The Phycologist

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

71st Annual Meeting Registrations

Hilda Canter-Lund Winners

BPS Funded reports

Number 103- Autumn 2022

The British Phycological Society is a registered Charity no. 246707 - *The Phycologist* is a registered publication - ISSN 0965-5301

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Editorial

Again, I must apologise as maternity leave was all consuming! Finally back at the grindstone however, which means in 2023 *The Phycologist* will be back on-track and on-time.

Meanwhile, please don't miss out on some interesting finds in this issue! We have a re-discovery of a Cosmarium species in Yorkshire, lots of great results from BPS funded projects and some much anticipated details for the 71st Annual Meeting that will be taking place at Newcastle University this coming January. This will be an in-person meeting which is the first in a while so I look forward to seeing many of you there!

As usual we have a showcase of the Hilda Canter-Lund photography winners and every year I am more and more impressed! I hope you enjoy the images and the stories behind them as much as I do.

Very best,
Amanda Burson

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

As a reminder, previous issues of *The Phycologist* can be downloaded at https://brphycsoc.org/the-phycologist-back-issues/

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71st Annual Meeting of the British Phycological Society

24th-27th January 2023

Newcastle University

The 71st Annual BPS Meeting will be hosted by The School of Natural and Environmental Sciences at Newcastle University from the 24th -27th of January. Please see the meeting website at https://bps2023newcastle.uk for all of the pertinent information.

Important things to remember:

- The registration and payment deadline for participating in the conference is the 15th of December and the abstract deadline is 1st of January.
- Session themes are Biotechnology; Citizen Science & Sci-Art; General phycology; and Phycology in a changing world
- Accommodation deals can be found on the meeting website!
- Queries about the meeting can be directed to the conference email at bps2023@outlook.com

This is an in-person only meeting so I look forward to seeing everyone there!

Call for nominations for membership of BPS Council

In accordance with our constitution (https://brphycsoc.org/constitution/) a council position is open for nominations with successful candidates taking up office after the AGM in Newcastle-Upon-Tyne in January 2023.

Ordinary Member Dan Franklin will end his current 3-years term as an ordinary member of council and so there will be a vacant position from January 2023 for a period of 3 years. This is a good opportunity to get involved in the life of our society, and gain experience in how a "learned society" works. The duties are not onerous, as an Ordinary Member you would be asked to be involved in one of the societies sub-committees, attend the two full Council meetings a year (one in the summer, one at the winter meeting), and partake in discussions and decision-making by electronic means. Reasonable travel and other expenses are met by the Society.

We would welcome applications from any of our members. Council is particularly keen to encourage early career researchers or people working in algal-related industries to consider this opportunity. If you are interested in serving and would wish to know more, please feel free to contact the President, Jane Lewis, Jane.Lewis@uhi.ac.uk,, who will be happy to have a conversation.

If you are interested in standing, the process is to put yourself forward as a candidate, send your nomination to the BPS Secretary (secretary@brphycsoc.org) with your name and the name of a seconder (who needs to be a BPS member too). You will need to send in your nomination to be received by midnight on November 25th, 2022 (two months before the next Annual General Meeting). If we receive more than one nomination for the position, there will be a ballot of members, and the Secretary will circulate details to all members of the BPS one month before the AGM. All completed ballot papers shall be returned to the Secretary before the AGM, and the results declared during the meeting, which will be held at the University of Newcastle Upon Tyne on Thursday, 26th January 2023.

Cosmarium latifrons P. Lundell re-discovered in the British Isles

Submitted by: Allan Pentecost and David Williamson

Figure 1. Ha Mire showing the pool in the foreground and Great Close Scar in the background.

During a freshwater algae weekend organized by Martyn Kelly at Malham Tarn Field Centre, Yorkshire during September 2021, a small calcareous pool was investigated in Ha Mire, just to the east of Malham Tarn (Fig. 1). The mire is fed from several limestone springs and seepages and is underlain by thin calcareous soils with occasional more acidic drift. With an altitude of 380 m it is an area fully exposed to westerly winds. The mire is colonised by a wide range of vascular plants including many calcicoles such as *Primula farinosa*. It is believed to have a long history as a marsh, disturbed only by occasional cattle and sheep incursions (Sinker, 1960). *Galium boreale* was recorded there by John Ray in 1671. The algal flora of the Malham Tarn area is well known when compared with most upland areas of Britain but Ha Mire has never been examined in detail so two brief visits were made during the September course, one near the track running from the Field Centre to the Malham Village road and the other from a small pool close to the centre of the mire containing abundant *Potamogeton gramineus*, *Utricularia* and the moss *Calliergonella cuspidatum* (Nat. Grid Ref. 34/8998 6662). Squeezings of the *Utricularia* revealed a rich haul of desmids, a significant number of which were new records for the area. Among them was *Cosmarium latifrons*. This desmid was reluctant to reveal itself and a considerable effort was needed to examine sufficient cells for confirmation.

This species was described by Per Magnus Lundell from a 'valley subject to frequent flooding' in Kungsparken near Uppsala, Sweden (Lundell, 1871). As far as we are aware, it has only been reported once before from the British Isles and that is by Roy & Bisset (1894) who noted it as 'extremely rare, Forfar, Barrelwell Moss near Brechin'. It was collected by a Mr. Scott, one of their many volunteer collectors. This record was repeated by West & West (1911) in their British Desmidiaceae (Vol. 4, p.33) accompanied by a copy of Lundell's original figure. Recent Google Earth images of the Barrelwell Farm area show only arable fields although a small area of wetland is apparent at grid ref. 37/564613.

The Ha Mire material had cells about as broad as long or slightly broader (Fig 2 a,b). The semicells were obversely trapeziform with broad slightly convex or almost straight apices and the sinus moderately deep and linear. The sides were more or less straight, granulate and markedly divergent giving the cell its characteristic shape. Within the margins were three rows of granules with a swelling in the centre, bearing three, to possibly four longitudinal rows of coarser warts, sometimes fused into faint ridges. The vertical view was elliptic with a three-granulate swelling on each side, the rest of the wall granulate except for the centre. The side view was globular with an inflation on each side and each semicell had a central pyrenoid. The

cells ranged 36.8-38.5 µm long, 38.5-40.0 µm wide and 27.0 µm in thickness with the isthmus 15.5-16.0 µm wide. These measurements compare well with the type: 34-38 µm long, 34-39 wide, 23.3 thick with isthmus 15 µm wide.

This desmid has been reported from other parts of the world. Hirano (1968) noted it from two areas in Arctic Alaska and provided a good figure. Its most northerly known location is from Barrow, Alaska at 71°N where it was found among wet grass and moss. At Umiat some distance to the south it was collected among *Sphagnum*. In Austria it has been reported from moorland (R. Lenzenweger, *pers. comm.*). Prescott et al. (1981) mentioned it from Connecticut and it has also been reported from the Ukraine (Petlovany & Tsarenko, 2015) and Japan (Hirose & Yamagishi, 1977). A var. *minor* was noted from Portugal by Sampaio (1944). The Wests noted records from Northern Russia & Norway. The species is evidently widespread in the northern hemisphere although several collectors have noted its rarity and preference for cool-temperate to arctic climates.

At Ha Mire, *C. latifrons* was associated with several other desmids, notably *Cosmarium pyramidatum* Ralfs, *Netrium interruptum* (Bréb.) Luetkem., *Staurastrum furcatum* Bréb., and *Xanthidium antilopaeum* Kütz. A further rare desmid was also found here, *Cosmarium tetrachondrum* P. Lundell. Other common algae were *Ankistrodesmus falcatus* (Corda) Ralfs, *Coelomoron pusillum* (Van Goor) Komarek, *Pseudostaurastrum enorme* (Ralfs) Chodat and *Quadrigula closterioides* (Bohlin) Printz.

A water sample taken on 13th November gave a pH of 6.24 and a specific conductivity of 63 µS/cm. In a sample from the edge of the mire In June 1988, the pH ranged from 6.9-8.0, total carbon dioxide 4.4-5.1 mMol, calcium 1.77-2.52 mMol, temperature 14-15.4 °C and specific conductivity 162-350 µS cm^{-1}. The mire water is therefore quite variable in composition and is probably related to the amount of rainfall, but it appears to be circumneutral and moderately base-rich. This agrees with the presence of *Calliergonella* at the site and contrasts with the noted occurrence of this desmid among *Sphagnum* above where water pH is almost invariably acidic and base-poor.

Acknowledgements. We thank Chris Carter for his assistance in tracking down some of the literature. Prof. R. Lenzenweger and Prof. E. Rott are thanked for information from Austria.

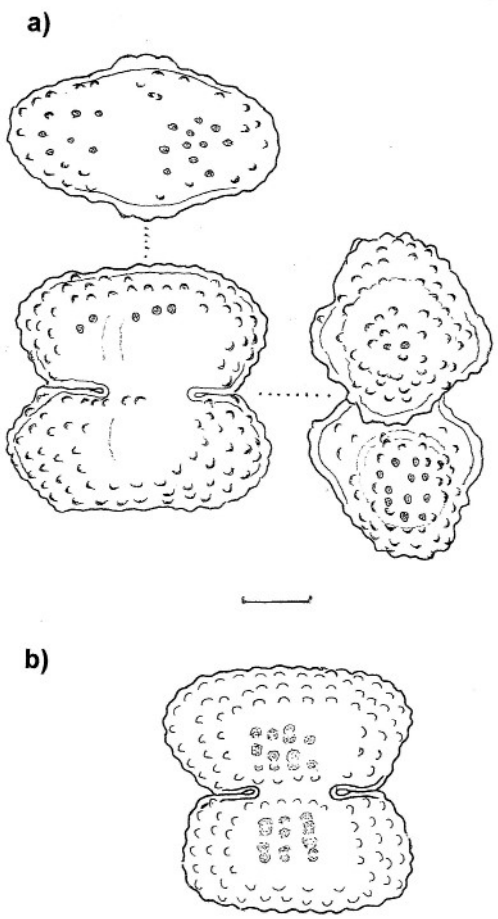

Figure 2. Drawings of *C. latifrons* from Ha Mire, Yorkshire. a) A cell in face, side and vertical view. b) another cell in face view showing the central ridges more clearly. Bar 10 µm. Drawings made by D. Williamson.

References:

1. Hirano, M. (1968). Desmids of Arctic Alaska. Contrs. Biol. Lab. Kyoto University 21: 1-80.

2. Hirose, H. & Takaaki, Y.(Eds.) (1977). Illustrations of the Japanese fresh-water algae. Tokyo. 933 pp.

3. Lundell. P. M. (1871). Die Desmidiaceis, quae in Suecia inventae sunt, obervationes criticae. Nova Acta Regiae Soc. Sci. Upsal. Ser. III, 8 (2): 1-100.

4. Petlovany, O. A. & Tsarenko, P. M. (2015). Desmidiales. In: *Algae of the Ukraine: diversity, nomenclature, taxonomy, ecology and geography*. Vol. 4. Charophyta. (Tsarenko, P.M., Wasser, S. P. & Nevo, E., eds.). pp. 61-448. Ruggell, Koeltz Scientific Books.

5. Prescott, G. W., Croasdale, H. T., Vinyard, W. C. & Bicudo, C. E. de M. (1981). A Synopsis of North American Desmids Part II. Desmidiaceae: Placodermae Section 3. University of Nebraska Press, Lincoln & London.

6. Roy, J. & Bisset, J. P. (1894). On Scottish Desmidieae. Ann. Scot. Nat. Hist. 1894 (10): 100-105.

7. Sampaio, J. (1944). Desmidias portuguesas. Bol. Soc. Broteriana 18: 5-547.

8. Sinker, C. S. (1960). The Vegetation of the Malham Tarn Area. Proc. Leeds Phil. Lit. Soc. Scientific Section. 8 (5): 1-37.

9. West, W. & West, G. S. (1911). British Desmidiaceae. Vol. 4. Ray Society, London.

BPS Funded Project Reports

Utilising population genetics to inform the conservation management of newly discovered maerl beds in the NE Atlantic

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Figure 1. One of the Guernsey maerl bed sites

Free-living red coralline algae are found throughout the world's coastal oceans, creating complex 3-dimensional reef-like habitats called maerl or rhodolith beds. These ecosystems support high biodiversity, play a major role in global biogeochemical cycling of carbon (van der Heijden & Kamenos 2015; Mao et al 2020) and sulphur (Burdett et al 2014). The NE Atlantic is global maerl bed hotspot, but their survival is threatened by acute and chronic ocean stressors: bottom disturbance (e.g. harbour dredging, trawling) smothers beds, causing physical damage that persists for decades (Barbera et al 2003), and climate change is projected to cause widespread decline due to ocean warming, acidification and changes in water flow (e.g. Simon-Nutbrown et al 2020). It is becoming increasingly recognised that loss of this ecosystem would have devastating ecological and socioeconomic consequences around the globe. As such, maerl beds are of priority conservation concern at national-international levels and listed as 'Vulnerable' or 'Endangered' on the IUCN Habitats Red List.

However, compared to other habitats such as coral reefs or kelp forests, our scientific understanding of maerl beds remains inadequate, limiting the extent to which conservation decisions can be based on empirical scientific evidence. In this project, we sought to investigate the population genetics of a newly discovered maerl bed network around Guernsey in the English Channel that on visual inspection appears to be in excellent condition (Figure 1,2). However, these beds are less 250 metres from a proposed expansion of the Longue Hougue South waste disposal site; the inevitable physical disturbance is already expected to "result in a loss of [maerl] habitat with no ability to recover" (Royal Haskoning EIA report).

