasonication and high-pressure homogenisation, as eco-innovative processing techniques, substantially improved protein extraction and content, highlighting their potential to enhance seaweed protein utilisation as a sustainable alternative protein source.

## **Kelp Farming and Carbon: A Drop in the Ocean?**

Maxine C Carvin<sup>1,2</sup>

Nathan G King<sup>1</sup>, Pippa J Moore<sup>2</sup>, Dan A Smale<sup>1</sup>

1 The Marine Biological Association of the UK

2 Newcastle University

Seaweed farming has been widely promoted as a low-carbon, climate-friendly industry, with claims that cultivated kelp may act as a 'blue carbon' sink by enhancing organic matter burial in nearby sediments. However, the extent to which farmed kelp contributes to local carbon sequestration remains unclear, particularly in temperate, small-scale systems. We investigated sedimentary carbon stocks and sources in and around a small-scale *Saccharina latissima*-*Mytilus edulis* farm in southwest UK. Sediment cores were collected at increasing distances from the farm and analysed for carbon content, sedimentation rates, grain size, and environmental DNA (eDNA). Carbon burial rates in farm-associated sediments ( $\sim 0.23 \text{ t C ha}^{-1} \text{ yr}^{-1}$ ) were comparable to background levels and remained low relative to recognised blue carbon habitats. eDNA analysis revealed consistently low and patchy signals of kelp, with sedimentary carbon dominated instead by seagrass and red algae. While sedimentation rates increased slightly beneath the farm following its establishment, we found no clear evidence that cultivated kelp biomass contributed significantly to local carbon stocks. Hydrodynamic processes in Porthallow Bay likely drive the rapid export of detrital material away from the farm, reinforcing the role of kelp as a carbon 'donor' rather than a local sink. Our results suggest that small-scale kelp farms in temperate, dynamic coastal environments have limited capacity to enhance local carbon burial,

and should not be promoted primarily as climate mitigation solutions. Instead, their contribution to sustainability lies in alternative benefits: low-impact food and feed production, replacement of carbon-intensive materials, and provision of habitat. Scaling decisions for the European seaweed industry should therefore prioritise these broader ecosystem services, while preservation of natural seaweed forests and other established blue carbon habitats remains critical for effective climate action.

### **Pelagic sargassum events in Jamaica: morphotype abundance, and analysis of the biochemical and elemental composition of the biomass after different drying treatments to inform valorisation pathways**

Thierry Tonon

University of York

Pelagic Sargassum species *S. natans* (morphotypes I and VIII) and *S. fluitans* (morphotype III) have been known for centuries in the Sargasso Sea of the North Atlantic Ocean. In 2011, a new area concentrating high biomass of these brown algae started developing in the Tropical Atlantic Ocean. Since then, massive and recurrent Sargassum influxes have been reported in the Caribbean and off the coast of Western Africa. These Sargassum events have a major negative impact on coastal ecosystems and nearshore marine life, and affect socio-economic sectors, including public health, coastal living, tourism, fisheries, and maritime transport. Numerous avenues for valorisation have been explored to mitigate the risks presented by Sargassum blooms and to turn this nuisance into benefits. Biomass composition and its potential changes associated with processing methods are important factors to be considered to implement valorisation strategies. Using seaweeds harvested on the coasts of Jamaica in summer of 2020 and across the full 2021 sargassum season, *S. fluitans* III was identified as the most abundant morphotype at different times and locations. Comparison of freeze-drying, sun-drying, and shade-drying to process the biomass showed that these treatments have variable impact on the content of key compounds found in brown algae including polysaccharides, phenolics, proteins, and pigments. Elemental composition was also investigated as sargassum is known to accumulate high levels of heavy metals and metalloids, including arsenic. Stranded biomass was used to prepare compost assessed for production of seedlings in the context of mangrove restoration. Compost and mulch derived from sargassum were also tested in the context of seed germination and seedling growth of corn, pepper, and tomato. Efforts towards the valorisation of seaweed biomass are important, in particular for coastal communities, often among the most adversely affected by sargassum influxes, that could reap direct benefits while contributing to sustainable environmental management.

### **Seaweed pilot-scale processing for fucoidan**

Jessica Adams

Aberystwyth University

Fucoidan is a complex sulphated polymer found within brown seaweeds, which has been feted as a beneficial molecule with a range of health benefits including anti-cancer, anti-inflammatory and antioxidant properties. A number of companies are extracting and selling this as a dietary

supplement globally, though typically at a low fucoidan content and/or with low bioactivity. In 2024-25 the project INNOSea ran between Aberystwyth University and company BioMara to produce high-quality, bioactive fucoidan at food grade at sufficient scale to conduct a dietary trial focusing on gut health, following BioMara's extraction methodology. Composition data was generated on fucoidan produced under different spray dried conditions, and the optimal conditions were repeated to produce a bulk quantity of spray dried material. This built on our previous experience of operating our pilot scale equipment in the food grade facilities and adapting processes was part of our learning experience. Results and findings from this study will be presented whilst retaining confidential company information where appropriate.

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## General Phycology Session 2

### **Contributions of benthic microalgal biofilms to sediment organic carbon stocks across a salt marsh gradient**

Graham J C Underwood<sup>1</sup>

Nicola J. D. Slee<sup>1</sup>, Jessica C. J. Underwood<sup>2</sup>, Christopher I. D. Underwood<sup>3</sup>, James L Pinckney<sup>4</sup>

1 School of Life Sciences, University of Essex

2 School of Archaeology, Geography and Environmental Science, University of Reading

3 Independent Scientist, Bristol

4 Estuarine Ecology Laboratory, Department of Biological Sciences, and School of the Earth, Ocean, and Environment, University of South Carolina

Salt marshes are important coastal habitats that store significant quantities of organic carbon. The contribution of halophytic plants to sediment total organic carbon (TOC) stocks in salt marshes is well described, but the importance of microalgae in salt marsh carbon budgets is less well understood. In this study, benthic microalgal (BMA) biofilms in sub-habitats within a South Carolina (USA) salt marsh were characterised, and related to sediment organic carbon, carbohydrate, water, organic matter and bulk density contents. There were significant differences in the contribution of BMA carbon to measures of total sediment organic content between unvegetated upper marsh sediments, within *Sporolobus* (Cordgrass) stands and on mudflats. Near Infra-Red (NIR) spectroscopy of sediment found different relationships in the nature of the organic matter present in sediments, with differences linked to the relative contribution of BMA to the overall carbon stocks. A variety of upscaling and modelling approaches estimated BMA carbon to contribute between 1.2 and 8.0 % of the surface sediment TOC, with a median stock of 0.06 ± 0.08 tonnes hectare<sup>-1</sup>, compared to salt marsh median total organic carbon stocks of 18 tonnes ha<sup>-1</sup>. Both measures could be modelled across a whole salt marsh using relationships between habitat type and position across the tidal height gradient to generate maps of salt marsh organic carbon stocks at a landscape scale.

### **Developing new tools for identification and listing of vulnerable seaweed species**

Juliet Brodie<sup>1</sup>, Elizabeth J. Cottier-Cook<sup>2,3</sup>, Phaik Eem Lim<sup>4</sup>, Ben Jennings<sup>1</sup>

1 Natural History Museum, Research

2 Scottish Association for Marine Science (SAMS)

3 University of the Highlands and Islands, SAMS

4 Institute of Ocean and Earth Sciences, University of Malaya

Malaysia Seaweeds and seaweed habitats lack adequate protection, despite their global importance in shallow marine ecosystem function, contribution to ecosystem services and their role in the seaweed industry that provides coastal communities with millions of livelihoods. The lack of direct conservation management for seaweeds relates to a major global knowledge gap in their status. The IUCN Red List is an authoritative tool in biodiversity conservation and works well for e.g. birds and mammals. However, this is not the case for seaweeds and other non-standard organisms. Factors such as clonal populations and complex life histories are not compatible with the Red List data driven approach. These aspects coupled with a lack of long-term datasets mean that very few seaweed species have undergone IUCN Red List assessments. This talk will present an alternative approach to assessing the status of seaweed species using the eucheumatoids (including species of *Eucheuma*, *Kappaphycus* and related genera), carrageenophytes of economic importance in the seaweed industry, as a case study. Through a combination of approaches, including information from herbarium specimens, specialists and people's knowledge (ethnophycology) to build a dataset on which conservation assessments can be made. This approach will potentially serve as a model for other groups of seaweeds, providing valuable evidence towards the global protection of seaweeds.

### **How diverse is *Plocamium* (Gigartinales, Rhodophyta) in Britain and Ireland?**

Christine A. Maggs<sup>1</sup>

Anne R. Bunker<sup>2</sup>, Francis St. P. D. Bunker<sup>2</sup>, David Harries<sup>3</sup>, Jo Wilbraham<sup>4</sup>, Juliet Brodie<sup>4</sup>

1 Queens University Belfast

2 MarineSeen, Pembroke

3 Pembroke

4 Natural History Museum, London

Harvey's *Phycologia Britannica* (1846-51), the foundation for seaweed floras of Britain and Ireland, included one member of the genus *Plocamium*, *P. cartilagineum*. This was followed by Dixon & Irvine in 1977, noting that there is much variation in general appearance. In 2005, investigating whether this variation might indicate cryptic species, Saunders and Lehmkuhl sequenced the partial large subunit (LSU) ribosomal RNA gene. They found three species in Britain and Ireland (*P. cartilagineum*, *P. subtile*, and a new species *P. maggsiae*); a second new species, *P. nanum*, was found only in northern France. Following subsequent examination of type materials, *P. cartilagineum* was identified as *P. lyngbyanum*, and *P. subtile* is a synonym of *P. cartilagineum*. We have taken a systematic approach to sampling by habitat and geographical locality in England, Wales, Scotland and Ireland, analysing samples using the barcode marker CO1. Our results are mostly congruent with the Saunders and Lehmkuhl study, and we found *P. nanum* for the first time in Britain and Ireland. We recorded no additional species, suggesting that these two studies provide a comprehensive understanding of *Plocamium* in Britain and Ireland. The two larger primarily subtidal species, *P. cartilagineum* and *P. lyngbyanum*, were generally

identifiable by habitat and morphology. The two primarily intertidal species, *P. maggsiae* and *P. nanum*, were much smaller and sometimes difficult to distinguish. Partitioning of these four cryptic or semi-cryptic species by habitat was not consistent.

### **Some Algal Trends from long term monitoring in Pembrokeshire Marine SAC**

Francis Bunker

MarineSeen / ASML / Plymouth University

In 2005, the Countryside Council for Wales (CCW) implemented a long-term monitoring programme to investigate the distribution and abundance of rocky shore organisms as part of the Pembrokeshire Marine SAC (Special Area of Conservation) intertidal monitoring programme. CCW has since become part of Natural Resources Wales (NRW) who have continued the monitoring. Reef is one of the Annex I features for which the SAC is designated and a specific area of interest are the intertidal bedrock reefs, particularly in the Milford Haven where there is a greater risk of water quality or other disturbance issues. A series of nine shore monitoring sites have been established. Six are in the Milford Haven waterway at Lawrenny Quay, Pembroke Ferry, Hazelbeach, Pembroke Power Station, South Hook and Monk Haven. One site is at the entrance to Milford Haven at West Angle Bay. Two sites are on the open coast, at Pen-y-Holt on the south coast of Pembrokeshire and at Nolton Haven in St Brides Bay, on the west coast of Pembrokeshire. A program of annual monitoring was carried out at most of these sites in most years since 2005. This talk explores some of major trends in the algae noted at these monitoring sites.

