British Phycological Society
Winter Meeting 2017

Abstracts Book

Programme

Wednesday 11th January	
14:00-17:30	**Registration Desk and Poster Mounting** Cemlyn Jones Laboratory – Craig Mair **Activities for meeting attendees** Meet in Cemlyn Jones Laboratory – Craig Mair **BPS Council Meeting (Council Members only)** 15:00 start, Meeting Room 1 (1st Floor) - Marine Centre Wales
18:00-20:00	**Registration, Ice Breaker and Posters (Sponsor: Taylor and Francis)** Cemlyn Jones Laboratory – Craig Mair
20:00-onwards	**Student Social and Buffet (all welcome!)** Auckland Arms Pub – Water Street, Menai Bridge

Thursday 12th January	
08:00-09:00	**Minibus Pickup** Locations in Bangor **Registration desk from 08:00** Marine Centre Wales - Foyer
09:00-10:30	**Opening Session (Chair: Andrew Davies)** Sarah Jones Lecture Theatre - Marine Centre Wales
09:00-09:05	**Introduction and Welcome** Andrew Davies – Organiser and School of Ocean Sciences
09:05-09:55	**Overseas Presidential Address:** Koen Sabbe: "Life in shifting sands: functional ecology of marine benthic diatoms"
09:55-10:15	**President of FEPS:** Olivier De Clerck: "A decade of FEPS: an introduction to the past, present and future of a Federation of European Phycological Societies"
10:15-10:30	**President of BPS:** Gill Malin: "How and why to tell the world about phycology?"
10:30-11:00	Refreshments and posters – Cemlyn Jones Laboratory – Craig Mair
11:00-13:00	**SPECIAL SESSION: "Dominating the intertidal: the biology of fucoids" (Chairs: Juliet Brodie and Chris Maggs)** Sarah Jones Lecture Theatre - Marine Centre Wales
11:00-11:30	Alexander Jueterbock: "North Atlantic fucoids in the light of global warming"
11:30-12:00	Ester Serraro: "Evolutionary processes in fucoid algae"

12:00-12:30	Paula Lightfoot: “Mapping intertidal seaweed communities from remote sensing data: an object-based approach”
12:30-13:00	Stuart Jenkins: “Fucoid macroalgae as ecosystem engineers: where natural history meets ecological theory”
13:00-13:50	Lunch and Posters – Cemlyn Jones Laboratory – Craig Mair
13:50-17:00	**Manton Prize - Student Presentations (Chair: Gill Malin)** Sarah Jones Lecture Theatre - Marine Centre Wales
13.50-14.10	Sebastiana Roccuzzo: “The use of natural infochemicals for sustainable and efficient harvesting of the microalgae *Scenedesmus* spp for biotechnology”
14:10-14:30	Nathan Chrismas: “Diversity and genomics of cyanobacteria in the cryosphere”
14:30-14:50	Henry Koehler: “Seasonal distribution of sediment-dwelling protists (SDPs) in intertidal flats of Sligo Bay, West of Ireland”
14:50-15:10	Seth Thomas: “Diatoms: From DMSP Synthesis to Global Significance”
15:10-15:30	Srilakshmy Harikrishnan: “Transcriptomics analysis to investigate the host responses of brown algae (*Ectocarpus* spp.) during infection caused by the oomycete pathogen *Eurychasma dicksonii*”
15:30-16:00	Refreshments and posters – Cemlyn Jones Laboratory – Craig Mair
16:00-16:20	Charlotte Walker: “Investigating the role of calcification in coccolithophores”
16:20-16:40	Graham Epstein: “Proliferation of the invasive kelp, *Undaria pinnatifida,* from marinas to rocky reef and the potential for its control”
16:40-17:00	Nathan King: “Thermal tolerance of range edge and range centre kelp populations: evidence for thermal ecotypes”
17:00-18:00	**BPS Annual General Meeting** Sarah Jones Lecture Theatre - Marine Centre Wales
19:00-onwards	**Meeting Dinner** Reichel Hall, Bangor University

Friday 13th January	
08:00-09:00	**Minibus Pickup** Locations in Bangor **Registration desk from 08:00** Cemlyn Jones Laboratory

09:00-10:40	**Ecology and Change 1** Sarah Jones Lecture Theatre - Marine Centre Wales	**Physiology and Biochemistry** Denis Crisp Seminar Room – Craig Mair
09:00-09:20	Eileen J. Cox: "Freshwater Diatom Flora of Britain and Ireland – filling a gap and addressing difficult issues."	Seth Davis: "Exploring the genomes of extremophilic red algae *Galdieria* with 2nd and 3rd-generation genomics to unlock Industrial Biotechnological applications"
09:20-09:40	Ingrid Jüttner: "Freshwater Diatom Flora of Britain and Ireland – an online identification tool"	Fleuriane Fernandes: "Use of FTIR spectrophotometry to monitor post-harvest treatments in seaweeds for enhancement of macromolecular composition"
09:40-10:00	Claire Passarelli: "Composition of microphytobenthic biofilms in coral reefs, and influence on coral recruitment"	Claire Gachon: "Novel strategies for preventing diseases in cultivated seaweeds"
10:00-10:20	Jacqui Pocklington: "Examining how kelp forest community dynamics differ along a latitudinal gradient in Great Britain"	Daniel Thornton: "Growth, death and exopolymer particle production by diatoms"
10:20-10.40	Dan Smale: "Towards a better understanding of ecological structure and functioning in UK kelp forests: An update on the Team Kelp (UK Division) fieldwork program and related outputs"	Mahasweta Saha: "The breakdown of bacterial "armour": feebleness of an invasive seaweed holobiont?"
10:40-11:10	Refreshments and posters – Cemlyn Jones Laboratory – Craig Mair	
11:10-13:10	**SPECIAL SESSION: "Microalgae and carbon cycling" (Chairs: Dan Thornton and Rupert Perkins)** Sarah Jones Lecture Theatre - Marine Centre Wales	
11:10-11:40	Tammi Richardson: "Carbon fluxes in ocean food webs: how phytoplankton community composition may (or may not) affect trophic dynamics and export"	
11:40-12:10	Graham Underwood: "Carbon fluxes in microalgal biofilms: the flows through dissolved organic matter and extracellular polymeric substances (EPS)."	
12:10-12:40	Kevin Flynn: "A new paradigm for marine planktonic primary production"	
12:40-13:10	Stephen Maberly: "Phylogeny, physiology and environment: Is inorganic carbon an important ecological factor for freshwater microalgae?"	
13:10-14:00	Lunch and posters – Cemlyn Jones Laboratory – Craig Mair (Final Council Meeting, Council Only – MCW 1st Floor Meeting Room)	

Home

14:00-16:00	**Ecology and Change** Sarah Jones Lecture Theatre - Marine Centre Wales	**Taxonomy and Applied Phycology** Denis Crisp Seminar Room – Craig Mair
14:00-14:20	Christine Maggs: "*Gracilaria vermiculophylla*: an invasive red seaweed has arrived in Britain"	Linda Medlin: "Advances in molecular tools for routine monitoring of toxic algae and pathogens in aquatic ecosystems"
14:20-14:40	Dorothea Bender-Champ: "Tropical macroalgae under future conditions"	Hiroshi Kawai: "Taxonomic revision of Agaraceae (Laminariales, Phaeophyceae)"
14:40-15:00	Michael Burrows: "Measuring climate change effects in rocky shore communities"	Pilar Díaz-Tapia: "Evolutionary history of the hyperdiverse red algal family Rhodomelaceae"
15:00-15:20	Juliet Brodie: "Brilliant and intense: structural colour in marine algae"	Joe Taylor: "Temporal dynamics of the coastal Cercozoa; revealing hidden diversity in an understudied group"
15:20-15:40	Kathryn Schoenrock: "Epibacterial diversity and function in the physiology of polar coralline algae"	Michael Steinke: "Taxon-specific volatile metabolomic signatures in three species of seaweed"
15:40-16:00	Luli Randell: "The effect of temperature on volatile organic compound production in coccolithophore species *Emiliania huxleyi"*	Alla Silkina: "An algal-bacteria consortium for successful waste remediation and probiotic effect for aquaculture feeding"
16:00-17:30	Meeting closed, but rooms available for meetings and poster take down	

Posters

Student Poster Competition	
1	Miriam Bernard: “Laboratory and field studies on the interaction between kelps and filamentous algal endophytes”
2	Cecilia Biancacci: “Establishment of *Osmundea pinnatifida* mariculture”
3	Charlotte Walker: “Characterisation of the elusive colonial haptophyte *Corymbellus aureus*”
4	Holly Welsby: “Seasonal Silicon Cycling in the Severn Estuary”
5	Keelan Lawlor: “Changes in total lipid and lipid class composition during the growth of three marine microalgae”
6	Jessie Lauze: “Developmental and ecological response of *Fucus vesiculosus* to chronic environmental contamination in the northwest Atlantic”
7	Jessica Knoop: " Seasonal observation of life history stages and population dynamics of the red alga *Porphyra dioica* in South Wales”
8	Héctor Cid: “Morphological changes, cell damage and metal localization after long term stress by Cu(II) and Pb(II) ions over the green seaweed *U. linza* on batch cultures”
9	Albert Pessarrodona: “Climate-driven shifts in species dominance affect kelp forest functioning”
10	Harry Teagle: “Climate-driven substitution of habitat-forming species leads to reduced biodiversity within a temperate marine community”

Posters	
11	Kathryn M Schoenrock: “A pan-Arctic assessment of biodiversity and ecosystems services provided by coralline algae reefs”
12	Chris Carter: “Studies of two interesting freshwater algae 1”
13	Chris Carter: “Studies of two interesting freshwater algae 2”
14	Gary S Caldwell: “Living Architecture: A Modular and Programmable Synthetic Ecosystem for the Built Environment”
15	Ricardo Bermejo: “Assessing spatial and temporal scales of variation in green tides: Tubular vs. Sheet-like morphologies”
16	Christine Campbell: “Addressing the future in a 21st century Culture Collection of Algae and Protozoa”
17	Joanna Wilbraham: “New Version of the AlgaeVision Website: A searchable photo catalogue of freshwater and subaerial algae”

18	Geraldine Reid: “The Algal Collections at National Museums Liverpool (World Museum, LIV)”
19	Gail Twigg: “Impact of Climate Change on Communities of Scottish Rocky Shores since 2002”
20	Alastair Skeffington: “How far can you trust your proteomics database?”
21	Moya O’Donnell: “Can Differences in Minimum Areas Lead to Different Conclusions? A Case Study in Green Algal Tides”
22	Manuela Iovinella: “Flexibility of thermoacidophilic red alga *Galdieria maxima* strains and their capacity to grow in non-acidophilic environments”
23	Angelo Del Mondo: “A spotlight on algal RAD52 in Cyanidiophyceae (Rhodophyta): a relic in algal heritage”
24	Jan Janouškovec: “Major transitions in dinoflagellate evolution unveiled by phylotranscriptomics”
25	Li-En Yang: “A review of the bladed Bangiales (Rhodophyta) in China: history, culture and taxonomy”

OPENING SESSION

Thursday 09:05-10:30

Presentations from BPS Overseas President, President of the Federation of Phycological Societies and the BPS President.

Thursday 09:05-09:55

Life in shifting sands: functional ecology of marine benthic diatoms

Koen Sabbe

Protistology and Aquatic Ecology Lab, Ghent University, Krijgslaan 281-S8, B-9000 Ghent, Belgium

Marine tidal flats are highly dynamic and variable environments, with pronounced shifts in resource availability and environmental disturbance occurring at multiple scales of space and time. Yet diatoms, minute algae living encased in glass cell walls, thrive in these shifting sands. Recent studies in our lab and elsewhere now show that at least part of their success can be attributed to highly performant behavioral, physiological and molecular adaptations, specialized life cycle strategies and intricate interactions with other diatoms, protists and bacteria within complex microbial consortia. I will draw from recent work carried out in our lab to illustrate aspects of marine benthic diatom functional ecology, including photophysiology, life cycle regulation, diatom-diatom and diatom-bacteria interactions. Finally, I will show how functional trait-based approaches can advance our understanding of the importance of diatom diversity for the functioning of these benthic microbial consortia.

Thursday 09:55 -10:15

A decade of FEPS: an introduction to the past, present and future of a Federation of European Phycological Societies

Olivier De Clerck

Biology Department, Krijgslaan 281 S8, 9000 Gent, Belgium

A decade ago, a revival of interest in establishing a Federation of European Phycological Societies had developed. By the time of 4th European Phycological Congress (EPC4, Oviedo 2006) a Founders Group of seven national phycological societies, each being represented on a Founders Council, had agreed on the principles, structure and aims of the Federation of European Phycological Societies. The foundation of FEPS at EPC4 was accompanied by a warm welcome to further national phycological societies/groups throughout Europe. And indeed in subsequent years another four societies joined. FEPS has been successful in the organization of 2 more EPC's (Rhodes, London) and behind the screens the organization of the next EPC which will be hosted by the Croatian Phycological Society (2019) has started already. In the meantime FEPS has launched a quarterly electronic journal, Perspectives in Phycological, covering all domains of phycology, including the contributions of phycological research to current and emerging issues in environmental, health and industrial sectors. A rightful question is, whether FEPS is more than an organizer of a congress once every four years or the publisher of an upcoming review journal. The answer is unequivocal yes. As president of FEPS, I strongly believe in the added transnational value of a Federation of Phycological Societies. Giving specific examples I will demonstrate how FEPS can be complementary to the national societies and fill voids in the present European phycological landscape. We have identified a number of initiatives related to biodiscovery, education and data accessibility, the first of which we hope to turn into a reality in the coming year already. These initiatives will however, not be realized unless the national societies play an active role in sustaining them, and FEPS offering structural support for transnational initiatives.

Thursday 10:15 -10:30

How and why to tell the world about phycology?