However, beyond discrete location records we have no information about the ecology, history or biogeochemistry of these beds. With generous funding from the British Phycological Society, we were able to conduct the first population genetics study in the area, conducted in collaboration with the Guernsey Biological Records Centre. In August

Figure 2. Another Guernsey maerl bed

2021, we collected hundreds of samples of maerl from across the Guernsey bed network, allowing us to understanding local-regional scale genetic features such as reproduction strategies and genetic diversity, and how that has changed over time. These samples were fixed in the field and subsequently processed for genotyping by sequencing in the Royal Botanical Gardens Edinburgh genetic laboratories.

Our results show that the Guernsey maerl beds appear to be composed of a single species - *Lithothamnion coralloides* – and appears to have local-regional scale genetic connection. These single species beds will likely have lower environmental resilience than beds composed of many species, highlighting a point of concern in terms of the longevity of these Guernsey maerl beds in the face of short-term coastal development and long-term climate change. The results from this work complement our other maerl bed population genetic research, and provides additional data resource for the several other maerl-forming species of red coralline algae we have additionally identified in the UK. Importantly, our genetic approach has allowed us to successfully construct the first whole genomes for *L. coralloides*, which we hope will be a fantastic resource for the wider phycological, ecological and genetic communities and we look forward to seeing reuse of these data.

As a Crown Dependency, Guernsey is not under the jurisdiction of UK nor EU law, and marine protection is in its infancy – two Ramsar sites constitute the entirety of its current marine protected area. However, their 2020 Strategy for Nature commits to improving marine ecosystem resilience. Results from this project are therefore a unique opportunity to align state-of-the-art ecological science with coastal development decisions, enabling us to directly inform the development of new marine management policies. As our results emerge, we are now in regular dialogue with the Guernsey Biological Records Centre and Guernsey State, with the aim of supporting a new marine conservation plan that specifically includes suitable maerl bed protection. In addition, our work has already stimulated discussions with other islands in the area, allowing us to gain a broader understanding of regional-scale connectivity, resilience and future survival potential, and supporting the development of regional-scale marine protection network.

We are indebted to the British Phycological Society's Project Award (award number 2021_BPS_0033) which provided the funds to support this research.

Algal-bacterial mutualism: A sustainable approach for the bio-remediation of textile wastewater

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Introduction

Phototrophic communities are constructed around the interactions between several autotrophic and heterotrophic microbes. In aquatic ecosystems, several inter-species and inter-kingdom associations allow the exchange of micronutrients like iron and vitamins, dissolved organic matter, and secondary metabolites[1,2]. Such associations ensure the stability of aquatic microbial communities and enable them to tackle environmental stress. Therefore, there has been a growing interest in understanding microbial interactions, eco-evolutionary principles of mutualism, and finding ways to incorporate microbial interactions for industrial sustainability.

Figure 1: (**A)** Satellite view of Panipat Industrial area. Approximately 400 large and medium scale textile dyeing industries are spread in the industrial sector. (**B)** Untreated dye waste from numerous industries is discarded on the open grounds, or (**C)** left in open drains leading to fouling and environmental contamination.

Microalgae-based processes have gained attention in the pharmaceuticals, food, cosmetics, and bioenergy industries, Microalgae such as *Chlorella*, *Chlamydomonas*, *Scenedesmus*, *Dunaliella*, etc., have been widely used to recover valuable products like lipids, polysaccharides, adhesives, vitamins, *β*-Carotene, and also for the cleaning of industrial wastewater[3]. *Chlorella* has demonstrated high bioremediation potential among different microalgae due to its rapid doubling time, high tolerance, high biomass production, and ease in scalability. Thus, microbial processes offer cost-effective, eco-friendly, socially acceptable, and sustainable wastewater treatment solutions. However, despite several advancements in bioremediation over the last two decades, the microbial wastewater treatment processes have not been universally accepted in industries as a sustainable alternative to conventional physicochemical processes. Bioremediation of wastewater primarily relies on single-species design, which is often challenged at industrial scales due to physiological limitations of organisms or lack of proper understanding of crucial environmental interactions. In general, microbial bioremediation processes lack consideration of (i) important inter-species microbial interactions, (ii) the impact of variability in abiotic factors, and (iii) the effect of micronutrient availability.

Therefore, in this study, we aim to address the challenges faced by single-species microalgal designs using synthetic dyes in textile wastewater as a case. We chose textile effluent owing to their increasing harmful impacts on aquatic ecosystems, especially in several developing countries. Often untreated textile effluent is discharged into the environment, polluting surface water bodies, underground reserves, and agricultural fields, thus causing socio-economic and environmental health impacts (Fig. 1). At the same time, the effluent which is collected from industries is treated in common effluent treatment plants (CETPs) rely on conventional physicochemical processes like chlorination and ozonation, which primarily aim to remove dyes and organic chemicals from wastewater but convert them into toxic sludge (Fig. 1A).

Microalgae have huge bioremediation potential; however, the bioavailability of iron is a growth-limiting factor. Though abundant in the environment, iron remains unavailable to microbes due to its presence as insoluble ferric (Fe^{3+}) or oxyhydroxides. Iron also precipitates out in alkaline conditions, a characteristic of textile water. However, in natural environments, algae depend upon the active associations with siderophore-producing bacteria for survival and growth. Bacterial siderophores improve iron availability in aqueous ecosystems. Such associations act like a barter system in which algae provides organic matter to heterotrophic bacteria in exchange for bioavail-

able iron. In this work, we demonstrate the importance of ecological principles of mutualism between algae and bacteria to remediate toxic dye in real textile wastewater. We have previously shown the active mutualism between *Chlorella sorokiniana* and *Ralstonia pickettii* PW2 based on the exchange of carbon sources and bioavailable iron[4]. In this study, we further extend our bioremediation design to the real textile effluent and highlight the influence of bioavailability of iron on bioremediation and the benefit of working with mutualistic organisms over single-species designs.

Materials and methods

This study tested a previously established algal-bacterial association between *Chlorella sorokiniana* and *Ralstonia pickettii* PW2 for their bioremediation potential in the real textile wastewater[4]. Untreated real effluent (RE) was collected from the outflow/drain of one of the textile industries in Panipat (29.363121 N, 76.992971 E), the biggest dyeing cluster in North India. The RE was kept in cold storage until further use. Additionally, a synthetic effluent (SE) was also prepared in the laboratory by exactly replicating the cotton dyeing process used in the industries. The physicochemical parameters like Nitrates, Potassium, Chlorides, pH were estimated using Hannah instrument multiparameter. The iron concentration in RE was estimated using ICP-MS techniques.

C. sorokiniana (CCAP 211/8K) was then acclimatized in the increasing concentration of RE and SE mixed with iron-deficient Bold's Basal Medium (3N-BBM+V; henceforth referred to as BBM). The microalgal culture was acclimatized at 28ºC under continuous white light at 80 µmol photons m^{-2} s^{-1} over 6 weeks.

The algal growth assay was carried out in two different setups, i.e., only algal (axenic) and algal-bacteria co-culture (consortium) in three different media (i) BBM, (ii) Real effluent (RE), and (iii) Synthetic effluent (SE). The growth of *C. sorokiniana* was monitored under the microscope using a hemocytometer. The algal growth curve was fitted in the logistic equation to determine the growth parameters (growth rate 'r', carrying capacity 'k', doubling time 'Dt', and area under curve 'auc') using the growth prediction modeling package '*growthcurver*' in R. The difference in algal growth in axenic and consortium setup was analyzed statistically.

The dye decolorization assay was carried out on widely used industrial Acid Black 1 dye (AB1, Sigma Aldrich; CAS: 1064-48-8). The assessment was done using Taguchi's L_{27} orthogonal array design to identify the influence of different environmental factors like iron concentration, dye concentration, and pH on dye degradation. The different ranges of the factors used were Fe: 1×10^{-7}, 1×10^{-6}, and 1×10^{-5}; pH: 7.0, 8.0, and 9.0, and (iii) dye: 5, 10, and 15 µM. The microalgal azoreductase enzyme activity (in Molar) was estimated in only algal (axenic) and algal-bacteria co-culture (consortium) setups by measuring the absorbance of AB1 dye at 618 nm. and using the formula 'A=E°CL', where A is the absorbance at 618 nm, E° is extinction coefficient 51600 $M^{-1}cm^{-1}$, C is the azoreductase enzyme concentration (in Molar), and L is pathlength (in cm). The variations in azoreductase activity in different setups were analyzed by a multiple linear regression model using Minitab. Additionally, the effect of the interaction between the factors (Fe*pH, Fe*Dye, and pH*Dye) on dye degradation was assessed by performing Partial Least Squares Path (PLSP) modeling.

The ferrireductase activity was determined in *C. sorokiniana* grown axenically and with *R. pickettii* under different iron concentrations ($FeCl_3.6H_2O$: 1×10^{-7}, 1×10^{-6}, and 2×10^{-6} M). After seven days, microalgal cells were harvested, washed, and resuspended in PBS. The ferrireductase activity was monitored as the formation of Fe2+-BPDS complex in a reaction mixture of PBS with 130µM HEPES (pH 8.1), 10µM Fe (with 10-folds EDTA), and 100µM Fe^{2+} chelator i.e., bathophenanthrolinedisulfonic acid (BPDS). The enzyme activity per unit cell was estimated spectrophotometrically at OD_{535} using the extinction coefficient 22140 $M^{-1}cm^{-1}$.

The microalgal dye degradation potential was also ascertained using analytical technique UPLC (Waters Acquity UPLC system, United States) using BEH C18 100mm×2.1mm column fitted with a photodiode array detector. The separation was achieved with a gradient of 10 mM ammonium acetate (pH 5.2-mobile phase A) and methanol (mobile phase B).

Results and discussion

Textile dyeing is a sequential process that requires treating the fabric with different chemicals under alkaline conditions (Table 1). Textile dyeing requires pre-treatment of fabric with enzymes like α-amylase to remove starch from cotton. Adding chemicals like OTS binders strengthens the fabric and improves the dyeing process. These pre-treatment processes are carried out at highly alkaline conditions (pH 12.89). The fabric is then treated with synthetic dyes at high temperatures (~70°C) under highly saline conditions. Final treatment requires multiple washing steps with detergent in hot and cold water.

In this study, the synthetic effluent (SE) was prepared by replicating the dyeing process using 25-gram raw cotton fabric. As per the industrial protocol, 1100 mL of SE was collected after the treatment of 25 grams of cotton, highlighting the textile industry's extensive water demand. The SE had a pH of 11.68 containing chemicals like α-amylase enzyme, starch, nonylphenol ethoxylate, soaps, NaCl, etc., as mentioned in Table 1. On the other hand, the real effluent (RE) was collected from the textile industry in Panipat. The physicochemical characterization of the RE and SE suggests the presence of Chlorides (SE: 261 ppm and RE: 220 ppm), Nitrates (SE: 620 ppm and RE: 373 ppm), Potassium (SE: 1.45 ppm and RE: 34.3 ppm), and total organic carbon (SE: 51.92 ppm and RE: 46.67 ppm). The pH of the RE collected from industry was 7.2 as industries use acetic acid to neutralize the textile wastewater before discarding it for further physicochemical treatment in the CETPs. Therefore, for this study, we also neutralized the SE to pH 7 using acetic acid (CH_3COOH) before acclimatizing dye decolorizer microalga *C. sorokiniana.*

C. sorokiniana was acclimatized in SE and RE at static conditions under continuous 24 hours illumination. The 14 days acclimatization period was initiated with 10% RE and 25% SE in BBM (v/v), and the algal cell growth was monitored periodically. Successively, the concentration of RE and SE was increased as the algal culture were transferred to fresh culture

Table 1: Textile dyeing treatment process for 25-gram cotton fabric to make synthetic effluent (SE)

Treatment Process	Chemicals used	Time duration	Wastewater collected (mL)	pH
Desizing	α-amylase (0.25%)	60 min	100	8.9
OTS binder	Nonylphenol ethoxylate (0.25%) + OT paste (soap) (0.25%)	60 min	100	8.72
Alkaline treatment	NaOH (3%)	15 min	100	12.89
	H_2O_2 (3%)	15 min		
	Sodium Lauroyl sarcosine (1%)	15 min		
Hot and cold washing	hot water (3 times) and cold water (2 times)	NA	500	11.52
Dyeing process	1-2 % azo dye + 5 % NaCl	30 min	100 (~70°C)	9.83
	$NaCO_3$ (0.5%)	30 min		
Cold washing	Sodium Lauroyl sarcosine 0.01%)		200	
		Total	1100	11.68
Neutralization	CH_3COOH			pH 7

flasks for acclimatization at higher effluent concentrations. After 6 weeks, *C. sorokiniana* was successfully acclimatized in RE (50% v/v in BBM) and SE (75% v/v in BBM). A concentration higher than 50% RE and 75% SE reduced cell growth, probably due to the toxicity of the effluent as it contains numerous chemicals, as mentioned in Table 1. After that, the algal cell growth was monitored to comment upon the population ecology of *C. sorokiniana* under different culture conditions.