### **Taxonomy of the Prasiolaceae (Trebouxiophyceae): new insights**

Svenja Heesch<sup>1</sup>

Michael D. Guiry<sup>2</sup>, Fabio Rindi<sup>3</sup>

1 University of Rostock & GEOMAR Helmholtz Centre for Ocean Research Kiel

2 AlgaBase, University of Galway

3 Polytech University of Marche

The Prasiolaceae, a small family of green algae currently placed in the class Trebouxiophyceae, is well known for having multicellular thalli and a preference for high-nutrient habitats: species are typically found in polar to temperate latitudes at sites frequently fertilised by animals, ranging from bird colonies along the coasts to urban sites regularly visited by dogs and other mammals. In recent years, the taxonomy of the family has been greatly advanced using genetic techniques. Previous studies have, for example, shown that the largest genus *Prasiola* is polyphyletic. To resolve this polyphyly, we established three new genera, and seven new combinations for species previously referred to *Prasiola*. Further, the isolation and cultivation of additional strains from urban and coastal habitats have led to the discovery of several new entities. Two new genera with one and two new species, respectively, have recently been described, while the description of several additional new taxa in the family is in progress.

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## Manton Prize: Microalgae and Microbiome

### Chemical ecology and cross talk between cosmopolitan phytoplankton and pathogenic Vibrios

Ann Mary V B

University of Exeter

The phycosphere, a microenvironment surrounding phytoplankton cells, serves as a critical hotspot for microbial interactions (Seymour et al., 2017). Nutrient and small-molecule exchanges that occur within the phycosphere are the primary mechanisms by which bacteria and phytoplankton interact (Platt and Whalen, 2023). Similar to the plant rhizosphere, the phycosphere is filled with exudates and secreted chemicals that establish a chemical environment distinct from the surrounding seawater, featuring spherical gradients that assist in directing chemoattractant bacteria towards algae sources (Cirri and Pohnert, 2019). Bacteria sense and react to chemical signals in the phycosphere, resulting in a dynamic chemical environment that facilitates various cross-kingdom micro-scale interactions, yet these exchanges remain poorly characterized. This study investigates the chemical underpinnings of intracellular and extracellular interactions between cosmopolitan phytoplankton species such as *Skeletonema marinoi* (diatom), *Cheateoceros calcitrans* (diatom), *Pheodactylum tricoratum* (diatom), *Alexandrium minutum* (dinoflagellate), *Prymnesium parvum* (haptophyte), *Anabaena cylindrica* (blue-green algae) and pathogenic *Vibrio* species, with a focus on chemical compounds mediating bacterial settlement. Settlement assays were conducted for five pathogenic *Vibrio* species (*Vibrio alginolyticus*, *V. vulnificus*, *V. parahaemolyticus*, *V. mimicus*, and *V. furnissii*) using cellular and supernatant crude extracts from phytoplankton species sampled across three growth phases (exponential, stationary, and decline). Fractionation of crude extracts into polar and non-polar components was also performed to determine their respective roles in *Vibrio* settlement. The findings indicate the existence of 'pro-*Vibrio*' chemicals in cellular extracts across all of the growth phases, particularly from the stationary phase, which promoted *Vibrio* colonisation. Polar intracellular chemical compounds derived from phytoplankton have been demonstrated to function as chemoattractants for all *Vibrio* species, except *V. parahaemolyticus*. Similarly, nonpolar intracellular compounds from *P. tricoratum* and *A. cylindrica* acted as chemoinhibitors for *V. parahaemolyticus*. A notable chemoinhibition effect in *V. parahaemolyticus* was detected from extracts of *P. tricoratum* across all growth stages. Likewise, *V. parahaemolyticus* was observed to be inhibited by polar extracellular chemicals from all three diatom species, however it exhibits a preference for the chemoattraction of other pathogenic *Vibrios*. Additionally, the chemoinhibition effect has been identified for *V. vulnificus* derived from *A. cylindrica*. Our findings revealed species-specific influences for various *Vibrios*. This signifies the selectivity of species interactions at various growth phases. These findings provide critical insights into chemically mediated phytoplankton-pathogenic *Vibrio* interaction. This research underscores the ecological relevance of such interactions, particularly in the context of climate change, which is intensifying the prevalence and extending the geographic range of pathogenic *Vibrio* and *Vibrio*-associated diseases. These findings are especially

pertinent for predicting the distribution of environmental *Vibrio* populations in marine and estuarine ecosystems and reducing the risk of infections from these pathogens.

### **Dealing with biased class sizes in AI-based automatic microalgal classification**

Holly Liken

Univeristy of Bristol

Microalgal monitoring methods primarily rely on the visual recognition of morphological features to provide classifications. This is a lengthy process requiring expert knowledge. Image acquisition methods, like flow cytometry, have enabled mass collections of images. Convolutional Neural Networks (CNNs) are an AI tool that has been applied for the detection and classification of microalgae, but varying natural abundances have created class bias within models. This reduces the overall accuracy. Data augmentation is a commonly applied technique to combat this; however, that is not an accurate representation of marine and freshwater systems. Here, AlexNet and ResNet50 were used to explore methods of mitigating class bias during model training, compared to the application of data augmentation. Initially, a naturally varied dataset containing 6 genera was trained and tested with cost-sensitive learning. A subset of WHOI-Plankton was then used alongside the CNNs to test cost-sensitive learning and a superior scoring rule, Penalized Logarithmic Loss. For both datasets, the recorded metrics were compared to the same architectures trained with augmented data. Analysis focused on the top-class confusions, morphological/phylogeny characteristics and misclassification rates. Initial investigations found that class bias was not solely reliant on the number of images per class, as morphological characteristics were the more dominant component in misclassification. This understanding implies that the application of hierarchical class definitions could be an effective method of classification, where a group classification model feeds into subsequent models for more specific classifications, allowing the model to differentiate more nuanced morphologies.

### **Orai-like calcium channels and their potential role in coccolithophore calcification**

Frieda Schlegel

The Marine Biological Association of the UK

Coccolithophores are calcifying marine algae, essential primary producers and play a pivotal role in the oceanic carbon cycle. However, many aspects of their biology remain poorly understood. Unravelling the mechanisms by which these haptophytes calcify will aid in understanding their response to changing oceans. Coccolithophores calcify intracellularly and face a particular challenge in transporting large amounts of calcium to the site of coccolith formation without disrupting other cellular functions. We have identified that coccolithophores possess a large group of novel calcium channel related to the Orai channels. The data presented here aims to investigate their cellular roles and their evolution in haptophytes, using a combination of bioinformatic analyses and physiological experiments. The phylogenetic analysis reveals a complex pattern of expansions of Orai-like channels in non-calcifying and calcifying haptophytes, indicating that they likely increased in number before the innovation of calcification first occurred in haptophytes. Initial experiments using Orai channel inhibitors show morphological effects on calcification and slight impacts on growth even at low concentrations,

particularly in heavily calcified species. These findings suggest that Orai channels play a specific role in the calcification process. Future plans involve producing multiple transcriptomic datasets from treated cells, to shed light on the molecular mechanisms affected by Orai channel inhibition and identify potential target proteins relevant in coccolithophore calcification. Understanding distinct mechanisms of calcification across species will assist in enhancing our predictions and understanding of how these significant algae react to future changing oceans

### **A novel, fast and reliable alternative for microalgal growth assessment in scalable cultivation systems**

José Ignacio Gayo-Peláez<sup>1,2</sup>,

Darren Oatley-Radcliffe<sup>1,2</sup>, Alla Silkina<sup>2</sup>

1 Department of Chemical Engineering, Faculty of Science and Engineering, Swansea University

2 Algal Research Group, Bioscience Department, Faculty of Science and Engineering, Swansea University

Microalgae, a diverse group of photosynthetic microorganisms, hold immense potential for sustainable applications in food security, renewable energy, and climate change mitigation. However, traditional methods for monitoring microalgal growth, including optical density (OD) measurements, cell count, and dry weight (DW) assessment, are labor-intensive, resource-intensive, and challenging to keep up to date in realtime for industrial applications. This study evaluates two novel devices, the Optura<sup>®</sup> Palm<sup>®</sup> and Optura<sup>®</sup> Spy<sup>®</sup>, which employ near-infrared (NIR) bio-reflectance technology to provide quick, automated, reliable and contactless cell culture/growth measurements. The aim of this study was to test the two devices across five microalgae species growth (*Microchloropsis gaditana*, *Chlorella vulgaris*, *Arthrospira platensis*, *Synechococcus elongatus*, and *Phaeodactylum tricornutum*), encompassing a range cell sizes, shapes, and taxonomic families of species for marine, brackish and freshwater environments. Measurements were benchmarked against traditional methods such as turbidity measurements (OD750), flow cytometry cell count, and dry weight analysis. Results demonstrated a strong correlation ( $R^2 > 0.9$ ) for most of the species and high accuracy even for growth of species with different cell morphologies. The Optura<sup>®</sup> Palm<sup>®</sup> is excellent for portability and ease of use, while the Optura<sup>®</sup> Spy<sup>®</sup> offers rapid adaptability for real-time monitoring in photobioreactors and large-scale cultivation systems. Key advantages of these small devices include rapid assessment and minimum labor requirements, automatization, prevention of human error, and low reliance on single-use consumables, aligning with the principles of sustainability and circular economy. By simplifying and automating microalgal growth assessment, these technologies provide an efficient, scalable, reliable and eco-friendly alternative to conventional methods, paving the way for more sustainable microalgal production and management.

### **Characterization of carbohydrate-active enzymes from species of green microalgae**

Aidan Salter

University of York

The climate crisis is accelerating the need to initiate a switch to a more sustainable and circular bioeconomy. A focus of research in recent years has been on harnessing the chemical potential

of cellulose and chitin, two of the most abundant polysaccharides found on Earth, for biofuels and value-added chemicals. Lytic polysaccharide monoxygenases (LPMOs), discovered just over a decade ago, are Carbohydrate Active enzymes (CAZymes) that cleave glycosidic bonds through oxidation. In 2018 the first family of LPMOs were discovered in algae, and their biological roles in these organisms remain enigmatic. A combination of bioinformatics, biochemical and physiological approaches were applied to understand the importance of LPMOs in *Chlamydomonas reinhardtii* and to explore biotechnological applications of these enzymes.

### **Nutrient controls on plankton communities in the South Atlantic subtropical gyre**

Arianwen Herbert

University of Oxford

Single-celled photosynthetic plankton are key players in marine biogeochemical cycles, yet their functional diversity in oligotrophic gyres remains poorly understood. These low-nutrient ecosystems, which are expanding under climate change, play an important role in global primary production and carbon sequestration. Nutrient (co-)limitation in the open ocean reflects gradients in nutrient supply and biological demand, with nitrogen often limiting productivity in low-latitude gyres and iron co-limiting in some regions. Here, we examine nutrient (co-)limitation and the associated community and physiological responses of plankton communities across the South Atlantic subtropical gyre. Along the 16°S transect, we conducted multifactorial shipboard nutrient-addition bioassays, adding nitrogen (N), phosphorus (P), and iron (Fe). Chlorophyll-a fluorescence and photophysiology measurements were used to assess community-level responses, while Analytical Flow Cytometry (AFC) resolved group-specific changes in photosynthetic plankton populations. Across all stations, N addition consistently stimulated chlorophyll-a-containing biomass, with a secondary enhancement observed under combined N + Fe enrichment at some stations. Phosphorus additions produced little or no positive effect. Photophysiological indicators showed relief from nutrient stress, and AFC analyses showed differential responses among phytoplankton groups, suggesting a variety of responses to nutrient availability amongst the natural community. Our results identify nitrogen as the primary limiting nutrient and iron as being potential co- or serially-limiting at some locations in the South Atlantic subtropical gyre. These findings refine current understanding of nutrient-limitation regimes in oligotrophic systems and highlight the sensitivity of plankton communities and the biological carbon pump to future shifts in nutrient supply under a warming ocean.