Gill Malin

Centre for Ocean and Atmospheric Sciences (COAS), School of Environmental Sciences, University of East Anglia, Norwich Research Park, Norwich, NR4 7TJ.

The overall aim of the British Phycological Society is to advance research and education by the encouragement and pursuit of all aspects of the study of algae. Our constitution also says that to further these aims we should increase public awareness of the importance and applications of algae, and contribute to public debate on issues involving algae. The academic landscape has changed dramatically since BPS was established in 1952 and also in more recent years. In the past phycology was mostly taught in botany departments and these and modules focussing on phycology are now rare. In addition, many people who are working on algae in academia and industry don't consider themselves phycologists, yet the subject continues to attract young people fascinated by algae. The Earth is also facing accelerating environmental change and population growth which brings increasing food, water and energy security issues. In this changing world aquatic ecosystems are coming under increasing pressure and the important roles that algae play and could fulfil are increasingly recognised. Ahead of the BPS 60th anniversary in July 2012 the BPS Council debated how to shape the future of the society. Work is ongoing but there is much more that could be done – where should we focus and how? In this presentation I will outline that discussion and additional thoughts on how we could progress - I will be looking to the audience for input and suggestions. Topics will include: training the next generation of phycologists; retaining expertise; embedding algae in the National Curriculum; connecting with amateur algae enthusiasts and the public; stand-alone meetings to focus on specific topics; the sustainable utilisation of algae; forging links with other societies and commercial partners; identifying phycological research priorities and emerging issues in science and policy; proactive lobbying of funders, policy makers and others.

SPECIAL SESSION – DOMINATING THE INTERTIDAL: THE BIOLOGY OF FUCOIDS

Thursday 11:00-13:00

Large brown fucoids are such a familiar feature of the intertidal seashore that it is easy to take them for granted. Yet these ecologically important habitat-forming seaweeds are increasingly being impacted by climate change. In this special session, four scientists, Ester Serrao, Alexander Jeuterbock, Stuart Jenkins and Paula Lightfoot, will talk about their research into these intriguing organisms. This will be a unique opportunity to find out about current thinking on the ecology and evolution of these seaweeds, ecological niche modelling, habitat monitoring using drone technology and conservation.

Thursday 11:00-11:30

North Atlantic fucoids in the light of global warming

Alexander Jueterbock[1], James A. Coyer[2], Irina Smolina[1], Lennert Tyberghein[3], Heroen Verbruggen[4], Jeanine L. Olsen[5], Galice Horau[1]

[1]Faculty of Biosciences and Aquaculture, Nord University, Bodø, Norway. [2]Shoals Marine Laboratory, University of New Hampshire, Durham, New Hampshire, USA. [3]Flanders Marine Institute (VLIZ), Innovocean Site, Wandelaarkaai 7, B-8400 Oostende, Belgium. [4]School of Botany, University of Melbourne, Parkville, Victoria, Australia. [5]Groningen Institute of Evolutionary Life Sciences (GELIFES), University of Groningen, PO Box 11103, 9700 CC Groningen, The Netherlands

Temperate and arctic intertidal ecosystems are likely to be profoundly affected by the responses of foundational seaweed species to global warming. Foundational seaweeds provide ecosystem services such as 3-dimensional habitats and food for invertebrates and fish, a blue carbon sink, nutrient fixation, and protection of the coastline from erosion. To predict the impact of climate change on fucoid seaweed meadows in the temperate and sub-arctic North Atlantic, we used a multidisciplinary approach, integrating Niche Modeling (biogeographic effect), heat-stress experiments (physiological plasticity), and population genetics (evolutionary responsiveness). Our findings predict and document that rising temperature is the most severe threat among climate change factors for fucoids. While rising temperature threatens fucoid seaweeds in warm-temperate regions, seaweed meadows will likely flourish in the Arctic intertidal with unpredictable changes in the structure and functioning of the Arctic intertidal ecosystem. The threatened southern-edge populations of many temperate seaweeds are ancient glacial refugia and centers of genetic diversity. Genetic diversity is considered to be the key for future adaptation to environmental change and for the long-term survival of species. Thus, a remaining key question is, whether the plastic or adaptive capacities of these populations are sufficient to survive climate change or if temperate fucoids are at risk to lose their centers of adaptive potential to future environmental change. Besides presenting our main findings, I will highlight current knowledge gaps and future directions of research.

Thursday 11:30-12:00

Evolutionary processes in fucoid algae

Ester Serraro

CCMAR, University of Algarve, Campus de Gambelas, 8005-139 Faro, Portugal

Climate-driven range shifts create evolutionary opportunities ranging from allopatric differentiation to recombination at contact zones. By analysing genetic markers and developing species distribution models, we inferred effects of range contractions, and expansions on the spatial distribution of the gene pool of several fucoid species. During range expansions distinct gene pools can form contact zones where processes of hybridization and introgression can take place, and as their modified genomes continue the range expansion such effects become magnified. Our results show that range shifts provide unique opportunities for introgressive recombination of genomes at contact zones, and these have played very important roles in fucoid biodiversity.

Thursday 12:00-12:30

Mapping intertidal seaweed communities from remote sensing data: an object-based approach

Paula Lightfoot[1], Nicholas Polunin[1], Catherine Scott[2], Clare Fitzsimmons[1]

[1]School of Marine Science and Technology, Newcastle University, Armstrong Building, Newcastle upon Tyne, NE1 7RU, UK. [2]Natural England, Lancaster House, Hampshire Court, Newcastle upon Tyne, NE4 7YH, UK.

The distribution and abundance of temperate intertidal seaweed communities around the British Isles have changed in recent decades and further changes are predicted due to ocean warming and acidification. Intertidal habitat maps are needed at both fine and coarse scales to monitor these changes and inform decision-making, but current methods of field survey and manual interpretation of aerial imagery can be time-consuming and subjective.

Object-based image analysis (OBIA) of remote sensing data is an increasingly popular method for producing habitat or land cover maps. Users create automated workflows to segment imagery, creating ecologically meaningful objects which are then classified based on their spectral or geometric properties, relationships to other objects and contextual data.

Using North Sea Marine Protected Areas as study sites, our research evaluates the potential of OBIA and remote sensing data for mapping and monitoring intertidal seaweed communities. We developed and tested OBIA workflows for interpreting ultra-high resolution imagery collected by an unmanned aerial vehicle (UAV) to map intertidal habitats at two thematic scales, comparing the accuracy, consistency and reproducibility of three supervised classification approaches. To evaluate the change-detection capability of OBIA in the intertidal environment, we developed and compared two methods for quantifying change in extent and distribution of seaweed communities from freely available aerial and LiDAR time-series data.

This talk will present and discuss our findings. We demonstrate that OBIA offers robust methods of mapping intertidal seaweed communities from ultra-high resolution UAV imagery (mean accuracy 83.4% ± 3.8%) and lower resolution aerial and LiDAR imagery (mean accuracy 71.0% ± 1.6%) and of detecting change in seaweed coverage.

Developed in partnership with the responsible monitoring authorities, OBIA methods could integrate ecological knowledge and remote sensing data as a basis for cost-effective intertidal monitoring protocols, providing solutions for large-scale rapid assessment and more targeted, detailed surveys.

Thursday 12:30-13:00

Fucoid macroalgae as ecosystem engineers: where natural history meets ecological theory

Stuart Jenkins

School of Ocean Sciences, Bangor University, Menai Bridge, LL59 5AB

Canopy forming fucoid macroalgae play a fundamental role as habitat formers or ecosystem engineers on temperate rocky shores worldwide. By modifying environmental conditions, fucoid canopies have a huge impact on species identities in understorey communities and modulate the direction and strength of interactions both among and within species. Here I review 2 decades of experimental work focusing on the community structuring roles of fucoids, placed within a context of global environmental change. Manipulative experiments on sheltered rocky shores have shown how the long lived canopy alga *Ascophyllum nodosum* may indirectly influence the balance between keystone grazers and algal domination of the substratum. Such interpretations were only possible owing to the long-term (12 year) nature of this work. Extension of such work to simulate realistic levels of disturbance has shown that loss of canopy at small spatial scales can have important consequences to fucoid recruitment and consequently to the mosaic of fucoids within *Ascophyllum* beds. As dominant members of rocky intertidal communities and hence the focus of experimental ecologists worldwide, fucoids have played an important role in generating understanding regarding the role of biodiversity in ecosystem functioning, including productivity, stability and invasibility. Two separate studies across replicate sites within Europe have examined the extent to which fucoid canopies may enhance resistance to disturbance and promote stability within understorey assemblages. Both studies demonstrate complex outcomes but latitudinal patterns in structure, functioning and stability are evident. Finally, extending the theoretical nature of fucoid research to invasion biology, experimental work has demonstrated how, through modification of resource availability, canopy forming fucoids- *Halidrys siliquosa* and *Cystoseira* spp - may modify the invasibility of algal assemblages.

MANTON PRIZE SESSION

Thursday 13:50-17:00

The Irène Manton (1904-1988, right) Prize is awarded at the Winter Meeting each year for the best student presentation.

Thursday 14:00-14:20

The use of natural infochemicals for sustainable and efficient harvesting of the microalgae Scenedesmus spp for biotechnology

Sebastiana Roccuzzo[1], Andrew P. Beckerman[2], Jagroop Pandhal[1]

[1]Department of Chemical and Biological Engineering, University of Sheffield, Mappin Street, Sheffield, S1 3JD, UK. [2]Department of Animal and Plant Sciences, University of Sheffield, Alfred Denny Building, Western Bank, Sheffield, S10 2TN, UK.

Microalgae offer a promising way to biofuels or animals feed. Open Ponds are regarded as the most economically viable option for large scale cultivation systems; however, many hurdles still exist, including reducing the energy inputs for harvesting cells. Also, they are open to invasion by grazers, which can potentially damage the cultivation. However, some invasive organisms have interactions with algae that are potentially beneficial to industry, which we aim to exploit. In this study, we focused on chemical cues (infochemicals) produced by the grazer *Daphnia*, reported to induce a defense mechanism of colony formation in microalgae, leading to sedimentation of algal cells and hence potentially providing a low energy and environmentally friendly harvesting method. In particular, we evaluated the role of *Daphnia* infochemicals on triggering flocculation of *Scenedesmus spp*, studying the combined impact of cues concentration and algal growth stage on flocculation efficiency, size distribution and composition of flocs. This was estimated by means of OD measurements, cell count and microscopy/image analysis. The highest removal efficiency was at ~80% for early exponential cultures exposed to concentrated cues. Image analysis of the aggregates, mainly composed by unicells, showed a high influence of algae growth stage and cues concentration on their size distribution. Further microscopy analysis of the flocs revealed a mucous material surrounding the algae cells, whose composition was analysed by FTIR spectroscopy, showing carbohydrates as main components. Furthermore, as the algae cell wall charge is one of the parameters affecting aggregation, we detected a *Daphnia* dependent variation in the isoelectric point of flocs vs planktonic algae. These results suggested an additional mechanism, other than colony formation, in response to predation risk and responsible for algal aggregation. These results show the potential advantages of using natural infochemicals over traditional coagulants, including lower costs and a more sustainable harvesting process

Thursday 14:10-14:30

Diversity and genomics of cyanobacteria in the cryosphere

Nathan Chrismas[1], Gary Barker[2], Alex Anesio[1], Patricia Sánchez-Baracaldo[1]

[1]Bristol Glaciology Centre, School of Geographical Sciences, University of Bristol. [2]Cereal Genomics, School of Biological Sciences, University of Bristol

In the extreme cold of Arctic, Antarctic and Alpine environments, cyanobacteria are of fundamental ecological importance as primary producers and ecosystem engineers. Yet while their role in biogeochemical cycles is well appreciated, the full extent of the diversity of cyanobacteria in the cryosphere is not yet known. Furthermore, the mechanisms that allow them to survive in such extreme conditions, and the means by which these mechanisms evolved, are not fully understood. In this project we used up to date genomic techniques to begin to answer some of these questions. First, by using a combination of traditional phylogenetics, phylogenomics and Bayesian ancestral state reconstruction we explored the diversity of cyanobacteria from polar and alpine environments and made predictions about which lineages of extant cyanobacteria are likely to have had cold-tolerant ancestors. The earth's cold environments are shown to support lineages of cyanobacteria from all across the cyanobacterial phylum. A total of 20 lineages have a putative cold tolerant ancestor and several of these lineages appear to be exclusive to the cryosphere. Second, we present the first sequenced draft genomes of cyanobacteria from the cryosphere; *Phormidesmis priestleyi* BC1401, isolated from cryoconite on the Greenland Ice Sheet, and *Leptolyngbya* sp. BC1307, isolated from the edge of Lake Hoare in the McMurdo Dry Valleys, Antarctica. Neither of these genomes exhibited the typical molecular hallmarks of psychrophily, corroborating the widely held assumption that polar cyanobacteria are cold tolerant rather than cold adapted. Instead, mechanisms for the production of extracellular polysaccharides and adaptation of the photosynthetic apparatus represent possible ways that these organisms deal with other pressures of the environment such as desiccation, freezing and high irradiance. Together the work presented here highlights the huge potential for investigating polar and alpine cyanobacteria at a molecular level and will serve as a springboard for future studies.

Home

Thursday 14:30-14:50

Seasonal distribution of sediment-dwelling protists (SDPs) in intertidal flats of Sligo Bay, West of Ireland

Henry Koehler, Lorraine Archer, Donal McGee, Nicolas Touzet

Centre for Environmental Research Innovation and Sustainability (CERIS) at the IT Sligo (Ireland)

Eutrophication in coastal waters has increased in the last decades worldwide owing to growing human populations and the development of industrial and agricultural activities. The EU - Water Framework Directive (WFD) introduced in 2000 set out measures to improve the quality of all water bodies by 2015. Phytoplankton diversity is considered a suitable biological indicator to determine the trophic state of coastal waters and its identification has traditionally been carried out by microscopy analysis. Intertidal sand-dwelling protists (protozoa and microalgae) have seldom been the focus of attention of ecological studies compared to planktonic organisms. This is partly due to the difficulty of carrying out microscopy analysis on samples containing high amounts of detrital organic and mineral materials. Yet benthic microorganisms are present in the sediments all year round and generally are not flushed out by tidal action in comparison to phytoplankton. Populations and communities at sites along the coastline may hence be viewed as sedentary and their structure a reflection of their local environment.