Interestingly, *C. sorokiniana* showed increased growth in SE (~5.1×10^6 cells mL^{-1}) and RE (~3.2×10^6 cells mL^{-1}) in comparison to the growth in carbon-limiting BBM (~1.5×10^6 cells mL^{-1}) (Fig. 2A). The algal growth was further enhanced in the presence of the bacterial partner *R. pickettii* in co-culture setups, but only in RE (~4.4×10^6 cells mL^{-1}) and BBM (~2.6×10^6 cells mL^{-1}). The increase in algal growth in RE and SE could be attributed to the presence of carbon sources in the effluent. The Total Organic Carbon (TOC) analysis suggests that RE and SE contained 46.67 and 51.92 ppm of total organics. The α-amylase enzyme used in the textile industry removes starch from cotton fabric. Microalgae are known to produce and even utilize starch as a carbon source. Even acetic acid used for neutralization can also be used as a carbon source. Therefore, a higher TOC in SE and RE may have led to a mixotrophic growth compared to only phototrophic growth of *C. sorokiniana when grown* in nutrient limiting BBM. Further, analysis of the growth parameters suggests that bacterial partner *R. pickettii* significantly enhanced the carrying capacity (k; p=0.000) and area under curve (auc; p=0.000) growth parameters of *C. sorokiniana* when cultured in BBM (k, Axenic: $1.6\pm0.09\times10^6$ and consortium: $2.4\pm0.07\times10^6$; auc, Axenic: $3.0\pm0.17\times10^8$ and consortium: $4.5\pm0.15\times10^8$) and RE (k, Axenic: $3.1\pm0.39\times10^6$ and consortium: $4.28\pm0.14\times10^6$; auc, Axenic: $5.3\pm0.76\times10^8$ and consortium: $7.4\pm0.15\times10^8$) (Fig. 2B). Here, carrying capacity and area under curve matrices represents the total overall growth of algal cells. There was also a significant reduction in the doubling time (Dt) when *C. sorokiniana* was grown with bacteria, but only in BBM (p=0.049). A smaller doubling time value suggests faster growth of alga. Thus, from the results, it can be inferred that textile effluent has a significant impact on *C. sorokiniana*, and it can increase the cell growth of the microalga.

As previously reported, siderophore producer *R. pickettii* enhances algal growth by increasing the iron availability for algae. The ICP-MS analysis of the RE suggests that the Fe concentration was around 0.090 ppm which can cause iron stress in the system. At lower iron concentrations, bacteria produce siderophores to chelate Fe^{3+} iron, which is shared as a public good and is used by microalgae. Moreover, the bioavailability of iron to microalgae is also subjected to environmental factors like alkaline pH and the presence of organic chelating agents, which can make iron unavailable for algal growth. The iron capture mechanisms in microalgae are also less explored and considered less effective than bacteria. As reported previously, *R. pickettii* in co-culture led to an increased algal growth under iron-deficient conditions of BBM. However, the present study also suggests that the bacterium significantly enhances algal growth in real textile wastewater. Thus, an algal-bacterial association will benefit algal growth in real textile effluent.

On the other hand, there was no significant difference in carrying capacity (p=0.718), doubling time (p=0.963), and area under the curve (p=0.0.096) matrices of *C. sorokiniana* when algae were grown alone and in the consortium in SE (Fig. 2B). Thus, there was no observable association between algae and bacteria, which could be due to higher carbon availability in SE as suggested by TOC analysis or the presence of sufficient iron. However, a long-term assessment of algal growth in SE will further strengthen this argument.

Based on the algal growth parameters results, we further analyzed the dye degradation potential of the algal-bacterial consortium in the real textile effluent (RE). The assessment was done using a partial factorial design to identify the role of variation in the environmental factors like Fe concentration, dye concentration, and pH on the dye degradation potential of *C. sorokiniana*. We choose the L_{27} Taguchi design to identify the impact of the individual abiotic factors and the impact of the interaction between the factors on

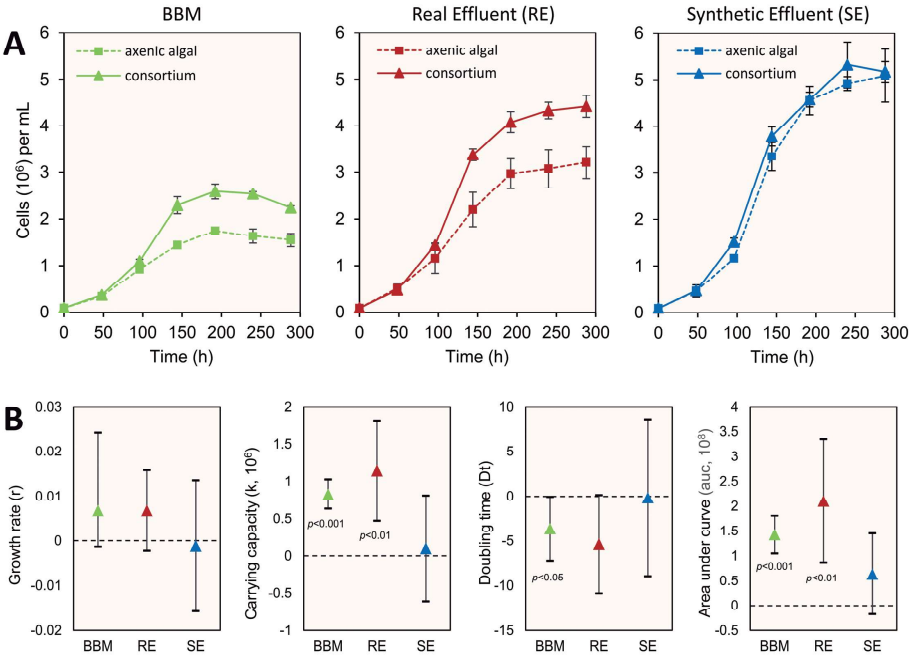


Figure 2: (A) The growth curves represent the difference in the growth of *C. sorokiniana* when grown axenically or in consortium with *R. pickettii* PW2 in BBM, real effluent (RE), and synthetic effluent (SE). (B) The confidence interval plots represent the significant difference in the growth parameters, i.e., growth rate 'r', carrying capacity 'k', doubling time 'Dt', and aand area under curve 'auc', of *C. sorokiniana* in consortium w.r.t. to axenic culture (horizontal dashed line)

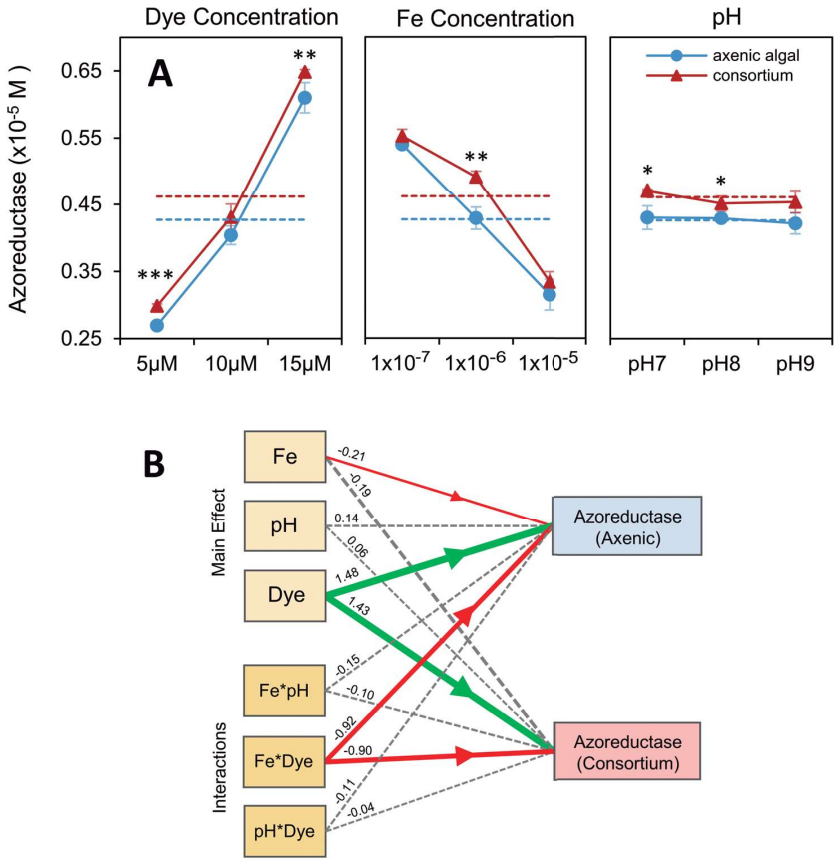


Figure 3: (A) The output of Taguchi's orthogonal array (L27) represents the impact of change in dye concentration majorly affecting azoreductase activity, followed by the change in iron concentration and pH. The symbols '*', '**', '***' represent p value with statistical significance of 'p<0.05', 'p<0.01', and 'p<0.001', respectively. (B) Output of the PLSP modeling of multifactorial L27 design. The red (negative correlation) and green (positive correlation) lines represent the significant effect of the change in factors and their interactions on the azoreductase in axenic and consortium setups. The dashed grey line represents a non-significant impact. The thickness of lines represents the values of path coefficients.

the algal dye degradation. As per the findings, the variation in dye concentration (delta value = 0.34) was the most prominent factor influencing dye degradation potential, followed by the variation in iron concentrations (delta value = 0.23). The change in pH (delta value = 0.01) has the least impact on the dye degradation potential of *C. sorokiniana* (Fig. 3A). Here, a higher delta value represents a higher impact of the variation in factor values on dye degradation. The azoreductase enzyme activity increased with the increase in dye concentration in the order: 0.61±0.04x10^{-5} M (15µM) > 0.40±0.02x10^{-5} M (10µM) > 0.27±0.02 x10^{-5} M (5µM) (Fig. 3A). Further analysis using Partial Least Squares Path Modelling (PLSPM) ascertained that variation in dye concentration showed a maximum effect on the azoreductase activity in axenic algal and consortium setup. There was also a significant positive correlation as azoreductase activity increased with dye concentration (Fig. 3B).

Dye degradation is an extracellular redox process governed by active enzymatic sites and the concentration of substrate (i.e., azo dye). Azoreductase is a plasma membrane-bound enzyme that facilitates electron transfer from within microbial cells to the azo bond (-N=N-) present in the azo dyes. An azo bond is a chromophoric group that gives color to the dye molecule. Thus, the azoreductase enzyme reduces the azo bond to break the dye molecule, removing the color. Interestingly, the azoreductase activity of *C. sorokiniana* in both axenic and consortium setup increased with the increase in dye concentration. However, there was a significant difference between the enzymatic activity at 5µM (p=0.0001) and 15µM (p=0.043) concentrations (Fig. 3A). The results suggest that in real textile effluent, the presence of siderophore producing *R. pickettii* increased the dye degradation potential of *C. sorokiniana*.

On the other hand, the azoreductase enzyme activity decreased with the increase in Fe concentration in the order: 0.54±0.02x10^{-5} M ($1x10^{-7}$ M) > 0.43±0.02x10^{-5} M ($1x10^{-6}$ M) > 0.31±0.03 x10^{-5} M ($1x10^{-5}$ M) (Fig. 3A). PLSPM analysis ascertained a significant negative correlation with azoreductase activity but only in axenic setup (Fig. 3A). Also, the azoreductase activity of *C. sorokiniana* in consortium culture at $1x10^{-6}$ M Fe concentration was significantly

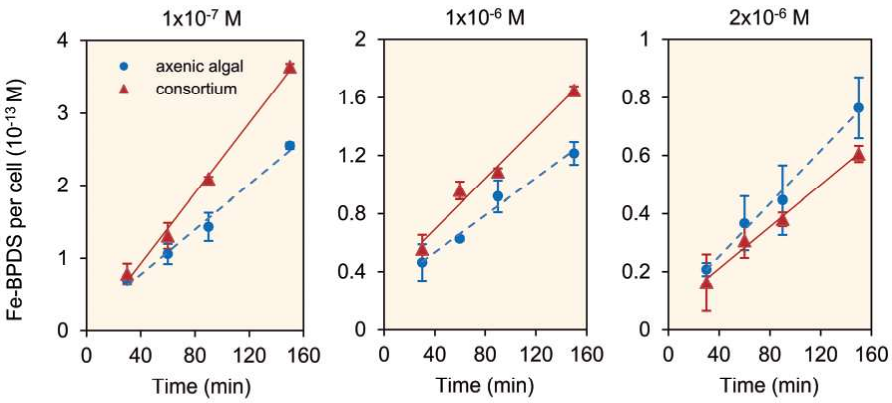


Figure 4: The difference in ferrireductase enzyme activity of *C. sorokiniana* in axenic algal and consortium setups under different iron concentrations.

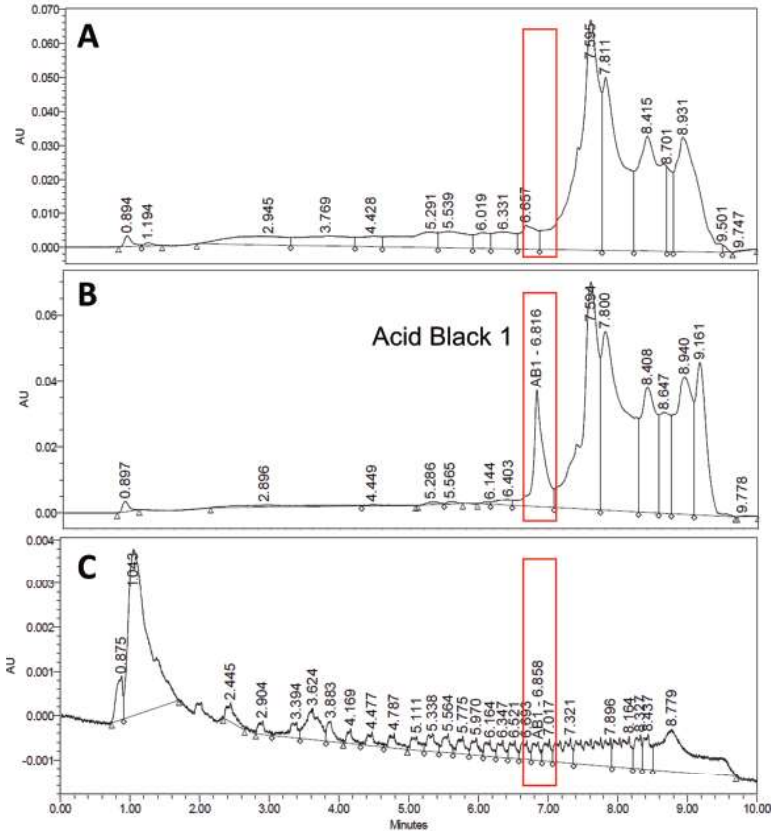


Figure 5: The UPLC analysis of (A) the real effluent (RE) showing multiple peaks of organic compounds, (B) real effluent supplemented with AB1 dye (Retention time 6.816), and (C) decolorized RE after 48 h of microbial treatment with the reduction in AB1 peak at 6.816.

higher than algae grown in axenic culture (p=0.004). At an intermediate iron concentration of 1x10^{-6} M, bacteria are known to produce siderophores, which also benefit microalgae. Siderophores capture Fe^{3+} iron to form siderophore-iron complexes. The transmembrane ferrireductase enzyme in microalga reduces the siderophore-iron complex to bioavailable iron (Fe^{2+}), thus increasing algal iron uptake and growth[5]. However, bacteria do not produce siderophores at a higher concentration but rather take iron via direct diffusion. The ferrireductase activity of the algae also reduces at higher dye concentrations, probably due to a shift in the iron uptake mechanism. The influence of extracellular iron concentration and its bioavailability on the algal enzymatic processes require further research as the area is underexplored.