### **Problem or opportunity? Utilising the biostimulant properties of microalgae for plant growth and pest control in hydroponic co-cultivation.**

Ilona Shadrach

Aberystwyth University & Swansea University

Background Hydroponics is an established agricultural practice but requires further development and technical control especially when considering contaminants and biofertilizer/biostimulant use. Microalgae is usually considered a pest within hydroponic systems mostly due to its nutrient uptake from the hydroponic media and biofilm production/biofouling. Recent studies consider re-evaluating the role of microalgae within hydroponics, (not as a

contaminant but as a collaborator), by utilising their biofertilizer/biostimulant properties, nutrient exchange and biological control potential for other contaminants (e.g. toxic algae). A successful co-cultivation of plant and microalgal culture would enable simultaneous production of two different crops/, reducing space, materials, and energy requirements associated with separate biomass productions, resulting in a net reduction of costs. Aim/Objective This research aims to identify whether a plant-microalgae co-cultivation can be mutually beneficial while also comparing species growth and biostimulant effect. Methods *Mentha spicata* cultivation was conducted in 250ml deep-water hydroponic setups, for 23 day runs, with respective microalgae co-cultivation, spirulina based biostimulant, and relevant controls. Microalgae species used were *Chlorella vulgaris* and *Synechococcus elongatus*. Mint and algae growth was quantified through plant measurements, leaf count, biomass accumulation, and algal cell concentrations. Results/Findings Improved mint budding and root growth was observed in selective microalgae treatments. Algae demonstrate some biostimulant effects for plant growth. Compared to respective algal control, co-cultivation did not show any reduction in growth and biomass accumulation. Biostimulant addition seemed to slightly improve initial growth of both mint and microalgae, indicating a dose-related effect where additional biostimulant injections are needed for prolonged benefit. Conclusion/Implications This research has successfully demonstrated the use of co-cultivations of plant and microalgae in a dual hydroponic system. It can be used for the development of further applications, for example, different hydroponic setups, scaled up systems, and investigating the effects of different algal species along with more diverse species of crops.

## **Variation in Lotic Parameters and its Influence in Structuring Stalk Forming Diatom Communities**

Adam Dingmann

Saint Cloud State University

Microalgae are well known for their importance in aquatic ecosystems because of their role as primary producers and utility as environmental indicators. For many microalgae, especially diatoms, morphological shape has been used as a diagnostic feature in species identification and a basis for establishing new species. This presupposes shape is a function of evolutionary history and represents a homology reflecting this history. However, few studies have attempted to understand the selective pressures on shape leading to adaptive success. This is especially true in stalk-forming diatoms. Flow regimes and maximum velocity in lotic systems seem to be of particular importance in determining which algal group will be present broadly and can act as a selective agent for facilitating the growth of specific species. Every lotic system has a unique set of both physical and chemical properties that influence community structure and species distribution. Diatom morphology in stalk forming taxa of specific size and shape can manipulate laminar flow dynamics. Here we demonstrate how alterations in the laminar environment via velocity and temperature can create optimal space for stalk forming benthic diatoms of various sizes and shapes. Results from two experiments, testing two related hypotheses. The first involves a field-based test confirming that flow speed influences stalk forming community composition and the second was a laboratory-based test exploring if flow direction can influence the dominance of either and lunata stalk forming taxa.

## **Quantifying bacterial assemblages associated with both farmed and wild populations of *Saccharina latissima* across the aquaculture growing season in SW England**

Jasmine Ramshaw

The Marine Biological Association of the UK/ University of Plymouth

Seaweed farming is the world's fastest growing aquaculture sector and understanding the mechanisms that promote seaweed health and limit wider ecosystem impacts will be fundamental for its expansion. Bacteria associated with seaweed hosts play fundamental roles for host health and development but the impacts of farming on these relationships is poorly understood. Here, we describe the bacteria-kelp relationships for farmed *Saccharina latissima* (Sugar Kelp) and compare it to a local wild population throughout the aquaculture growing season (February - June) in SW England to determine the impact that farming has on these communities. Kelp-associated bacterial communities were quantified, using 16s amplicon sequencing, at two farms and one wild population in SW England at three timepoints (early, mid, and late growing season). Kelp-associated bacterial community structures were significantly differentiated from the surrounding seawater, as well as from each other across both site and timepoint. Only timepoint influenced community diversity (alpha diversity) with all sites having more diverse bacterial communities at the late timepoint. This could potentially be due to increased time for bacterial colonisation or to increased fouling as the season developed. Studying the influence of aquaculture on kelp-associated bacterial communities during the growing season is a vital step towards understanding wider impacts on biodiversity, water quality (i.e. recreation and fishing in farmed areas) and on kelp health and yield, which has potential commercial importance. This work facilitates the further exploration of these potential future benefits and issues in order to enable sustainable industry development and expansion.

## **Dimethyl Sulfoniopropionate (DMSP) Metabolism in green tide forming seaweeds**

Catherine Philip

Plymouth Marine Laboratory and University of East Anglia

Ulva seaweeds, notorious for causing green tides, are prolific producers of Dimethylsulfoniopropionate (DMSP), one of the most abundant organosulfur compounds in marine environments. DMSP can be enzymatically cleaved to produce dimethylsulphide (DMS), a volatile compound that plays a key role in atmospheric sulphur fluxes and climate regulation. Although DMSP is ubiquitous in Ulva, its physiological function remains uncertain. It is thought to contribute to stress protection and to mediate interactions with associated bacteria that utilize DMSP as a nutrient source, promoting further DMS production. This study investigated the bacterial communities associated with Ulva through a combination of 16S rRNA gene sequencing, DNA-stable isotope probing (DNA-SIP), and metagenomic analyses, targeting both culture-dependent and culture-independent communities. Several bacterial species were isolated and identified via 16S rRNA gene sequencing, representing members of the Flavobacteriaceae, Nocardiaceae, Micrococcaceae, Vibrionaceae, Psychromonadaceae, Alteromonadaceae, Marinomonadaceae, and Pseudoalteromonadaceae families. Many of these isolates were capable of using DMSP as their sole carbon source, indicating an active role in DMSP metabolism and produced DMS and Methanethiol (MeSH) through DMSP degradation.

Results from DNA-SIP and subsequent sequencing revealed that members of the genus *Marinomonas* were dominant DMSP degraders within the *Ulva*-associated microbiome. These findings suggest that *Marinomonas* and related taxa could play a central role in converting algal-derived DMSP into DMS and provide new insights into the microbial interactions that influence sulphur cycling in the marine environment.

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## Science Outreach

### **Plenary: Science Communications, Engagement, and Outreach – a whistle-stop tour of recent activities from SAMS and CCAP**

Mikey Ross<sup>1,2</sup>

Rachel Allen<sup>1,2</sup>, Eric Bear, Andy Crabb<sup>1</sup>, Joanne Field<sup>1,2</sup>, Iona Harvey<sup>1</sup>, Will Harvey<sup>1</sup>, Mia Leng<sup>1</sup>, Helen McNeill<sup>1</sup>, Cecilia Rad-Menéndez<sup>1,2</sup>, Anuschka Miller<sup>1</sup>, Euan Paterson<sup>1</sup>, Julie Platt<sup>1</sup>, Jamie Rowell<sup>1,2</sup>, Rachel Saxon<sup>1,2</sup>, Naomi Thomas<sup>1,2</sup>, Alexander Thomson<sup>3</sup>, Francisca Vermeulen<sup>1</sup>, Julie Watson<sup>1</sup>, Evie Whyte<sup>1,2</sup>

1 Scottish Association for Marine Science (SAMS)

2 Culture Collection of Algae and Protozoa (CCAP)

3 Seawilding

Communication, public engagement, and outreach activities are of growing importance for science and dissemination. Participation in such activities increases accessibility of information and transfer of knowledge, while also enhancing trust in science. Ideally, effective science communication and engagement activities will raise awareness of key issues, have meaningful societal change, and hopefully to inspire future generations.

This talk will provide a whistle-stop tour of communication, engagement and outreach efforts undertaken at the Scottish Association for Marine Science (SAMS) and the Culture Collection of Algae and Protozoa (CCAP). A smorgasbord of recent examples will be presented including: i) the use of alternative platforms and technologies for effective communication; ii) the interface of algal science, art, and innovation; iii) an overview of various outreach and engagement activities at local schools, regional, and national scientific events (e.g., the Microalgae Museum); iv) and finally highlighting some things to look forward to in 2026. This talk aims to demonstrate the impact, added-value, and benefit that participating in such activities may have on your research.

This presentation will provide a brief overview of a multitude of different activities that one may engage in. It will act as an appetiser for the other speakers and members of the British Psychological Society to showcase their excellent work in this area.

## **BPS education and outreach: a session to explore our current activities and plans, and to plot new directions**

Daniel Franklin

Bournemouth University

One of the aims of the BPS, enshrined in our constitution, is to “increase public awareness of the importance and applications of algae, and to contribute to public debate on issues involving algae”. We all know from the general confusion over the term “phycology” and from the fact that many, even scientifically trained, colleagues show a very poor awareness of algal diversity and importance, that there is much to do. In the education and outreach team we are addressing the BPS constitutional aim in several ways, and these are always under review. In 2025 we participated in a large scientific outreach event in London, and going forward we aim to participate in at least one large scale event each year, as well as at smaller events as opportunity allows. In tandem with this, we aim to improve and enhance the BPS website with outreach news, resources, and links and to increase our use of the BPS social media channels and the BPS YouTube channel. In terms of education, we plan to work more with curricula developers and teacher trainers, though this is a more challenging aspiration. Contributing to policy debates is also more challenging than straight outreach and the BPS could potentially learn from other learned societies (e.g. the BES) on the productive and effective ways in which to achieve this. Finally, the Hilda Canter Lund prize, which we continue to run, provides a global competition that showcases the beauty and importance of algae – all members are encouraged to make an entry to this annual competition. Please come to the talk to learn more, share your ideas and get involved - we seek new members for the team!

## **Fostering Students Awareness and Attitudes toward River Environments: Development of a Diatom-Based Educational Program**

Matthew Julius

St. Cloud State University

This study examined changes in students awareness of lotic environments and the influence of behavioral attitude formation through a diatom-based educational lesson plan implemented in secondary schools in India, Japan, and the United States. The curriculum uses historic and recent diatom collections, river photographs, and the SimRiver simulator to help students understand the relationship between human activities and river water quality. Text mining analysis, using TWINSpan and Correspondence Analysis, revealed a significant increase in environmental awareness among students after the lessons. The qualitative analysis of students responses revealed distinct patterns in their behavioral attitudes. In the Indian groups, a relatively high proportion of students exhibited autonomous and action-oriented attitudes. In contrast, Japanese students frequently showed concern for environmental issues, but their responses often reflected other-dependent thinking. Students in the U.S. group offered fewer behavior-related responses, which may be attributed to the favorable local environment, the geographical disconnect between the lesson materials and the students everyday surroundings, and the generally shorter nature of their written responses. The program demonstrated its effectiveness in raising students environmental awareness and supporting the development of attitudes toward action. Furthermore, incorporating historical and international comparisons appeared to

promote the transition from awareness to action among students. These findings suggest that this lesson program may serve as valuable contributions to the United Nations Department of Economic and Social Affairs Sustainable Development Educational Goal 6 (SDG 6).

### **What's science outreach for?**

Susi Arnott

Walking Pictures

Slimewatch 1 was an interactive art-science collaboration in central London. Microphytobenthos of the tidal Thames were documented both scientifically and aesthetically. The work was conducted by academics and a diligent undergraduate, and outputs were exhibited in a range of settings from art galleries to Universities. With the support of BPS, some of the ideas have now been developed, a few miles away in Deptford. The funding proposal envisaged hundreds of members of the public contributing their smartphone images of mudbanks from different positions along the Creek, at different seasons and times of the tide and day. But the Discovery Centre hosting Slimewatch 2 were keen to involve volunteers and visitors in collecting and identifying samples for themselves. Staff were already accustomed to safely guiding low-tide walks to look at the built environment, plants and animals; now microalgae are routinely included. Rather than 'citizen science', with participants simply contributing labour and data, we called this 'community science'. Concepts of time and space are involved via tidal cycles and live microscopy. Engagement with primary producers in a densely urbanised location prompts discussions about carbon negative commuters', the ecosystem they support, and the climate and nature crises. Meanwhile this PI has been increasingly engaged in Science Outreach in other contexts: via accredited Carbon Literacy trainings but also public outreach about climate change within financial, civil service and political contexts in London 'and even on the streets, during demonstrations. Fellow scientists have been finding their own ways to raise awareness of the polycrisis and the need for action. (Examples include a TV personality, a paediatric oncologist, a pheromone specialist and a Professor of Chemistry at UCL.) What we research, and how, are not the only considerations in addressing the challenges of the Anthropocene; this presentation will invite discussion of the options open to us as scientists.

