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The Phycologist

The Newsletter of The British Phycological Society

NUMBER 34 - MARCH 1993

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EDITORIAL

Welcome to the first issue of 1993!. This issue contains reports and news mainly from the January Winter meeting at Swansea, which was a great success (many thanks to Kevin and Krystyn Flynn for making things run seamlessly). Yet again the meeting contained more papers and talks than previous years, though to find out more see the reports given by our new overseas vice-President along with two student contributions. This is the second year for the newsletter in its new format. The editors hope that at least you will be getting used to seeing it three times a year and familiar with the copy dates. We are always willing to receive offers of articles on areas of wide interest or on areas of research you wish to raise to the society generally. Notices of meetings other than the BPS Winter meetings will also be welcomed - remember The Phycologist has a circulation of over 600 specialists. We are trying to separate different items into categories such as Society News, Articles (Winter meeting programme or abstracts), Reports of Other Meetings, Letters and Notices. If you do have any comments or likely articles or meeting reports please contribute.

The innovation this year is the inclusion of the Winter Meeting paper and poster abstracts. Remember, the abstracts can be fully referred to since The Phycologist is a registered publication - ISSN 0965-5301). The move of these abstracts from the British Phycological Journal to The Phycologist is part of that Journals transition into the European Journal of Phycology. We hope that the efforts in typesetting have been worthwhile and that you are pleased with the results.

Philip Wright.

PS. I would like to personally thank both Phil Wright and David Williams for stepping into the breach to rescue this issue when I fell ill during the Winter Meeting.

Robert Edyvean.

COPY DEADLINES:

JANUARY 31
MAY 31
SEPTEMBER 30

REVIEWERS STILL REQUIRED

Reviewers are required for the books that continue to come in to the editor. It is important that books received are reviewed at the earliest possible opportunity and we are getting towards a rapid turn round. However, to be sure of this we still need more reviewers "on our files". Potential reviewers should write to the Editor. Reviewers should realise that their reviews must be received by the next deadline after receipt of the book, they should be between 500 and 1000 words and preferably sent to the editor on computer disk (see back cover for details). In return the reviewer gets to keep the book!

CONTRIBUTIONS TO THE PHYCOLOGIST

Type specimens of British marine algae in the Edinburgh Herbarium

F. G. Hardy
Department of Marine Sciences and Coastal Management, The University, Newcastle upon Tyne, NE1 7RU.

SUMMARY

The Greville Collection in the Herbarium of the Royal Botanic Garden, Edinburgh, contains the type specimens of six species of British marine algae (two red algae and four brown algae). These are described in this paper.

THE ALGAL HERBARIUM

The herbarium of Robert Kaye Greville (1794-1866), which the Garden began purchasing in 1845, is one of the most important collections incorporated into the Herbarium of the Royal Botanic Garden, Edinburgh. The section devoted to British marine algae contains the type specimens of six species (two Rhodophyta and four Phaeophyta). The red seaweed *Cordylecladia erecta* (Grev.) J. Ag. was first described as *Sphaerococcus? erectus* Grev. (Erect *Sphaerococcus*) by Greville in 1828 from specimens collected by Mrs Griffiths in Devon in 1827 (Greville, 1828, t.357). The text states that the species was found at Tor-Abbey rocks, Meadfoot, Waldon Rocks, Torbay, and Sidmouth. The lectotype, at Edinburgh, is from this last locality. In 1830, the species was renamed as *Gracilaria erecta* (Grev.) Grev. (Greville 1830 p.124) and it changed name once again in 1852 to *Cordylecladia erecta* (Grev.) J. Ag. (Agardh, 1852). Jones (1962) considered that the valid name was *Gracilaria erecta*; however, the species has been returned to *Cordylecladia* by Irvine (1983). Paratypes are located in the herbaria at the Natural History Museum, London (BM), and at Lund, Sweden (Agardh Herbarium). The type specimen of *Polysiphonia spinulosa* Grev. (Round- fruited Polysiphonia) was collected at Appin by Captain Carmichael and described by Greville in 1824 (Greville, 1824, t.90). Other pieces of this specimen are located at the Natural History Museum, London (BM), at Trinity College, Dublin, and in the Agardh Herbarium at Lund, Sweden. Writing of its discovery, Greville (1824) states: "It is fortunate when the active and intelligent naturalist is rewarded by the discovery of new objects, for the time and patience he expends in bringing to light the more hidden treasures of our Flora. Captain Carmichael, as we have indeed already noticed, has thus been repaid. The present interesting alga is one of his recent acquisitions, and not the least beautiful. As yet it must be accounted extremely rare".

The brown alga *Herponema velutinum* (Grev.) J. Ag., always found growing epiphytically on *Himanthalia elongata* (L.) S. F. Gray, was originally described by Greville (1828, t.350) as *Sphacellaria velutina* (Velvet Sphacellaria). It was collected from Sidmouth, Devon in December 1827.

The brown alga *Petrospongium berkeleyi* (Grev. in Berk.) Nag. in Kutz. was originally described by Greville, in Berkeley (1833, p.5), as *Chaetophora berkeleyi* from a specimen collected in Torquay, Devon, and this specimen is now at Edinburgh, together with a pencil drawing by Greville (labelled "Chaetophora. Rocks. Torquay. Mr. Berkeley. June").

Punctaria latifolia Grev. was collected by Mrs. Griffiths in Sidmouth, Devon, in May 1822 and described by Greville in 1830 (Greville, 1830, p.52). Writing there, Greville states: "I have never seen any specimens of this species, except one found by Dr. Drummond, near Belfast, and those communicated by Mrs. Griffiths (now at Edinburgh), some of which being gathered at Sidmouth during my residence there, I had an opportunity of examining in a fresh state".

C. Agardh described a species of brown alga growing on eel- grass as *Zonaria tenuissima* (Agardh, 1824, p.268). From specimens found commonly on the coast of the Isle of Bute (now at Edinburgh), Greville (1830, p.52) renamed this *Punctaria tenuissima* (C. Ag.) Grev.

The algal herbarium at Edinburgh is receiving a considerable amount of curatorial attention at present and it is hoped that this will reveal further interesting specimens.

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Stress limitation

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INTRODUCTION

The communication of science requires an adherence to definitions of descriptive terms. Unfortunately there are many terms in general usage which are poorly defined thus leading to confusion and a disruption of scientific discussion. In phycology, some examples of such terms are "biomass", "primary production" and, the subject of this note, "limitation". In this discussion the main point of reference is to stress and limitation at the whole cell or organism level.

TYPES OF LIMITATION

There are two forms of limitation; rate and yield limitation.
RATE limitation describes a situation where a condition affects the rate of a process. In the absence of other factors, the same end result is attained but that point takes a longer time to reach. (Of course in population dynamics the effect on the population of a difference in rate may well ensure that the same end point is not attained because of competition from other organisms.) Importantly there can be several rate limitations acting simultainously. For example if several substrates are present at low concentration then the rate of growth may be increased by an increased concentration of either substrate. An increase in concentration of several substrates may lead to a synergistic effect on the rate of growth.
YIELD limitation is a totally different matter, although before yield limitation is attained a period of rate limitation is experienced as the substance in question passes through a rate limitating phase before reaching zero. Unlike rate limitation there can only be one yield limitating factor at any point in time.

INTERACTIONS BETWEEN STRESS AND LIMITATION

"Stress" is a term associated with "limitation". Stress may be considered as a continuous scale from zero (where all conditions are optimal) to maximal where growth is halted by some factor. There are three phases of stress -
a) In the first phase, the organism can respond and overcome the stress so that growth continues with minimal disruption.
b) In the second phase, the organism can no longer maintain growth rates by adjusting metabolic proceses and the stress becomes rate limiting.
c) Finally the stress becomes so great that growth halts with yield limitation.