However, in the present study, the difference in the azoreductase activity between axenic and consortium setup was insignificant when there was no iron supplementation (Nil) (p=0.132) and at a higher Fe concentration of 1x10^{-5} M (p=0.290) (Fig. 3A). At higher concentrations, bacteria do not produce siderophores. The PLSPM analysis of the interaction effect of Fe*Dye showed a significant impact on azoreductase activity. However, there was a negative correlation between them (Fig. 3B). The results suggest that the increase in Fe concentration has a significant negative moderation effect on azoreductase activity. This means that adding more iron to the system will reduce the azoreductase activity in the alga, which will further decrease by adding more dye. Thus, higher iron inhibits dye degradation in *C. sorokiniana*. The study, thus, highlights the importance of iron concentration in bioremediation setups. A higher concentration of Fe inhibits oxidoreductases mechanisms like azoreductase in algae. Thus, monitoring and controlling the concentration and availability of such micronutrients can play a vital role in enhancing the enzymatic oxidoreductases process and resultant bioremediation output. However, pH variation did not cause any significant change in the azoreductase activity. However, there was a significant difference in the azoreductase enzymatic activity of *C. sorokiniana* in axenic and consortium setup at pH 7 (p=0.01) and pH 8 (p=0.03) (Fig. 3A).

We further analysed the activity of the ferrireductase enzyme in *C. sorokiniana*. The alga showed maximum ferrireductase activity in low iron supplementation of 1x10^{-7} M. The activity was more in the algae grown in the consortium (3.6x10^{-13} M) with siderophore producing bacteria in comparison to algae grown alone (2.2x10^{-13} M) (Fig. 4). On supplementing the setup with 1x10^{-6} M Fe, the ferrireductase activity was reduced to 1.4x10^{-13} M in consortium setup and 0.9x10^{-13} M in axenic setup. Finally, in the treatment setup with 2x10^{-6} M Fe, the ferrireductase activity was minimum with a negligible difference between the axenic (0.6x10^{-13} M) and consortium (0.5x10^{-13} M) setup. As shown in this study, the azoreductase activity of microalga *C. sorokiniana* was inhibited with the increase in Fe concentration. We propose that since ferrireductase and azoreductase enzymes are part of the plasma membrane-bound redox system, the co-expression of both iron reduction and dye reduction pathways could be regulated by iron bioavailability.

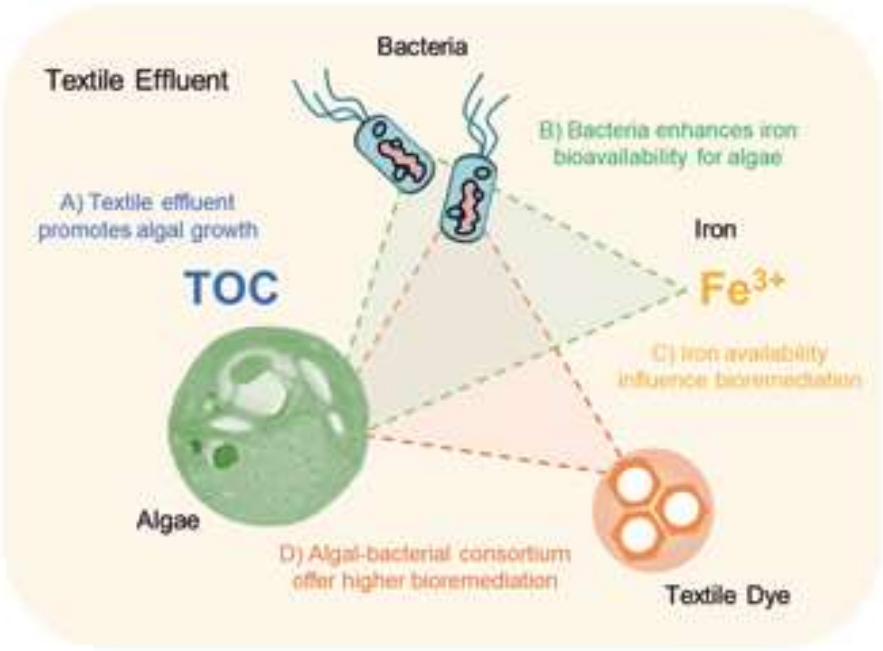


Figure 6: Iron-mediated bioremediation of synthetic dyes in textile wastewater. The bacteria increase growth and bioremediation potential of algae in real textile waste. Extracellular iron concentration plays a key role in determining the activity of the dye degradation mechanism in algae.

Lastly, we analysed dye removal using the UPLC technique to ascertain the bioremediation potential of the algal-bacterial consortium in the real textile effluent. The UPLC analysis suggests that AB1 dye (Retention time 6.816) was removed after microbial treatment (Fig. 5). In addition, peaks between RT 7 - 10 min in the UPLC chromatogram suggest that the RE contains numerous organic compounds with high polarity. The microbial treatment of 48 hours not only removed AB1 dye but also led to the removal of the additional organic compounds. Thus, the reduction of these peaks could be attributed to the increased algal growth in a mixotrophic system compared to only phototrophic growth in BBM. Thus, the consortium is suitable to work with textile wastewater.

Conclusions

We conclude that bioremediation using mutualistic organisms is advantageous over single-species designs (Fig. 6). *Chlorella sorokiniana* is a stress-tolerant microalga that can grow on real textile effluent. The organic compounds in real effluent also promote algal growth as the algae grow under mixotrophic conditions. The presence of siderophore-producing *Ralstonia pickettii* bacteria enhances the bioremediation potential of *C. sorokiniana* as it increases algal growth and azoreductase activity. We propose that the bioavailability of iron is a key factor in determining the dye removal efficiency of microalga in real waste. The addition of a high amount of iron led to the reduction in the degradation potential of alga. This could probably be due to a change in the iron uptake mechanism in algae. Therefore, monitoring iron concentrations and bioavailability is key to enhancing redox reaction-dependent processes in algae. Further investigation in this direction will help uncover the exact relation of iron-dependent pathways with bioremediation potential.

References

1. Kazamia, E., Helliwell, K.E., Purton, S. & Smith, A.G. 2016. How mutualisms arise in phytoplankton communities: building eco-evolutionary principles for aquatic microbes. *Ecol. Lett.* 19:810–22.

2. Helliwell, K.E., Pandhal, J., Cooper, M.B., Longworth, J., Kudahl, U.J., Russo, D.A., Tomsett, E. V et al. 2018. Quantitative proteomics of a B12-dependent alga grown in co-culture with bacteria reveals metabolic tradeoffs required for mutualism. *New Phytol.* 217:599–612.

3. Patel, A.K., Choi, Y.Y. & Sim, S.J. 2020. Emerging prospects of mixotrophic microalgae: Way forward to sustainable bioprocess for environmental remediation and cost-effective biofuels. *Bioresour. Technol.* 300:122741.

4. Rawat, D., Sharma, U., Poria, P., Finlan, A., Parker, B., Shyam Sharma, R., Mishra, V. et al. 2021. Iron-dependent mutualism between Chlorella sorokiniana and Ralstonia pickettii forms the basis for a sustainable bioremediation system. *bioRxiv*. 2021.06.15.446916.

5. Amin, S.A., Hmelo, L.R., Van Tol, H.M., Durham, B.P., Carlson, L.T., Heal, K.R., Morales, R.L. et al. 2015. Interaction and signalling between a cosmopolitan phytoplankton and associated bacteria. *Nature*. 522:98–101.

Editor's note: This project was supported by Phycological Research Recovery Award number 2021_BPS_0039 from the British Phycological Society.

Hilda Canter-Lund Competition 2021

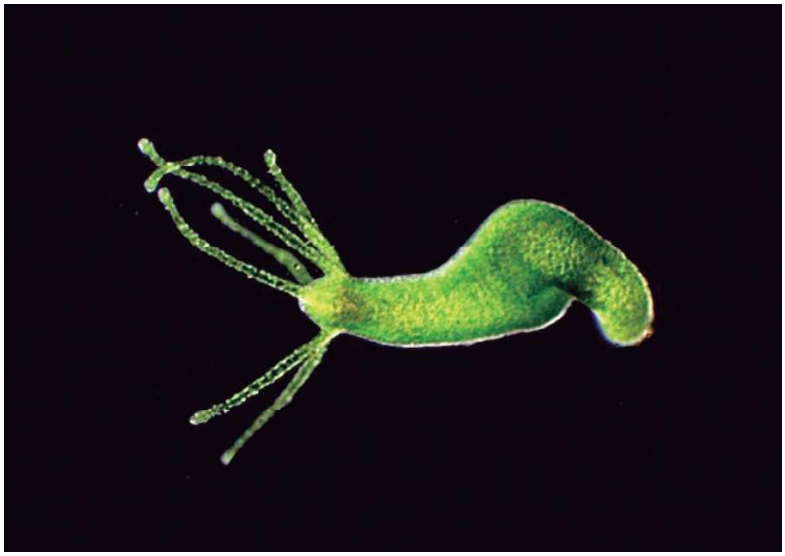
This award was established by the British Phycological Society in recognition of Hilda Canter-Lund, whose stunning photographs will be known to many members. Her photomicrographs of freshwater algae combined high technical and aesthetic qualities whilst still capturing the quintessence of the organisms she was studying.

Congratulations to all that made the shortlist, the competition was strong this year, and the BPS thanks everyone who submitted images and voted for their favourites.

Winners

Julia Van Etten with "Green with Algae"

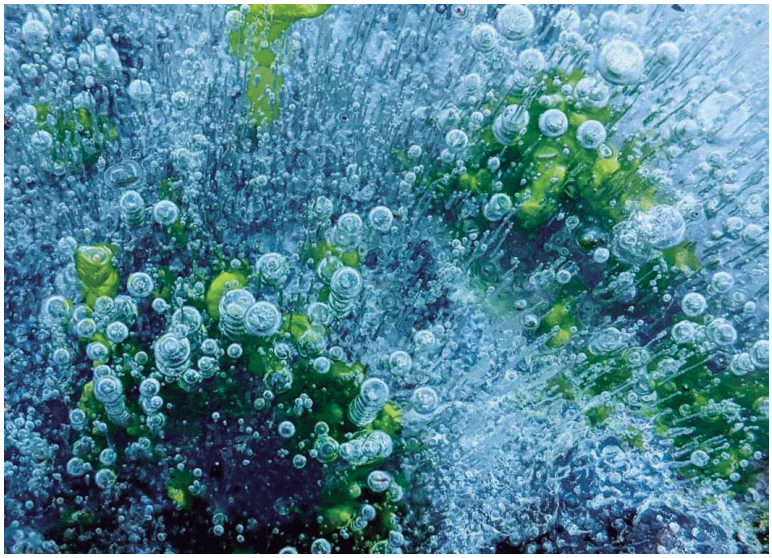
Julia Van Etten is a Ph.D. candidate in the Bhattacharya lab at Rutgers University (USA). For her research, she mainly studies the evolution of polyextremophily in the Cyanidiophyceae, an ancient group of red algae. Outside of the lab she spends her free time finding and photographing protists and other microscopic or small organisms for her multimedia project "Couch Microscopy", which has gained a large social media following and has been featured by many news outlets over the years. She is most passionate about communicating all aspects of algal biology to the public and loves to engage with other phycologists!



This is an image of many organisms, the animal *Hydra viridissima* (a freshwater cnidarian) and thousands of symbiotic *Chlorella vulgaris* cells (a green alga) that give the animal its vibrant green color! More than that, the algae provide products of photosynthesis to the hydra to give it the energy to survive when prey is scarce. In exchange, the hydra provides the algae with a safe and stable environment for long periods of time. Many algae are part of symbioses that are vital to the function of communities and ecosystems. Although we can't see the individual algal cells in this photo, we can still see their impact. This image was taken with an Amscope T340B microscope and MU120 camera, at 20x total magnification, darkfield. The hydra itself was about 3mm long in this photo and at least twice that length when its tentacles were fully extended.

Lucie Novoveska with "Frozen Bubbles"

Lucie is a self-proclaimed algae nerd. She is passionate about applying her algae background in the biotechnology. Lucie earned her PhD from Dauphin Island Sea Lab (USA) in 2011 and since worked in 4 biotech companies in the USA and UK. Lucie is an associate editor for *Journal of Applied Phycology,* work group leader for EU COST action Ocean4Biotech and number one fan of Culture Collection of Algae and Protozoa (Oban). In her spare time, Lucie is a keen tennis player, she drives anything electric and enjoys making movies and getting people excited about phycology.



This is a photograph of a frozen rock pool by Dunstaffnage castle in Scotland. During our lunch break in February, we wandered around the beach and noticed that not only the rock pools are frozen but that there are bigger bubbles around oxygen-producing *Ulva* spp. The sudden freeze locked everything in place (including photosynthesis).