This study focuses on the seasonal distribution of sediment-dwelling protists (SDPs) in intertidal flats of Sligo Bay, Ireland. The well-established molecular method PCR-DGGE (Polymerase Chain Reaction – Denaturant Gradient Electrophoresis) and HPLC-based pigment analysis were used to investigate the community structure of SDPs. The molecular data generated will provide the foundations for the future ecological mapping of particular benthic protists species, population and/or communities of interest. It is anticipated that diversity results could contribute to the development of new environmental quality indices for incorporation to extent monitoring programmes.

Thursday 14:50-15:10

Diatoms: From DMSP Synthesis to Global Significance

Seth Thomas, Martin Johnson and Gill Malin

Centre for Ocean and Atmospheric Science, School of Environmental Sciences, University of East Anglia, Norwich Research Park, Norfolk, NR4 7TJ

Diatoms are a globally important group of microalgae, contributing as much as 40% of oceanic primary production, and playing key roles in the global biogeochemical cycling of carbon, nitrogen, phosphorus and other elements. The importance of diatoms in the global cycling of sulphur is becoming increasingly evident. Dimethylsulphoniopropionate (DMSP) is the cellular precursor of the volatile trace gas dimethylsulphide (DMS). Only a small portion of DMSP ends up as DMS but this oxidises in the atmosphere forming sulphate particles that can act as cloud condensation nuclei. Overall this increases global albedo resulting in climate cooling. Generally, increased DMSP concentrations will result in larger DMS emissions and increased cooling. DMSP is produced by various marine microalgae, a trait shared with diatoms albeit at lower concentrations than other phytoplankton taxa. A high global biomass and experimental evidence of cultures of diatom species upregulating DMSP production under common environmental stress conditions, e.g. decreased nutrient availability, changes in salinity and temperature, give the impetus for our detailed study of this group. Our experiments aim to quantify DMSP synthesis, half-life and exudation using stable isotope methods coupled with analysis by gas chromatography with mass spectrometry, with diatom cultures exposed to nitrate deficiency, decreased salinity and increased temperature. Ultimately, we will incorporate the synthesis and exudation rate data into the global biogeochemical model PlankTOM10. Improving our understanding of global DMSP and DMS budgets will help us towards understanding the climate of the future.

Thursday 15:10-15:30

Transcriptomics analysis to investigate the host responses of brown algae (*Ectocarpus* spp.) during infection caused by the oomycete pathogen *Eurychasma dicksonii*

Srilakshmy L Harikrishnan[1],Michiel Van Bel[1],Yacine Badis[2], Antonios Zambounis[2], Martina Strittmatter[2], Lieven Sterck[1], Claire MM Gachon[2], Yves Van de Peer[1]

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The tiny filamentous brown microalga *Ectocarpus*, like any other living organism, is plagued by diseases caused by different types of micro-organism like fungi, oomycetes, bacteria or viruses. The fungal-like micro-organism oomycete *Eurychasma dicksonii*, which infects more than 40% of the tested algal species, is used as a model to investigate the molecular mechanism of these interactions. Importantly, not all algae are equal: some species are resistant (R) to the infection, whereas some are susceptible (S). To further investigate the algal responses to infection, we analyzed RNAseq data of three different species of *Ectocarpus*: i. *Ectocarpus siliculosus* (genome strain (S)) ii. *Ectocarpus* sp (R) iii. *Ectocarpus fasciculatus* (R) treated with two strains of *Eurychasma dicksonii*. Differentially expressed algal genes were identified between the mock and the infected samples for each of the above treatments. The orthologous genes in three different *Ectocarpus* species were identified through PicoPLAZA: 11.094, 1504 and 696 of the *Ectocarpus* genes were shared across all three species, across *E. fasciculatus* and *E. siliculosus* and across *E*. sp and *E. siliculosus* respectively. Using the available high quality genome annotation of *E. siliculosus*, we were able to functionally annotate more than 70% of the *E. sp* and *E. fasciculatus* transcriptomes. We then compared the expression levels of these orthologous genes across the *Ectocarpus* transcriptomes. With the integration of gene expression, functional annotation and orthologous gene data, a subset of genes that are highly induced during susceptible and resistant interactions across the three *Ectocarpus* species was obtained, and will be tested for in-situ functional validation using FISH. A similar approach is also carried out with the *Eurychasma* transcriptomes, in order to identify key genes involved in virulence and infection. Specific highlights of these analyses, such as their significance in the light of algal evolution and disease management in aquaculture, will be presented.

Thursday 16:00-16:20

Investigating the role of calcification in coccolithophores

Charlotte E. Walker[1,3], Alison R. Taylor[2], Gerald Langer[1], Toby Tyrrell[3], Colin Brownlee[1,3] and Glen L. Wheeler[1]

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Coccolithophores are globally distributed, unicellular marine algae belonging to the phylum Haptophyta. Characterised by their internally produced calcite coccoliths, bloom forming species in particular play a crucial role in ocean biogeochemistry through the transport of carbon from surface waters to the deep ocean. Despite their ecological significance, the role and process of calcification remains poorly understood. One of the reasons for this is that studies to date have predominantly focused on *Emiliania huxleyi,* the most globally abundant coccolithophore species, which can readily exist in a non-calcified state in laboratory culture without a significant impact on cell fitness. However, emerging evidence suggests that there are important physiological differences between species and that the mechanisms of calcification in *E. huxleyi* are not typical of all coccolithophores. *Coccolithus braarudii,* a significant contributor to global calcite production, has been highlighted by recent literature as a contrasting species to *E. huxleyi* in calcification mechanisms. We applied a multifaceted approach to examine the impact of disrupting calcification in *E. huxleyi* and *C. braarudii* in culture experiments. We find major physiological differences between these species and demonstrate that inhibition of calcification has a major impact on *C. braarudii* fitness. These findings suggest that calcification may have distinct cellular roles in these organisms, which may have important implications for our understanding of the evolution and ecology of coccolithophores and their response to our changing oceans.

Thursday 16:20-16:40

Proliferation of the invasive kelp, *Undaria pinnatifida,* from marinas to rocky reef and the potential for its control

Graham Epstein[1], Dan Smale[1], Steve Hawkins[1,2]

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The kelp *Undaria pinnatifida* is one of only two marine macroalgae included in the Invasive Species Specialist Group list of 100 most invasive species of the world. Despite its widespread distribution in the UK, *Undaria* has been found on natural substrates in only a few areas, with the majority of records from marina pontoons.

The distribution and abundance of *Undaria* in marinas and adjacent rocky-reef habitats was surveyed across 5 regions on the south coast of Devon and Cornwall. *Undaria* was recorded at all 13 surveyed marinas, however was found at only 17 of 35 reef sites, all within 2 regions (Plymouth Sound and Torbay). At reef sites, probability of occurrence and abundance was greater at more wave-sheltered sites with lower coverage of canopy-forming macroalgae, particularly *Laminaria* spp. However, it was also significantly related to the level of propagule pressure from marina habitats, indicating potential proliferation from marinas to natural reef.

To investigate the potential for restricting its spread, a variety of exclusion methods were applied to experimental patches of marina pontoon at two sites, and maintained monthly. This included selective exclusion of *Undaria,* mechanical clearing of all fouling, and thinning of all macroalgae. Across all manipulations, *Undaria* was found to have an extended recruitment period allowing it to persist year round. Recruitment was diminished by clearing the gametophyte seed-bank and presence of competing macroalgae; however the temporal pattern of recruitment was seen to be highly plastic, altering based on exclusion method.

Excluding or limiting *Undaria* in marina habitats would be highly challenging, but could limit its spread to natural reef habitats. The results of this study should help advise on methods and priorities for the control of this highly invasive species. Further, ongoing work will examine the impacts of *Undaria* on native assemblages in natural and artificial habitats.

Thursday 16:40-17:00

Thermal tolerance of range edge and range centre kelp populations: evidence for thermal ecotypes

Nathan G King[1], David C Wilcockson[1], Laura Hoelters[1], Dan A Smale[2], Pippa J Moore[1,3]

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Climate change is causing the redistribution of marine species, which can have serious consequences for the functioning of entire ecosystems. If we are to understand and predict how distributions will change as climate change progresses we must first understand the physiological traits that explain existing distributions. Kelp forests are amongst the world's most ecologically important habitats, providing a range of goods and services important to human society. Unlike mobile biota they must utilise physiological and biochemical pathways in order to deal with a changing thermal environment. *Laminaria digitata,* an important canopy forming shallow-subtidal/ low-intertidal kelp, is distributed on both sides of the Atlantic with trailing edges at Cape Cod on the eastern US seaboard and the 17 ^{o}C summer isotherm in the English Channel. Southern populations in the NE Atlantic have seen recent declines with poleward contractions predicted over the next 100 years. In this study, we examine the heat shock response (upregulation of Hsp70 mRNA) to common garden temperature stress (8-32 ^{o}C) of central and trailing edge populations. Results indicate that populations are adapted to local temperature regimes with edge populations showing greater capacity to cope with higher temperatures. No difference in seasonal comparisons was observed indicating a limited plasticity in regional heat shock responses. If tolerances are genetically fixed and thermal ecotypes are present then it may not just be trailing populations that are susceptible to climate change. This would have serious implications for species response models and management strategies and warrants further investigation.

ECOLOGY AND CHANGE 1

Friday 09:00-10:40

Friday 09:00-09:20

Freshwater Diatom Flora of Britain and Ireland – filling a gap and addressing difficult issues.

Eileen J. Cox

Science Resources, The Natural History Museum, Cromwell Road, London, SW7 5BD.

Diatoms are a key group for the ecological assessment of freshwaters under the Water Framework Directive, but no modern diatom flora covering Britain and Ireland exists. Although diatoms were originally to be included in the Freshwater Algal Flora of the British Isles, it became clear that this was impractical, given the number of diatom taxa and associated taxonomic problems. Approximately 2800 species of freshwater diatoms have been recorded from Britain and Ireland, and diatom taxonomy has been subjected to significant revision over the last 20 years.

A history of the British Diatomaceae by William Smith (1853, 1856) represents the only explicitly British diatom flora (marine, brackish and freshwater taxa). Hendey (1964) published an account of British marine diatoms, Hartley (1986) compiled a checklist of diatom species records, Sims (1996) edited an Atlas of diatom illustrations, Whitton et al. (1998) made a coded checklist of taxa, and most recently a CD-based interactive key to common river diatoms was produced (Environment Agency 2007). Only Krammer & Lange-Bertalot's four volume contribution to the Süßwasserflora von Mitteleuropa (1986, 1988, 1991a, b) attempted to cover freshwater diatoms in northern Europe, but this is now taxonomically out-dated. It was also written in German, which created problems for some users.

It is clear from the results of ring tests that there are recurring problems with the identification of some diatom species due to variable access to specialist literature, while inconsistent taxonomic treatments reduce the accuracy / comparability of ecological assessments. The new flora will greatly expand the species coverage (from the CD identification key), incorporate the most recent taxonomic revisions, and integrate ecological information from British and Irish sites. Its online format will also allow rapid content updates. This talk will present the background to the project, and some important aspects of its design and delivery.

Friday 09:20-09:40

Freshwater Diatom Flora of Britain and Ireland – an online identification tool.

Ingrid Jüttner

Natural Sciences, Amgueddfa Cymru – National Museum Wales

Diatoms are a key group for the ecological assessment of freshwaters under the Water Framework Directive, but no modern diatom flora covering Britain and Ireland exists. It is known that there are recurring problems with the identification of some diatom species, due to variable access to specialist literature, and differences in taxonomic opinion. These problems impact on the accuracy of ecological assessments. The new flora will incorporate the most recent taxonomic revisions, and the format will allow rapid update of contents.

The website 'Diatom Flora of Britain and Ireland' is an online identification tool for researchers, students, and professionals with an interest in diatom taxonomy, ecology and biogeography. It has been available online since December 2016 and provides a documentation of taxa found in the British Isles using light and scanning electron microscope images. Descriptions and literature references are currently available for 192 taxa with an emphasis on those frequently encountered during water quality assessments. The website will be updated continuously with a minimum of 80 taxa added annually.

The British Phycological Society has provided funding from 2014 – 2018 for the team of 10 editors (Martyn Kelly, Bowburn Consultancy; Eileen Cox, David Williams, The Natural History Museum, London; David Mann, Royal Botanic Garden Edinburgh; Helen Bennion, Roger Flower, Viv Jones, Carl Sayer, University College London, Environmental Change Research Centre; Chris Carter, Northampton) to meet for workshops and visit facilities and collections to compile data and images for the website.

The website is hosted by Amgueddfa Cymru – National Museum Wales and was designed by James Turner. This talk will introduce the features of the website and outline plans for its development in 2017/18.