EXAMPLES

An example of non-limiting stress is seen with growth on surplus nitrate in comparison with ammonium. The absence of ammonium results in a stress which leads to the derepression of nitrate assimilatory processes. Another example is growth on an organic source of P which requires the use of alkaline phosphatase to liberate inorgnic-P for uptake. Note that the presence of alkaline phosphatase activity is often used to detect P-"limitition" when in fact there may be no limitation occurring.
Both P and Fe are examples of nutrients for which there may be a wide scale of rate-limiting stress. Whilst both are required as structural components (in that each cell must contain P and Fe), they also have important roles in cell-energetics. In the short term, even the complete absence of new P or Fe will not prevent population growth because the cellular P and Fe may be divided between the new cells. Eventually of course this rate limiting stress becomes yield limiting. For such nutrients, it becomes very difficult to determine the level of stress which is associated with significant stress,

especially as stress caused by such factors may affect other processes. For example a lack of Fe may affect the use of nitrate and so lead to symptoms of N-stress even though nitrate may be present in adequate amounts in the environment.

PROBLEMS IN ECOLOGY

The problem for the ecologist is to determine the physiological state of the population of interest. What factor(s) are rate or yield limiting? This problem is exacerbated when, as is often true of nutrients such as N and P, the natural concentrations are already at such a level that some stress is always present. That is not to say that growth need be in anyway limited, just that the organism is not growing under optimal conditions. There are several approaches which could be used to determine stress in nature -

a) MORPHOLOGY may indicate if stress is present by the presence or otherwise of structures. An example is of heterocysts in cyanobacteria capable of N2- fixation which are not produced when a surplus of fixed inorganic-N is available.

b) PHYSIOLOGICAL DETERMINATIONS have used tests of metabolic processes in an attempt to determine levels of limitation or stress. Such methods may include additions of the suspected nutrient followed by incubation for a period of time. Such tests should be of short duration else the experimenter will induce other stresses on the organism. Other methods may examine the presence or otherwise of indicator enzymes or metabolites.

c) MOLECULAR BIOLOGY methods are now being developed. Given that any test conducted in order to detect stress in organism should be as short as possible, methods to determine stress at the molecular level would seem to be ideal. In theory one could look for the signs of stress (in the synthesis of stress-proteins for example) and detect signals at a level of sensitivity previously unattainable. One could also probe individual species or even cells. However, there are two major problems -

i) The usual problem exists of not knowing when a stress is in anyway limiting (complicated by resources in nature seldom being in excess).

ii) This is complicated further because molecular methods do not readily provide information on rate processes. Whilst the mRNA or the presence of an enzyme or cofactor may be detected, even if that detection can be quantified in a sensible fashion, it is very difficult to relate that to enzyme activity for example.

If molecular biology is to contribute to attempts to the determine the state of natural populations then molecular biologists must work hand in hand with physiologists who themselves must work with ecologists so that they all understand what the signal/s is/are that they require to measure.

CONCLUSIONS

In the three approaches for determing stress or limitation described above, there is a consistent problem. The points at which stress becomes rate or yield limiting are rarely if ever defined or determined. We are all guilty of using these terms with poor definition and indeed it is not a trivial matter to determine the different states with a useful degree of accuracy. We should however at least be aware of the three stages of stress and prefix "limitation" with either "rate" or "yield". The problems associated with the subject of limitation are perhaps indicative of a larger problem in biology. With the ever increasing range of analytical tools at our disposal, and the presures to use them, we sometimes lose sight of what we are actually trying to measure and why.

BPS field meeting, Anglesey, 17-19 July 1992

Dr. J. Brodie and Dr E.Jones
Bath College of Higher Education, Newton Park, Bath BA2 9BN. and UCNW, Bangor.

A seaweed identification course took place on Anglesey on 17-19 July 1992. The species listed in this paper are those that were collected by the group who attended the field meeting. Larger collections were made on 18.7.92. than on 19.7.92. Adverse weather conditions made collecting at LWMST too hazardous on exposed shores and this has curtailed the list.

Sites visited

1. Church Island, Menai Strait (18.7.92).
2. Rhosneigr (18.7.92).
3. Penmon (19.7.92).

SPECIES LIST	SITES		
RHODOPHYTA	1	2	3
Ahnfeltia plicata (Huds.) Fries			+
Audouinellia floridula (Dillw.) Woelkerling	+		+
Bostrychia scorpioides (Huds.) Mont.		+	
Calliblepharis ciliata (Huds.) Kütz.	+		
C. jubata (Goodenough & Woodward) Kütz.		+	
Callophyllis laciniata (Huds.) Kütz.	+		
Catenella caespitosa (Withering) L. Irvine in Parke & Dixon	+		
Ceramium rubrum (Huds.) C. Ag.	+	+	+
Chondria dasyphylla (Woodw.) C. Ag.		+	
Chondrus crispus Stackh.	+	+	+
Corallina officinalis L.	+	+	+
Cryptopleura ramosa (Huds.) Kylin ex Newton	+	+	+
Cystoclonium purpureum (Huds.) Batt.	+		
Delesseria sanguinea (Huds.) Lamour.	+	+	+
Dilsea carnosa (Schmidel) O. Kuntze		+	
Furcellaria lumbricalis (Huds.) Lamour.	+	+	
Gelidium latifolium (Greville) Born. & Thur.		+	
G. pusillum (Stackh.) Le Jolis		+	
Griffithsia corallinoides (L.) Batt.			+
G. flosculosa (Ellis) Batt.	+	+	+
Gymnogongrus griffithsiae (Turner) Martius	+		
Heterosiphonia plumosa (Ellis) Batt.		+	
Laurencia hybrida (DC) Lenorm. ex Duby			+
L. obtusa (Huds.) Lamour.		+	
L. pinnatifida (Huds.) Lamour.		+	
Lithophyllum incrustans Phil.		+	
L. sp.		+	
Lomentaria articulata (Huds.) Lyngb.	+	+	+
Mastocarpus stellatus (Stackh.) Guiry	+	+	
Melobesia membranacea (Esper) Lamour.		+	
Membranoptera alata (Huds.) Stackh.	+	+	+
Nitophyllum punctatum (Stackh.) Grev.	+		
Palmaria palmata (L.) O. Kuntze	+	+	+
Phycodrys rubens (L.) Batt.	+	+	+
Phymatolithon purpureum (P. & H. Crouan) Woelkerling & L. Irvine	+	+	
P. laevigatum (Foslie) Foslie		+	
P. lenormandii (Aresch. in J. Ag.) Adey	+		+
Plocamium cartlilagineum (L.) P. Dixon	+	+	+
Pneophyllum lobescens Y. Chamberlain		+	
Polyides rotundus (Huds.) Grev.		+	
Polysiphonia elongata (Huds.) Spreng.	+		
P. lanosa (L.) Tandy	+	+	+
P. macrocarpa Harv. in Mackay	+		
P. nigrescens (Huds.) Grev.	+		
Porphyra purpurea (Roth) C. Ag.	+	+	
Rhodophyllis divaricata (Stackh.) Papenf.	+		
Titanoderma sp.		+	
'Terete gracilarioid'	+		