Abbey Dias with "Future of Underwater Forests"

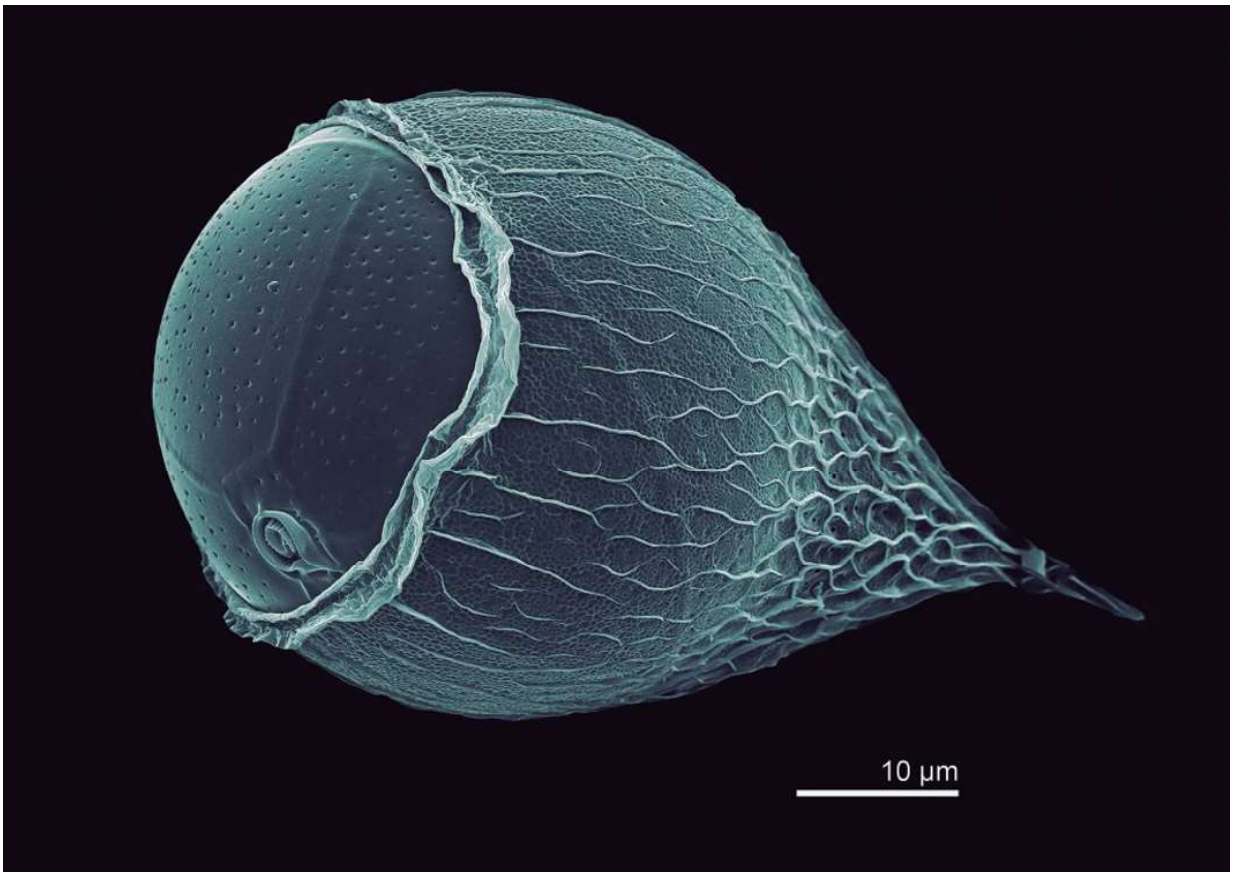
A ripe sorus sinks to the ocean floor, promising a future for underwater forests. Through a complicated lifecycle called alternation of generations, this reproductive package of spores will eventually grow into bull kelp (*Nereocystis luetkeana*) and begin the process all over again. This photo was shot in a mixed forest of *N. luetkeana* and giant kelp (*Macrocystis pyrifera*) in Monterey, California. As a result of climate impacts and urchin overgrazing, kelp forests are facing severe decline (90% loss) along the California coast. The future of these underwater forests may depend on human intervention. I am a graduate student studying *N. luetkeana* restoration in northern California, USA. My lab's work involves harvesting these sori and releasing spores onto rocks in the lab. Once the sporophytes become visible to the eye, we plant them back in the ocean. I use visual storytelling to communicate science with stakeholders, focusing on California's kelp crisis.

Martin Stevens with "Iridescent Rainbow Wrack"

Rainbow wrack (*Cystoseira tamariscifolia*) is sometimes called magic seaweed, for when out of water it looks dull and brown, but submerged it takes on a stunning iridescent blue, green, and violet coloration. It can often be found in pools along the rocky shore, seemingly glowing in the sunlight. This image was taken with a wide-angle lens and dome port, to obtain the split shot, with a single strobe flash underwater the bring out the colours of the seaweed.

Mark Edlund with "Darkside of Didymo

The diatom *Didymosphenia geminata* recently appeared in streams along Lake Superior's (US-Canada) North Shore for the first time. Under DIC illumination, the didymo cells are seen growing on heavy mucilage stalks creating thick mats of periphyton. Concerns center on how the invasion of these streams will affect their ecology, recreational uses, and the tourism-based economy of the region. (Olympus BX51, 20X PlanFl, DIC)



Emilio Soler Onís with "Cannibal Lector"

Blepharocysta splendor-maris (Ehrenberg) F.Stein (Dinophyta) being eaten by a Tintinnida. Scanning electron microscope image (scale bar 10 µm)

BPS Funded Training Support

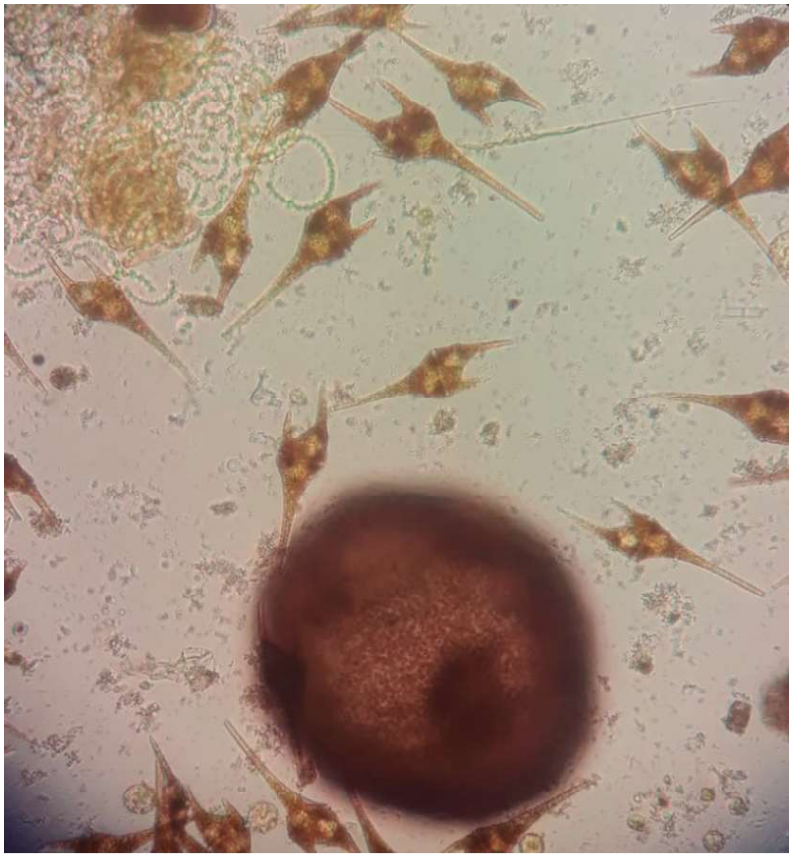
CCAP Algaculture for Biotechnology course 2022: A great opportunity to increase skills and knowledge

Submitted by: Iván Privitera Signoretta

Grupo de Ingeniería de Procesos Químicos, Biológicos y Ecológicos, Planta Piloto de Ingeniería Química (PLAPIQUI), Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Universidad Nacional del Sur (UNS). Bahía Blanca, Argentina. iprivitera@plapiqui.edu.ar

In February (9th-10th), thanks to the support of the British Phycological Society, I had the chance to attend the course virtually. It was really interesting and useful. Despite distance, professors were attentive to the students to relinquish any doubt, and the classes had a wide range of algaculture topics such as; metabolomics, bioinformatics, photobioreactors and other subjects related with algae cultivation. They were two intense, but very satisfying days. Personally, this course helped me a lot. It gave me many tools and training for my research topics. I started being interested in microalgae some years ago, when I was student at CAECE University, in Buenos Aires. Then I moved to Bahía Blanca to finish my thesis degree in Biology. After working with freshwater phytoplankton, doing qualitative and quantitative analysis, in 2019 my group and I were able to determine a Dinoflagellate (Ceratium furcoides) bloom, in Paso de las Piedras Reservoir, which provides water to the cities of Bahía Blanca and Punta Alta, in the Province of Buenos Aires. After that, I graduated and got a scholarship to do my PhD in Biology in a chemical engineering institute. Nowadays, I am in the third year of the scholarship, and most of my work and activities are focused in the study of microalgae production, but particularly cyanobacteria production. At present, I´m doing sample accounting of *Microcystis Aeruginosa* and *Dolichospermum Circinale*. We are starting to use culture techniques with the aims of studying the metabolic and genetic profiles of both cyanobacteria, but specially *D. circinale*.

I am also a Biotechnology Technician, so for me it is very important to develop tools and knowledge about overproduction of some important metabolites related with cancer, for example. The main objective of my thesis is to develop computational tools (GEMs, Genomic Scale Models, which are mathematical models of metabolic networks) for the study and optimization of the production of metabolites of cyanobacteria for biotechnological and environmental purposes. Otherwise, another activity I do in the laboratory is to analyze phytoplankton community for the Water Authority of the Province of Buenos Aires (which is a public water quality management agency), as a high-level technical service. All these activities are strongly related with the CCAP Algaculture for Biotechnology course, which was (again, thanks to the BPS) a fantastic opportunity to make contacts, share opinions, learn from very experienced people in the field, and continue growing in the fantastic world of microalgae.



Cyanobacteria colonies: *Microcystis aeruginosa* and *Dolichospermum circinale*, and Dinoflagellates: *Ceratium furcoides* (20X). A freshwater sample from Paso de las Piedras reservoir, Province of Buenos Aires, Argentina.

CCAP Algaculture for Biotechnology course 2022: A great opportunity to increase skills and knowledge

Submitted by: Bas De Vos
University of Cape Town

I am a PhD student at the University of Cape Town completing a thesis which uses interdisciplinary modelling to determine the feasibility of a commercial recirculating system integrating the sea urchin (*Tripneustes gratilla*) with the macroalgae *Ulva lacinulata*. This is supervised by John Bolton, Mark Cyrus and Brett Macey.

A large part of the work I need to do is rearing larvae of *T. gratilla*, which require 3 species of microalgae. Culturing the microalgae is a very difficult task. CCAPs course, which was made possible for me by the BPS, gave me great insight into various techniques required to improve our production of our microalgae. I have already referred to the resources many times.

Furthermore, some higher-level lectures in this course where really inspiring. The sessions held by the industry experts demonstrated the vast potential of algae and how it can make a meaning impact on our near future. Also, some of the research being done in CCAP is truly fascinating. I would sincerely like to thank CCAP and BPS for making this possible.

Algaculture for Biotechnology: CCAP Course

Submitted by: Imran Ahmad

Algae and Biomass Research Laboratory, Malaysia-Japan International Institute of Technology,Universiti Teknologi Malaysia,54100, Kuala Lumpur, Malaysia Email: mustafwibinqamar@gmail.com

I am currently a third-year PhD student at the Universiti Teknologi Malaysia under the supervision of Dr. Norhayati Abdullah. My topic of research is bioremediation of restaurant wastewater using microalgae. With the great support of the BPS, I was fortunate enough to attend the online training course programme titled "Algaculture for Biotechnology" organised by the Scottish Association for Marine Science (SAMS) and the Culture Collection of Algae and Protozoa (CCAP) on February 9–10, 2022. It was a diverse training programme covering all the essential topics, from strain isolation, culture, scaling up and going up to algal biotechnology, bioinformatics, and genetics. The speakers were extremely knowledgeable about their subjects, and the hands-on videos were fantastic. Out of all the interesting and informative lecture sessions, I enjoyed the large-scale cultivation and metabolomics part the most, as they are very near to my area of research. It will be my pleasure to join any other programme in the future.

Improving my Microalgae Biotechnology with the CCAP Course

Submitted by: Antonela Martelli[1],2

[1]Centro para el Estudio de Sistemas Marinos – CONICET, Laboratorio de Oceanografía Biológica (LOBio),2Universidad Nacional de la Patagonia San Juan Bosco, Argentina

The aquaculture of microalgae has been very useful for many years because the potential to produce various nutrients, compounds, and products for the food, pharmaceutical, and cosmetic industries. Additionally, to the improvement in the sustainability of various processes such as water remediation, biofuel production, among many others. Considering metabolites for food, microalgae can be used to produce various compounds such as proteins, carbohydrates, lipids, pigment carotenoids and different vitamins and minerals (Alam, et al., 2020). Due to these components, there is an emerging industry in the use of microalgae as as feed for the aquaculture industries of fish and invertebrate production. There is also an increasingly powerful industry around the production of microalgae for the extraction of their biomolecules as highly valued products in the nutraceutical and food industry for people. Nutritious omega-3 supplements of microalgal origin whose emerging market is constantly growing, and its adequate intake can prevent numerous diseases. This discipline is in constant research development and is expected to mitigate the global population deficit around the incorporation of omega-3 in the diet of people, which should be between 500-1000 mg d-1. Natural pigments such as astaxanthin, b-carotene and phycocyanin, are the main pigments obtained and used in the cosmetic and nutraceutical industry. Additionally, interest in microalgae-based antibiotics and pharmacologically active compounds is also growing. There are a variety of products in the pharmaceutical sector derived from algae and their application such as: antivirals, antimicrobials and antifungals, and drugs and therapeutic proteins (Alam, et al., 2020). Therefore, microalgae are not only used as a superfood source, but they can also be used as prevention and therapy; and that is why research into new applications is in continuous development.