### **SeaKey: an app, webkey and print version to guide the identification of seaweed species of the German North Sea and Baltic Coasts**

Nikolas Kappas<sup>3</sup>

Inka Bartsch<sup>1</sup>, Tosia Schmithüsen<sup>1</sup>, Ralph Kuhlenkamp<sup>2</sup>, Andreas Wagner<sup>1</sup>, Svenja Heesch<sup>3</sup>, Florian Weinberger<sup>3</sup>, Rolf Karez<sup>4</sup>

1 AWI Alfred Wegener Institute for Polar Research

2 phycomarin

3 GEOMAR Helmholtz Centre for Ocean Research Kiel

4 LfU Landesamt für Umwelt Schleswig Holstein

Until now, Germany lacked an up-to-date resource on seaweeds present along the German coastline, based on regional information. In order to facilitate their identification, the new project SeaKey fills this gap. The browser-based app makes an important contribution to access the

world of algae for students, university teachers, monitoring agencies and the interested educated public. The newly developed SeaKey currently provides identification aids for 68 species of brown algae growing along the German Wadden Sea and at the island of Helgoland. Identification keys for green and red algae will follow. Launched in 2025, a parallel sister project will extend the approach to the seaweeds of the German Baltic Sea coast. The SeaKey is based on a matrix concept, whose innovative approach offers variable access options. Users may enter the identification matrix at different levels, depending on their knowledge and the visible characteristics of the inspected species. The key is available at <https://seaweeds.awi.de/>, and in the Google Play or Apple App Stores. It will be continuously expanded over time. The SeaKey comprises three parts, i.e. a digital and printable matrix key, the SeaKey app, and a web and print version of a glossary comprising more than 1000 terms on all three algal groups. Additionally, standardized profiles for the brown algal species will be published in 2026. Although with a regional German focus, the identification key and the glossary are available in English.

### **Gwymona, a local community project exploring creating ways of connecting people with seaweed**

Kirsti Davies  
Gwymona

This presentation introduces Gwymona, a local community project led by artist and researcher Kirsti Davies, which explores creative ways of connecting people with seaweed. Because seaweed habitats are largely inaccessible and unseen, engagement can be challenging. Through creativity we can bring these mysterious underwater habitats to life, allowing people to feel the awe that we know exists beneath the waves. To encourage this connection, the project presents seaweed not only as a marine organism, but as something relevant to everyday life - as a material, food, medicine, cultural heritage, and an essential part of our planet's systems. The presentation will also share the outcomes of a week-long seaweed festival held locally. The festival brought together a diverse range of participants through collaborations with local businesses, immersive walks and creative workshops. A core theme was the Welsh context, highlighting that despite a declining connection to seaweed here, investing in this past cultural heritage offers meaningful opportunities for rural regeneration and coastal resilience going forward. We will share practical strategies for making seaweed accessible, including sensory, cultural and artistic routes into learning that reduce barriers for those without scientific backgrounds or coastal access

### **Creating an interactive art-science installation with living microalgae**

Andrew Stone and Jon Somerscales  
Studio Blue Green

Studio Blue Green (Andrew Stone & Jon Somerscales) will share insights into their immersive artwork and exhibition 'Phycologica', presented in Bristol in October. Funded by CO2RE (UK Government's GGR programme), the experimental work featured an interactive, multisensory installation where visitors exchanged breath with bioluminescent microalgae, that aimed to drive an embodied connection to the unseen world of microalgae through experiential storytelling. Paired with exhibition content and workshops, it strove to illuminate algae's deep importance to

the planet and its vast potential contribution towards future sustainability. Merging the fields of biology, art and technology, they'll share observations and learnings from; Cultivation, R&D, Production and Public Engagement and invite thoughts on future iterations. The project was generously supported by Dr Chris Williamson, Dr Sonia Giulietti and all at Bristol University's Microlab, Joanne Field at CCAP (SAMS) and the wider algae community.

### **An adventure through Wales, the land of seaweed**

Emma Heathcote

Borth; International education and business development business

From evolutionary impact to sensory wellbeing, from peasant forage food on a global scale to elitist posh-restaurant cuisine, and from innate connectivity with the sea to cultural representation, our life on planet Earth owes a mammoth debt to seaweed. Seaweed has played a crucial role in evolution by providing the ancestry for land all plants, shaping early animal evolution through ecosystem modification, and potentially contributing essential nutrients to support human brain development. But seaweed just keeps on giving ! As a critical resource and protagonist in evolutionary development, seaweed is also a critical resource for environmental and cultural sustainability, and not least of all, in Wales. Whereas celebrity chefs and eminent scientists are reigniting a global appreciation for seaweed, in Wales, it is highly likely that our collective memories have never actually forgotten our seaweed credentials. We've been known to eat it, bathe in it, farm with it, feed it to our animals, insulate our homes with it, heat our homes with it, and even use seaweed in the production of Welsh arts and crafts. In Wales, we are proud to indulge in a multi-sensory overload of seaweed. Despite our extravagant indulgence in seaweed, our appreciation of seaweed is inseparable from our sea-scape existence. We experience seaweed through an innate and ancient connection with the sea, and an overwhelming sense of wellbeing. Seaweed connects us to our ancestry, from the soft slimy sludge between our toes, to the stench of rotting vegetation on the beach, we live with seaweed. From the salty slime of laverbread in our mouths, to the wafts of salty residues in our hair, we are loaded with seaweed. Please join me on an adventure through Wales, the land of seaweed.

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## Poster Abstracts

### Manton-eligible: Microalgae

#### **The over-looked middle class of phytoplankton: the significance of nano-phytoplankton in the sub-Antarctic region of the eastern Pacific.**

Sarah Le Besque

University of Oxford

Phytoplankton community structure is poorly understood in the highly under-sampled eastern Pacific sector of the Southern Ocean. The sub-Antarctic zone (SAZ) is where Antarctic Intermediate Waters form, making it an important sink of carbon in the ocean. The eastern Pacific region of the SAZ is a unique High Nutrient, Low Chlorophyll (HNLC) region, receiving the lowest input of iron rich dust compared to other sub-Antarctic areas. Our observations covered the evolution of a spring bloom, with an increase in phytoplankton biomass and drawdown in surface micro- and macronutrient concentrations. Using HPLC pigment data and imaging flow cytometry (CytoSense), the community structure of the sub-Antarctic, and Polar Frontal Zone was analysed and the environmental variables controlling the phytoplankton distribution investigated. A community shift with latitude was evident, becoming more diatom dominated further south and closer to the Antarctic Polar Front (APF), where an increase in silicate and iron was observed, highlighting the importance of these fronts for the upwelling of remineralised nutrients to the surface ocean. To convert cell abundance to biovolume, a new method was applied that accounts for variations in cell morphology of larger phytoplankton. HPLC analysis determined that the main dominating algal group was nanoflagellates (Prymnesiophyceae), with nanophytoplankton (3-20  $\mu\text{m}$ ) overall contributing to roughly half of the total phytoplankton biomass from CytoSense analysis. This study indicates that nano-phytoplankton are significant contributors to phytoplankton biomass in the sub-Antarctic eastern Pacific during a spring bloom, a time when biomass reaches its maximum. This could have implications on how phytoplankton contribute to carbon export in these regions.

#### **Deciphering community interactions and biotechnological applications of the microalgal microbiome**

Andy Stawowy

Swansea University

Microalgae are vital primary producers and have extensive biotechnological potential, including bioremediation, biofuels, biofeed, or pharmaceuticals. Although large-scale cultivation of microalgae has seen significant scientific and technological advances, it is still a niche market compared to macroalgae. The main reasons for this are high operational costs, inconsistent yields, and gaps in regulations and knowledge, resulting in a push for more efficient cultivation methods. One proposed solution is co-cultivation of microalgae with organisms already

occurring in the microalgal microbiome, or the phycosphere, which has been shown to have beneficial effects such as faster growth, higher yields of valuable products, or cheaper harvesting. However, the phycosphere community structure, interactions between microalgae-associated microorganisms, and their effect on microalgal growth are still poorly understood. This project aims to use metabarcoding techniques and high-throughput screenings on agar and in liquid cultures to investigate the microbiomes and microorganism-microalgae interactions of three biotechnologically important microalgae: *Tetradesmus obliquus*, *Tetraselmis suecica*, and *Nannochloropsis oceanica*. The microorganisms will be identified using Sanger sequencing (culturable isolates) and NGS sequencing (non-culturable communities) with sets of 16S rRNA gene and ITS primers. To analyse the type of microbial interaction (positive, negative, neutral), high-throughput testing will employ an automated robot pinning pairs of culturable isolates and the microalga onto solid agar plates with subsequent image-based analysis of the interactions. Based on this screening, the microalgae will be co-cultured with beneficial microorganisms to identify the mechanisms of their interaction with specific focus on criteria important for biotechnological applications, including biomass yield, biochemical composition, flocculation rates, and removal efficiency of selected environmental contaminants. The microbial strains beneficial to microalgal application identified and characterized in this study will contribute to the current need to promote a green, bio-based economy.

### **Examining the impact of the world's largest icebergs on Southern Ocean phytoplankton communities**

Hey-Won Wong

University of Bath/ British Antarctic Survey

Phytoplankton are the basis of productivity in the Southern Ocean, making it a determinant and suitable tracer for Antarctic ecology. Giant icebergs, over 18km in length, have been associated with enhanced phytoplankton growth by the release of nutrient-rich meltwater, including iron, which is often limiting in the Southern Ocean. Other key nutrients include nitrates/nitrites, phosphates, and silicates. However, the ecological effects of giant icebergs are lesser known, and giant iceberg-associated phytoplankton taxa have yet to be characterised. Here we show a significant difference in phytoplankton communities between two giant icebergs: A76a and A23a sampled in January 2023 and December 2023, respectively. Phytoplankton from surface samples taken from station surrounding giant icebergs A76a and A23a were identified and enumerated using light microscopy. Higher overall cell abundance was recorded in iceberg A76a which was dominated by diatoms, a silicate-reliant group. In contrast, A23a possessed lower phytoplankton abundance and a nanoflagellate dominance. These results reflected the environmental data of the icebergs. Iceberg A76a showed high chlorophyll association, in parallel to the high cell counts. A23a appeared highly nutrient-associated (NO<sub>3</sub>, PO<sub>4</sub>, SiO<sub>2</sub>), likely due to lower phytoplankton uptake. Our results demonstrate an absence of typical giant iceberg phytoplankton taxa. In actuality, there were significant differences between A76a and A23a in both phytoplankton composition and abundance. These differences are associated with the icebergs nutrient profiles as well as surrounding oceanographic environment. However, the nutrient profiles may be related to the age of the icebergs. A76a had calved 2 years, and A23a 23 years prior to the time of sampling. An older iceberg may exhibit a reduction in nutrient-rich meltwater release due to structural changes in the ice. Sampling for iron and analysis of samples outside of iceberg influence may aid further comparisons.

## **Salinity Adaptation in *Nannochloropsis*: Cellular, Culture-Level, and Media Chemistry Perspectives**

Raed Yaseen

Swansea University

The marine microalga *Nannochloropsis oceanica* is a promising species for high value biomass production due to its high lipid content and resilience to environmental conditions variation. This study investigated the growth performance and salinity tolerance of *N. oceanica* cultured under two salinity conditions (40 and 60) over a 32-day period. Growth in small (100-400 mL), medium (18L) and large scale (80L) was monitored using optical density measurements, haemocytometer cell counts, and dry weight determination as indicators of biomass production. Cultures maintained at 40 exhibited a steady linear increase in biomass throughout the experimental period, indicating stable growth under moderate salinity. In contrast, cultures grown at 60 displayed initially higher biomass accumulation but experienced pronounced fluctuations during mid-experiment, reflecting physiological stress and osmotic adjustment responses. Despite this, *N. oceanica* gradually acclimated to the elevated salinity, and final biomass yields at 60 approached those obtained at 40, especially in the large scale. These results suggest that high salinity initially constrains growth stability but does not permanently inhibit cellular productivity once adaptation occurs. Moreover, the observed physiological adjustments under saline stress indicate the potential for enhanced metabolite accumulation, which may benefit biotechnological applications requiring high-value compound synthesis. Overall, this study highlights the salinity tolerance and adaptive capacity of *N. oceanica*, providing insights into optimizing culture conditions for large-scale algal cultivation. The findings contribute to understanding how environmental salinity influences microalgal growth dynamics and offer guidance for improving biomass yield and biochemical productivity in sustainable marine bioresource systems and supports its use as a resilient feedstock and functional ingredient in sustainable aquaculture production systems.