SPECIES LIST	SITES		
CHLOROPHYTA	1	2	3
Bryopsis plumosa (Huds.) C. Ag.	+		+
Chaetomorpha linum (O.F. Müller) Kütz.	+		
Cladophora pellucida (Huds.) Kütz.	+		
C. rupestris (L.) Kütz.	+	+	+
C. spp.	+	+	+
**Enteromorpha compressa* (L.) Grev.	+	+	+
E. intestinalis (L.) Link	+	+	+
E. prolifera		+	+
Pringsheimiella scutata (Reinke) Marchewianka			+
Rhizoclonium tortuosum (Dillw.) Kütz.	+		
Ulva lactuca L.	+	+	+
PHAEOPHYTA			
Ascophllyum nodosum (L.) Le Jolis	+	+	+
Asperococcus fistulosus (Huds.) Hook.		+	
Chorda filum (L.) Stack.	+	+	
Cladostephus spongiosus (Huds.) C. Ag.	+		+
Colpomenia peregrina (Sauvageau) Hamel		+	
Cystoseira nodicaulis (With.) Roberts		+	
Desmerestia aculeata (L.) Lamour.		+	
D. ligulata (Lightf.) Lamour.		+	
Dictyoya dichotoma (Huds.) Lamour.	+	+	
Ectocarpus siliculosus (Dillw.) Lyngb.	+	+	+
Eudesme spp.		+	
Fucus serratus L.	+	+	+
F. spiralis L.	+	+	+
F. vesiculosus L.	+	+	+
Halidrys siliquosa (L.) Lyngb.	+	+	
Laminaria digitata (Huds.) Lamour.	+	+	+
L. hyberborea (Gunn.) Fosl.	+	+	
L. saccharina (L.) Lamour.	+	+	
Pelvetia canaliculata (L) Dcne et Thur.	+	+	+
Scytosiphon lomentaria (Lyngb.) Link		+	
CYANOPHYTA			
Dermocarpa spp.		+	
Lyngbya aestuarii Gom.	+		
L. kuetzingii Schmidle			+
Microcoleus chthonoplastes Thur.	+		
Pleurocarpa crepidinum Collins			+
Rivularia atra Roth.	+		

*This species has been lumped with Enteromorpha intestinalis in Burrows (1991). However, it has been decided to record it as a separate species for the purposes of this list.

Although the species recorded would not be comprehensive of the shores that were investigated in Anglesey, nevertheless, the results do reflect the broad range of species to be found in this area. Species of note include *Enteromorpha prolifera* and *Cystoseira nodicaulis*, both of which are not recorded for Anglesey in the Provisional Atlas of the Marine Algae of Britain & Ireland (Norton 1985), though known in local records

since the 1950's. *Enteromorpha prolifera* is almost certainly under- recorded whereas *C. nodicaulis* appears to have a much more restricted distribution. Also of note is *Laurencia obtusa*, which is abundant in some pools at Rhosneigr, a species that is rare in Britain (Hiscock 1986).

Acknowledgements We would like to thank all the people who participated in the seaweed identification weekend. In particular we thank Jason Hall-Spencer for identification of crustose reds, and Brian Whitton and Paul Joslin for identification of the Cyanophyta.

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Hiscock S. 1986. A field key to the British red seaweeds. Field Studies Council Occasional Publication No. 13 (AIDGAP). 101pp.

Norton T.A. 1985. Provisional Atlas of the Marine Algae of Britain and Ireland. Institute of Terrestrial Ecology, Huntingdon. 171pp.

NEWS AND VIEWS

BPS field meeting, Anglesey, 1992 - a view from the trenches!

The society held a field meeting in Anglesey, North Wales over the weekend of July 17-19th. As a student in relative isolation in Scotland I found the course both enjoyable and useful.

On the Friday night I eventually managed to locate phycologists with a better sense of direction than my own. They had adjourned to a den of iniquity on Bangor Campus. On my arrival it was claimed to be the Fiddoedd Bar, but they had been there a while.

At the crack of dawn the next day we arose to catch the ebbing tide. Our first collection site was Church Island in the Menai Strait. This interesting shore had a seven metre tidal range, bedrock with malicious patches of mud, and rapid currents, yet extreme shelter from wave action. On the lower shore *Laminaria digitata* was in its cape form under which corallines were virtually absent, being replaced with *Audouinella floridula* and erect algae more tolerant of sediment cover. The top of the shore was fringed by salt marsh species.

After breakfast we assembled at the laboratory and spent the day investigating the haul. There was a hierarchy of seaweed enthusiasts at the meeting, this being immediately apparent from the quality of their collecting bags; students generally forgot theirs or had ones with holes in, Bath rent-a-mob had Phycsoc regulation issue bags, whilst amateur naturalists and seasoned professionals alike had fancy clip together ones with pouches attached.

In the informal environment that prevailed the whole cross section of expertise was catered for. Novices learnt the basics, phycologists from afar had the opportunity to extend their private herbaria, and specialists got excited about obscure groups. Drs Eifion Jones and Juliet Brodie spent most of their time dashing about with foliose reds, J cloths and generally being helpful.

Shortly after the next low tide, since we took the scenic route, we were to be found at a hurricane lashed shore on the southwest coast of Anglesey called Rhosneigr. The tumultuous seas had not stopped the wind surfers, so the elements did not stop us! Fortunately the lower littoral and sublittoral flora of this shore had been removed and freshly deposited on the strandline. The midshore pools also provided some interesting foraging, with goodies such as *Laurencia obtusa* and stacks of corallines. Here the shore was backed by sand dunes, contrasting well with the morning site of Church Island.

I thought Sunday morning's early start was antisocial until we heard cries of "Get orff moi lighthouse!" issuing from a belligerent individual on Penmon Point. Flagellation with stiff kelp stipes was considered, but instead the party retreated from his vicinity and cowered on the adjacent limestone slabs until he went away. People interested in blue-greens were fortunate enough to miss the tirade since they had not yet left the puddles in the car park. The remainder of Sunday was spent working up and labelling specimens, as well as preserving tricky individuals.

Although this meeting was brief, it gave participants ample opportunity to exchange ideas and information. Thanks go to Dr Jones's local knowledge, which allowed us to obtain a good feel for the intertidal flora of Anglesey. I look forward to the Isle of Wight field meeting.

Jason Hall-Spencer

FORTHCOMING MEETINGS

BRITISH PHYCOLOGICAL SOCIETY FIELD MEETING

PHYCOLOGICAL FIELD COURSE

Friday-Monday 17th-20th September 1993

Isle of Wight

Course director: Dr Bill Farnham

This field course is intended for professionals, students and amateurs who need or wish to acquire a knowledge of the seaweed flora of British shores.

For further details please contact:

Dr Juliet Brodie,

Bath College of Higher Education,

Newton Park, Newton St. Loe,

Bath BA2 9BN.

III Congreso Latinoamericano de Ficologia
I congreso mexicano de ficologia
1a. Renunion Iberoamericana de Ficologia

Palacio de Mineria, Cuidad de Mexico, 17-23 de Octubre de 1993

details from: M.en C. Eberto Novelo
Coordinator General
Lab. de Ficologia
A.P. 70-620, Coyoacan
D.F. 04510, Mexico.
Fax: (525) 5488186. BITNET: TAVERA@UNAMVM1

1st International Symposium on detection methods for cyanobacterial toxins.

27-29th September 1993, University of Bath, UK.

Details from:
Dr. S.A.Clark,
PHLS CAMR
Porton Down,
Sailsbury
Wiltshire SP4 0JG
Tel: 0980 (Int.+44 980) 610391 Fax: 0980 (Int.+44 980) 611096)

Vth International Seaweed Biogeography Workshop

12-16 July 1993, The University of Cape Town, S.Africa.

Details from:
Dr. John.J. Boulton
Botany Department,
University of Cape Town
Rondebosch 7700
South Africa.
Tel: (21) 650 3402 Fax: (21) 650 3726 INTERNET: BOLTON@BOTANY.UCT.AC.ZA

The Natural History Museum, London; University of Oxford, Department of Plant Sciences, Oxford; The Systematics Association

Models in Phylogeny reconstruction

An Internaition Symposium to be held at the Natural History Museum, London during August, 1993

Organisers: Robert W. Scotland, University of Oxford; David M. Williams, Darrell J. Siebert, The Natural History Museum, London

In 1982 the Systematics Association published the proceedings of an international meeting on the topic of methods and problems in phylogenetic reconstruction. since that meeting cladistic methodology has become almost universally accepted as the method of choice for reconstructing the interrelationships between taxa. However, the assumptions underlying the method are still in dispute. Sets of assumptions (models) for phylogenetic inference have been developed by molecular systematists (at the level of the gene), by developmental biologists (at the level of ontogenetic transformations) and by evolutionary biologists (at the level of taxa).