All of the points above are the foundations to my motivation and the scientific questions that drive the line of my research in the academic centre of science (CONICET) in Argentina. My project is entitled "Microalgae Biotechnology: applications in food industry". My objective is to promote microalgae as a new platform to produce omega-3 by sustainable aquaculture. For this, I am searching for new microalgae in the marine coast of Patagonia Argentina, using isolation methods and diverse ways to culture. When I have sufficient biomass, I harvest and analyze the bioproduct of interest. The course Algaculture for Biotechnology offered by Culture Collection of Algae and Protozoa (CCAP) was very useful for me as I learned and/or refreshed all of the techniques and scientific skills related to microalgae production.

References:

1. Alam, M. A., Xu, J. L., & Wang, Z. (Eds.). (2020). Microalgae biotechnology for food, health and high value products. Singapore: Springer.
2. FAO (2021). Food and Agricultural Organization of United Stations. Statistical production of aquaculture. 2021.

Return of the Marine Seen Course

Submitted by: Shauna Corr

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On the 16th of May the 'Marine Seen: Collecting and Identifying Seaweeds' Course returned to Plymouth after three years and I was lucky enough to be in attendance. For the first time the course was held at the Plymouth Marine Station, who were wonderful hosts possessing ample facilities and views across Sutton Harbour and Plymouth Sound. The week was led by experts in the field, Francis Bunker, Christine Maggs, Juliet Brodie, Anne Bunker, Jason Hall-Spencer, and Line Le Gall from the Muséum national d'Histoire naturelle. The course attracted participants from a range of backgrounds, from NGOs and students to those interested in local marine life, making it a great opportunity to meet and engage with many different people interested in phycology. The week was segmented into lectures, fieldwork led by the experts, followed by lab work where we were provided with guidance, keys, and microscopes to learn how to ID for ourselves.

The week commenced with an "Introduction to Seaweeds" lecture from Christine Maggs covering the phylogenetic background of seaweeds and the features used to classify the algal groups. After which we had our first field trip to Warren Point which is a sheltered, tide-swept shore. Here, I got to try my first bit of foraged *Osmundea pinnatifida* and even managed to get a glimpse of the sea grass meadow. On returning to the lab, we identified some of the species we had gathered including a beautiful *Nitophyllum punctatum* individual which had bleached to a golden green colour with bright red cystocarps. We were then fortunate enough to be given a seaweed pressing demonstration from Juliet Brodie – something I have been avidly doing ever since.

The following day we learnt about seaweed reproduction and the relevance to its identification, before going into the field to collect some more specimens. This time, we headed to Mothercombe, an exposed shore with sandy habitat. After having lunch on the beach, the experts led us on a guided walk through the rock pools helping us identify species as we went, a particular highlight for me was Line Le Gall discovering a great specimen of *Bryopsis plumosa* which is currently part of my new herbarium! The fieldwork was followed by an informative talk on the identification of green seaweeds by Anne Bunker before continuing identifications from those specimens found in the field back in the lab.

Moving on from the introductory course, Wednesday delved into the advanced course with a lecture on the Ceramiales and a lab session identifying the differences of *Polysiphonia* and *Ceramium* seaweeds. Following on from a fieldtrip to Mount Batten, a sheltered shore, with an impressive diversity of species, we continued identifying Ceramiums, managing to key out *Ceramium ciliatum* using a high-powered microscope (Fig. 1a). The course continued with some wonderful talks on Coralline algae, the Bangiales, *Cladophora*, *Ulva*, and filamentous seaweeds, with a special talk from Juliet Brodie on fluorescence in seaweeds and Line Le Gall on her work with the International Barcode of Life. Our last fieldtrip was to Renney Rocks, an exposed rocky shore with rock pools, here we saw some wonderful specimens of fluorescent *Carpodesmia tamariscifolia* (formerly *Cystoseira tamariscifolia*) and *Mesophyllum lichenoides* (Fig. 1b).

At the beginning of the week, we were told we would know at least 40 new species, but this course far exceeded my expectations. Not only did the course organisers make sure we were able to identify the seaweeds found on the fieldtrips but set us up with the skills to go out into the wider field and identify seaweeds by ourselves. Besides being taught key skills such as seaweed collection, sectioning, slide preparation, and how to identify those tricky reds and greens, the fieldtrips to different shores which contained a wealth of distinct species made every field trip and lab session unique and interesting. Therefore, this course is an excellent opportunity for anyone interested in learning about seaweeds, whether that be a student, professional ecologist, or those passionate about their local wildlife. I am very grateful to the British Phycological Society for their financial support through BPS Award 2022_BPS-0110 enabling me to attend this event and would like to thank the organisers and participants for making the course such a great experience.

Microscope photos taken of (top) *Ceramium ciliatum* and (below) *Mesophyllum lichenoides* during the course.

Seaweed Course in May

Submitted by: Perle Deaibes

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In May 2022, I had the chance to participate in the advanced module of a seaweed course which was organised by the British Phycology Society (BPS) at the Plymouth Marine Station. The advanced seaweed course program included fieldtrips to Renney Rocks and Mount Batten, and various seaweed talks on the Ceremiales, the Bangiales, the international barcode of life, coralline algae and non-native species. It also involved many lab sessions to key out a *Polysiphonia* and a *Ceramium*, to identify green seaweed and *Cladophora*, filamentous green and brown seaweed, species among the *Ulva* genus, and red crustose seaweed. In this report, I aim to assess my experience as an undergraduate in Marine Biology during the course. I will first relate what I learnt during the lab sessions. Then, I will explain which talks have particularly drawn my attention. Lastly, I will describe my experience during the fieldtrips.

First, I learnt to differentiate a great number of species of seaweed which would have been highly difficult to identify without training and the use of a microscope. Learning their differences made me confident in identifying species in the future and in collecting seaweed with more accuracy. Moreover, this will be an invaluable skill that I could use in my future research projects when having to collect and identify seaweed species for my laboratory experiments.

In addition to the lab sessions, each day was filled with talks about seaweed, their life history, their phylogenetical dilemma, and many more. I was mesmerised by the one given by Juliet Brodie on seaweed iridescence when looking at the beauty of the phenomenon in *Chondrus crispus* and *Cystoceira tamariscifolia*. Moreover, I found the talk given by Line LeGall, the guest speaker and director of the seaweed department at the Musée d'Histoire Naturelle de Paris, particularly revealing as she shared her different theories on why algal biodiversity is higher in the Mediterranean, which may be due to a "trapping" mechanism when seaweed spores enter the basin through the Strait of Gibraltar.

What I particularly enjoyed during the course was going on fieldtrips. I had already visited Mount Batten and Renney Rocks when going on field trips with Plymouth University. However, having a description of the different species of seaweed on each shore opened my eyes to the algal biodiversity that they harbour and made me appreciate these places even more. Furthermore, the fieldtrips were essential in providing background information on seaweed habitats. Not only was this important to witness the differences in seaweed communities across each shore, but it also helped me to accurately to identify species that were later identified in the lab.

Overall, being on the seaweed course was very rewarding. It made me explore places that I already knew while focussing on their algal biodiversity. It taught me how to identify species of seaweed which I would not have been able to recognise without training. More importantly, it motivated me to explore more shores to collect, and preciously preserve my future collection of seaweed herbarium. Finally, I would like to thank the organisers of the seaweed course for all the knowledge that I gained over the run of the course and the BPS committee for funding my participation in the course (BPS Award Number: 2022_BPS_0109).

Freshwater Macroalgae of Ireland identification course

Submitted by: Katrina Woodfield

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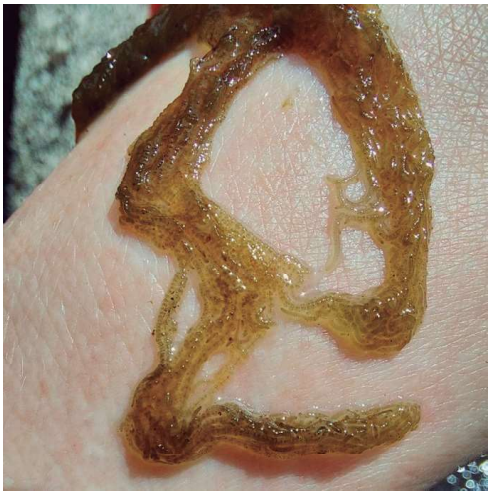
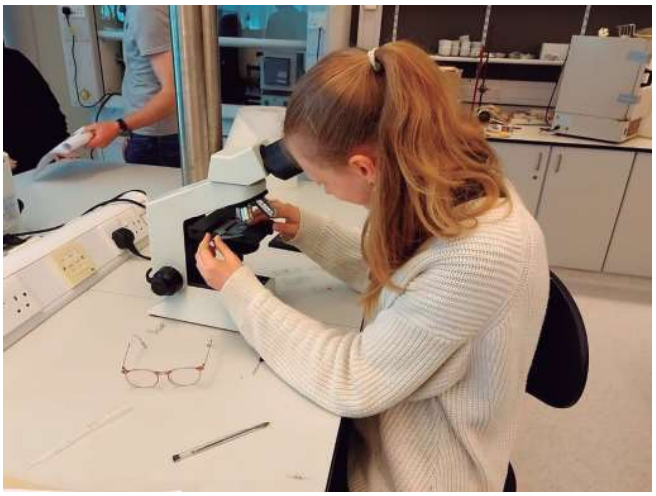
Quiet Man Bridge, Connemara, Ireland



Macroscopic view of a *Batrachospermum* specimen found at the Quiet Man Bridge.



Using a microscope in the lab.

As an undergraduate starting my degree in the middle of a pandemic, the closest I'd got to any practical aquatic ecology was observing mayflies and stoneflies over a Teams call. While I was grateful for all the work my lecturers did to enrich our online modules, I was incredibly excited to get out into the field and lab. My first hands-on experience was made possible by the BPS Student Bursary (BPS award number: 2022_BPS_0097), which enabled me to travel to Ireland and attend a course on macroalgal identification in Galway.

The purpose of attending this course was to prepare me for my dissertation partnered with the Freshwater Biological Association (FBA). The project aims to simplify a method of rapid water quality assessment using macroalgae for citizen scientists. However, I would need to learn the techniques underpinning RAPPER, the original method developed by Martyn Kelly. On the 26th of May, I received a warm welcome from Martyn Kelly and Bernie White at the National University of Ireland Galway. The half-day was spent listening to introductory talks by Martyn, interspersed with opportunities to observe various genera in both their macroscopic and microscopic form. I gained valuable microscopy skills and a newfound appreciation for the beauty of algae. From the intricate helical chloroplasts of *Spirogyra* to the distinct musty smell of *Phormidium*, it was fascinating learning how to identify each genus and explore its defining characteristics.

The second day of the course involved grabbing some waders and heading out into the field. We all bundled into a minibus which took us through the idyllic Irish landscape to the two sites we studied. At the first site, we were given free rein to investigate the stream bed; under the expert guidance of Martyn and Bernie, who pointed out the key specimens to observe. In particular, the coarse, knobbly filaments of *Lemanea* in a fast-flowing section of the stream. I gained critical field experience, learning how to properly take and store samples for later observation in the lab. The second site was somewhat of a tourist destination. We surveyed a small section of the Owenriff River which flows under the Quiet Man Bridge. The spot was made famous by the 1950s film 'The Quiet Man', where John Wayne pauses on the bridge to take in the view. In the brilliant weather conditions we had, it was clear to see why this spot was chosen. But for us, the more interesting landscape was under the bridge. *Batrachospermum* was one widespread genus at this site, easily recognisable by its unusual texture and beadlike appearance. Martyn described the texture as frogspawn-like, a unique descriptor which citizen scientists might find helpful as an identification aid.

The final part of the course involved observing the samples taken from the field and attempting to identify them to a genus level. Finally, Martyn gave a concluding talk on the rapid assessment of water quality using macroalgae. This was opened to a discussion on the practicalities of including these techniques in regular water quality monitoring.

I learned an immense amount over the two days including practical skills, theoretical knowledge, and the opinions of those working directly with monitoring water quality. I would like to thank Martyn and Bernie for all their help and for organising my place on the course. Additionally, I would like to thank the BPS who made attending the training course possible. The experience was highly enjoyable and will prove instrumental when completing my project with the FBA.

BPS Funded Travel Bursary Reports

Let's talk about kelp: PhD experiences of online vs in-person conferences

Submitted by: Nora Salland

3rd year PhD student, Marine Biological Association of the UK, Plymouth & University of Southampton

I was excited to receive the BPS student award (2021_BPS_0070) to go to the BPS meeting at Swansea University, Wales, early this year (2021). However, another wave of the pandemic hit us during winter causing participation in this year's meeting to be fully virtual (again). Instead of meeting new people during the conference dinner or chatting with fellow seaweed-lovers while sipping a wine during the poster session, the online platform 'Gathertown' was our meeting hotspot. To be fair – Gathertown gave us great opportunities to interact with one another, especially with the support of 'infohackit' and their organized social events. While sliding our avatars across the monitor (did you realized that they could dance?!), I gave my first conference talk ("Winners and losers in the Southwest: Re-visiting historical kelp sites"). Previously, I was hoping to give my first talk to a 'real-life audience', but maybe it was good practice to do it in front of the screen for the very first time, with less excitement but also manageable levels of nervousness.