## **Using Environmental DNA to Quantify Algae Communities**

Jenny Smith

Cardiff University

In drinking water supply reservoirs, microalgae and cyanobacteria, form a key component of the water system but under the various conditions can have significant negative consequences for water quality and risks for end users. Issues include algal blooms, the release of both toxic chemicals and foul tasting (non-toxic) metabolites into water bodies. To anticipate these issues, water companies need to monitor algal communities in reservoirs. Current practices involve manual identification using traditional microscopy, however, this is time consuming, labour intensive and can be biased by a phycologist's level of taxonomic expertise. Furthermore, these analyses tend to identify microalgae to genus level only, which may not provide the resolution needed for informing water quality management and predictive modelling. As part of the Ofwat-funded Artificial Intelligence (AI) for Algal Monitoring project in conjunction with Bristol University and water companies from across the UK, Jenny's PhD project involves using environmental DNA (eDNA) to quantify and monitor algal communities in reservoirs. The genetic information will be used to ground-truth Bristol University's AI community to determine if the AI tool is sufficient for

industry needs. In addition to ground-truthing the AI data, this project aims to use network analyses and investigations into coevolution between algae taxa, to identify ecological associations between species that could reveal indicator taxa of water quality risks.

### **Can microbial interactions enhance red body production in *Nannochloropsis oceanica*?**

Jooyoung Ser

Mohamed Emran, Miguel Rivera, Steve Slocombe

Swansea University

Microalgal biotechnology is emerging as a key contributor to the circular bioeconomy, offering strategies to mitigate carbon emissions, reduce reliance on petrochemical products, and support sustainable aquaculture. Global microalgal production is estimated at roughly 50,000 – 130,000 t dry weight per year. This includes high-value algae such as *Spirulina*, *Chlorella*, *Dunaliella*, and *Haematococcus*. *Nannochloropsis oceanica* is of particular interest due to its production of red bodies that contain ketocarotenoids, Omega 3 fatty acids, membrane proteins and carotenoids, including astaxanthin. Astaxanthin is a ketocarotenoid that is used in aquaculture and agriculture feed as well as cosmetics and pharmaceuticals. Observations of *N. oceanica*'s cell cycle reveals that the naturally occurring red body packaging mechanism is released from cells during division. It has been proposed that the red body acts as a transport organelle shuttling algaenan precursors from the plastid into the apoplast. These red bodies offer a potentially more bioavailable and sustainable alternative to produce carotenoids and other valuable compounds.

Fluorescence microscopy and preliminary microbial staining suggest that diverse bacterial communities associate with *Nannochloropsis* cultures, especially around biofilms of cellular debris and clumps of red bodies. The interactions between these microorganisms and *N. oceanica*, including their specific associations with red bodies, are yet to be understood. Such interactions may play crucial roles in population dynamics, nutrient cycling, and phase transitions between light-growth and dark-division states. Incorporating mathematical modelling frameworks could help unravel these complex dynamics by quantifying growth–interaction feedbacks, identifying potential regulatory mechanisms, and predicting conditions that favour red body formation. Integrating experimental observations with modelling efforts will not only deepen our understanding of these ecological interactions but also guide strategies for optimising culture stability and enhancing red body yield at scale. Ultimately, the combination of biological insight with predictive modelling may accelerate the development of algae based feed supplements and advance sustainable aquaculture systems.



# Manton-eligible: Macroalgae

## **Effects of a fermented macroalgal biostimulant on spring wheat (*Triticum aestivum* L. cv. KWS Cochise) growth, yield and seed quality.**

Adam Reeve

University of Plymouth

Background: Nitrogen fertilisation of agricultural crops is common practice to enhance plant biomass assemblage, chlorophyll production and photosynthesis, flowering and fruiting, and immunity (Lægriid *et al.*, 1999). Sustained use of synthetic fertilisers to support global food demand has led to soil degradation and declining ecosystem function (Tilman *et al.*, 2001). Conversely, macroalgal biostimulants that are rich in macro- and micronutrients offer a sustainable alternative that may reduce dependence on synthetic fertilisers (Prisa *et al.*, 2024). Yet, their specific effects on cereal crops such as spring wheat, remain underexplored. Aims/purpose: This study aimed to determine the efficacy of a fermented macroalgal biostimulant on essential growth characteristics (height, mass, tillering, and spike attributes), yield, and seed quality (size, weight, and nutritional profile) of spring wheat. Methods: A 12-week greenhouse experiment was conducted under control conditions to assess the growth, yield and seed quality of 45 spring wheat plants. Treatments included a fermented macroalgal (*Saccharina latissima*) biostimulant (10 ml of 5 ml-l dilution; n = 15), a nitrogen-iron liquid fertiliser (10 ml of 10 ml-l dilution at 27-0.5 NFe; n = 15), and a water control (10 ml; n = 15). Results: The fermented macroalgal biostimulant significantly enhanced several growth and yield parameters relative to the nitrogen-iron fertiliser and control. Treated plants exhibited increased seed length and area (vs the NFe fertiliser and control), higher protein content (vs control), and greater dried root mass, earlier tiller initiation, increased height after two weeks growth, and higher 1000 grain weight (vs NFe treatment). These results suggest that fermented macroalgal extracts could provide a sustainable supplement or partial replacement for conventional fertilisers in cereal production.

## **Effects of thermal priming on the *Saccharina latissima* transcriptome response to heat stress**

Anne Margrete Nilsen

Anne M. L. Nilsen<sup>1</sup>, Niko Steiner<sup>2</sup>, Inka Bartsch<sup>2</sup>, J. Mark Cock<sup>3</sup>, Alexander O. Jueterbock<sup>1</sup>

1 Faculty of Biosciences and Aquaculture, Nord University, Universitetsalléen 11, 8026 Bodø, Norway

2 Alfred Wegener Institute, Helmholtz-Centre for Polar- and Marine Research, Bremerhaven, Germany

3 Algal Genetics Group, CNRS, Sorbonne Université, UMR 8227, Station Biologique de Roscoff, Roscoff, France

*Saccharina latissima* (sugar kelp) is a brown macroalgae of high ecological importance, forming the basis of kelp forests providing essential ecosystem services. Across the North Atlantic, kelp

aquaculture is expanding, leading to increased economic interest in the kelp as part of a sustainable blue bioeconomy. However, rising sea temperatures and frequent marine heatwaves now threaten both wild populations and production security. Strategies to enhance kelp growth and resilience will be of high importance for both restoration and aquaculture. Priming, a technique common in agriculture, involves pre-exposing early life stages to moderate stress to induce a molecular priming memory, enhancing performance during later stress exposures. This study investigates the effects of warm priming in *S. latissima*, where gametophytes were exposed to 20 °C for three weeks prior to sporophyte formation. Young sporophytes derived from primed (20°C) and naive gametophytes (10°C) were grown at 10°C and then subjected to heat stress (21.5 °C for 48h) followed by recovery at 10°C. Transcriptomic profiles and photosynthetic performance (Fv/Fm, Plabs) were analyzed to investigate priming induced changes in thermal stress resilience. Primed sporophytes showed an earlier and stronger transcriptomic response during heat exposure, with 1,419 differentially expressed genes (DEGs) compared to 564 in controls, while controls showed delayed substantial downregulation after the exposure (2,027 DEGs). Principal component analysis indicated differential recovery in primed kelps. Gene ontology enrichment analysis highlighted upregulation of pathways related to protein phosphorylation, chloroplast function, and post-transcriptional regulation by ncRNA in primed sporophytes during recovery, linking priming to altered regulation of stress responses. Our findings suggest that warm priming of *S. latissima* gametophytes induces a molecular memory persisting through meiosis, leading to modified stress responses in the sporophyte generation. We propose thermal priming as a promising strategy to strengthen kelp resilience for aquaculture and restoration, while supporting the preservation of genetic diversity.

### **Functional traits of a canopy-forming seaweed vary with wave exposure and latitude.**

Jessika Banham

Josh Mutter, Tom P Fairchild, John N Griffin

Swansea University

Functional traits are increasingly utilised in ecological research for determining how organisms interact with their environment and can improve estimates of ecosystem services. Canopy-forming brown macroalgae form ecologically important intertidal forests, but few previous studies have examined how they vary along environmental gradients through the lens of functional traits. Specific thallus area (STA), analogous to specific leaf area in plants, relates to the area available for photosynthesis versus the mass invested in structural material and therefore indicates the growth strategy and productivity of individual algae. To investigate large-scale patterns in this trait, STA of *Fucus serratus* was sampled across sites of varying wave exposure spanning 5 regions of the UK, ranging from Orkney to Plymouth. Preliminary results suggest that *F. serratus* has lower STA on wave-exposed shores, presumably because it requires higher proportions of structural material to persist. Potential influences of latitude (temperature) will also be explored. While STA cannot be taken as a direct measurement of growth rate and performance, the results so far suggest that *F. serratus* individuals on exposed shores must invest more in structural materials relative to the area of their fronds. Therefore, increases in wave energy expected in some regions under climate change may indirectly reduce the productivity of these intertidal forests.

### **Modelling the effect of abiotic conditions on algal growth**

Charlotte Jennings

Newcastle University

Rising sea temperatures and increased rainfall have been linked to the growing frequency and extent of macroalgal blooms in coastal ecosystems. This study investigates how abiotic weather factors influence algae and seagrass cover at Budle Bay, Northumberland, a protected coastal site that has experienced recurring algal blooms, intensifying year on year. Environmental data, including sea and air temperature, nutrient concentrations, solar radiation, wind parameters and water movement were analysed using Principal Component Analysis (PCA) to identify environmental gradients. Generalized Linear Models (GLMs) and Structural Equation Modelling (SEM) were then applied to determine relationships between environmental gradients and algal and seagrass cover found at Budle bay between 2023-2024. PCA revealed that PC1 represented a gradient from cool, nutrient-rich to warm, sunny conditions, indicating a change from summer to winter conditions, while PC2 reflected variation in wind and water movement. Non-entrained algal cover increased significantly under these summer conditions (PC1), whereas entrained algae were more abundant under winter like conditions (negative relationships with PC1 and PC2). Seagrass cover was positively associated with PC1. Seasonal patterns were evident, with higher PC1 scores and greater algal and seagrass cover during spring and summer months. SEM analysis showed that entrained algae negatively affected seagrass cover, while non-entrained algae had a positive effect. Overall, this study highlights that temperature, light, and nutrient conditions are key drivers of algal and seagrass dynamics at Budle Bay. The findings provide insight into how climate driven environmental changes may shift coastal ecosystem structure and function, with implications for management under ongoing climate change.