This meeting will explore various models, and their relevance, to the construction of cladograms and what valid biological and evolutionary inferences can be made from cladograms.

The symposium should be of interest to all those involved in systematics and evolutionary biology.

If you wish to receive further information and registration details please contact:

David M. Williams,
Department of Botany,
The Natural History Museum,
Cromwell Road, London SW7 5BD, U.K.

British Phytoplankton Discussion Group Meeting

Southampton 19-21 April 1994

The tradition of these meetings has in recent years lost some momentum we intend to convene the next meeting in Southampton between 19 and 21 April 1994.

In the past three meetings have been focused on one or two topics of interest to both the marine and freshwater phytoplankton research communities which after a brief introduction have allowed free wheeling discussion. The meetings have been a particularly useful forum for research students and young researchers to present their work as posters and invite comment and discussion from more established phytoplankton workers.

The suggested theme for the meeting next April is:

"New technologies and techniques for studying phytoplankton"

I would welcome comments or other suggestions.

It is also intended to run some practical workshops related to the above topic.

If you are interested in receiving further details of this meeting in due course please write to

Dr Duncan A. Purdie,
Department of Oceanography,
The University,
Highfield,
Southampton SO9 5NH. UK.

REPORTS FROM THE BRITISH PHYCOLOGICAL SOCIETY WINTER MEETING SWANSEA JANUARY 4-7 1993

THE IRENE MANTON PRIZE FOR THE BEST RESEARCH STUDENT TALK

"Council of the Society have agreed that a prize in the region of £150, together with a Certificate, will be awarded annually for the best paper delivered at the Winter Meeting"

Following the death of Profesor Irene Manton FRS, of the University of Leeds, on 13th May 1988 money became available from her Estate to fund two annual prizes for young research scientists. The first is for the best PhD thesis in Botany and is administered by the Linnaean Society of London, based on nominations invited from Heads of Departments. The second, awarded for the first time in 1993, is a prize for the best paper delivered by a postgraduate research student at the annual winter meeting of the British Phycological Society. At the January 1993 Meeting of the Society there were seven contenders for the Manton Prize (see The Phycologist, Issue 33, November 1993, p. 10) and a panel of five evaluators assessed each talk for scientific quality and clarity, visual impact, oral clarity, timing, etc.. The overall standard of the science and the presentations was very high, but in the opinion of the judges the best paper was given by Carolyn Heath from the School of Biological Sciences, University of Birmingham. Her contribution, with her supervisors Drs. Maureen Callow and Barry Leadbeater, was entitled "Control of calcification in algal biofilms". Carolyn took her first degree in Industrial Biology at the Polytechnic of the South Bank (now South Bank University) and she is currently in the third year of her PhD. Her research centres upon determining the extent to which precipitation of $CaCO_3$ on submerged structures in hard, fresh waters is mediated by algal metabolism, and establishing a protocol for studying the effect of inhibitors of crystal formulation on $CaCO_3$ precipitation. She hopes that her work will lead to the formulation of a paint system that will reduce fresh water fouling in the natural environment. We wish our first prize winner well in her future research career.

Professor L.V. Evans, Chairmen of the Evaluation Panel

VIEWS OF THE B.P.S. WINTER MEETING 1993 - SWANSEA

Winter Meetings of the British Phycological Society! Old memories re-emerge: sitting in coats in ice-cold lecture rooms, catching the last plane leaving the country in the middle of a snowstorm, trying to find a way to make electricity work for a continental "European", surviving the food. But wasn't it worth it?. The excitement was in the science!. To listen to the peers of phycology and to get constructive criticism and encouragement from them was all that was needed in those days. The British Phycological Society Winter Meeting 1993 in Swansea was different. It was a meeting of superlatives: the largest number of participants (157), the largest number of presentations (69 oral and 21 posters), the best food I've experienced so far at BPS-meetings, and a charming but also efficient organization (thanks to the Flynn's, Kevin and Krystyne). It was the first time that the Irene Manton Prize for the best student paper delivered at the meeting was awarded and the presentations of all competitors were excellent and of a high standard. Some additional highlights included the Presidential address by Brian Whitton (everything you always wanted to know about the blue-greens but did not dare to ask Brian privately), the auction - all items sold thanks to Trevor Norton!, and finally the beer (plenty and always available; were there any "last calls"?). Even some "Europeans" (continental) showed up at the meeting this time!. Thanks to global warming, the weather in January does not threaten anyone any more, or?. Yes, of course, algae and other life forms were threatened along the Shetland Islands in one of the worst oil-spills in this area. And the science?. Algae have been multiplying faster than phycologists in recent years. So what can one do with the algal biomass and still make a profit?. Asking a young phycologist about the goals of her research, the answer hardly came as a surprise: to get a job as a water quality management officer. The times, they are changing!.

Michael Melkonian

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Having battled our way through fog shrouded countryside we eventually arrived at the University, greeted by the impressive sight of Swansea bay sweeping majestically round to The Mumbles. Closer inspection revealed miles of golden (but soggy) sand and with a good imagination you could picture the beach on a fine day covered with students, revising for summer exams of course! The meeting started with a poster session. A good chance (for us newer members) to recollect who's who in the world of phycology and to strike up the annual exchange of ideas in a relaxed atmosphere. The posters themselves reflected the wide range of research being undertaken, covering subjects such as the biochemical make-up of algae (Barwell *et al.* and Rogers *et al.*), algal metabolism (Stengel & Dring and Nimer *et al.*) and bloom characteristics (Jones *et al.*, Jackson *et al.* and Harris *et al.*). The next day, after a hearty breakfast, the first set of talks began. The morning was devoted to the subject of marine eutrophication. Originating from Brighton I have seen many different things on the beach however, I have never seen a green tide. As the morning progressed we were presented with many pictures of shores concealed by great mounds of seaweed. I found these sights particularly beautiful but it seems that this phycologist, for one, is wrong and our slimy friends are viewed by most as a nuisance. We were firstly informed of how best to predict marine eutrophication (R.Gowen). The model proposed linked the effect of nitrate content on the concentration of chlorophyll in the sea locks of Scotland. Crossing this land mass, the next speaker (P.Reid) eluded to the fact (amongst sniggers) that most nutrient input to the North sea originates from continental estuarine sources, and that Britain's contribution to the increase in nitrate and phosphate in this water body is minimal. S.LeBozec told of how one country on the continent was trying to reduce nutrient input. Unfortunately though it seems the implementation of phosphate removal from waste water treatment plants is not sufficient to limit the growth of *Ulva* in the bay of Saint Brieuc. This was all rounded off by an extremely thorough overview of green tides (R.Fletcher) in which the success of the algae responsible was blamed on the method of reproduction, adapted metabolism, fast growth rates and unattached morphology. After coffee I plumped for a bit of biochemistry and physiology. This session clarified the use of inorganic carbon by specific algae (A.Johnston) and improved my understanding of algal calcification, dispelling the myth that this feature of algal metabolism increases the flux of CO_2 from the atmosphere to the ocean (J.Raven). However my longer lasting memory of this section is seeing the camera man flash! Lunch was followed by a session on toxic algal blooms although after later discussions it became apparent that it may have been wrongly named. The organisms and toxins responsible for these harmful blooms were described (S.Heaney) along with a number of diagnostic tests. J.Taylor demonstrated the use of autofluorescence to assess the geographical and seasonal diversity of natural picoplankton populations. An alternative approach described by T.Birkbeck is to identify the toxins