Since my award budget from the BPS virtual meeting was nearly untouched, I was allowed to use the remaining money for another conference and I choose to go to the MBA Postgraduate Conference in Liverpool. This time I was lucky enough to go in person. The conference was organized by students at the Liverpool John Moores University, and I presented some preliminary results during the poster session ("Winners and losers of ocean warming – Temporal shifts in kelp populations in southwest England"). The conference was a great place to meet students across England and Europe, to learn about their research, methods and to share experience about PhD life, ups, downs and future plans. My personal highlights of the conference was the media training and discussion panel, followed by a nice dinner and a (long) social night out in Liverpool's pubs.

Thanks to the BPS for supporting me to go to both conferences and gain more experience in presenting my work to fellow scientists, as well as to network with colleagues. Thanks also to my supervisory team in supporting me along my PhD journey, and the organizing committee of the BPS meeting (Swansea) and the MBA Postgrad conference (Liverpool).

Avatar group picture after the BPS conference in 'Gathertown' (aka virtual Swansea)

Presenting my poster in Liverpool in front of students and fellow researchers

Overlooking Liverpool at the MBA Postgrad Conference Dinner

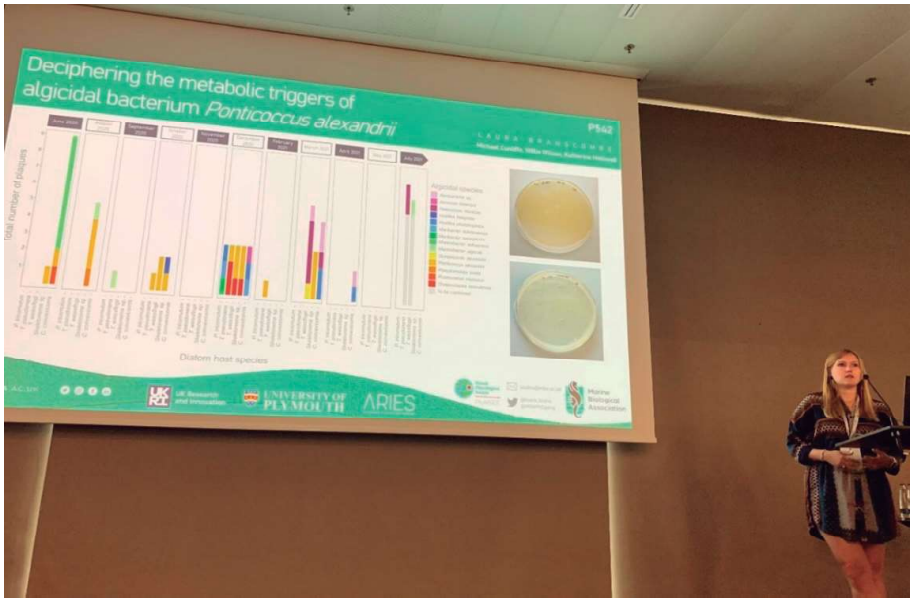
Algae in a microbial world

Submitted by: Laura Branscombe

Marine Biological Association of the UK, University of Plymouth, laubra@mba.ac.uk

The 18th International Symposium for Microbial Ecology was held from the 14th – 19th August in the beautifully scenic Lausanne, Switzerland. The meeting saw over 2000 delegates come together from all corners of the globe to present and discuss their research, and hosted sessions ranging from Marine Microbial Ecology to Plant Microbial Ecology to Global Biogeochemical Cycles. I was lucky enough to be able to attend and present my research at this meeting with the financial support of the British Phycological Society (BPS Award number: 2022_BPS_0095), and after 2 years of attending virtual conferences, it was refreshing to finally get the chance to interact with other researchers at an in-person meeting.

The week kicked off with a fantastic presidential address by Nicole Dubilier, and I continued to be overwhelmed by the quality of presentations given throughout the week. This year's ISME meeting was heavily focused on all things bacterial and viral; therefore, I felt that it was a brilliant opportunity to highlight the importance of phycological research to such a varied community of microbiologists. I presented both a poster and flask talk entitled "Deciphering the metabolic triggers of algicidal bacterium *Ponticoccus alexandrii*", where I discussed findings from my PhD project exploring the impacts of algicidal bacteria on bloom-forming diatom species. The co-existence of diatoms and marine bacteria within the phytoplankton has resulted in a broad spectrum of complex interactions, ranging from synergistic to antagonistic. Notably, antagonistic algicidal bacteria are known to influence diatom physiology and may play a significant role in diatom bloom termination events, hence shaping phytoplankton communities. Despite this, a lack of systematic reviews of the diversity and abundance of algicidal bacteria in nature means we have a limited understanding of the ecological significance of such interactions. Throughout my PhD at the Marine Biological Association and the University of Plymouth, I have been working to address this knowledge gap by investigating the diversity and abundance of diatom algicidal bacteria in the Western English Channel. In doing so, we have highlighted a seasonally persistent, broad range algicidal bacterium, *Ponticoccus alexandrii*, and are now working to untangle the algicidal mechanism, which facilitates the interaction between *P. alexandrii* and a range of bloom-forming diatom species.



Despite the small number of microalgae focused delegates present at ISME18, I had no problem connecting with other delegates who were keen to discuss algal research. I thoroughly enjoyed attending my first large international conference, as it allowed me to not only expand my knowledge base, but also meet new friends and broaden my scientific network. I would like to extend a huge thank you to both the organising committee of ISME18, and to BPS for their travel bursary award, which enabled me to attend what turned out to be an incredibly rewarding meeting.

The 10th International Symposium on Inorganic Carbon Utilization by Aquatic Photosynthetic Organisms (CCM10)

Submitted by: James Barrett

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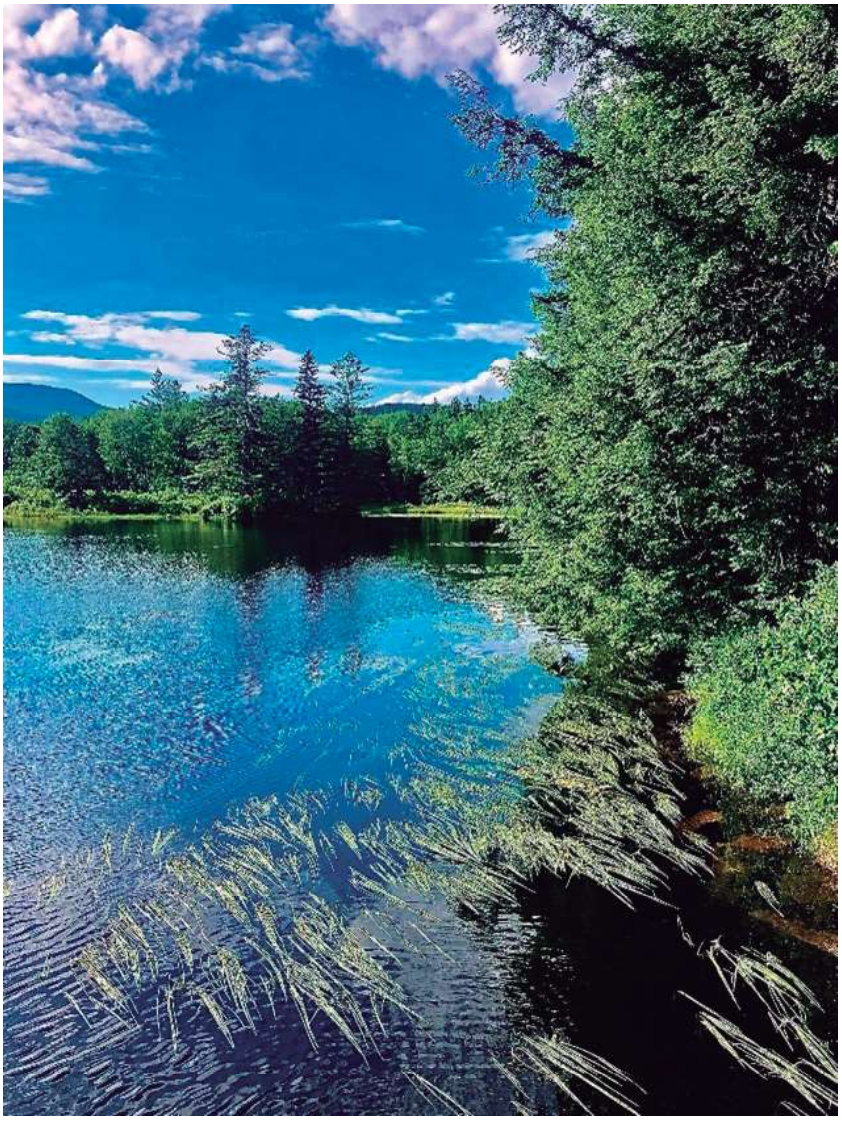
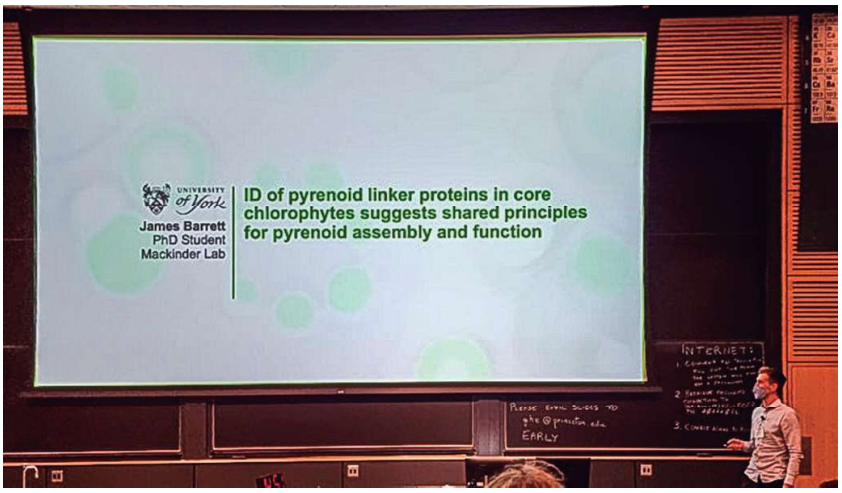
From 6th-8th July I had the pleasure of heading stateside to attend a twice-postponed CCM10 hosted by the formidable lab of Martin Jonikas at Princeton University, New Jersey. If you'd told me when I registered, I'd be giving an oral presentation I might have been suitably terrified – but two years of pandemic-stricken experiments made that a more reasonable prospect. After a white-knuckle taxi from New York to Princeton we were greeted by a collection of familiar and new friendly faces from the forefront of carbon dioxide-concentrating mechanism (CCM) research from across the world – in 3D for the first time in the three years of my PhD as well! Princeton provided a perfect setting for an accessible conference to come - that was complimented by fantastic organisation and a kayak trip with eastern painted turtles and freshwater algae!

An inspiring keynote talk from Manajit Hayer-Hartl set the stage perfectly for the 45 talks and 30 posters to come over the following three days. As is always the case when algae are involved, we were treated to huge range of topics from evolutionary context to biochemical elucidation of CCMs from algae and cyanobacteria across the tree of life. Presenting my work on the bioinformatic, biochemical and biophysical interrogation of pyrenoids in the core chlorophytes my talk fell snuggly into the 'Other eukaryotic CCMs' session between Ulva aficionado and collaborator Jonas Blomme and a host of outstanding diatom talks from the corners of the world. It was hugely gratifying to receive feedback and suggestions from peers in the community which the conference organisers did a great job of fostering. I was thrilled to hear my peers agreed that my findings begin to suggest that pyrenoid assembly and function is underpinned by a conserved set of biochemical and biophysical principles that have evolved convergently within the core chlorophytes – something we are excited to pursue moving forward.

I'm hugely grateful to the BPS (award no: 2022_BPS_0107) for funding my visit to the CCM10 – my first international conference, from which I learned so much and fostered many new partnerships





Exploring the submerged aquatic vegetation of Chesapeake Bay

Submitted by: Emma A. Ward

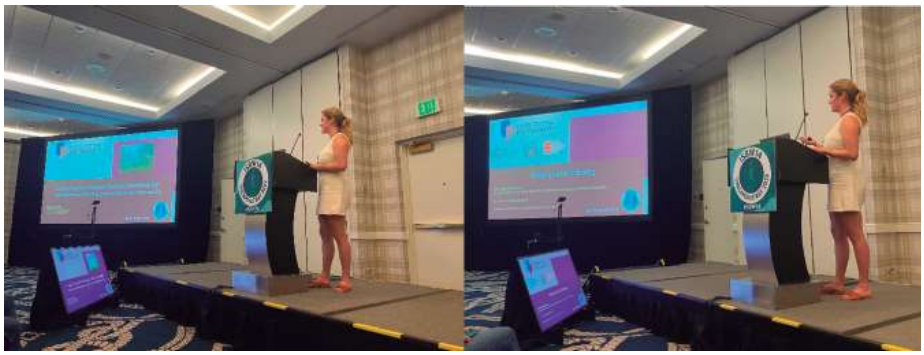
Institute of Marine Sciences, School of Biological Sciences, University of Portsmouth; emma.ward@port.ac.uk

The Chesapeake Bay region of the United States has piqued the interest of scientific researchers for decades and as such its submerged aquatic vegetation (SAV) research is part of one of longest running temperate SAV monitoring programs (since 1984). Therefore, the Chesapeake waterfronts of Annapolis, Maryland, made a fitting background to the 2022 world seagrass conference and 14th international seagrass biology workshop. With the fantastic support of the British Phycology Society through one of their student travel grants (BPS Award number:2022_BPS_0105) I was able to attend this meeting of SAV specialists; which due to the previous Covid-19 restrictions meant this was in fact the first conference that I had been able to attend in-person as part of my PhD.