Home

Friday 09:40-10:00

Composition of microphytobenthic biofilms in coral reefs, and influence on coral recruitment

Claire Passarelli[1,2], Audrey Loubet[3], Cédric Hubas[3], Saki Harii[1], Hideyuki Yamashiro[1]

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Microphytobenthic biofilms play numerous roles in coral reefs, including potential roles on coral recruitment. However, their ability to play these roles is dependent on their composition, whose variations are currently poorly understood. As the coral cover decreases in coral reefs worldwide, while macroalgal cover is increasing, it is worth assessing if human influence or macroalgal development could modify the composition of biofilms in coral reefs, and through them prevent a successful recruitment by corals. In this study in Okinawa, Japan, we characterised the composition of microphytobenthic biofilms in two reefs submitted to different human impact, and at several sites with various biotic environments within each reef. We then tested how changes in compositions of these biofilms affected their ability to stimulate the recruitment of the larvae of the coral *Acropora tenuis*, a common species in these reefs. We hypothesised that the composition of biofilms will vary both between reefs, and depending on their biotic surroundings within each reef; and that biofilms grown in an impacted reef or near macroalgae will be less able to stimulate coral recruitment than biofilms grown in a pristine reef or near healthy corals. Our results showed that biofilms in the two reefs had different microbial composition, mostly due to changes in the photosynthetic community. Only slight differences between biofilms from various biotic environments were found within each reef. The composition of the biofilm matrix was also different between reefs, with an accumulation of glucose in exopolymers in the pristine reef which suggested higher photosynthetic rates than in the impacted reef. These changes in microbial and matrix compositions impacted the ability of biofilms to promote the recruitment of larvae of *Acropora tenuis*; microphytobenthic biofilms dominated by diatoms, with a high photosynthetic activity, seemed to be the most efficient in stimulating the recruitment of coral larvae.

Friday 10:00-10:20

Examining how kelp forest community dynamics differ along a latitudinal gradient in Great Britain

Jacqui Pocklington[1], Jane Delany[1], Charlotte Foster[1], Nova Mieszkowska[2], Ben Holt[2], Leoni Adams[2], Kathryn Pack[2], Sue Hull[3], Nicola Dobson[3], Ruth Dunn[3], Jane Pottas[3], Mike Burrows[4], Hannah Grist[4], Peter Lamont[4], Justine Millard[5], Leonie Richardson[5], Heather Sugden[1]

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Kelps in the United Kingdom have been relatively understudied compared with other marine groups, despite being widespread and ecologically important. Due to the location of the UK, astride an important biogeography boundary of cold arctic waters meeting warmer boreal waters, the seas around our coastline present a unique opportunity to study the implications of sea temperature rise on range shifts, especially for those species whose northern or southern distribution limit lies within this region. It is unclear how species in this area will respond to these changes. One of the most dramatic intertidal range shifts observed in recent years has been that for the cold water kelp *Alaria esculenta*, with its current southern limit at Seaton Sluice, Northumberland. This study serves to document the distribution and abundance of kelp species across the infralittoral zone of the UK and record its associated flora and fauna. Quantitative surveys were carried out during Spring and Autumn in four regions: South West England, South Wales, West Scotland, and the North East of England, benefiting from the network of marine labs engaged in the Capturing our Coast programme. *Laminaria digitata* was widespread. Regional differences were found in the distribution and abundance of the kelp *Laminaria ochreleuca* and *Alaria esculenta*.

Friday 10:20-10:40

Towards a better understanding of ecological structure and functioning in UK kelp forests: An update on the Team Kelp (UK Division) fieldwork program and related outputs

Dan Smale[1], Harry Teagle[1], Albert Pessarrodona[1], Martin Sayer[2,3], Michael T. Burrows[3], Nathan King[4], Mathilde Bue[4], Pippa Moore[4]

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Kelp forests dominate shallow rocky habitats across much of the world's temperate coastline. As foundation species, kelps support high levels of primary productivity, magnified secondary productivity, and provide habitat for highly diverse associated assemblages. However, a recent lack of targeted research on subtidal kelp forests in the UK has led to pressing knowledge gaps, which current impede our ability to conserve and manage these critical habitats during a period of rapid environmental change. Over the past 3 years, a significant field-based research effort has focussed on examining the ecological structure and functioning of kelp forests dominated by *Laminaria hyperborea*. We have quantified a suite of ecological and environmental variables at 12 sites, nested within 4 regions, that span 9° in latitude (~3°C in mean sea temperature), from Orkney in north Scotland to Plymouth in southwest England. The population structure of *Laminaria hyperborea* is variable at multiple spatial scales, but sporophyte density and morphology is strongly influenced by site-level variability in wave exposure. Sporophyte biomass and standing crop of carbon varies at regional-scales, and tend to increase with increasing light availability and decreasing temperature. The broader structure of kelp forest habitat also varies between both sites (driven by variability in wave exposure and sedimentation rates) and regions, with the cold-water kelp *Alaria esculenta* prominent in the north and the warm-water kelp *Laminaria ochroleuca* present in the south. Crucially, growth rates, biomass accumulation and detritus production of *Laminaria hyperborea* also vary along the regional-scale temperature gradient. By using a space-for-time substitution approach, we predict that continued sea water warming will lead to a reduction in primary productivity and shifts in community composition and canopy structure in kelp forests dominated by *Laminaria hyperborea*, which could influence the wider functioning of nearshore coastal ecosystems.

Home

PHYSIOLOGY AND BIOCHEMISTRY

Friday 09:00-10:40

Friday 09:00-09:20

Exploring the genomes of extremophilic red algae *Galdieria* with 2nd and 3rd-generation genomics to unlock Industrial Biotechnological applications

Seth J. Davis

Department of Biology; University of York. York YO10 5DD.

Galdieria are red algae that exhibit wide metabolic versatility and display enormous capacity to thrive at highly acidic conditions (down to pH 0) and temperatures above 55 °C, which is the theoretical limit of eukaryotic life. Members in this genus display broad metabolic repertoires allowing vigorous chemoheterotrophic growth on virtually any sugar, sugar-alcohol or organic acid source and they are additionally capable of photoautotrophic growth aerobically and anaerobically. *Galdieria* are metabolic workhorses. They are known to detoxify contaminants under high concentrations of toxic metals and thus are targets for bespoke bio-mining applications for precious metal and rare-earth metal accumulation. The constellation of biochemical versatility in differing strains suggests a large repertoire of metabolic enzymes, which are potentially a rich source of thermo-stable proteins for biotechnology. We are tapping in to these resources by examining the phylogenomic space of dozens of our newly sequenced *Galdieria* genomes. We also will report the first-ever eukaryotic draft genome *de novo* assembled from the MinION nanopore 3rd-generation sequencing approach. The extremophile lifestyle of *Galdieria* makes them fascinating organisms to study from both a mechanistic viewpoint and to find those novel species with properties that have industrial biotechnological (IB) applications.

Friday 09:20-09:40

Use of FTIR spectrophotometry to monitor post-harvest treatments in seaweeds for enhancement of macromolecular composition

Fleuriane Fernandes[1], Hilary Redden[2], Maria Scolamacchia[1], Kevin J Flynn[1], Claudio Fuentes-Grünewald[1]

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The aim of this study was to test the utility of FTIR-spectroscopy to monitor macromolecules composition (proteins, lipids and carbohydrates) in two economic kelps species (*Laminaria digitata* and *Saccharina latissima)* and in the environmentally important green algae *(Ulva lactuca)* when they are exposed to post-harvest treatments of temperature, salinity, nitrate and light. An increase in carbohydrates content was found in kelps species when they were stressed using temperature (> 200% in *Saccharina* and > 125% in *Laminaria*). In *Ulva* an increase in macromolecules composition was found when they were subjected to nitrate depleted conditions. Such changes simultaneously warn of the importance of rapidly processing material after harvesting, as well as the utility of controlled manipulations to enhance composition for commercial exploitation. FTIR spectroscopy was found to be a reliable and rapid tool to provide quasi-real time analysis for monitoring these changes.

Home

Friday 09:40-10:00

Novel strategies for preventing diseases in cultivated seaweeds

Claire M.M. Gachon[1], Martina Strittmatter[1], Yacine Badis[1], Pedro Murúa[1], Benoît Calmes[1], Bertrand Jacquemin[2,3], Myriam Valero[2,3], Marine Vallet[4,5], Soizic Prado[4], Elizabeth J. Cottier-Cook[1].

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In any agricultural or aquaculture system, pests and pathogens typically reduce production yields by a fifth to a third; this also holds true for cultivated seaweeds. As seaweed cultivation develops and intensifies worldwide, the frequency and severity of disease outbreaks is increasing, for example on *Gracilaria*, *Pyropia,* eucheumatoids and kelps. Here, I will brush over different strategies developed in my group to describe and characterise hitherto unreported diseases of seaweeds and control pathogens in a cultivation context.

As a prerequisite for the implementation of meaningful breeding strategies in brown algae, I will introduce our work on the mechanisms and heritability of disease resistance in *Ectocarpus*; we find that disease resistance is a phenotypically stable, quantitative, and heritable trait. Its fundamental mechanism is not only conserved against several pathogens but also across the entire brown algal lineage, thus providing proof-of-concept to breed for disease resistance in commercially important species.

To address the need for fast cost-effective tools fit for the quantitative phenotyping of numerous individuals, nephelometry will be described as a novel, non-invasive method for medium-throughput biomass measurement of macroalgae; application examples will be presented not only for disease diagnostic, but also for fertility and *in vivo* growth measurement.

I will also briefly introduce our work on commensal or beneficial microbes naturally associated to seaweeds that may counteract pathogens and be used as biocontrol agents and the outcome of a collaborative initiative undertaken in the framework of *GlobalSeaweed*, leading to recommendations for policy-makers.

Friday 10:00-10:20

Growth, death and exopolymer particle production by diatoms

Daniel C. O. Thornton[1], Jie Chen[1], Elise Wilbourn[1] and Sarah D. Brooks[2]

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Exopolymer particles play a significant role in the marine carbon cycle. They are a large pool of organic carbon and affect the aggregation of particles and the biological carbon pump. Exopolymer particles form from precursors produced by phytoplankton and are operationally defined by the dyes used to stain them. Transparent exopolymer particles (TEP) are composed of acid polysaccharides and Coomassie staining particles (CSP) contain proteins. Factors that affect the production and composition of exopolymer particles are poorly constrained. A limitation of current methods to quantify exopolymer particles is the lack of compositional information and the ability to express TEP and CSP concentrations in terms of carbon. To address this knowledge gap we are developing Raman spectroscopy methods to characterize the chemical composition of individual TEP particles. Observations of exopolymer particles in an upwelling region in the eastern Pacific Ocean and laboratory experiments with *Thalassiosira weissflogii* indicate that TEP and CSP are distinct populations of particles rather than polysaccharide and protein components of the same particles. We hypothesize that autocatalytic cell death plays a major role in the formation in the of exopolymer particles as an increase in cell permeability is associated with death. *Thalassiosira weissflogii* was exposed to hydrogen peroxide as a stressor, resulting in a reduced quantum yield of photosystem II, increased caspase-like activity, and an increase in the proportion of permeable cells. CSP concentrations were not affected by hydrogen peroxide concentration and did not correlate with indicators of stress and death. However, there was an increase in the TEP concentration in the cultures, indicating that TEP formation was associated with cell permeability and death. These data indicate that different environmental factors and physiological processes affect the production of different types of exopolymer particle.

Friday 10:20-10:40

The breakdown of bacterial "armour": feebleness of an invasive seaweed holobiont?

Mahasweta Saha[1,2] and Florian Weinberger[1]

[1]Benthic Ecology, Helmholtz Center for Ocean Research, Düsternbrookerweg 20, 24105 Kiel, Germany. [2]Current address: Trace Gas Biology, School of Biological Science, University of Essex, Colchester CO4 3SQ, United Kingdom.

Seaweeds represent up to 40 % of all introduced marine species, and some seaweeds can significantly affect the composition and functioning of marine benthic communities. Within ten years after its first discovery in the Kiel Fjord in 2005 the East Asian invasive red seaweed *Gracilaria vermiculophylla* has spread approximately 100 km eastward and 120 km northward along the German Baltic Sea coast, inhabiting now many lagoons and sheltered bays between the German-Danish border and Neustadt. During the first two years after its discovery *Gracilaria vermiculophylla* increased its biomass in the Kiel Fjord massively. However, this was followed by a sudden decline in late summer 2008, when the alga decayed in nearly all inhabited parts of the bay within few weeks. Co-cultivation of healthy *G. vermiculophylla* from unaffected environments with small amounts of decaying material from the Kiel Fjord in laboratory assays demonstrated that the decay was apparently caused by an infectious disease. Thus, 59 different species of epibacteria isolated from *Gracilaria* were tested for their capacity to induce decay in a bleaching assay. Out of these, 3 were found to induce the disease, while 19 others significantly reduced the risk of decay and were thus protective. When protectors and pathogens were tested together, the protective strains fully prevented the negative impact of the bleachers, hinting at the presence of an associational defense offered by *Gracilaria's* epibacteria. Presence of such an associational resistance was also supported in a follow up bioassay where surface extract of *Gracilaria* and its associated microbiome attracted the beneficial strains, but deterred the detrimental ones. Thus, we suggest that the breakdown in 2008 was due to a collapse of such associational resistance provided by bacterial partners.

SPECIAL SESSION – MICROALGAE AND CARBON CYCLING

Friday 11:10-13:10

Microalgae are found in marine, freshwater, and terrestrial habitats at all latitudes on Earth. They are a taxonomically diverse group of single-celled photosynthetic organisms that play an important role in global biogeochemical cycles and ecosystem function, accounting for an estimated 40 to 50 % of global primary productivity. Presentations in this session will explore processes associated with the physiology and ecology of microalgal carbon cycling and fluxes through ecosystems. Presenters include Tammi Richardson (University of South Carolina), Graham Underwood (University of Essex), Kevin Flynn (Swansea University) and Stephen Maberly (Centre for Ecology & Hydrology).

11:10-11:40

Carbon fluxes in ocean food webs: how phytoplankton community composition may (or may not) affect trophic dynamics and export

Tammi L. Richardson

Department of Biological Sciences and School of the Earth, Ocean and Environment, University of South Carolina, Columbia, South Carolina, USA 29208

Phytoplankton species vary greatly in size, shape, and chemical composition. This variation, in turn, influences trophic interactions and rates of biogeochemical cycling, and is thought to have considerable impacts on the rates and magnitude of organic material exported from the surface ocean to the deep sea. My presentation will focus on two aspects of phytoplankton community composition: cell size (small vs. large) and palatability to grazers ("yummy" vs. not). For each scenario, I will examine the pathways and ultimate fate of the phytoplankton primary productivity through marine food webs, and will address whether our conventional ideas of carbon flow – e.g., large phytoplankton are grazed by large grazers which results in high export fluxes - are supported by data from the field. I will use examples from my work in the Sargasso Sea, and from a recent collaboration with American and German scientists on models of carbon flow through food webs of the eastern Fram Strait.