produced by the blooms using techniques such as mouse bioassays, HPLC, and ELISA. Finally we were told that these nuisance algae may have a use after all (J.Gladstone & J.Lopez-Real). It seems that after composting, seaweed waste can be used as a fertilizer however, it cannot be applied to potatoes due to it's high salt content. Perhaps the authors should contact Golden Wonder since it brings a whole new meaning to ready salted crisps. That night after lamb and leeks (what else?) we all relaxed with a drink. Since I was speaking the next morning I slunk off early before the dancing commenced but I gather the disco was a great success. The morning began with round one of the Manton prize presentations. The talks were all of a very high standard and I did not envy the judges task of choosing a winner. It was encouraging to see that all contenders were working on totally different aspects of phycology and all the talks were extremely interesting. For reasons that will become obvious I will skip over this part of the meeting as I feel uncomfortable discussing the relative merits/pit falls of specific individuals. Round two was followed by the presidential address in which Brian Whitton presented us with a pictorial guide to the rise and rise of the Cyanobacteria. He certainly convinced me of the diversity of this phylum when it was announced that representatives of the group are even found amongst the hairs of the three toed sloth. After lunch saw the specialized session on Biomineralization and as suspected SEM enthusiasts would have been pleasantly impressed. The structure and production of lorica by *Stephanoeca diplocostata* was described with some beautiful pictures (B.Leadbeater), whilst D.Mann speculated on the processes involved in the formation of diatom valve patterns. A phenomena they seem capable of performing upside down, on their sides and back to front! Finally, with the help of a magic bag of tricks we were told of a brilliantly simple model which predicts the nucleation stages in the formation of coccoliths in a selection of coccolithophores (J.Young).

That night we all attended the BPS dinner and after gorging ourselves on chicken Kiev we came to the moment of truth, the announcement of the Manton prize winner. As Len Evans explained the origins of the prize, the tension mounted and it began to feel like a night at the Oscars. The sacred envelope was handed over to Brian Whitton and a faint drum roll could almost be heard as it was opened. Much to my delight the name announced was my own and as cries of 'speech' came from the crowd, I felt as though I should have been thanking my manager instead of my supervisors. But seriously I honestly felt thrilled and privileged to win. The night continued with the infamous BPS auction and the prize 'catch' of the night was without doubt the portraits of Manton and Parke. As the auctioneer so succinctly put it, with these hanging on the wall of your laboratory the continuing high standards of phycological research are guaranteed, order your copies now! The auction was a great and very amusing event that raised over £500 for the society. The next morning feeling somewhat bleary eyed I attended session B, in which I learnt of how the acidification observed when brown algae are exposed to blue light can not be connected to photosynthetic response (R.Schmid). This was followed by an interesting discussion on the utilization of inorganic carbon by various algal species (S.Maberley). With the prospect of a fog filled journey ahead I'm afraid I left the conference prematurely. On reflection the success of a conference is perhaps best judged on how useful it was to the individual. Personally I enjoyed this conference immensely as I came away feeling as if I had really increased my knowledge in areas such as inorganic carbon metabolism, marine eutrophication and identification of algae. Finally I shall address the question on all of your lips 'what did you do with the prize money?'. Well in a bid to broaden my education I bought a vast tome on world history and was somewhat miffed to find not a mention of algae anywhere!

Carolyn Heath

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This year's winter conference was the first meeting of the British Phycological Society that I have attended. I was glad to return to the University College of Swansea, where I studied for an MSc in 1989. The college faces Swansea Bay to the south, with a long sandy beach which can be reached over the footbridge across the main road, and behind it to the north there is a large public park running up the slope of the hill. It is a great place to walk around, though the cold wet weather and the early dark gave me little chance to do so that week. The first evening we met and talked over a buffet supper and looked at everybody's posters, which covered a good range of physiological and ecological topics. On Tuesday morning I attended the session on nuisance algae. We began with eutrophication. R.J. Gowen told how Scottish west coast lochs were studied to find the relationships of phytoplankton growth to nitrate concentrations. P.C. Reid of the Department of the Environment talked on the Paris Commission Working Group on Nutrients and the programmes it has started for tackling eutrophication, taking care to stress how little of it we cause. We went on to troublesome macrophytic algae. R.L. Fletcher described `Green Tides', huge growths of *Ulva* and *Enteromorpha* green algae in waters close to shore, which shade or bury other algae, increase sedimentation, rob the water of oxygen as they rot, and make ugly, smelly messes on shore. Serge Le Bozec of CEVA told how these affect Brittany in places such as the Bay of Saint-Brieuc. D.W. Jeffrey told how spectral scanning from aircraft was used to map algal growth in Dublin Bay. After coffee we moved on to dinoflagellates. F.X. Neill from the University of Malaga described a bloom of *Gyrodinium cf. aureolum* in a Spanish ria, described confusingly as a `green tide'. John Dodge gave an interesting talk on the biogeography of dinoflagellates round the British Isles,

both planktonic species and shore - dwellers. The beach dwellers such as *Amphidinium herdmanii* actually have flattened bodies which can move between sand grains. Jane Lewis of the University of Westminster summarised the biology of dinoflagellate resting stages or cysts, formed after sexual reproduction and able to survive overwinter in sediment. These cysts are probably important in starting each year's new growth, and may be involved in the spread of toxic species such as *Alexandrium tamarense*, which may be carried as cysts in the ballast water of ships. K.J. Flynn discussed how the production of Paralytic Shellfish Poisoning toxins by Alexandrium species depends on the physiology of the cells, increasing in conditions which favour the production or accumulation of these nitrogen-rich compounds such as low phosphorus supply. After lunch, S.I. Heaney gave a brief history of toxic blooms in the UK and the programmes to monitor them, including both Paralytic and Diarrhetic Shellfish Poisoning (PSP and DSP) from marine dinoflagellates, and freshwater blooms of the toxic cyanobacterial genera *Microcystis* and *Oscillatoria*. D. Jackson described the problem of DSP in Ireland, which threatens the important mussel industry at Bantry Bay, causing closures which prevent the mussels being sold in summer and allow unharvested mussels to be lost in storms. Ken Jones discussed harmful blooms around the world, and described the IOC Harmful Algal Blooms Programme which aims to fight the problem through research, management and education. There followed an interesting general discussion on a range of points, such as where the research should be directed, whether fisheries should help pay for it, an alleged lack of interest from the Department of Health, and just what the term `bloom' refers to anyway. After the tea-break, T.H. Birkbeck described possible alternatives to the mouse assay presently used to detect PSP and DSP toxins, avoiding the suffering caused to live mice and the subjectivity of timing the deaths of the animals. He concluded that the best hopes for alternative PSP tests lay in tissue- culture assays measuring the blocking of sodium channels by the toxins, and that the DSP toxin, okadaic acid, could be detected by it's inhibition of protein phosphatases. J.A. Taylor explained how strains of small planktonic cyanobacteria can be detected and identified immunologically using continuous flow cytometry. The day's talks were finished by J. Gladstone and J.M. Lopez- Real, who talked on composting as a way of disposing of the great masses of seaweed washed up on beaches. From a student's viewpoint, the most exciting part of the conference came on Wednesday. This was the first award of the Irene Manton Prize for the best talk by a research student at the conference. There were seven entrants from four universities. The University of Birmingham rather dominated, giving three of the speakers. A.J. Love described a study of dense cyanobacterial blooms in the phosphorus-poor waters of Ravensthorpe Reservoir. She found that the blooms relied on phosphorus released from the sediments at times when oxygen was low in the bottom water. Carolyn Heath talked on precipitation of calcium carbonate by algal biofilms in hard water areas, which adds to the fouling of boats. She studied the effects of depth and of an antifouling paint on the process, and the possibility of reducing the calcification by using precipitation inhibitors. Harriet Jones told how she investigated the feeding of the Prymnesiophycean flagellate *Chrysochromulina brevifilum*, which gets it's carbon both by photosynthesis and by catching prey. She followed it's digestive processes by electron microscopy, and measured it's growth and feeding rates, finding it grew faster when supplied with prey, and that it took more prey when it had less light. Two more of the seven entrants came from the colleges of the University of London. B.R. Hitchings of Royal Holloway College talked on the phytoplankton in water bodies at the Dungeness shingle beach. Using the TWINSPAN and CANOCO community analysis packages, Hitchings found correlations between species distributions and salinity. David Santillo of Queen Mary and Westfield College described how he grew two marine phytoplankton species in chemostats to find how they responded to low nitrogen supplies. From the University of St. Andrews in Fife, Rupert Craggs explained how he screened over 100 species of microalgae to find those best suited for growing in algal ponds to remove nutrients from effluent and reduce eutrophication. There was just one overseas entrant, H.R. Engledow from the University of Cape Town, who talked on the biogeographical patterns of the Namibean seaweed flora. The seaweed diversity decreases with decreasing latitude, which could be explained by factors such as temperature patterns, intrusions from a warm northern current, inundation by sand and silt, less variable habitats, and past conditions. Afterwards B.A. Whitton gave the presidential address. He spoke on the diverse forms of cyanobacteria, and on the problems of using cultures of them that have been grown for countless blue-green generations in artificial conditions. In the afternoon I attended the sessions on biomineralisation. J.A. Raven talked on sensory perception and mineralisation in algae, first on how the Characeae use barium sulphate crystals in their rhizoids to sense gravity, and then on the puzzle of how coccolithorids are able to take up large amounts of calcium to make their coccolith scales without upsetting their calcium signalling system. D.G. Mann of the Royal Botanic Garden in Edinburgh gave a fascinating talk on how diatoms form their intricately patterned silica walls. Another fine lecture was given by Jeremy Young from the Natural History Museum in London on how coccolithorids form their round coccoliths. Using a very simple model of folded paper he showed how the core of the coccolith is formed as a ring of interlocking crystals, and then went on to show how in different species these crystals grew outwards into different forms. That evening we sat through the AGM, and learned something of the Society's activities. After that came the