### **Plant seedling growth and soil respiration responses to seasonal United Kingdom seaweed wrack extracts**

Jose Gutierrez Higa

Cardiff Univeristy

Macroalgal extracts offer an alternative option to increase crop yields and plant performance whilst reducing reliance on inorganic chemical fertilisers. Macroalgae have high concentrations of bioactive compounds capable of enhancing crop growth, stress tolerance and pest resistance. This study investigated whether seasonal variation in the chemical composition of three brown seaweeds *Ascophyllum nodosum*, *Fucus serratus* and *Fucus vesiculosus* affected plant growth in *Arabidopsis thaliana*, *Beta vulgaris* and *Lactuca sativa* through different extract concentrations. Crops were treated with 1:20, 1:50 and 1:100 dilutions from macroalgal extracts and compared to controls tap water, deionised water and one commercial macroalgae-based fertiliser made from *A. nodosum*. Dry weight assessment results revealed that moderately diluted dosages had better effects on plant growth than concentrated dosages, showing that the most suitable concentrations of all macroalgae extracts are 1:50 for *Arabidopsis*; no trend was detected in *B. vulgaris* or *L. sativa* growth. Overall, there were peaks of increased plant growth when treated with extracts harvested in June and August, which correlates with fertility peaks in commercial brown macroalgae in the wild. These results suggest that the optimal harvest for *A. nodosum*, *F. serratus* and *F. vesiculosus* for plant stimulant products should occur between May and August at sustainable harvest levels. Soil respirometry trials using the extracts showed no differences in CO<sub>2</sub> fluxes between the macroalgal species, different harvesting seasons, or

correlation with plant biomass. It is therefore likely that macroalgal extracts impact the plant directly and produce minor impact on soil microbiota. Thus, these results support the use of macroalgal fertilizers as a low-cost and environmentally friendly alternative to chemical fertilisers.

### **The role of kelp-bryozoan symbiosis in the carbon cycle**

Ethan Quah

University of Plymouth

Kelp forests play an important role in the marine carbon cycle and have been proposed to be major carbon sinks. However, these forests also provide habitat for a plethora of calcifying organisms, such as epibionts. Encrusting organisms can affect carbon budgets by reducing (1) the irradiance available for photosynthesis and (2) seawater alkalinity via the formation of CaCO<sub>3</sub>. To date, productivity estimates are almost exclusively based on epibiont-free kelp, despite epibiont influence on host photosynthesis being poorly understood. Blades of *Laminaria digitata*, a dominant northeast Atlantic kelp species, are readily colonised by the bryozoan *Membranipora membranacea*. Using this symbiosis as a model system, we aimed to predict the effect of bryozoan cover on kelp photosynthesis by closed oxygen evolution. We found a clear negative correlation between gross photosynthesis and bryozoan cover. Instantaneous and daily net photosynthesis are negative above a bryozoan cover of 94% and 84% (respectively), marking the transition from carbon sink to source. Our results align with previous research on brown macroalgae (*Fucus serratus*) but disagree with some evidence from red macroalgae (*Gelidium* spp.). We therefore argue that mutualism between seaweeds and bryozoans may be restricted to macroalgae without a carbon concentrating mechanism, and bryozoan cover should be incorporated into kelp forest carbon budgets. To pinpoint the source of photophysiological disruption, we used a multi-scalar approach utilising: (i) chloroplast efficiency, (ii) pigment analysis, and (iii) untargeted metabolomics. Fouling both significantly lowers maximum quantum yield of photosystem II (Fv/Fm) in localised tissue beneath bryozoan colonies, and results in substantial shifts in overall metabolite profiles between bryozoan-free and fouled tissue. We only saw a significant change in one pigment, zeaxanthin, that decreased in fouled tissue. Our findings demonstrate that *M. membranacea* fouling induces significant metabolic costs and localized photophysiological stress in *L. digitata*.

### **Trait linkages reveal seasonal trade-offs between growth and reproduction in furoid seaweeds along a South Wales coast.**

Abrar Shakil

Swansea University, UK

Reproductive and morphological traits provide valuable information on species ecological roles and potentially allow us to track impacts of environmental change. Furoid seaweeds including *Fucus serratus*, *F. vesiculosus*, and *Ascophyllum nodosum* are important habitat-formers and support biodiversity and ecosystem functioning on North-East Atlantic rocky shores, where they are subjected to accelerating climatic warming. Surprisingly, few studies have characterised phenological variation in these species in the NE Atlantic. In this poster, we present preliminary

findings from a field study at a moderately exposed rocky shore in S. Wales, UK, examining seasonal variability in the reproductive and morphological traits of three furoid species. Individuals are being sampled monthly, with information gathered on population-level reproductive status, reproductive effort, and key morphological traits such as specific thallus area. Preliminary findings reveal clear interspecific differences in both reproductive and morphological traits, with stronger reproductive effort linked to higher resource-acquisition traits (e.g., greater specific thallus area) and more conservative morphologies in upper-shore individuals during peak reproduction periods. Together, these findings provide baseline information for monitoring future phenological shifts in response to climate change, potentially support efforts to gather propagules for restoration activities, and indicate how species ecological roles may vary with season and environmental stress. Keywords: Reproductive phenology, morphological traits, trait linkages, seasonal variability, environmental stressors.

### **Working towards functional recombinant sulfatases for Ulvan polysaccharide breakdown**

Raye Scottow

Aberystwyth University

Marine eutrophication, often caused by agricultural runoff, leads to the overgrowth of algae such as *Ulva* species, forming large 'green tides'. These events create environmental problems but also produce an abundant source of biomass that is currently underused. The main polysaccharide found in *Ulva* is ulvan, a complex, sulfated sugar polymer with potential uses in food, pharmaceuticals, and biofuels. To fully break down ulvan into simple sugars that can be converted into useful products, several enzymes are needed. However, one key group of enzymes, sulfatases, remains difficult to produce in an active form. This poster will cover the project which aimed to create functional recombinant sulfatases that could remove sulfate groups from ulvan, enabling complete enzymatic breakdown. Building on previous work from the EU-funded MACSSFT project, six sulfatase genes from *Alteromonas* sp. 76-1 were co-cloned with a formylglycine-generating enzyme (FGE) gene into the expression plasmid pET-28a(+). The FGE enzyme is essential for activating sulfatases through post-translational modification. Traditional restriction enzyme-based cloning was used to insert both genes onto the same plasmid, followed by transformation into *E. coli* expression strains. Successful co-expression of sulfatase and FGE proteins was confirmed for two of the constructs using SDS-PAGE, with the sulfatases expressed in a soluble form. Initial screening using synthetic substrates showed no activity, which is a known limitation for sulfatases, so testing on natural ulvan substrates will be carried out next to assess functionality. Developing functional ulvan-active sulfatases would complete the enzyme set needed for ulvan degradation, allowing the sustainable conversion of *Ulva* biomass into valuable products. This work supports future biotechnological applications that turn environmental challenges like green tides into opportunities for sustainable resource use.

## **Biodiversity enhancement and climate impacts of integrated multi-trophic aquaculture at an offshore location in the southwest UK.**

Eric Harris-Scott

University of Portsmouth

Integrated multi-trophic aquaculture (IMTA) presents an alternative to established monoculture techniques for low-trophic species, promoting circular principles regarding natural resource use and waste product management whilst providing ecosystem services (ES). IMTA methods strategically organise species from different trophic guilds to leverage waste products and/or detritus of one species to enrich the resources available to other species. Innovation in aquaculture systems can help tackle the major global challenges of food security, climate mitigation and biodiversity enhancement through low-impact resource production and sustainable aquaculture management practices. Our research, conducted at the UK's first large-scale (120 hectare) offshore IMTA system, focuses on non-fed aquaculture species, blue mussel (*Mytilus edulis*) and sugar kelp (*Saccharina latissima*). We aim to quantify provisioning, regulating and supporting ES through measuring nutrient cycling, carbon burial, community evenness and trophic linkages, demonstrating additional benefits beyond production yields. To generate robust data on ecological performance and environmental impacts, we will compare IMTA to monoculture kelp systems, control sites and reference coastal habitats. Carbon (C) and nitrogen (N) content of cultivated mussel and kelp will be measured, utilising stable isotopes and C:N ratios to uncover detritus fate and carbon sequestration potential. To analyse nutrient pathways, nutrient concentrations will be measured in the field and in flow-through aquarium setups to inform the capacity of kelp species to assimilate mussel waste. To assess biodiversity enhancement, underwater video, visual census and life-stage-specific monitoring devices will scrutinise IMTA contribution to habitat functions, assessing ecosystem resilience and robustness over time. We highlight a scalable and transferrable aquaculture model, demonstrating a replicable system to support low-impact protein production using an ecosystem approach to aquaculture. Our research findings will inform sustainable aquaculture development at large-scale in offshore environments, crucial for driving investment in future blue economy strategies and contribute to best-practice methodologies for assessing ES provision from aquaculture.

## **Enhancing Alginate Yield and Efficiency: Mechanochemical-assisted Extraction from *Laminaria digitata***

Kiri Belcher

AWI (Alfred-Wegener institute)

Alginate is a biopolymer derived from brown seaweed and has widespread industrial applications due to its unique gelling properties. However, current extraction methods are energy-intensive, time-consuming, and generate waste streams, raising concerns about sustainability. This research aims to address these challenges by investigating a novel mechanochemical assisted extraction process. We hypothesize that this method will reduce extraction time and eliminate the need for toxic solvents without compromising alginate quality, offering a more sustainable solution for industrial use. Mechanochemical techniques were employed to obtain alginate from brown seaweed, with an emphasis on increasing mechanical disruption over short durations to enhance yield while using organic solvents. Key properties such as yield, viscosity, molecular

weight, and the M:G ratio were monitored throughout the extraction to understand the key parameters that result in alginate composition changes. Our results show that alginate extraction can be completed in under 120 minutes, and with varying degree of disruption, this method can produce both high, medium and low molecular weight alginates. Additionally, the process eliminates toxic solvents and allows for targeted production of alginates with different molecular weights, making it adaptable to various industrial needs. This method can enhance sustainability by reducing chemical use, and offers a scalable alternative to conventional extraction technique.

### **Characterising the CO<sub>2</sub> Concentrating Mechanism in Brown Macroalgae**

Kate Bowler

University of York

Brown macroalgae play a significant role in global carbon sequestration, fixing inorganic carbon through photosynthesis. They are thought to employ CO<sub>2</sub> concentrating mechanisms (CCMs), which enhance carbon fixation by concentrating CO<sub>2</sub> at the active site of the photosynthetic enzyme Rubisco. Pyrenoids are Rubisco-containing microcompartments and are a key component of the biophysical CCM, and are found in many diverse eukaryotic algal lineages. Most of our current understanding of pyrenoids come from the model green alga *Chlamydomonas reinhardtii*. Our understanding of pyrenoids found in other algal lineages is much more limited, with pyrenoids in brown macroalgae remaining almost completely unexplored. This project begins to address this knowledge gap by focusing on *Ectocarpus*, a genus of small, filamentous brown algae 'widely regarded as a model for brown algal research. Pyrenoids found in *Ectocarpus* chloroplasts are large, stalked and protrude out of the chloroplast. This project aims to characterize the *Ectocarpus* pyrenoid using a range of experimental approaches; firstly, bioinformatics to identify putative CCM candidate proteins; and electron microscopy to investigate pyrenoid ultrastructure. In addition, we aim to use biochemical pyrenoid isolation combined with mass spectrometry to investigate pyrenoid protein composition. This multifaceted approach will help to enhance our current understanding of pyrenoid diversity and evolution, and begin to provide a blueprint for CCM components in brown algae.

### **Self-cleaning slipways: Harnessing species interactions for sustainable management of coastal infrastructure**

Sally Henderson

Swansea University

Ecologically engineered infrastructure supports ecological functions and anthropogenic demands. Integrating nature-based solutions with ecologically engineered infrastructure could reduce the impact of man-made structures on the marine environment. Biofouling is a major issue on coastal infrastructure, such as slipways, where it must be periodically removed to meet safety standards. Intertidal grazers naturally inhabit coastal infrastructure and rocky shores globally; the common limpet (*Patella vulgata*) is well-known for its capacity to control algae abundance and distribution. Yet, harnessing limpet grazing services on slipways is currently hampered by invasive cleaning methods and a lack of substrate complexity. To harness grazing potential and create self-cleaning slipways, surfaces must be carefully engineered to provide grazer refuges while also minimising water and sediment collection 'factors that promote algal

growth. Small-scale field experiments have refined substrate designs and provided a proof-of-concept for self-cleaning slipways. A scaled-up experiment (1 m<sup>2</sup> units) is now in place to determine which designs facilitate grazing at a scale relevant for slipway use. Results show limpets can perform well at scale and that they provide an effective night-cleaning service 'resting' in protected areas during the day and foraging on exposed surfaces at night. A final grazer diversity experiment is now in place to investigate additional grazing species that occupy habitat ranges outside of *P. vulgata*'s natural range. The aim is to determine whether combining multiple species leads to grazing complementary and broader resource exploitation across the whole slipway gradient. Ultimately, optimising designs (substrate and species type) to conduct a full-scale (whole slipway) demonstration are the key next steps towards realising the potential of this nature-based solution.