11:40-12:10

Carbon fluxes in microalgal biofilms: the flows through dissolved organic matter and extracellular polymeric substances (EPS).

Graham J. C. Underwood

School of Biological Sciences, University of Essex, Colchester, Essex. CO4 3SQ

Microalgal biofilms are physically-structured systems found widely in marine, freshwater and even terrestrial habitats. The physical juxtaposition of autotrophs and heterotrophs, along steep physico-chemical gradients, contribute to promoting the high rates of primary production and carbon flow that are observed. Dissolved organic matter, in a wide range of forms (from small organic molecules to massive extracellular polymeric substances, EPS) plays a significant role in the flux of carbon within these biofilm systems. Not taking account of the flow of carbon though the DOM pool underestimates the contribution of microalgal systems to overall carbon cycling. This paper will draw on examples from estuarine, marine, polar and terrestrial examples, illustrating the diversity, temporal and biological reactivity of different components of the DOM pool, and the evidence for specialised groups of heterotrophs that utilise this carbon source.

Home

12:10-12:40

A new paradigm for marine planktonic primary production

Kevin J Flynn, Aditee Mitra

Biosciences, Wallace Building, Swansea University, Singleton Park, Swansea SA2 8PP, UK.

Traditionally the marine planktonic food web has been considered to be dominated by plant-like phytoplankton and animal-like microzooplankton. A review of the protists comprising these groups has led to a revised functional group description that in totality threatens, offers, to overturn this paradigm that supports marine biology. Other than the important exception of the diatoms, and ca. half the microzooplankton, it transpires that the bulk of the marine planktonic protists are mixotrophic, combining phototrophy and phagotrophy within the same cell. The basis of the new paradigm that sees mixotrophs at the heart of marine primary production will be explored, together with the various challenges and opportunities that become apparent with the revelation.

12:40-13:10

Phylogeny, physiology and environment: Is inorganic carbon an important ecological factor for freshwater microalgae?

Stephen Maberly

Lake Ecosystems Group, Centre for Ecology & Hydrology, Lancaster Environment Centre, Lancaster LA1 4AP, UK

Phytoplankton are important primary producers in many freshwaters and in excess are symptoms of poor water quality. This talk is based on three strands. First, the phytoplankton come from a wide range of phylogenetic groups including prokaryotic cyanobacteria, and eukaryotic algae from the Plantae, Chromalveolates and Excavates. Secondly, the supply of dissolved inorganic carbon in freshwaters is very variable because of variable geology and productivity within their catchment. Thirdly, in productive systems rates of carbon-uptake by primary producers can exceed rates of supply from the catchment, the atmosphere and heterotrophic regions where CO_2 is produced such as the sediment, depleting the carbon-reserves. Together, these three facts raise the possibility that inorganic carbon is an ecologically important factor that might limit phytoplankton productivity in freshwaters and control the temporal and spatial distribution of species. I will briefly illustrate these three strands before tying them together to tackle the title of the talk using field data on inorganic carbon concentrations and phytoplankton composition and laboratory experiments characterizing the ecophysiological properties of different phytoplankton species or communities.

ECOLOGY AND CHANGE 2

Friday 14:00-16:00

Friday 14:00-14:20

Gracilaria vermiculophylla: an invasive red seaweed has arrived in Britain

Caroline Magill[1], Christine A. Maggs[2], & Stacy A. Krueger-Hadfield[3]

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Gracilaria vermiculophylla is native to the NW Pacific (Japan, Korea, China). It was first reported outside this range in the Eastern Pacific, and has been present in the Western North Atlantic (Virginia, North Carolina) since the 1970s. In Europe it was initially found in France in association with oyster aquaculture and spread rapidly around Atlantic coasts of Europe, becoming abundant in estuarine habitats. In the British Isles, it was first observed in N. Ireland in 2008 near an oyster farm, but had never been recorded in England. We surveyed its distribution and abundance in N. Ireland between 2008 and 2016. In England, in 2015 we discovered a single thallus near Kingsbridge, Devon, and found a large biomass of *G. vermiculophylla* in Christchurch Harbour, Dorset. We predicted that the Christchurch population could have originated from nearby Poole Harbour, a traditional site of oyster cultivation; in 2016 we found *G. vermiculophylla* in the lagoon at Brownsea Island, Poole Harbour, where it had been reported in 2010 as *Gracilariopsis longissima*. No reproductive structures were observed and the population appeared to be stable and reproducing vegetatively – the algal thalli were extensively coated with tubes of the lagoon amphipod *Corophium insidiosum*. We observed cystocarpic and tetrasporangial thalli in Carlingford Lough and Christchurch Harbour and showed by microsatellite genotyping that both populations were only partially clonal.

Friday 14:20-14:40

Tropical macroalgae under future conditions

Dorothea Bender-Champ[1,2], Guillermo Diaz-Pulido[1,2,3], Ove Hoegh-Guldberg[1,2], Sophie Dove[1,2]

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Coral reefs worldwide are exposed to increasing ocean acidification, climate change, nutrient enrichment and overfishing. But not only reef-building corals are affected by the changing conditions, other invertebrates, vertebrates and algae are also exposed to these changes. Tropical macroalgae have a variety of roles in these ecosystems, and while they are not the ecosystem engineers, they are an important part of this ecosystem, providing food, shelter and settling substrate for corals. On the other hand, algae are believed to thrive under conditions that are deleterious to coral health and, furthermore, are strong competitors for space. In order to gain insight into algal performance under future conditions, we conducted several studies. To this end, we exposed the algae to ocean acidification, elevated temperatures and increased nutrient loads as well as combinations of these factors. Several physiological parameters, such as growth, photosynthesis and respiration rates, nutrient uptake, pigment concentrations and reproduction rates were estimated to gain a comprehensive understanding. Overall, the data showed very little evidence for increased algal growth rates, with some algae showing decreases in growth and even mortality under future conditions. It seems that ocean acidification and potential energy savings achieved by the downregulation of carbon-concentrating mechanisms do not outweigh other negative effects, such as potential thermal effects and nutrient toxicity.

Friday 14:40-15:00

Measuring climate change effects in rocky shore communities

Michael T. Burrows

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Changes in the distribution and abundance of rocky intertidal macroalgae and animals have long been used to measure responses to changing climatic conditions. Most changes are reported on a species-by-species basis in terms of fluctuating abundance and shifts in geographical ranges. Responses are variable and often hard to ascribe directly to climate change. Here I use the Community Temperature Index (CTI) approach to show how rocky intertidal communities have changed over large geographical scales and long time periods with climate. CTI measures the relative proportions of cold-water and warm-water species by averaging range midpoint temperatures, termed the Species Temperature Index (STI), for each species in the community. Geographical ranges for UK species were mapped from literature reports and matched to average sea surface temperatures to produce a thermal niche, described by percentiles of the resulting frequency distribution of coastal temperatures. Analysis of CTI values from surveys of Irish and UK rocky shores shows that, spatially, communities change in composition gradually from the warmer southwest to the colder east and north parts of the region. CTI measures based on macroalgae are less sensitive to changes in temperature than those based on animal species. This is because of the greater variability in STI values ('thermal diversity') for animal species compared with macroalgae, as expressed by the standard deviation of STI values, and a tendency towards wider species thermal ranges for macroalgae. A small decline in CTI values has occurred since 2002 at sites in the south and west of the UK, in line with changes in sea surface temperatures around the UK over the same period. In contrast, CTI values from annual surveys of 20-plus sites in Shetland have closely tracked changes in temperature since 1976. We recommend this approach as an extremely useful yet simple index of climate change response.

Friday 15:00-15:20

Brilliant and intense: structural colour in marine algae

Juliet Brodie[1], Chris J. Chandler[2], Bodo D. Wilts[3] and Silvia Vignolini[4]

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Structural colour is well-documented in nature where its function may include a means of visual communication, mate attraction or camouflage. It is widespread in the marine environment and the appearance of iridescent blue tips in the gametophyte phase of the red alga *Chondrus crispus*, for example, will be a familiar sight in rock pools in the intertidal in the North Atlantic. Structural colour is reported for red and brown algae, yet the phenomenon is largely unexplored. In the red algae two structural mechanisms are responsible for structural colour, either iridescent bodies or multi-layered cuticles, whereas in the brown algae, only iridescent bodies have been observed. The functional purpose of structural colour in these algae is unexplored experimentally, but studies from leaves of flowering plants have speculated that such colour may function as photoprotection or as predator deterrents. Here, we will explain how structural colour is produced in the algae and discuss possible evolutionary relationships with terrestrial plants. By reviewing their distribution and ecology we will also explore the functional relevance in the brown algae where structural colour is confined to species of the Fucales and Dictyotales. We will also explore the hypothesis that structural colour protects the seaweeds from radiation damage and discuss this in relation to climate change.

Friday 15:20-15:40

Epibacterial diversity and function in the physiology of polar coralline algae

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Primary colonizers of marine surfaces are often bacteria, especially on algae which produce exopolymeric substances that probably found these associations. Algae is an important habitat for bacteria and the association reciprocally influences the ecology, physiology, and biochemistry of each symbiont: while the epibacteria within the biofilm acquire resources and substrate from the host, they are also responsible for the physiochemical environment of the host alga, acting as a diffusive boundary layer (DBL) between the alga and its environment. This research project uses Miseq techniques to define epibacterial abundance and diversity and microsensors to define the role they may play in essential nutrient uptake in the Arctic coralline alga, *Lithothamnion glaciale*. *L. glaciale* is free-living coralline alga known to provide habitat and refuge for many marine species in the north-north eastern Atlantic. This species has a limited distribution along the southwestern coastline of Greenland and because biofilms play a role in the ecological functioning of corallines, we are curious to understand how they may function in this species distribution and physiology in this particular polar environment. We target nitrogen because green, red, and brown algae have no know nitrogen fixing mechanisms and nitrogen is a limiting resource for marine algae.

Friday 15:40-16:00

The effect of temperature on volatile organic compound production in coccolithophore species *Emiliania huxleyi*

Luli Randell[1], Mahasweta Saha[1], Alex Dumbrell[1], Frances Hopkins[2], Gill Malin[3] and Michael Steinke[1]

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Some key volatile organic compounds (VOCs) such as dimethyl sulfide (DMS) and isoprene have been intensively studied. In contrast, disentangling the environmental volatile metabolome using signature peaks on gas chromatograms has received little attention. This study aims to develop novel tools for the detection of signature VOCs with the purpose of translating such information into an indicative database on the diversity of VOCs in phytoplankton and its application to assess phytoplankton health. Growth and VOC production were quantified at temperatures of 16 and 26 °C in the coccolithophore species *Emiliania huxleyi* (strain CCMP 373). Gas chromatography with flame ionisation detection (GC-FID) was used to monitor VOC production during exponential and stationary growth phases. Cultures grown at 16 °C showed higher growth rates (0.194 ± 0.130 d-1) than those grown at 26 °C (0.095 ± 0.166 d-1). Most signature peaks were higher in exponentially growing cultures at 16 °C compared to 26 °C. Data suggests that significant changes in volatile metabolomes can be used to monitor the effects of temperature on algal physiology and could be applied as a diagnostic tool to monitor health and, since biological interactions can alter VOC signatures, food web functioning.

TAXONOMY AND APPLIED PHYCOLOGY

Friday 14:00-16:00

Friday 14:00-14:20

Advances in molecular tools for routine monitoring of toxic algae and pathogens in aquatic ecosystems

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Microarrays are oligonucleotides applied to the surface of a glass slide in an ordered array. When rRNA sequences are used, these are called phylochips, which can identify organisms and is a relatively new, innovative microarray application. Phylochips can facilitate monitoring for any microorganism in any environment and visualize its changes in abundance over time for long-term records. We developed in three EU projects: a phylochip for the detection of toxic algae in marine waters and for freshwater pathogens in freshwater and tested them with environmental samples in 5 countries for the toxic algae and 6 countries for the freshwater pathogens. Water samples were filtered until they clogged or concentrated into one litre using a kidney dialysis filter, **of which free filters are being distributed upon request**. Total RNA was extracted using TriReagent, fluorescently labelled and hybridised to the phylochip. The pattern captured via fluorescent excitation in the microarray scanner is exported as an excel file and analyzed based on presence/absence of probe signals in a hierarchical fashion. For a species to be present, probes for higher taxa, viz., genus to kingdom must also be present. Where calibration curves have been made, then the microarray signal can be converted into cell numbers. In a fourth EU project microarray probes were transferred to a SHA coupled to an electrochemical and a colorimeter detection. The electrochemical detection was 16 fold higher than that obtained in earlier applications and the colorimetric detection was automated for a real time in-situ assay in a buoy.

Friday 14:20-14:40

Taxonomic revision of Agaraceae (Laminariales, Phaeophyceae)

Hiroshi Kawai[1], Takeaki Hanyuda[1], Xu Gao[1], Makoto Terauchi[1], Masahiko Miyata[2], Sandra C. Lindstrom[3], Nina G. Klochkova[4] and Kathy A. Miller[5]

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We have reexamined the taxonomy of Agaraceae (Laminariales, Phaeophyceae) based on phylogenetic analyses of 6 mitochondrial and 6 chloroplast gene sequences from *Agarum*, *Costaria*, *Dictyoneurum* and *Thalassiophyllum* species as well as representative species from other laminarialean families. The genus *Agarum* was paraphyletic, comprising two independent clades, *A. clathratum/A. turneri* and *A. fimbriatum/A. oharaense*. The latter clade was genetically most closely related to *Dictyoneurum* spp., and morphologically the species shared a flattened stipe bearing fimbriae (secondary haptera) in the mid to upper portion. The phylogenetic position of *Thalassiophyllum* differed between the two datasets: in the chloroplast gene phylogeny *Thalassiophyllum* was included in the *A. clathratum/A. turneri* clade, but in the mitochondrial gene phylogeny, it formed an independent clade at the base of the Agaraceae, the same position it took in the phylogeny when the data from both genomes were combined despite a larger number of bp being contributed by the chloroplast gene sequences. Considering the remarkable morphological differences between *Thalassiophyllum* and other Agaraceae, and the molecular support, we conclude that *Thalassiophyllum* should be reinstated as an independent genus. *Dictyoneurum reticulatum* was genetically close to but independent of *D. californicum* and morphologically distinctive due to its midrib. In conclusion, we propose to treat *A. fimbriatum* and *A. oharaense* in a new genus, and the reinstatement of the genus *Thalassiophyllum*.