Society Dinner, which proved a cheerful business with magnificently short speeches, and the famous auction. The winner of the Irene Manton Prize was announced as Carolyn Heath. The last talks of the conference were on Thursday morning. N.J. Anderson explained how diatom remains in lake sediments can be used to infer the past nutrient concentrations of lake water. B.S.C. Leadbetter described a study on the release of nutrients from bacteria by flagellates feeding on them, supplying four flagellate species with bacteria carrying different 'loads' of nitrogen and phosphorus and measuring the release of phosphate and ammonia. P.A. Joslin told how Liverpool Docks had been invaded by a skeletonless form of the silicoflagellate *Dictyocha speculum*, dense blooms occurring after the competing diatoms had died away from silicon depletion but leaving enough nitrate and phosphate. P.J. Wright talked on the fertilisation of *Fucus serratus* eggs by sperm, and on how a two protein extract from the sperm was able to block fertilisation of the egg by whole sperm and to induce the naked egg to start releasing cell wall material. M.J. Dring described how blue light in brief pulses stimulates brown algae to increase their photosynthesis rates, and told how a theory to explain this was tried and demolished. S.C. Maberley told how he studied carbon uptake in the freshwater diatom *Asterionella formosa*, which takes both carbon dioxide and bicarbonate ions, concluding that ecologists should consider the forms of carbon available rather than just the total inorganic carbon present. I look forward to next year, when I should have something of my own among the posters.

Timothy J.M. Taylor

NOTES ON THE ANNUAL GENERAL MEETING, JANUARY 1993 - SWANSEA

Proposed increase in subscription

At present the membership fee is £10, with £10 going towards the cost of the journal. The subsidised price of the journal to society members is £15.50, but the realistic cost is £19. Council therefore proposed that the cost to members receiving the journal should rise £5, although the membership fee for the society will remain the same. Thus:

Member receiving journal	£25
Member not receiving journal	£10

For student and retired members (reduced subscription to the society):

Student/retired receiving journal	£20
Student/retired not receiving journal	£5

The proposal to raise the contribution to the journal in January 1994 was put to the AGM for approval. Proposer: Dr R.I.Jones, Seconder: Dr M.E.Callow. Carried without dissent.

The income and expenditure accounts for the year ending 18 September 1992 are given below.

Change of Membership Secretary

Membership records have been partly computerized, but, as the present Membership Secretary has worked from home and has not been able to cope as efficiently as she would like to in this respect, she has decided to relinquish the post and hand over to someone with good computer facilities. Mr S.J.M.Droop of the Royal Botanic Garden Edinburgh will therefore succeed her.

Recruitment

Council approved the appointment of Dr P.K.Robinson to consider recruitment. He described the need to improve recruitment to the society and has produced a handout to obtain names of potential members but welcomes other ideas to attract new members. Dr Robinson views his job as an "assistant" to the Membership Secretary. It is envisaged that a membership list will be produced (possibly biennially) but with more extensive information, including fax and E-mail numbers and research interests.

Election of Council for 1993.

Dr M.J.Dring takes over as President.

Prof.J.A.Raven and Prof.M.Melkonian had been nominated as President elect and Overseas Vice-President respectively. As only three nominations (Dr M.T.Gibson, Dr. P.Hayes & Dr A.M.Johnston) were received for the 3 vacancies for ordinary members of Council these are duly elected.

Thanks were expressed to retiring members of Council: Prof.L.V.Evans, Dr K.J.Flynn and Mr D.M.Williams.

Honorary members.

Nominations for two new honorary members had been received by Council.

Dr E.A.Haworth suggested that the BPS was the only UK society able to provide recognition of the contribution made to science by Mr J.R.Carter. These were seen in his own work and publications, collaborative studies and unstinting personal assistance to many other phycologists. She described him as the most professional of amateurs, now in his 80's.

Dr J.M.Lewis nominated Prof.A.D.Boney for his eminence as a scientist, latterly in Glasgow, together with his support for post-graduate students. He had served the society as a past President, Hon.Secretary and long-standing member, until recently taking responsibility for the back issues of the journal.

The nominations were approved by the meeting.

Birthdays

The Hon.Secretary had been informed that two of our honorary members have had significant birthdays. Dr J.W.G.Lund was 80 in November and Mr N.I.Hendey 90 at the end of January. Congratulations would be sent on behalf of the society. The Hon.Secretary would appreciate being informed of similar events.

Deaths

It was also brought to the society's attention that Elsie Conway, another honorary member, died early in 1992. An obituary will follow in a later issue.

Next Winter Meeting

The next BPS winter meeting will take place in Liverpool, (January 4th-7th 1994) with Prof.B.Moss acting as local secretary. It was proposed another "applied" day should be included.

Field meeting

Dr J.A.Brodie reported that last year's meeting was successful and that Dr Bill Farnham had agreed to lead a weekend meeting on the Isle of Wight from 17th-20th September 1993. Students can obtain support from the scientific meetings fund to attend. Future ideas were solicited. Thanks were expressed to Dr Brodie for her work.

Phytoplankton discussion group.

Dr R.I.Jones announced that there would be a meeting of this discussion group at Easter 1994 in Southampton.

Applied phycological forum.

Dr J.Jones asked if members could pass on any interesting information on applied phycology to her for inclusion in this publication.

Conservation Committee.

Because Dr S.Hiscock (Scott), co-ordinator of the committee, has submitted her resignation Dr D.M.John reported on the activities relating to Conservation after a vote of thanks had been expressed. D. John's report is given below.

Dr John asked for increased action by members of the society. He also commented that the committee has not changed for many years, but he wishes to review this. If members wish to join they are asked to notify Dr. John at the Natural History Museum. The committee also asks to be made aware of conservation issues, because response often needs to be speedy. It is hoped to introduce conservation issues in the Newsletter.