### **Marine Forests in Flux**

Nadia Frontier<sup>1</sup>

Karen Robinson<sup>2</sup>, Chris Yesson<sup>3</sup>, Sarah Wakelin<sup>4</sup>, John Griffin<sup>1</sup>

1 Swansea University

2 Natural Resource Wales

3 ZSL Institute of Zoology

4 National Oceanography Centre

Macroalgal detrital pathways have the potential to transfer carbon to long-term deep ocean sinks, however, warmer oceans may reduce the supply of macroalgal detritus due to accelerated decomposition in response to temperature. Global estimates of macroalgal carbon sequestration have recently estimated the proportion of carbon entering carbon sinks and recent local advances have generated maps documenting these hotspots. The current project will use a combination of field-based and particle tracking models to assess the relative importance of macroalgal decomposition pathways across a latitudinal gradient, spanning the North East Atlantic. A particular focus will be dedicated to macroalgal traits across this gradient, contributing towards understanding their relative role in influencing decomposition dynamics. Methodological approaches using in situ litter bag experimentation, in parallel to an ex situ common garden approach, will permit robust comparisons of macroalgal decomposition between climate-sensitive regions. In addition, the production of detritus across spatial gradients will be extracted using remote sensing techniques metrics to improve the resolution and transferability of oceanographic models. Hypotheses of warm water species decomposing faster than cold water conspecifics will be assessed against a suite of macroalgal traits whilst accounting for additional environmental and biological covariates such as exposure, substrate and herbivory. The overall aim of the project is to parameterise oceanographic models to generate and validate predictions of macroalgal carbon sequestration.

## **Seaweed on my lunch tray: challenges and opportunities of including macroalgae in Welsh school meals**

Jennifer C. Griffiths<sup>1,2</sup>

Charoula K. Nikolaou<sup>2</sup>, Jessica M. M. Adams<sup>1</sup>

1Institute of Biological, Environmental and Rural Sciences (IBERS), Aberystwyth University  
2NRI, University of Greenwich

### Background

The inclusion of seaweed in Welsh school meals is an atypical practice but offers a great opportunity to enhance childhood nutrition, support local livelihoods, preserve the use of traditional foods and contribute to sustainability targets. Seaweeds particularly provide a source of iron and B vitamins whilst being low in fat, sugar and calories; they are also a whole-food, animal-free food providing umami flavouring.

### Methods

- Literature search and gathering of official datasets
- Consultation of targeted groups (caterers, wholesalers, parents)
- Data manipulation

### Results

- 5g seaweed, particularly *Porphyra* species (laver), would enhance the provision of protein, fibre, potassium, calcium, magnesium, iron, zinc and vitamin B12 in the diets of school children. Literature suggests biotin, folate and pantothenate may also be high but insufficient data is available through the UK official nutrition (CoFID) dataset to quantify its dietary significance.
- Sodium and iodine may be exceeded
- Purchase options are limited to one product for caterers and not within budget

### Recommendations & Conclusions

A significant contribution to the nutritional value of school meals may be possible through increasing supply and demand, thus bringing it within budget

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## **General phycology posters**

### **Economic and physiological considerations of using *Haematococcus lacustris* and *Chromochloris zofingiensis* for astaxanthin production**

Francisca Vermeulen Phil Peterson

Scottish Association for Marine Sciences (SAMS)

Astaxanthin is a high-value antioxidant compound used extensively in aquaculture, pharmaceuticals and nutraceuticals. Currently the microalgae *Haematococcus lacustris* (HL, formerly known as *H. pluvialis*) is used to produce astaxanthin though *Chromochloris zofingiensis* (Cz) might be a potential viable alternative. Cz has a much faster growth rate compared to HL, though produces less astaxanthin overall. The objective of this research is to understand the interdependencies of astaxanthin synthesis in HL and Cz when grown under stress conditions and assess the economic availability. To assess the economic viability of using Cz and compare this with current HL cultivation we need to resolve several aspects including growth rate, biochemical breakdown of all carotenoids and their associated lipids,

optimal cultivation conditions and induction strategies including the various carbon sources which can be utilised. Therefore, microalgae will be grown in 1L Algem and 65L Varicon Aqua airlift photobioreactors to test scalability of the optimised stress induction method. Pigment and lipid composition of cultures will be determined (GC-MS, HPLC, spectrophotometry) and carotenoid pathway analysis will be carried out by qRT-PCR. This pathway analysis will help assessing the influence of added carbon on the different pathways for astaxanthin production in the two different microalgal strains. Experiments in 1 L and 65 L PBRs will show how scaling up might influence yields as well as transcript levels of genes involved in TAG and astaxanthin biosynthesis. Outcomes from this research will contribute towards making large scale astaxanthin production more industrially viable in the longer term.

### **Advancing Mapping and Monitoring of Canopy-Forming Brown Macroalgae Using Multispectral Remote Sensing**

Joshua Mutter

Swansea University

Canopy-forming brown macroalgae support diverse organisms and provide critical ecosystem services. Monitoring their forest cover, recognized as an Essential Ocean Variable, is increasingly feasible using publicly available satellite data. The Brown Algal Index (BAI) has shown promise in differentiating canopy-forming brown macroalgae on rocky shores, enabling rapid cover assessments. However, its large-scale application across shores, where species may have varying pigmentation and reflectance, remains underexplored. Additionally, while the overall cover is informative, the ability to differentiate between species or species groups would enhance ecological insights. We trained and tested predictive models using Sentinel-2 data and ground-truthed multispectral UAV surveys from varied rocky shores around Great Britain. Our results demonstrate that BAI can robustly estimate total brown macroalgal cover when parameterized with data that accounts for the natural heterogeneity of rocky shores. However, we caution that applying a single BAI regression model universally may weaken predictions mainly due to species-specific reflectance variations. Random Forest classifiers accurately predicted species-group cover during cross-validation within the same set of shores but require additional data to generalize to novel shores with differing conditions. These findings support the potential of multispectral satellite imagery to upscale intertidal macroalgal mapping and monitoring, with preliminary evidence for its use in species-level differentiation to improve ecological assessments.

### **Cavitation Mediated Fucoxanthin Extraction in Methanol Water Solvent Systems**

Madhubalaji Chegu Krishnamurthi

University of Bath

Cavitation Mediated Fucoxanthin Extraction in Methanol Water Solvent Systems Fucoxanthin, a marine xanthophyll pigment abundant in brown seaweeds, is known for its antioxidant, anti-inflammatory, and anticancer properties, making it a valuable bioactive compound for nutraceutical and functional food applications. However, its limited aqueous solubility and dependence on toxic organic solvents such as methanol pose major challenges for its

sustainable and food-grade utilization. To address this issue, the present study investigates the acoustic cavitation-assisted extraction and solubility assessment of fucoxanthin in binary solvent systems composed of methanol and water at varying ratios (100:0, 75:25, 50:50, 25:75, and 0:100, v/v). Introducing a cavitation-based method coupled with lower solvent use will align the process along green chemistry principles. The results revealed a strong dependence of fucoxanthin extraction on solvent composition, with solubility increasing proportionally to methanol concentration up to a 75:25 (methanol:water) ratio. Beyond this ratio, a marginal decline in extraction was observed. Below 75% methanol (50:50, 25:75, 0:100), excess water in the system led to poor solubility of lipophilic fucoxanthin which resulted in low extraction. 75:25 methanol:water provided the appropriate balance to extract fucoxanthin while maximising cavitation intensity, leading to disruption/dissociation of Fucoxanthin Chlorophyll a/c-binding Protein (FCP) complexes / thylakoid membranes thereby favouring maximal release. At 100% methanol: good chemical solubility for free fucoxanthin, but reduced cavitation intensity and possible differences in membrane interaction/protein denaturation dynamics led to lower yields. The 75:25 (v/v) solvent system was identified as the optimal balance between extraction efficiency and reduced methanol usage. This preliminary investigation provides fundamental insights into fucoxanthin extraction and solubilisation behaviour under acoustic cavitation and establishes a basis for substituting methanol with greener alternatives such as ethanol or other bio-based solvents for safe, food-compatible extraction processes. The findings contribute to advancing the production of high-value marine carotenoids for industrial applications. Keywords: Fucoxanthin, acoustic cavitation, solubility, methanol water system, sustainable extraction, green solvents

### **Unravelling our knowledge of macroalgae in the German Baltic Sea - a review of monitoring and research in the last decades**

Nikolas Kappas<sup>1</sup> Florian Weinberger<sup>1</sup>, Svenja Heesch<sup>1</sup>, Rolf Karez<sup>2</sup>

1 GEOMAR Helmholtz Centre for Ocean Research Kiel

2 LfU Landesamt für Umwelt Schleswig Holstein

Macroalgae are an important cornerstone of benthic ecosystems, increasing biodiversity and providing shelter and resources for other organisms through photosynthesis and biomass accumulation. Despite only a small fraction of the benthic habitats in the German Baltic Sea consisting of the hard bottom substrate required by habitat-forming macroalgae, their importance for reaching and maintaining a good ecological state according to the European Water Framework Directive (WFD) has long been recognized. From 2006 onward, monitoring efforts were made to ascertain the ecological status of benthic near-shore habitats through governmentally funded field surveys. These have focused mostly on *Fucus* spp. as the primary habitat-forming macroalgae in the Baltic. Specifically, the maximum depth distribution of *Fucus* has been used as Ecological Quality Standard (EQS), together with the biomass of opportunistic algae within the assemblages. However, comprehensive knowledge about the species richness and abundance of macroalgae in the German Baltic Sea is still lacking, as there has been no overarching survey yet. Especially smaller, annual species have only been recorded as indicators for eutrophication within field surveys for the WFD. This study will identify knowledge gaps, shed light onto the different monitoring approaches and combine the data that has already been collected to create such a comprehensive overview of macroalgae in the German Baltic Sea.

## **How Long Before We Hit the Bottom? Settling Dynamics of *Saccharina latissima* from in situ and laboratory measurements**

Giulia Leanza Martyn Emyr Roberts

Bangor University

Kelp forests are among the most productive marine ecosystems, playing a crucial role in global carbon cycling through both their biomass and detritus. Despite growing recognition of macroalgae as a significant carbon source, knowledge remains limited regarding the degradation rates of detached kelp material and its potential for offshore transport. This study investigated the degradation dynamics of *Saccharina latissima* detritus over eight weeks at two contrasting sites (subtidal and intertidal) in North Wales. We quantified fresh weight loss, assessed key environmental and biological drivers, and tracked changes in settling velocity. We hypothesised that degradation would accelerate over time, differ between sites due to environmental and faunal variability, and influence particle sinking behaviour. Our results confirmed that kelp detritus degraded progressively, with fresh weight loss increasing over time. Degradation patterns varied significantly between sites, driven primarily by abiotic factors (light and temperature) at Menai Bridge and by benthic community composition at Plas Newydd. Notably, sinking velocities increased with degradation, suggesting that particle fragmentation and waterlogging enhance the potential for both long-distance transport and benthic export. These findings demonstrate that *S. latissima* detritus undergoes rapid decomposition under natural conditions, with significant implications for carbon fate in coastal ecosystems. The interplay between local environmental conditions and biological activity indicates that assumptions of long-term kelp carbon storage may be overly simplistic. This research underscores the need to incorporate decomposition rates and site-specific processes into blue carbon accounting frameworks to refine estimates of kelp's contribution to oceanic carbon sequestration.