Friday 14:40-15:00

Evolutionary history of the hyperdiverse red algal family Rhodomelaceae

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The Rhodomelaceae, with about 1000 species growing worldwide in all benthic habitats in the photic zone, is by far the most diverse family of the red algae. It exhibits both high species diversity and a wide range of morphological architectures. The Rhodomelaceae is therefore a good candidate as a model for testing evolutionary hypotheses, but to date there has been no attempt to construct a molecular phylogeny of the family. We used a phylogenomic approach with the aim of resolving relationships among the major lineages of the family. Subsequently, we constructed a time-calibrated phylogeny to unravel the timing and tempo of the diversification of the Rhodomelaceae, and analysed the evolutionary development of morphological traits. Finally, we propose an explanation for the observed patterns, as well as speculating why this family has achieved such high taxon diversity.

Friday 15:00-15:20

Temporal dynamics of the coastal Cercozoa; revealing hidden diversity in an understudied group.

Claire Pearce[1], Thorunn Helgason[1], Michael Cunliffe[2,3], Joe D. Taylor[1,2]

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Planktonic Cercozoa are abundant protists within the marine environment. However, their Rhizarian cousins, the Foraminifera, have received much greater attention. Assessment of global micro-eukaryotic diversity has shown the Cercozoa to be present in all oceans across the globe. Many in this group are bacterivores meaning they are the most numerous predators on earth. Members of the Chlorarachniophyceae contain chloroplasts and are mixtrophs meaning that they are important components of several functional groups. Knowledge of the diversity and dynamics of marine cercozoa is limited, in part due their lower abundance than other protists (i.e dinoflagellates) in the environment. This means they are often in low abundance in high-throughput sequencing (HTS) libraries that use general Eukaryotic primers. Targetted HTS has already been applied to the Cercozoa soil systems, here we apply Cercozoa specific primers combined with HTS to profile planktonic Cercozoa over a 13 month time series at a coastal sampling station. From >1 million high quality short read sequences we found >250 Cercozoa OTUs at the site. We detected OTUs from a range of orders and novel lineages with Chlorarachniophyta. Glissomonadida, Imbricatea, Thecofilsosea and Novel clade 2 dominating the libraries. Within these there are potential members of a variety of functional groups including predators, parasites and primary producers. There are clear temporal changes within Cercozoa communities across the time series with several OTUs correlating in abundance with environmental variables such as bacterial abundance and specific phytoplankton groups. This work shows the Cercozoa are both taxonomically and functionally diverse within coastal seas and their role within marine biogeochemical cycles should not be underestimated.

Friday 15:20-15:40

Taxon-specific volatile metabolomic signatures in three species of seaweed

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Every organism emits specific metabolomic signatures. The volatile metabolome represents the diffusive subset of this and has been applied for pest control and yield improvement in agricultural systems and to develop non-invasive biomarkers in the diagnosis and monitoring of human diseases. Aquatic environments are of particular relevance since the directional quality of volatiles is further enhanced by low diffusivity and microbial production/consumption processes. However, environmental volatile metabolomics is poorly explored for the assessment of structure and function in marine systems. We developed the first steps of an analytical pipeline based on gas chromatography (GC-FID) to quantify biogenic volatile organic compounds (BVOCs) from seawater, and a semi-automated routine for chromatogram alignment and averaging. Freshly collected phaeophyte, chlorophyte and rhodophyte seaweeds (*Fucus vesiculosus*, *Ulva lactuca, Ceramium* sp.) showed taxon-specific volatile metabolomes of increasing complexity. The sulfur gas dimethyl sulfide (DMS) was a significant feature in the chloro- and rhodophyte (111 ± 90.0 and 18 ± 21.7 nmol DMS g^{-1} FW h^{-1}, respectively) whereas the phaeophyte showed lower production of 0.6 ± 0.25 nmol DMS g^{-1} FW h^{-1}. Rates of isoprene production were about three magnitudes lower but similar across the different taxa (1.9 to 11.8 pmol DMS g^{-1} FW h^{-1}). Principal Component Analysis (PCA) demonstrated clear separation of algal genera based on their volatile metabolome signatures. This suggests that volatile metabolomics could be adopted as a novel integrated approach to understand marine food web structure and function by focusing on marine BVOC signatures and their sensitivity to 'bottom-up' and 'top-down' controls. We currently explore the effect of temperature on volatile metabolomes and assess the role of BVOCs in the selective recruitment ('farming') of specific bacteria to the seaweed holobiont.

Home

Friday 15:40-16:00

An algal-bacteria consortium for successful waste remediation and probiotic effect for aquaculture feeding

Alla Silkina[1], Olga Polenogova[2], Shariza Azizan[3]

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Microalgae are an untapped resource with more than 30.000 species, of which fewer than 15 are in commercial production. Microalgal biomass is one of nature's richest raw materials in vitamins, proteins, and other nutrients. The potential application areas include waste remediation and production of feed for farmed fish and animals. The mass cultivation of microalgae is always associated with bacterial communities. Current knowledge of the composition and role of the bacterial communities associated with microalgal mass cultures is not very well known (Biondi et al., 2016; Natrah et al., 2014; Ramanan et al., 2016). Several researches (Biondi et al., 2016; Fukami et al., 1997) shown the stabilising effect of mass culture, when microalgae symbiotically grown with the bacterial associations.

An algal-bacterial consortium was isolated from an industrial site of steelwork production, at TATA Steel Strip Ltd in Port Talbot, UK and its bioremediation capacity tested. The mixed culture was "applied" to different waste-stream treatments from technological processes undertaken at the Steelwork and an anaerobic digestion plant at Dŵr Cymru Welsh Water. The research of algal mixed community applied for the waste waters and flue gas remediation was investigated in terms of presence pathogenic bacteria, after cultivation on waste nutrients. The predominant algal species in the consortium was *Franceia amphitricha*. Other algal taxa present in the consortium included: *Scenedesmus sp., Chlorella sp., Chlamydomonas sp*. and *Desmodesmus sp*. The bacterial community was composed by *Morganella morganii, Providencia rettgeri, Micrococcus luteus, Micrococcus radiodurans, Micrococcus lylae.* Different waste streams shown presences of different species in a bacterial composition, but less influenced on changes of microalgae consortium.

The physiological role of bacteria-algae consortium is studied. The biomass application was investigated as a feeding ingredient for aquaculture. It was find out that these algae-bacteria consortium provided probiotic activities and could be used in aquaculture for larvae and fish health.

Student Poster Competition

Student Poster 1

Laboratory and field studies on the interaction between kelps and filamentous algal endophytes

Miriam Bernard[1], Sylvie Rousvoal[1], Laurence Dartevelle[1], Akira F. Peters[2] and Catherine Leblanc[1]

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The marine brown macroalga *Saccharina latissima* is an important primary producer in temperate to cold northern hemisphere shores and an economically relevant seaweed with high industrial potential. Morphological changes - such as dark spots, twisted stipes and deformation of the blades - have been observed in wild populations and seaweed farms. The putative cause for the occurring symptoms is the filamentous endophytic brown alga *Laminarionema elsbetiae*, which is highly prevalent in European *Saccharina* populations but has also been found in its secondary host, the brown alga *Laminaria digitata*. *L. elsbetiae* is known to invade stipes and fronds of its hosts, however nothing is known about the molecular mechanisms of the interaction. To get further insight into the host-endophyte relationship and possible defence mechanisms, a co-cultivation bioassay was developed in order to monitor the impact of the endophyte on growth of laboratory-raised individuals of both kelp species and to test the pathogenicity of the endophyte according to Koch's postulates. First results revealed that co-cultivation of *L. elsbetiae* with *S. latissima* juveniles does not induce changes in growth or morphology of its primary host. On the contrary, growth of *L. digitata* significantly decreased within less than a week when co-cultured with the endophyte. A qPCR-based approach was set up to detect and quantify endophytic filaments within the host. Based on this method a field survey was designed to localize the endophyte within *S. latissima* sporophytes. It was shown that endophytic filaments are most abundant in the blade tip, i.e. the oldest part of the blade, suggesting that the endophyte either enters the host at an early stage or preferably infests old tissue. Ongoing experiments and field surveys aim to decipher and better understand the bases and mechanisms of the biotic interaction between the endophyte and its hosts.

Student Poster 2

Establishment of *Osmundea pinnatifida* mariculture

Cecilia Biancacci[1], Prof John Day[1], Dr Gordon J. McDougall[2], Jim Treasurer[3], Dr Michele Stanley[1].

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Worldwide production of seaweed is a profitable sector, with an annual value of US $6.4 billion. Sustainable production of algae for human consumption/high value chemicals is of vital importance for the development of robust supply chains for algal products, especially in relation to the growing demand of seaweeds products. In Europe the focus has been on the use of seaweeds as gourmet food and low-volume-high-value raw materials for novel applications. UK coastal waters constitute an ideal environment for a variety of seaweeds that have played a role in the diet and culture of coastal communities for more than 4,000 years. Currently in Scotland, seaweeds are mainly harvested from intertidal macroalgal beds. In the future, natural harvesting will be insufficient to meet the rising demand, leading to significant environmental damages. The focus of this project is the supply of *Osmundea pinnatifida*, a red macroalga, collected from the wild and marketed in its dried form as a peppery seasoning. It is used both for food and nutraceutical applications. Currently a pack retails at £12 for approximately 5g dry weight. The establishment of pepper dulse mariculture, will provide a more consistent and sustainable product, reducing the environmental impact of harvesting wild material and ensuring future employment for coastal communities. Key aspects of the project will be: improving crop yield, optimizing the cultivation; tailoring the color/texture/taste of the product for the market; assessing the biochemical/chemical composition of seasonal collected samples, to identify the best nutrient profile for a commercial exploitation; developing a methodology for cultivation, with the establishment of tank and/or outdoor cultivation systems at the industrial partner facilities, and the application of a reliable cryopreservation methods, in order to store and preserve the most promising strains ensuring a stock population. This challenging project represents the chance to translate research from academia to industry.

Student Poster 3

Characterisation of the elusive colonial haptophyte *Corymbellus aureus*

Charlotte E Walker[1,2], Olivia K. Pearse[1], Susan Wharam[1], Angela Ward[1], Gerald Boalch[1], Glen L. Wheeler[1]

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Corymbellus aureus was first identified as a colonial haptophyte in British waters by J. C. Green in 1976. Alongside the colonial nature, *C. aureus* was characterised by the presence of two flagella, oval body scales and a short non-coiling haptonema arising from an apical groves. Although initially successfully isolated and cultured, the strain was soon lost. Since then there have been very few accounts of this elusive, yet distinctive, haptophyte. Here we identified the presence of the described *C. aureus* in L4 plankton samples, collected weekly off the coast of Plymouth. The strain was successfully isolated and examined using light microscopy. Subsequently, molecular methods were used to identify its position within the haptophytes. Here we present evidence from the sequenced 28S ribosomal DNA that '*C. aureus*' was found to be a haptophyte and is likely to be closely related, or belong, to the *Phaeocystis* genus. These observations also indicate that some haptophytes have an ability to form more complex colonies than previously thought.

Student Poster 4

Seasonal Silicon Cycling in the Severn Estuary

Holly Welsby[1], Katharine Hendry[2], Rupert Perkins[3], Marian Yallop[4], Sandra Arndt[5]

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Rivers are the main conduit of dissolved silicon to the oceans, providing an essential nutrient to marine diatoms that contribute to approximately half of all surface ocean productivity. Coastal silicon cycling has gained global attention with new insight into the importance of estuarine benthic-pelagic coupling as a potential source of silicon to the marine budget. As a hypertidal estuary, the Severn is a highly dynamic biogeochemical factory. However, despite being a key component in the estuarine benthic-pelagic coupling, the role of the diatom-dominated biofilms in their mediation of benthic dissolved silica (BDSi) and biogenic silica (BBSi) in these intertidal mudflats remains unclear. We provide a first assessment of the seasonal distribution of BDSi and BBSi standing stocks, relative to the ecological functioning of these biofilms. This was achieved through the assessment of biofilms biomass (chlorophyll pigments) and their photosynthetic activity measured using variable chlorophyll fluorescence, nutrient availability and external environmental pressures. We show that BDSi and BBSi standing stocks exhibited seasonal variations that are likely attributed to the biological uptake of silicon, with near complete consumption of BDSi during the spring, summer and autumn, corresponding to increased biomineralization resulting in peak standing stocks of BBSi. We compare our new results, from 2016, to previously published data from 2014 in order to address interannual variability of silicon cycling. Our findings highlight the relative importance of diatom-dominated biofilms, and how changes in their bioproductivity influence the BBSi flux in the Severn Estuary intertidal mudflats. These hitherto largely ignored processes have the potential to contribute to the Severn Estuary silicon export to the UK southwest pelagic zone.

Student Poster 5

Changes in total lipid and lipid class composition during the growth of three marine microalgae.