REPORT OF THE CONSERVATION COMMITTEE

Last year we reported that Bob Fletcher would represent the BPS should there be a second public inquiry concerning a proposal to construct a roadway along the foreshore at Pegwell Bay, Isle of Thanet, Kent. If this development went ahead in this Grade 1 SSSI then scientifically important algal communities on the chalk cliffs would be lost. Ian Tittley has informed us that the second public enquiry has been postponed and promised to keep us informed of any future developments. Mojo Underwater Engineering were granted permission until October 1991 by the Crown Commissioners to extract maerl samples from the seabed one mile from Castlebay, Barra, in the Western Isles. The company required the samples in order to determine whether commercial exploitation was feasible. We understand samples were never taken and the company is unlikely to be granted permission should they reapply. The Crown Commissioners have received many objections to sampling from local fishing interests and on environmental grounds. Scottish Natural Heritage has initiated a project to develop a system for evaluating rivers for conservation (SERCON). The Project Development Group have written to individuals and organisations `with acknowledged expertise in fields related to river conservation and ecology' to comment on a draft document. The BPS was not contacted despite having amongst its membership some of the leading authorities on river ecology and the management of aquatic systems. After consultation with other members of the Conservation Committee a letter has been sent to the Group expressing concern that:

(a) The BPS had not been consulted directly,

(b) Macro- and microalgae are important components of river systems and both should be `attributes' considered by SERCON, and

(c) Any `expert system' is unlikely to find wide acceptance unless account is taken of all systems currently in use including those involving algae.

The BPS was asked to comment on a draft of the `JNCC Wild Plant Conservation Strategy' document. This was circulated to all members of the Conservation Committee and the comments collated by its co-ordinator. A letter of support for the strategy was sent along with three pages of comments on the document to the Head of the Conservation Branch of JNCC before the end of January deadline. A workshop on `Alien Introductions' took place at the XIVth International Seaweed Symposium held at Brittany, France. Professor Inga Wallentius distributed information sheets at the Symposium listing known introductions into European countries. She requested participants to send her information on any new ones not listed. Several participants found *Undaria pinnatifida* (Wakame) cast up on the beach in front of the symposium centre at St

Malo. It has been grown at the Ile of Ouessant (off Brest) since 1983 and is farmed in several other areas in France. This kelp represents an important potential threat to shallow marine ecosystems in western Europe. A four-year contracted survey was completed on the fauna and flora of Scottish sealochs as part of the Marine Nature Conservation Review (MNCR). These data will be incorporated along with that from other sources into a conservation assessment for each loch and for preparing the MNCR theme report on sealochs. This is one of nearly 20 major theme reports that will be the eventual outcome of the MNCR. Experimental harvesting of kelp (*Laminaria hyperborea*) was carried out off the west coast of Scotland in the summer of 1992 by the company Kelco. The dredges used for harvesting tear the kelp plants from the rock complete with holdfast. Recovery of the kelp after harvesting will continue to be monitored.

Dave John and Sue Scott.

Report of Representative on former Plant Life Conservation Committee

The Plantlife Conservation Committee has split into:

(a) The Conservation Advisory Group, a group open to representatives actively involved in Plantlife, and

(b) Plantlife Link Group, a forum for societies and organisations actively involved in plant conservation.

Societies like the BPS are members of the Link Group. They are expected to share information and expertise and work together to set the agenda for, and promote, plant conservation. At the first meeting in September of Plantlife Link it was agreed to develop a conservation strategy for Plantlife with inputs from all its member societies/organisations. It has been agreed to make available to the Link Group the document `Conservation Priorities of the British Phycological Society' (prepared by the BPS Conservation Committee) to assist them in the formulation of their conservation strategy. Plantlife is concerned with two initiatives involving algae, one a Red Data Book on British Stoneworts and the other a seaweed nature trail. The Red Data Book has been prepared for Plantlife by Nick Stewart and Judith Church and is shortly to be published. Seventeen British and 11 Irish are included in it, two British and one Irish are now extinct. As a result of the project's findings, the bearded stonewort (*Chara canescens*) has been proposed for inclusion on Sch. 8 of the Wildlife and Countryside Act, 1981. Sponsorship is being sought for a seaweed nature trail leaflet for Folkestone.

Dave John

REPORT OF THE MEMBERSHIP SECRETARY

As at the end of 1992 the membership of the B.P.S. was as follows:

	Paid up for 1992	In Arrears for 1992
1. Members taking the Journal		
Ordinary	431	35
Honorary	7	-
Retired	34	2
Student	54	21
2. Members not taking the Journal	28	5
Total	554	63

37 new members joined the B.P.S. in 1992 and 2 former members rejoined. I was disappointed to find that only 14 of these new members were students and ask all supervisors to encourage their students to join the Society. 14 members resigned in 1992 and a further 56 were struck off for non-payment.

It was with regret that we learnt of the death of Dr. Conway, one of our Honorary members, during the year. On a happier note, I am pleased to report that two new Honorary members, Professor Don Boney and Mr John Carter, were confirmed at the AGM at Swansea.

I announced at the Swansea meeting that I would be resigning from the post of Membership Secretary and am delighted that Stephen Droop, of the Royal Botanic Gardens Edinburgh, has taken over the post.

It is important that paid-up members who have not received any of the issues of the 1992 BPJ contact Stephen as soon as possible so that the publisher, Academic Press, can send replacements. Although arrangements have been made for back issues to be made available to the society following the change to Cambridge University Press, it will be much easier to obtain replacements before the contract with Academic Press is settled.

THE BRITISH PHYCOLOGICAL SOCIETY
INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED
18 SEPTEMBER 1992

1991	Expenditure		1992
	Br. Phycol. J., Vols 24 & 25	403.00	
	Br. Phycol. J., Vol 26	7765.50	
		8168.50	
	Add: Hon. Editors Honararium 1991	1000.00	
	Provision for Vol. 27, 1992	10075.00	
	Provision for Eds. Honararium 1992	1000.00	
	Less: Provisions made in 1991 accounts	10610.00	
10191.50			9633.50
22.75	Sub. to Biological Council		22.75
742.37	Newsletter expenses		2161.18
75.00	Public liability insurance premium		85.00
21.88	Credit card service charge		67.08
638.50	Scientific meetings fund awards		642.00
128.00	Flora Committee travel expenses		81.40
15.00	Refund of overpaid subscriptions		154.28
30.00	Credit card payments & cheques not honoured		80.00
15.00	Bank charges		11.35
	Contribution to red seaweed flora project 90/91		500.00
	Freshwater meeting travel		297.00
	C.U.P. meetings		132.97
	Subscription Foundation Science & Technology		69.91
	Legal fees		264.38
	VAT scheme		35.25
	Overpaid interest		121.11
	Field meeting		77.50
	Manuscript		25.00
	Support prymnesiophyte symposium		500.00
35.15	Propectus printing		-
523.55	European discussion meeting		-
56.00	Transfer of monies to winter meeting		-
10.00	Provision for Mary Parke Bursary		-
500.00	Less Prov. for contribution to flora project 90/91		500.00
	Officer's expenses		
-	Hon. President	50.00	
502.10	Hon. Secretary	717.02	
95.57	Hon. Membership Secretary	86.98	
51.00	Hon. Teasurer	18.35	
			872.35
1380.23	Council meetings		727.25
15033.60	Total expenditure		16061.26
3041.99	Excess income over expenditure		7085.73
18075.59			23146.99

1991	Income		1992
	All subscriptions received in 1992	10956.08	
	Add: subscriptions received in advance in 1991	532.49	
	Less: subscriptions received for 1993	656.20	
8063.78			10832.37
5784.25	Profit from *Br. phycol. J.*		4804.04
451.97	Surplus from Birmingham meeting		1440.92
355.00	Phycological sale		610.64
-	Donation Irene Manton estate		1979.62
-	Refund Bank charges		24.00
-	Sale reprints		59.08
	Donations S.M.F.		120.00
10.00	Donation M. Parke Bursary		-
120.00	Newsletter advertising revenue		-
200.00	Industrial support for Edinburgh meeting		-
56.00	Monies from winter meeting		-
15041.00	Income excluding interest		19870.67
	Interest:		
1492.92	National savings fund Investment account	1300.23	
997.28	Forward Trust	1001.42	
338.11	Midland Bank Enterprise High Interest Account	234.06	
206.28	Scientific Meetings Fund H.I.A.	740.61	
			3276.32
18075.59	Total Income		23146.99