## **Recovery from acidification in streams after long-term liming.**

Ingrid Jüttner<sup>1</sup>, Oliwia Franczak<sup>1,3</sup>, Martyn Kelly<sup>2</sup>, Ian Vaughan<sup>3</sup>, Steve Ormerod<sup>3</sup>, Haydn Probert<sup>4</sup>, Louis Macdonald-Ames<sup>4</sup>, Simon Evans<sup>4</sup>

1 Amgueddfa Cymru – Museum Wales, Department of Natural Sciences

2 Bowburn Consultancy

3 School of Biosciences, Cardiff University

4 The Wye and Usk Foundation

We studied the effects of long-term liming on stream diatoms during three projects between 2003-2025 in the upper River Wye catchment, Wales. The streams, located in base-poor upland areas, are affected by acidification as a result of deposition of air pollutants and forestry practices. Variations in water chemistry, diatom species composition and diversity, and in the index Diatom Acidification Metric (DAM) were compared between different types of land cover and flow conditions. Streams located in conifer plantations had low pH and very low species richness, and were treated with lime. Of the two methods tested, catchment and in-stream liming, the latter proved most successful and has been used annually since 2007. Electrofishing was carried out for several years before and after liming to monitor the recovery of salmon populations. Diatom species composition changed after liming with species tolerant of low pH,

in particular *Eunotia exigua* (Br b. ex K tz.) Rabenh., becoming less abundant and being replaced by acid-sensitive species, predominantly *Achnanthydium minutissimum* (K tz.) Czarn. In 2013, DAM index values and ecological quality ratios (EQR), which were both lower in conifer and acid grassland areas before liming than elsewhere, had improved after liming, and in many areas the ecological status class of limed streams had become good or high. A change to diatom assemblages with predominantly acid-sensitive species after liming correlated with increasing numbers of juvenile salmon which had migrated upstream to sites that lacked fish prior to liming. To investigate long-term effects of liming and potential effects by climate warming, we reinvestigated all streams in 2024/25 during low and high flow conditions. We report changes in diatoms in streams limed annually since 2013 and compare those with long-term changes in untreated acidified streams in a neighbouring catchment, and with changes observed in untreated reference streams that are unaffected by acidification.

### **Drones and Droids: Are you ready to investigate an algal bloom using marine robots?**

Francisca Vermeulen

Scottish Association for Marine Science

Drones and Droids is an educational card game intended to teach early secondary school children about robotics and marine science. Players take the role of robot pilots on the SAMS research vessel, and must co-operate with each other to investigate an algal bloom off the coast of Lismore. They use their robots to lay out map cards, surveying the mission area as they go, and are governed by a turn limit in the form of event cards. The map cards describe the instruments the robots use to inspect that part of the ocean, how they recover information about the algae and how the bloom is interacting with the environment. The event cards introduce a random element, as pilots must deal with unexpected calamities based on the real experiences of SAMS roboteers. Different robots move in different ways informed by their actual behaviour and equipment. The source of the bloom can be inferred by identifying the most prevalent species and the conditions of the ocean in the mission area, and the phycological knowledge taught by the game is essential to solving the mystery. Scientific information in the game is accurate to the knowledge of the marine scientists based at SAMS. We have spent the last year playtesting the game and received enthusiastic feedback from students and pro-gamers alike, and have now completed a successful crowdfunding campaign to be able to produce this game in bulk, to be supplied to schools, museums and game shops. This poster will contain information on the game specific to its use as a teaching tool for informing students about the ocean and the mysterious beings within.

### **Surfacing Data: Digitisation of the Brown Algae Collection at the Natural History Museum**

Haley Gladitsch

Holly Belton-Horrocks, Larissa Welton, Krisztina Lohonya, Jo Wilbraham

Natural History Museum

As biodiversity loss and climate change accelerate, research using herbarium specimens combined with modern advances in DNA sequencing and statistical modelling can provide insights into the organisms and ecosystems most impacted. In this vein, algae specimens at the

Natural History Museum (NHM) have been recently used to track non-native species, assess conservation statuses, and reconstruct genetic diversity in historical kelp ecosystems. However, the increasing demands of modern large-scale research questions requires greater accessibility, which remains a significant challenge for expansive historical collections like that of the NHM, comprising over 700,000 algal specimens. The collection's taxonomic, temporal, and geographical scope makes it a valuable resource for a diverse range of users spanning taxonomists and conservationists, to artists and historians. Digitisation can therefore help to connect researchers and the public to specimen images and their associated data. While digitisation has been ongoing at the NHM for a decade, in 2024 the brown algae collection was chosen as a pilot for mass digitisation. In the last year, c. 40,000 specimens were digitised, including all type specimens re-imaged to higher resolution. This work has demonstrated that the collection holds more than half of the known brown algae diversity, comprising over 1,000 taxa in approximately 250 genera with global geographical coverage. Following the finalisation of this work, the dataset will be freely available on the NHM's online data portal, making specimens more findable for internal and external users of the herbarium. The project has enabled the development of enhanced workflows for red algae and other cryptogamic groups, which are set to be digitised in 2026 as part of a DiSSCo UK-funded project. By transforming this significant algal collection into a digital resource, the NHM continues to play a vital role in addressing the urgent global challenges in conservation and biodiversity today and for the future.

### **Changes in the microbiome of farmed *Kappaphycus* species in Malaysia associated with 'ice-ice' disease**

Robert J. Mrowicki<sup>1</sup>

Juliet Brodie<sup>1</sup>, Phaik-Eem Lim<sup>2</sup>, Sze-Wan Poong<sup>2</sup>, Pui-Ling Tan<sup>2</sup>

1 Science Group, Natural History Museum

2 Institute of Ocean and Earth Sciences, University of Malaya

Euchematoid red seaweeds, comprising the genera *Euchemuma* and *Kappaphycus*, provide over 90% of the global supply of carrageenan, a hydrocolloid used in foods, cosmetics and pharmaceuticals, with the vast majority of production occurring in Southeast Asia. While global demand for carrageenan is increasing, seaweed production systems in the region are threatened by climate change and low genetic diversity of farmed species, making them increasingly vulnerable to pests and diseases. In particular, 'ice-ice' disease (IID), characterised by whitening of the thallus followed by disintegration of tissues resulting in loss of biomass and reduced carrageenan yield, is commonly encountered throughout euchematoid producing regions. The disease processes underlying IID are still poorly understood, with knowledge of IID microbiology limited by a lack of culture-independent molecular studies comparing diseased and healthy tissues. To address this problem, samples of healthy and IID-affected tissues of *Kappaphycus alvarezii* and *K. malesianus* were collected from a seaweed farm in Sabah, Malaysia during a 45-day cultivation period, whereby 16S DNA metabarcoding was performed to characterise changes in the bacterial microbiome. Seaweed-associated microbial communities differed between healthy and diseased tissues, with differences driven by particular bacterial taxa. These results provide new evidence of the potential roles of different microbial groups in the disease response of *Kappaphycus* species and contribute to a unified case description of IID. Further complementary studies involving multiple euchematoid species and cultivars across a range of

environmental contexts are required to elucidate IID causative factors, which will support the development of evidence-based management guidelines to limit the risk of disease outbreaks.

### **Characterisation of Ulvan Saccharifying Enzymes from *Alteromonas* sp. 76-1**

Valerie J. Rodrigues<sup>1</sup>,

Matthias Wietz<sup>2</sup>, Jessica Adams<sup>1</sup>

1 Institute of Biological, Environmental and Rural Sciences (IBERS), Aberystwyth University,

2 Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI)

Uncontrolled macroalgal blooms known as green or golden tides are increasingly occurring around the world, due to eutrophication of the marine ecosystem. These blooms result in the generation of large quantities of biomass that are currently underutilised. The predominant cause of green tides is the genus *Ulva* spp. which contains ulvan, a sulphated polysaccharide with unique monomers such as rhamnose, glucuronic acid, iduronic acid and xylose. Oligomers and monomers of ulvan have several applications in the biomedical, biofuel, cosmetic and fine chemical industry. These applications often necessitate the breakdown of the polysaccharide to oligosaccharides or monomers and can be achieved through enzymatic saccharification. Owing to the complexity of ulvan, the synergistic action of several enzymes such as ulvan lyases, unsaturated glucuronyl hydrolases, rhamnosidases, xylosidases and sulfatases are essential for its complete saccharification. Koch et al (2019), reported the presence of a plasmid with several ulvan metabolising CAZymes in *Alteromonas* sp. 76-1 isolated from the Patagonian continental shelf. This plasmid has genes for the complete set of enzymes required to breakdown ulvan to monomers. Here we report the characterisation of some of the enzymes present on this ulvan saccharifying plasmid. This work can contribute to the development of sustainable enzymatic technologies for the utilisation of green seaweed biomass generated due to algal blooms. Reference: Koch H.et al (2019) *Frontiers Microbiol.*10:504

### **Marine Biodiscovery Network Initiative**

Zoe Coombes and Hannah Morris

Faculty of Medicine and Life Science, Swansea University

The Marine Biodiscovery Network Initiative is a collaborative partnership between Higher Education Institutions and industry across Ireland, Wales, and France designed to unlock the potential of marine biodiversity for health and wellbeing. Our mission is to advance the discovery and commercialisation of bioactive compounds from seaweed, microalgae, and jellyfish, driving innovation in pharmaceuticals, nutraceuticals, and skincare.

This initiative brings together leading academic expertise in marine biotechnology, bioprocessing, and translational research with industry partners committed to sustainable product development.

The collaborator bring together expertise including high-throughput screening, advanced tissue models, metabolomics, and pilot-scale biorefining, with a joint aim of accelerating the journey from marine resource to market-ready solutions.

At present we are seeking funding for project that is structured around three integrated Work Packages (WPs):

**Pharmaceuticals:** Identification and optimisation of marine-derived compounds with therapeutic potential, focusing on oncology and women's health.

**Nutraceuticals:** Development of functional ingredients and formulations to support health and nutrition, including bioavailability and safety studies.

**Skincare:** Exploration of marine bioactives for cosmetic applications, targeting skin health and repair through innovative assays and sustainable processing.

Our approach prioritises co-creation, knowledge exchange, and infrastructure sharing to build a robust network capable of securing major funding under Horizon Europe and UKRI schemes."



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# *SUBMIT*

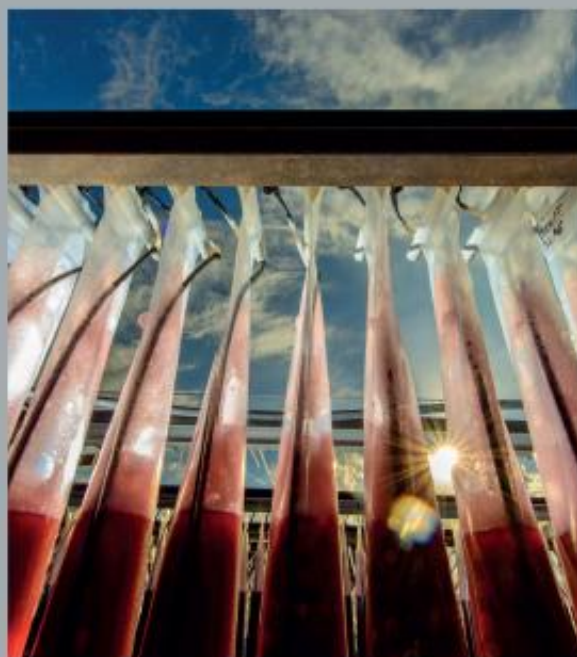
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Volume 3 Issue 1 December 2022

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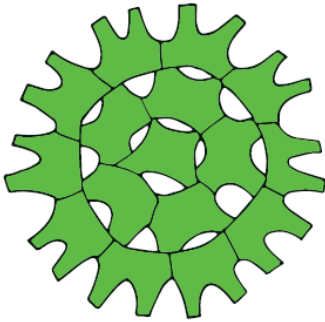
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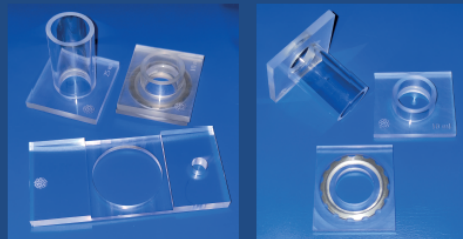


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