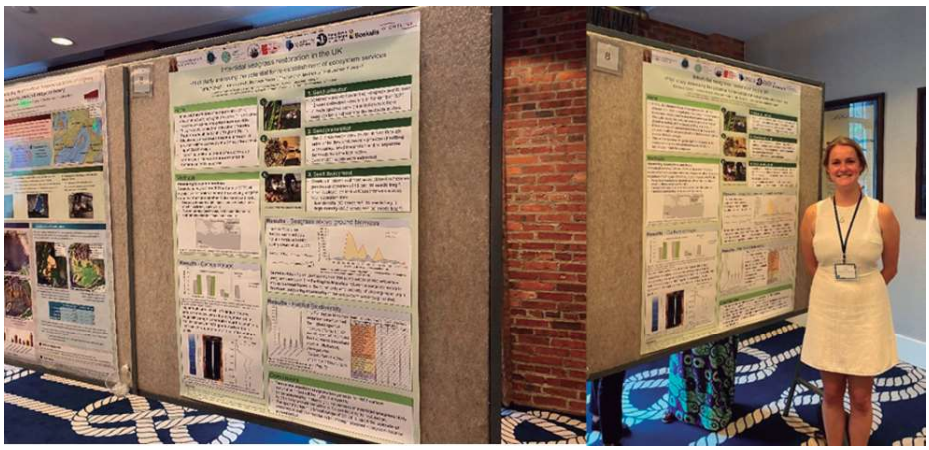
The conference opened with a fantastic plenary on the SAV research and partnership collaborations undertaken in Chesapeake Bay during the recent decades, discussing the positive success stories and SAV regeneration witnessed around areas of the bay. Although this was also matched with the realism of working hard to maintain partnerships and addressing setbacks, such as a massive decline in acreage seen in 2019. The second session of the day on host-pathogen interactions was a fantastic opportunity to solidify some in-person connections, as I was finally able to meet face-to-face with two of my co-authors from an international collaboration on the range expansion of Marinomyxa marina, a phytomyxid parasite found within the seagrass *Halophila stipulacea*.

Day two was perhaps my highlight as alongside watching other fantastic talks I was able to present a proportion of my PhD work on coastal connectivity and carbon provenance in the carbon ecosystem services session. It was a fantastic experience to present at such a large research platform and to delve into carbon focused conversations with the other presenters and attendees after the session. The breadth of carbon focused talks ranged from in situ experiments (metabolism studies and sediment coring) to remote sensing (satellite mapping) and literature reviews, which included my meta-analysis showcasing an updated global carbon provenance database for seagrass sediments formulated of isotopic carbon signatures. This updated global database highlighted that certain temperate seagrass bioregions typically aggregate a higher proportion of allochthonous organic carbon (ex situ i.e., saltmarsh and algal derived organic carbon) in their sediments. Following on from my oral presentation I later had the chance to present a poster showcasing some of the active intertidal seagrass restoration work we have been undertaking at the University of Portsmouth with our partners and collaborators; The Hampshire and Isle of Wight Wildlife Trust; Boskalis Westminster and Wightlink ferries. This project aims to assess the success of intertidal seagrass restoration techniques and the potential for restoration to support synergistic reestablishment of ecosystem services in UK intertidal seagrass.

The initial conference presentation days and final workshop days were broken up by field trips to various parts of Chesapeake Bay. I was lucky enough to head to the northern region of the bay, which is in the tidal fresh zone and houses some of the bays' most diverse grass beds; formed from various aquatic plants. From the town of Havre de Grace a pontoon boat took us to the middle of the Susquehanna flats where we could jump in and explore the grass



Presenting my talk on carbon provenance and coastal connectivity within the conference's carbon ecosystem services session.



Poster session Tuesday evening showcasing the University of Portsmouth's intertidal seagrass restoration undertaken with The Hampshire and Isle of Wight Wildlife Trust; Boskalis Westminster and Wightlink ferries.

Exploring Chesapeake Bay by boat (left) and several aquatic plant species collected on the snorkel exploration (Left to right; Hydrilla verticillata; Stargrass, Heteranthera dubi; Wild Celery, Aythya valisineria).

from below the water via snorkelling. There was such a wide variety of grass species, especially compared to my typical PhD fieldwork sites which house *Zostera marina* and *Zostera noltei*, which admittedly in comparison are far different being that they are marine sites housing true marine angiosperms. The most distinct of the Susquehanna Flat species was the Water Stargrass (*Heteranthera dubia*) given it was currently in bloom and many small yellow flowers could be spotted. The most similar looking to the seagrass species I work with was Wild Celery (*Aythya valisineria*) which had a notable light green strip down the strap blades. It was fantastic to swim amongst such abundant beds the leaves reached from the floor to the water surface meaning you were in fact swimming through the grass and not above it as you might perhaps expect. This trip was fantastic to really give context to some of the work that had been discussed earlier in the week and provide a direct connection to the habitats themselves. I believe most of us would agree that there is often nothing akin to seeing habitats especially underwater habitats in situ, they simply come alive in the water.

The week was rounded out by some fantastic workshops some of which focused on satellite mapping, crowdsourcing data via volunteers and facilitated migration. Though all very distinct they had one common purpose aiming to push the frontier of seagrass research forward, whether that was new ways of utilising citizen science such as mobile apps or accessing new remote sensing tools. It was fantastic to be integrated into these discussions and contribute to workshop outputs. Overall, the conference was a fantastic experience and one I would recommend to other research students, it both incorporated research from around the world and gave a fantastic insight into the watershed conservation approach currently underway at Chesapeake Bay. In doing so this created the perfect platform to discuss not only the marine seagrasses, but also other submerged aquatic vegetation. I would again like to take the opportunity to thank the British Phycology Society whose financial support made my attendance possible and without whom I would not have had the chance to present and network at the pinnacle event for seagrass researchers.

References:

1. doi.org/10.1016/j.aquabot.2022.103554

A Visit to the MBA

Submitted by: Cristina Galobart

Centre d'Estudis Avançats de Blanes (CEAB-CSIC), Girona. cgalobart@ceab.csic.es

On July 10th 2021, I arrived for the first time in Plymouth to work with the BEECH group at the Marine Biological Association (MBA). I am PhD student from the Centre d'Estudis Avançats de Blanes interested in the conservation of marine forests, in particular, of those dominated by brown macroalgae. The aim of that three-month stay was to start working with already available data as a collaboration between Dr. Emma Cebrian (my PhD supervisor) and Dr. Dan Smale. In a nutshell, we aimed to quantify the functional diversity of macroalgal forests dominated by different structural species. Specifically, we used algal community data of a *Laminaria hyperborea* forest (N Scotland), a *Saccorhiza polyschides* forest (N Portugal) and a *Laminaria rodriguezii* forest (NE Spain). During the stay, I was encouraged to attend the 70th Annual BPS Meeting, held in Swansea during the first week of January 2022. Even though the meeting went finally online, the organization team run a brilliant conference in the circumstances. Prior to the conference, we discussed our results and we realised that including a fourth community to the analysis would broaden the scope of our study and would help us understand another facet of the macroalgal ecosystem functioning. In this line, we decided to sample *L. ochroleuca* forests from the SW

of England, and thus, the idea of returning to Plymouth for a second one-month stay at MBA arose to work again (and of course have fun) with the BEECH group. The first step to study the functional diversity of a community is to assess its species diversity and abundance. So, the objective of this stay was to obtain a detailed database of the present species in the *L. ochroleucha* forests. In July 2022, I spent a month sorting and identifying the algal specimens at the laboratory. Having the opportunity to be back in the sunny Plymouth allowed me learning at first-hand about another macroalgal system, very different from those I found in the Mediterranean Sea. I had previously collected and identified algae from benthic samples from the Mediterranean, but marine flora from the Atlantic coast was a world quite unknown to me. Both placements represented an excellent opportunity to improve my identification skills and to acquire a broader knowledge about macroalgal marine forests. Now, it's time to come back home and work with the results. I would like to thank the BPS for funding my 70th Annual Meeting (award 2021_BPS_0061) and partially support my second stay at the MBA. And special thanks to the amazing BEECH team: Dan, Nora, Cat, Emma, Nathan, Katie, Larisa, Sophie, Maxine, and Ed. See you soon!

Algal, Research, Innovation and Environmental Science (ARIES) launch event

Submitted by: Dr Mikey Ross

CCAP Manager, Michael.Ross@sams.ac.uk

The Culture Collection of Algae and Protozoa (CCAP) is a Biological Resource Centre located within the Scottish Association for Marine Science (SAMS), in Oban, on the west coast of Scotland. Globally, CCAP is one of the oldest, largest, and most diverse service collections; with approximately 3,000 different strains of microalgae, macroalgae, cyanobacteria, algal pathogens, and protozoa.

CCAP is supported by NERC-UKRI as a National Capability Service. As such, CCAP provides a range of services to facilitate the algae research and commercial communities. These services range from the provision of algal starter cultures and growth media, Molecular services, cryopreservation, Confidential and Patent Deposition, consultancy, education, teaching and outreach. In addition, we undertake collaborative research to supplement the collection.

On the 27th of April, CCAP launched a new service – the Algal, Research, Innovation and Environmental Science (CCAP-ARIES) centre – in a blended mini-symposium event in a marquee at SAMS. CCAP-ARIES was developed to enhance and complement the collection and to centralise research and service provision around increased cultivation capacity of algae, increase the on-site analytical, genomic and metabolomic capability that supports algal research in the user community, and deliver advanced training to UK and international researchers. The CCAP-ARIES centre was fully supported by just over £500k funding from NERCs World Class Large-scale Research Infrastructure scheme, in late 2020.

The symposium had a full and varied schedule, with presentations providing a history of SAMS and CCAP. Academic presentations highlighted the new Cultivation and Downstream Processing facilities, Metabolomic and Molecular services available through CCAP-ARIES. There were presentations from industry partners and services providers including Dr Fred

De Boever (SAMS – Bioinformatics Gateway), Dr Marco Lizzul (Varicon Aqua – Photobioreactor provider), Dr Richard Phillips (Membranology – membrane filtration), and Prof Saul Purton (Algae-UK and BPS).

Lunch was provided by Argyll College, part of the University of Highlands and Islands, under the guidance of Chris Wolfe. His catering students developed the marine-themed menu using local and sustainably sourced ingredients. Following this, attendees were provided a tour of SAMS and CCAP facilities, including the ARIES photobioreactors that had been inoculated with *Chlorella vulgaris* (CCAP 211/11B), *Phaeodactylum tricornutum* (CCAP 1055/18), *Porphyridium purpureum* (CCAP 1380/1A), and the macroalgae *Asparagopsis taxiformis* (CCAP 1341/1). Afterwards, there was a ribbon cutting ceremony to mark the official opening of the CCAP-ARIES centre. Finally Postgraduate students, all affiliated with CCAP, then provided a series of flash presentations summarising their research projects; these ranged from wastewater treatment with macroalgae, development of biorefineries, through to using algae in space exploration. The symposium was closed with a drinks reception and table-top demonstrations from the industry partners.

A full itinerary and background to the event can be found in this link https://readymag.com/u1892175579/3556964/4/

Dr Mikey Ross (CCAP Manager) said "The launch event was a huge success, and I don't think that anything could have gone any better…even the sun was shining! There was a real buzz to the day, and I think that people were really thrilled to be able to attend events and network in-person again. It was a privilege to host such an event, and it turned out to be more of a celebration. I was really heartened to see so many people at the event, some having travelled quite some way to attend. The CCAP-ARIES centre is a landmark moment for CCAP, and one which I hope will be of real benefit to the community."

CCAP would like to thank the BPS for contributing towards they event by providing travel bursaries for some the attendees (BPS Award number: 2022-BPS_102). Some of the recipients of the BPS bursaries have provided some of their insights of the CCAP-ARIES launch event, below.

Dr Emily Kostas

BBSRC Discovery Fellow – UCL

I was extremely excited to attend both the CCAP-ARIES and the Seaweed Academy launch events in April 2022, particularly since they were one of the first 'in-person' events that I attended since the pandemic. It was wonderful to visit (a sunny and warm!) Oban and SAMS again, and catch up with fellow phycology colleagues from around the UK. Both events were exceptional, filled with inspiring presentations, tours of the centre, and the new research facilities and services that are available. As a researcher myself, it was particularly useful to grasp a better understanding of the different types of analysis and analytical systems that have been set up at CCAP- ARIES, such as their pigment analysis system. I am certain that I will be sending some of my samples to CCAP-ARIES for pigment analysis in the near future. However, the highlight for me was seeing *Asparagopsis taxiformis* growing in a photobioreactor; a beautiful example of applied phycology and engineering! I would like to thank the British Phycological Society for awarding me a travel grant to attend these events, which contributed towards to my accommodation costs. Thank you very much!

Dr Yixing Sui

Research Fellow – University of Greenwich

It has been a great pleasure and honour to have participated in the launching event of CCAP-ARIES. I also much appreciate the travel grant provided by the British Phycological Society. I have known SAMS and CCAP for a long time during my time spent in algal research, nonetheless, it was the first time I had the chance to visit SAMS and CCAP in Oban. I was impressed by the beautiful location, but more importantly, I truly felt the enthusiasm from all the researchers and student towards the work they do. Thanks to the different talks given by experts including the British Phycological Society, and eye-opening visits to the laboratories and facilities at SAMS, I am so proud to be part of the algal research community. I much look forward to the next event!

INSTRUCTIONS FOR CONTRIBUTORS

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

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

Submission of Copy and Deadlines

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Deadlines are **March 1st** for the April issue, **September 1st** for the October issue.

Typesetting by Agnès Marhadour
Printed by Monument Press, Stirling, UK