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Addition of nutraceuticals (bioactive components) to food products shows promise as diet based prevention for many chronic diseases. These compounds are often hydrophobic and not easily incorporated into food products, (McClements 2012). Phospholipids, from microalgae are ideal candidates for the production of liposomes, not only allowing incorporation of the hydrophobic compound of interest, but also potentially providing omega-3. Studies have shown that phospholipids have the ability to modify uptake of dietary omega-3 fatty acids increasing adsorption of DHA in infants, (Carnielli et al. 1998), and reducing cholesterol and reducing hepatic fibrosis in mammalian models, (Wilson et al. 1998; Lieber et al. 1990). Three species were studied, *(Cylindrotheca fusiformis* CCAP 1017/2, *Nannochloropsis oceanica* CCAP 849/10, *Isochrysis galbana* CCAP 927/1). Lipid and pigments were extracted from samples taken throughout the growth phase. Percentage total lipid extract was determined and lipid classes were analysed by HPTLC and scanning densitometry. Results indicated that *C. fusiformis* phospholipid varied over the growth of the culture (3.11-14.51% of total lipid), no rapid increase in phospholipid was seen at the start of logarithmic growth phase. *N. oceanica* had overall high proportion of phospholipids, with the highest at day 5 (21.37% of TL), corresponding to the beginning of logarithmic growth, with the proportion of phospholipids remaining high throughout the log phase of the culture. *I. galbana* performed poorly in comparison, detectable phospholipid was only present at day 10 and 13, (1.03-2.79% of TL). Photoautotrophic microalgae can be produced without carbon substrates and can grow on land or utilise water sources unsuitable for terrestrial plants, conferring advantages over terrestrial plants and bacteria. With careful selection of species, microalgae could be useful future sources of complex polar lipids and phytosterols potentially for use as additives or delivery systems for high value nutraceutical products.

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Student Poster 6

Developmental and ecological response of *Fucus vesiculosus* to chronic environmental contamination in the northwest Atlantic

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Brown algae are important habitat-creating species in intertidal communities. *Fucus vesiculosus,* one member of this group, is prevalent in rocky intertidal habitats of the northeastern United States, where algal beds provide feeding and nursery habitats for commercially important fish and invertebrate species. Due to commercial and residential expansion along populous coastal waterways, organisms residing in these habitats are often subject to anthropogenic pollutant exposure. In the case of New Bedford Harbor on the southeast coast of Massachusetts, high levels of polychlorinated biphenyls and heavy metals have contaminated coastal ecosystems for decades. Although declared a priority cleanup site by the United States Environmental Protection Agency, these ecosystems remain loaded with dangerously high levels of contaminants. Despite the fact that *Fucus vesiculosus* has been historically abundant in and around the New Bedford Harbor, very little research has looked at how this contamination might affect primary productivity.

Our studies focused on the reproductive capacity of mature individuals, the ability of zygotes to meet critical developmental landmarks, and the ecological condition of populations of *Fucus vesiculosus* with varying historical exposure levels to the most common environmental contaminants. We found strong correlations between increased contaminant load and poor biological condition (delayed development, impaired or arrested ability to release gametes, and decreased biomass and density). These findings suggest a grim outlook for recovery of populations from heavily contaminated areas, but also provide insight into the ability of these fucoid algae to resist the damaging effects of chronic contamination; a quality which allows them to survive in these habitats. In an environment under increasing stress from climate change, it is important to understand the condition of these habitats and how human-induced habitat destruction has affected sessile macroalgae on a long term scale.

Home

Student Poster 7

Seasonal observation of life history stages and population dynamics of the red alga *Porphyra dioica* in South Wales

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As a result of growing public and industrial interest in using natural and local products, red algae of the genus *Porphyra* are facing increasing harvesting pressure in South Wales. Yet there is little information on their autecology, leaving collection guidelines and management strategies poorly informed. We therefore investigated seasonal life history stages and population dynamics in a species exploited in South Wales, *P. dioica*. A permanent area (30 x 30 m) at Freshwater West was sampled monthly from April – November 2016. *P. dioica* density (individuals·m^{-2}), cover (%), maximum length and width (cm) as well as environmental parameters (pH, water temperature) and benthic substrate type were recorded in the field. Reproduction status (% reproductive female and male thallus area, number of released zygotospores/agamospores per cm^2 reproductive thallus area and % zygotospore/agamospore germination) was assessed under controlled laboratory conditions. Results revealed highest *P. dioica* density, abundance, maximum length and width in May. With a high sand input into the sampling area during the end of May, the majority of the *P. dioica* population was buried. Following rising temperatures and day length resulted in decreasing condition of individuals - thalli appeared pale and were overgrown by epiphytes. *P. dioica* density and cover increased again from September onwards. Reproductive peaks occurred in spring and autumn. Zygotospores/agamospores that germinated into conchocelis were released throughout the studying period, but amount and percentage of germinating spores decreased during summer. Conchocelis development was followed in culture, but the completion of the life cycle was not successful. The filamentous conchocelis stage was not observed in the field. The study shows the strong seasonal variation of *P. dioica* in South Wales and advances the knowledge base for further resource management.

Home

Poster 8

Morphological changes, cell damage and metal localization after long term stress by Cu(II) and Pb(II) ions over the green seaweed *U. linza* on batch cultures.

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We present preliminary results to show how the green seaweed, *Ulva linza,* responds, at a cellular level, to heavy metal exposure to both Cu(II), as an essential metal, and Pb(II), as a non-essential toxin. Thalli were exposed for 7 days (long term stress), either to each ion in different concentrations, or to a mix containing both metals. Cell ultrastructure was then examined using Transmission Electron Microscopy (TEM), with metal bioaccumulation quantified by Inductively Coupled Plasma Mass Spectrometry (ICP-MS). Moreover, as a first step to identifying how the cell deals with elevated metal concentrations, we looked at metal localisation within the cell using Transmission Electron Microscopy coupled with Energy-dispersive X-ray spectroscopy (TEM-EDS). We looked specifically at the relative extents to which cellular metal accumulation was localised to the cell wall and the cell interior. Our results will be used to direct future RNAseq studies that will differentiate the cell's responses to essential (Cu) and non-essential (Pb) metal elevations.

Student Poster 9

Climate-driven shifts in species dominance affect kelp forest functioning

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Changes in climatic conditions have shaped the distribution of life throughout Earth's history. Contemporary climate change is reorganizing the composition of ecological communities by inducing species migrations (range shifts), which can lead to the decline and substitution of established taxa in newfound habitats. There is a pressing interest to know how such shifts in species abundance –especially when climate migrants become dominant– will affect the properties of ecosystems and the services they deliver.

Kelps provide the foundation for habitat in many temperate reef systems, supporting abundant biodiversity and driving ecosystem function. We investigated how a shift in the distribution of *Laminaria ochroleuca*, a warm-temperate kelp, may have affected ecosystem processes associated with carbon and nutrient cycling, such as primary production, trophic dynamics, and detritus decomposition. We surveyed two mixed kelp forests at the poleward edge of *L. ochroleuca* distribution and compared the biomass dynamics of this kelp with that of the currently dominant cold-water kelps, *Laminaria hyperborea* and *Laminaria digitata*.

Laminaria ochroleuca was more productive than the cold-water kelps and exhibited a distinct growth strategy. A greater proportion of its production entered higher trophic levels, as this species was a preferred food and was subjected to higher grazing rates. Like the other kelps, most of primary production was lost via erosion of the lamina, which decomposed faster than that of its main subtidal competitor. Our results seem to be underpinned by differences in key functional traits such as blade surface area and nutritional quality.

Our study shows that climate change can indirectly affect ecosystem functioning by reorganizing community structure. The climate-mediated range extension of L*aminaria ochroleuca* has modified the dynamics of kelp forests, with notable ecological ramifications. The delivery of ecosystem services however, should not be critically impaired, as core ecological processes were maintained or enhanced.

Student Poster 10

Climate-driven substitution of habitat-forming species leads to reduced biodiversity within a temperate marine community

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1) Habitat forming species, such as reef-building corals and canopy-forming macroalgae, can alter environmental conditions and provide habitat for a vast array of marine life, from invertebrates to marine mammals.
2) This investigation examines the consequences of recent shifts in the relative abundances of two species of kelp, a warm water species, *Laminaria ochroleuca*, and a cool water species, *Laminaria hyperborea*, by defining their properties as habitat-formers and comparing their epibiotic assemblages. Algal and invertebrate assemblages associated with kelp stipes and holdfasts were compared between the two species, and from two sites with differing environmental conditions.
3) Significant differences were found in the structure of assemblages inhabiting both the stipe and holdfast between species, and between sites. The results suggest that local environmental conditions influence the structure of these assemblages.
4) This study shows that changes in the relative abundances of habitat forming species, as a consequence of rapid environmental change, alter local biodiversity patterns and potentially lead to impoverished assemblages. Crucially, while the structure of habitat-forming species may appear broadly similar, their functioning as biogenic habitats for associated biota may differ considerably.

Posters

Poster 11

A pan-Arctic assessment of biodiversity and ecosystems services provided by coralline algae reefs.

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Non-geniculate coralline algae, both crustose and free-living forms (maerl), are some of the most prominent reef builders in the shallow marine environment. In the Arctic, corallines structure reef habitats in both crustose reef flats (Alaksan Arctic) and in large maerl beds (North Atlantic). Both communities are known to be biodiversity hotspots in this extreme environment, however very few geographic regions have been investigated in the Arctic. In Greenland kelp forests and maerl beds were surveyed using video transects, quadrats, and biodiversity grabs. The dominant species in these two habitats are not mutually exclusive, which is exemplified by kelp swaths and estimated percent cover of coralline algae from transects. One kelp species, *Agarum clathratum*, can be particularly abundant in maerl beds and crustose coralline algae (CCA) is very common on the hard substrate, underneath invertebrates and algae, in kelp forests. Furthermore, habitats are alternatively more diverse depending on the scale of measurement (transect and quadrat vs. grab) indicating that kelp forests and maerl beds are important to specific species and life history stages. This is a preliminary report of this work, and we continue to investigate the vulnerable coralline habitats and their ecosystem services.

Posters 12 + 13

Studies of two interesting freshwater algae.

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Two particularly interesting freshwater algae have been studied:

1 The Chlorophyte *Oedogonium idioandrosporum* (Nordstedt *et* Wittrock) Tiffany which has apparently not been recorded in the British Isles since G.S. West in 1899.

2 A Rhodophyte from the genus *Paralemanea* apparently new to the British Isles and closest to the taxa described as *Paralemania catenata* f. *nodosa* Knappe & Huth and *Paralemanea catenata* (Kützing) M.L.Vis & R.G.Sheath.

Images showing the key reproductive and taxonomic features (some as 3D anaglyphs) are presented together with a little historical background.

Home

Poster 14

Living Architecture: A Modular and Programmable Synthetic Ecosystem for the Built Environment

Rachel Armstrong[1], Gary S. Caldwell[2], Andrew Adamatzky[3], Ioannis Ieropoulos[4], Juan Nogales[5], José L. Garcia[5], Barbara Imhof[6], Waltraout Hoheneder[6], Angelo Vermeulen[6], Davide De Lucrezia[7], Martin Hanczyc[8]

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Living Architecture (LIAR) is a modular bioreactor-wall, which is based on the operational principles of microbial fuel cell technology and synthetic 'consortia' of microbes. LIAR is conceived as a next-generation selectively-programmable bioreactor and integral component of human dwelling, capable of extracting valuable resources from waste water and air, generation of oxygen and production of proteins and fibre by manipulating consortia performance. Its operational principles are grounded in distributed sensing, decentralised autonomous information processing, high-degree of fault-tolerance and distributed actuation and reconfiguration. Applications within urban systems are examined as a form of customizable microagriculture for installation in domestic, public (schools, hospitals) and office environments. Such a system has far reaching impacts on the building performance (resilience, resource recycling) manufacturing and design with ecosystems. The project will establish: foundational concepts through which 'designed' metabolisms can computationally process, recycle, remediate and synthesise valuable compounds from waste water; transferable principles by which synthetic ecosystems can shape the environmental performance of our living spaces to increase our health, productivity and ecosystems impact; and, new standards for synthetic 'ecosystems' through consortia design, engineering and optimization. http://livingarchitecture-h2020.eu/

Poster 15

Assessing spatial and temporal scales of variation in green tides: Tubular vs. Sheet-like morphologies

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In coastal lagoons and estuaries, one of the most evident signs of eutrophication is the proliferation of fast-growing opportunistic macroalgae, mainly Ulvoid species. Blooms and accumulations of Ulvoids have been called green tides. Although these blooms are not toxic to humans, these can cause relevant deleterious consequences for human activities and biodiversity. Anthropogenic nutrient enrichment of estuarine and coastal waters seems to be a key factor to explain the development of green tides. However, the extent, distribution, and species composition of blooms vary strongly among systems of similar nutrient loading, which compromises our ability to predict these events based on information about nutrient status alone. Therefore, additional factors may play a role in the control and development of macroalgal blooms. In order to elucidate these factors, the identification of relevant scales of variation is a necessary prerequisite before explanatory models can be proposed and tested. In this study spatial (perpendicular and parallel to the coast) patterns of biomass distribution were assessed for two Ulva morphologies in three Irish estuaries at three different occasions during bloom development. The obtained results revealed that sheet-like morphologies showed a more random pattern of spatial distribution than tubular ones. This should be related to the fact that sheet-like Ulva is commonly detached from the substrate, while tubular morphologies are generally attached to the substrate. For both morphologies a significant spatial variation was observed perpendicular to the coast, which suggest a role of the tide in the observed distribution. Temporal changes in biomass can also be observed, with an increase in the biomass of laminar morphologies over the studied period, while the opposite trend was observed for tubular morphologies. These results suggest the existence of a temporal succession between different Ulva morphotypes, which should be considered when these blooms are modelled or management actions are proposed.

Home

Poster 16

Addressing the future in a 21st century Culture Collection of Algae and Protozoa

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As time progresses, the needs of Biological Resource Centre (BRC) users evolve and technology advances. It is therefore imperative that culture collections review practices to keep abreast of this changing world. CCAP has addressed this in several ways: Diverse Taxonomy – the wide taxonomic breadth of our Collection continues to grow and we have adopted a policy of genetic bar coding and as well as morphological examination to strengthen our confidence in the identity of our strains; Purity – similarly we are reviewing our holdings to remove unwanted contaminants and will, in additional to conventional methods, utilise flow cytometric techniques to this end; Cryopreservation – we have the latest technology in liquid nitrogen generation and continue to develop methods for preserving recalcitrant strains; Quality Assurance – CCAP is currently refining practises and completing the documentation to gain ISO 9001:2015 accreditation; finally, Nagoya Protocol – our accession policy has been amended to ensure deposits are compliant and staff are trained in awareness and implementation. Through these developments we aim to provide our users with high quality, dependable strains for biotechnology, ecotoxicology, aquaculture and many other uses.

Poster 17

New Version of the AlgaeVision Website: A searchable photo catalogue of freshwater and subaerial algae

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A new and considerably expanded version of the *AlgaeVision* website was released in December 2016. This version is designed to be used with the second edition of *The Freshwater Algal Flora of the British Isles* (John, Whitton & Brook 2011), with each image entry accompanied by the page number for the taxonomic description and illustration(s) in the book. It contains more than twice the number of images in the earlier version and these cover 250 genera, 680 species and 80 intraspecific taxa; representing about 35% of the taxa recorded from the British Isles (excluding diatoms). Some brackish-water and marine Cyanobacteria are included and the only colourless representatives are dinoflagellates. The website is a searchable reference resource designed to assist algal identification and therefore contains mostly images of living algae showing diagnostic features essential for naming algae with a fair degree of confidence. A Scratchpads platform has been used to create the new version and is searched using a hierarchy of algal names. Unlike the earlier version each entry has a link to a page in AlgaeBase and the website will be regularly expanded by the addition of new/replacement images and taxonomy and nomenclature will be updated.

Poster 18

The Algal Collections at National Museums Liverpool (World Museum, LIV)

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The herbarium (LIV) at National Museums Liverpool, World Museum, currently houses around 10,800 algal specimens (excluding diatoms). LIV houses historical material from the 18th, 19th and 20th centuries and is actively expanding its contemporary collections.

The collection has a number of early British collections such as the Thomas Velley herbarium consisting of eight volumes of marine algae from the south coast of England (1789-1802) and Hulme's 'The Scarborough Algae' (1842). The herbarium contains collections from Ross's voyage of the Erebus and Terror (1839-43), to the Southern and Antarctic Regions. It also includes notable collectors such as John Ralfs, James E. Smith, François Joseph Chauvin and John Boswarva.

The most significant collection in the algal herbarium is the University of Liverpool herbarium (LIVU), which comprises of around 4,000 specimens reflecting Liverpool's long involvement in phycology. This includes collections from Elsie Burrows, Mary Parke, Frederik C.E. Børgesen, Edward F. Linton, M. Díaz-Piferrer, S.R. Lenormand, George Russell, Elsie Conway, Peter Dixon, Robin South and N.L. Gardner. It also has a number of exsiccatae, including Hauck & Richter Phykotheka Universalis which includes specimens from Paul C. Hennings, Theodor Reinbold and Heinrich Heiden.

A recent addition to the herbarium is the Ann Archer Algal collection, consisting of about 800 specimens, representing the period 1958-65 collected for her taxonomic research on the branched members of the Cladophorales. It represents localities from around the North West of the United Kingdom; predominantly Anglesey. It also includes collections from the Isle of Mann, Shetland and Guernsey. The collection consists of herbarium sheets, microscope slides, drawings and notebooks from her research work. Ann was Elsie Burrows first PhD student.

Work is currently underway to identify the algal type specimens at LIV and to make them available online.

Home

Poster 19

Impact of Climate Change on Communities of Scottish Rocky Shores since 2002

Gail Twigg and Michael T. Burrows

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Geographical distributions and abundance of species in the rocky intertidal in Scotland have been surveyed over the last 15 years to detect changes and allow interpretation in the context of climate change. Surveys between 2002-2010 were preceded by two decades of rapid temperature increases through 1980-1990 when average annual SST around Scotland rose by around 0.6°C. Since 2000, temperatures around Scotland have remained relatively stable, with no obvious upward trend. 154 surveys in 2014-2015 around the coast of Scotland revisited and extended the spatial coverage of surveys done between 2002-2010, with reference to earlier studies from 1950s to 1980s. Changes in species abundance showed disproportionate representation of macroalgae among those showing an increase. All species of macroalgae increased in abundance with the 8 most-increased species being macroalgae. The largest decline seen was in *Mytilus edulis* populations that decreased in abundance at 54% of sites by average of around one abundance category on the SACFOR scale. Sea surface temperature has not increased since 2002 across Scotland's coasts and, as expected, no northward range extensions were evident for those species that reach their poleward geographical range limits in Scotland. The pattern of change among species was not related to their thermal affinities, but was similar to patterns of responsiveness to ocean acidification shown in other parts of the world. Higher frequency observations of community change at sites near Oban show fluctuations often masked in long-term studies, particularly in terms of cover of intertidal fucoids. Monthly temperature readings and photographs were taken of the same area of rocky shore from 2005 to 2014. Photographs were used to score abundance using the SACFOR scale for macroalgae, and the mid-range percentages used to express cover numerically. The results show how a storm in 2011 dramatically changed species abundance.

Home

Poster 20

How far can you trust your proteomics database?

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As DNA and RNA sequence data becomes available for more and more algal species, proteomics is being increasingly used as a tool to help characterise the metabolic capabilities of algae and to investigate how they respond to environment change. However in most proteomic pipelines, a proteins can only be identified if that protein is present in a database of predicted protein sequences. This database is most often derived from *ab initio* and homology based predictions from genomic sequence data, sometimes with RNAseq support. This method relies on prediction algorithms trained on well-studied species such as *Arabidopsis thaliana*, and so is not likely to perform well when applied to distantly related algal genomes. Prediction is likely to be especially poor for genes relating to functions specific to these algae, which are also likely to be some of the most interesting genes for the phycologist.

While endeavouring to use proteomic techniques to study the calcifying haptophyte *Emiliania huxleyi*, we suspected that poor gene models were limiting the quality and number of protein identifications. Thus we have developed a computational pipeline to: i) assess the extent of any database problems; ii) determine the best experimental or computational strategy to resolve the problems; iii) find unannotated regions of genomic DNA that are likely to encode proteins in a sample of interest; iV) provide a fully independent corroboration of database search methods. This pipeline should allow researchers to determine how much information they are failing to extract from their proteomic data, and provide them with the tools to plan strategies to improve the situation.

Poster 21

Can Differences in Minimum Areas Lead to Different Conclusions? A Case Study in Green Algal Tides.

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The minimum sampling area is the smallest area wherein the species composition of a community is adequately represented. Different methodologies have been proposed to determine this area. Previous studies focused on green tides, blooms mainly consisting of Ulvoid species, have used fixed minimum areas ranging from 625 cm^2 to 2500 cm^2. This study investigates the effect of different minimum sampling area in our ability to assess the spatial scales of variation in green tides. In this case, spatial patterns (perpendicular and parallel to the coastline) of biomass distribution of Ulvoid species were assessed on one occasion in an Irish estuary located in Courtmacsherry, County Cork using two different sampling area sizes (650 cm^2 and 2500 cm^2). The obtained preliminary results showed that biomass distribution varied significantly in areas of biomass coverage less that 80% for both sampling area sizes. This was not the case for areas of biomass coverage 80% or above, where there was little variation of biomass distribution for both sampling area sizes.

Home

Poster 22

Changes in total lipid and lipid class composition during the growth of three marine microalgae.

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Geothermal sites are extreme environments spread throughout the world, although limited to volcanic areas, often characterized by low value of pH (< 3). A low species diversity usually characterize these acidic environments, mainly composed by bacteria, fungi and a few algal species. Microalgae belonging to the class of Cyanidiophyceae (Rhodophyta) (Ciniglia et al., 2014) are polyextremophilic both for pH (≤ 2) and for temperature (up to 55° C) and among them, *Galdieria maxima* (Sentsova et al. 1991) can also live heterotrophically (De Luca, et al., 1972). In this study, we report the first recovery of *G. maxima* in neutral or subneutral Turkish geothermal sites. A molecular and physiological characterization was made in order to compare these new strains with other acidophilic strains of *G. maxima* from Iceland, Russia and Turkey (Güçlükonak, Sirnak), contrasting the idea that these species cannot tolerate different ecological conditions (Gross, 1999). *G. maxima* cells were exposed in culture to higher pH conditions of 7.0, 6.5, 6.0, 5.0 and 1.5. All *G. maxima* strains acidified the medium as growth increased, with a direct correlation, thus giving a reliable mean that lowering pH to an optimal level would be a strategy to survive in some niches not ideal for them. All *G. maxima* strains were able to utilize ammonium as well as nitrate as nitrogen source, however, the growth performances were disturbed by nitrate at pH 5, since nitrate assimilation requires a net influx of hydrogen into the cell for reduction, thus providing a net effect of increasing of culture pH to 6,2.

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Poster 23

A spotlight on algal RAD52 in Cyanidiophyceae (Rhodophyta): a relic in algal heritage

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Rad52, due to its capacity to join impaired DNA endings, is the main actor involved in double-strand break repair as well as in meiotic recombination, together with the RAD51 recombinase (Symington, 2002). The present paper displays the detection and characterization of RAD52 homologs in some Rhodophyta genomes. A broad correspondence of the homologs of the RAD52 proteins was provided, in order to perform phylogenetic analyses. Our data confirm the presence, the role and the functionality of RAD52 DNA-repair orthologue in Cyanidiophyceae, a group of polyextremophilic red microalgae (*Galdieria, Cyanidium* and *Cyanidioschyzon*) with a long evolutionary history (1.5 BYA, Yang et al., 2015); these microalgae are perfectly suited to the environmental extremes offered by the volcanic and post volcanic areas, where temperatures rise above 50°C, and high sulphuric acid concentrations, generated by the oxidation of sulphur gaseous emissions, greatly reduce the pH to values prohibitive for the majority of eukaryotic life forms (pH 0.5-3.0) (Ciniglia et al., 2014). These archean-like environments are considered as the scenario where eukaryogenesis and meiosis would have occurred concurrently (Gross and Bhattacharya, 2010). The deficiency of RAD52 in the vast majority of photosynthetic protists, sexuated or not, is intriguing, as well as its absence in plants, considering the role in homologous recombination process and its relatively high conservation across eukaryotes. Its presence in Cyanidiophycean genomes would give a reliable mean that RAD52 gene would have been inherited by a photosynthetic ancestor, and retained as a relic heritage in some photosynthetic eukaryotes still living in primordial-like environments, while lost in others, even in closely related Rhodophyta with intricate life cycles.

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Home

Poster 24

Major transitions in dinoflagellate evolution unveiled by phylotranscriptomics

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Dinoflagellates are key species in marine environments, but they remain poorly understood in part due to their large, complex genomes, unique molecular biology, and unresolved in-group relationships. We created a taxonomically representative dataset of dinoflagellate transcriptomes, and used this to infer a strongly supported phylogeny in order to map major morphological and molecular transitions in dinoflagellate evolution. Our results show an early-branching position of Noctiluca, monophyly of thecate dinoflagellates and paraphyly of athecate ones. This represents the first unambiguous phylogenetic evidence for a single origin of the group's cellulosic theca, which we show coincided with a radiation of cellulases implicated in cell division. By integrating dinoflagellate molecular, fossil and biogeochemical evidence we propose a revised model for the evolution of thecal tabulations and suggest that the late acquisition of dinosterol in the group is inconsistent with dinoflagellates being the source of this biomarker in pre-Mesozoic strata. Three distantly related, fundamentally non-photosynthetic dinoflagellates, Noctiluca, Oxyrrhis, and Dinophysis, contain cryptic plastidial metabolisms and lack alternative cytosolic pathways, suggesting that all free-living dinoflagellates are metabolically dependent on plastids. This finding led us to propose general mechanisms of dependency on plastid organelles in eukaryotes that have lost photosynthesis; it also suggests that the evolutionary origin of bioluminescence in non-photosynthetic dinoflagellates may be linked to plastidic tetrapyrrole biosynthesis. Finally, we use our phylogenetic framework to show that dinoflagellate nuclei have recruited novel DNA-binding proteins in three distinct evolutionary waves, which included two independent acquisitions of bacterial histone-like proteins.

Home

Poster 25

A review of the bladed Bangiales (Rhodophyta) in China: history, culture and taxonomy

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We review the cultural history, mariculture and taxonomic work to date of *Porphyra* sensu lato (bladed Bangiales) in China. The bladed Bangiales is a red seaweed group with high species biodiversity and economic value. In China, species occur along the length of the coast and are highly integrated into the country's culture. Chinese people have used species of the bladed Bangiales (*Porphyra* sensu lato) as foods and pharmaceuticals for about 1700 years with many references to these seaweeds in ancient books. The mariculture of bladed Bangiales in China also has a long history and an industry has been established based on some species, notably *Pyropia yezoensis*. Scientific taxonomic study of the bladed Bangiales in China began in the late 1920s. To date, twenty-five species and five varieties have been recorded for China, based on morphological identification, of which twelve species are considered to be endemic to the country. The majority of species have distribution data associated with them including evidence of possible change due to increasing water temperatures along the coast. Given that the extent of biodiversity of the bladed Bangiales in different parts of the world has been revealed using molecular approaches, there is a need for a molecular taxonomy to document species diversity in China. It is also important to document species distributions, as they include taxa of the wild stocks for seaweed cultivation and at the same time coastal habitats are increasingly impacted by the effects of an increasing human population and an expanding mariculture industry. There is a considerable body of literature on the bladed Bangiales, but much of it is Chinese and in obscure publications. Here, in addition to the above, it is our aim to make this information available to readers worldwide.

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