THE BRITISH PHYCOLOGICAL SOCIETY
BALANCE SHEET AT 18 SEPTEMBER 1992

1991	Capital	1992
14088.86	Capital at 20 September 1991	17130.85
3041.99	Surplus	7085.73
17130.85	Capital at 18 September 1992	24216.58
	Add: Liabilities	
9610.00	Provision for *Br. phycol. J.*	10075.00
1000.00	Provision for Eds. Honararium 1992	1000.00
532.49	Subscriptions held in advance	656.20
1650.00	NCC contract mcnies in hand*	3029.20
10.00	Mary Parke Bursary in hand	10.00
166.40	Uncleared cheques	1252.94
500.00	Provision for Red Seaweed research	-
30599.74		40239.92

* see Appendix 3

1991	Assets	1992
	Balance in Reserves 18 September 1992:	
15878.85	National Savings Investment Account	15374.62
9476.66	Forward Trust	10478.08
0.71	Midland Bank Enterprise High Interest A/C	0.00
3763.55	Scientific Meetings Fund High Interest A/C	12824.52
1479.97	Current Account	1562.70
30599.74		40239.92

Appendix 1

Subscriptions received in arrears for 1990	45.22
Subscriptions received in arrears for 1991	763.06
Subscriptions received in 1992 for 1992	9491.60
Subscriptions received in advance for 1993	591.20
Subscriptions received in advance for 1994	55.00
Subscriptions received in advance for 1995	10.00
	10956.08

Appendix 2

Commission deducted at source by bank for handling foreign cheques £84.00

Appendix 3

Nature Conservancy Council Contract Account

1991	Expenditure	1992	1991	Income	1992
	Paid to Queens University:		3954.00	In hand at 20/09/91	1650.00
13971.60	Transfer of NCC payments	-	11667.60	Received from NCC	1073.20
-	Transfer of BP donation	1344.00	-	Donation from BP	1650.00
1650.00	BP/NCC payment in hand	3029.20			
15621.60		4373.20	15621.60		4373.20

Appendix 4

Scientific Meetings Fund

Carried forward		3187.85
Add		
	Donations	120.00
	Excess Birmingham meeting	1440.92
	Sale	610.64
	Interest 90/91	84.96
	Notional interest	363.50
Less		
	Student support	642.00
		5165.87

Appendix 5

Irene Manton Fund

Carried forward		2024.45
Add		
	Additional legacy	1979.62
	Sale reprints	59.08
	Notional interest	303.50
		4366.65

The above are in accordance with the books and vouchers of the British Phycological Society which in our opinion give a true account of the transactions during the year ending 18 September 1992.

Hon. Auditors: Dr. A. Rumpus A. E. Rumpus.

ABSTRACTS OF THE BRITISH PHYCOLOGICAL SOCIETY WINTER MEETING SWANSEA JANUARY 4-7 1993

N.J. ANDERSON (Geobotany Division, Danish Geological Survey)

Closing the gap: biogenic silica retention in lake sediments

Silica cycling in freshwaters consists of uptake by diatoms (primarily), some initial recycling in the water column following grazing by zooplankton and death, and finally major periods of silica release from surficial sediments following crop sedimentation. The agreement between phytoplankton crop size and input to surficial sediments is well documented. but the extent of permanent burial less so. However, the abundance of diatoms in sediments of most small lakes indicates that not all diatom frustules dissolve to be re-used during the next period of growth. For many small, temperate monomictic lakes replenishment from the catchment is important. An attempt to estimate permanent burial of boigenic silica in small lake sediments will be made by reference to small lakes of varying trophic status and diatom communities. Whole-basin estimates of biogenic silica retention will be presented, together with relationships to total diatom content and other geochemical parameters.

N.J. ANDERSON, C.E. GIBSON* and B. RIPPEY** (Danish Geological Survey; Aquatic Sciences Division, * Department Agriculture. Northern Ireland; ** University of Ulster)

The use of diatom sediment assemblages to define pre-disturbance phosphorus conditions in lakes

Pre-disturbance conditions in most lakes are unknown. Some knowledge of the degree perturbation is, however, important. for management strategies. In the absence of suitable documentary evidence, baseline conditions can be estimated using palaeolimnological methods. Weighted averaging calibration has permitted the phosphorus tolerances of many diatom species to be defined more clearly, and hence the construction of transfer functions to infer historical epilimnetic phosphorus concentrations from diatom assemblages preserved in the sediments. An example of a phosphorus training set fro Northern Ireland will be given, together with its application to lakes with varying disturbance histories. The implications of the method for management will be briefly discussed.

G.L.A.BARKER, P.K.HAYES, L.K.MEDLIN, J.C.GREEN. (Department of Botany, University of Bristol, Alfred Wegner Institut Bremerhaven and Plymouth Marine Laboratory).

Genetic diversity in *Emiliania Huxleyi*

The coccolithophorid *Emiliania huxleyi* (Prymnesiophyceae) has a cosmopolitan distribution, inhabiting both open ocean and coastal waters from polar to sub tropical latitudes. Examination of stable differences in growth rates, morphology and cross reactivity to specific antisera has made it possible to separate the taxon into two sub-groups, designated morphotypes A and B (Brand 1982,Young *et al* 1991 Bleijswijk *et al* 1991). We have obtained small subunit ribosomal DNA (ssu rDNA) sequence data for isolates of *E.huxleyi* from the Sargasso Sea, and from two stations in the Atlantic,all of type A morphology. The two type A clones collected on the 20° W line at latitudes of 24° and 59°N, respectively, had identical ssu rDNA sequences. The ssu rDNA sequence from a type B clone collected from the English channel was found to have a pairwise distance value of zero when aligned with type A sequence. We conclude from this data that the classification into types A and B needs more investigation. We also present preliminary data which suggests that the production of RAPD fingerprints may be useful in distinguishing closely related forms within the taxon *Emiliania huxleyi.*

C.J. BARWELL, E.M. CUNNINGHAM and M. GUIRY* (Marine Natural Products Research Group, University of Portsmouth and *Ryan Marine Institute, University College Galway)

European marine algae as a source of phycobiliproteins.

Phycobiliproteins such as phycoerythrin exhibit fluorescence properties in vitro which have resulted in their use as labels for biomedical diagnostic reagants. In addition, their colour properties make them of interest as natural colourants of cosmetics and pharmaceuticals. A high proportion of commercial phycoerythrin production occurs from red algae cultured and harvested outside of Europe. However, European coastal waters support stocks of red algae which are potential commercial sources of phycobiliproteins.In our experience, some European red marine red algae are potential economic sources of phycobiliproteins. These may be isolated, for use as colourants, by standard protein isolation methods which are amenable to being scaled up for commercial production.

C.J. BARWELL, Y.C.MA, S.MABEAU* AND T.J.NICHOLLS (University of Portsmouth and *CEVA, Pleubian, Brittany, France)

European marine algae: a potential source of high value human food products.

Countries such as China and Japan traditionally use marine algae to flavour and embellish food dishes for human consumption. Used as such they constitute what may be termed high-value food products. In Europe there is a limited use of algae as human food. We consider that European consumption of high-value algal food products can be increased with concomitant economic benefits for algal-based industry.

Appearance, texture and taste would be essential attributes. In addition, the presence of beneficial nutritional constituents would assist the products' promotion. Potentially edible algae are being evaluated for beta-carotene (pro vitamin A) and vitamin E. *Porphyra* spp. and *Ulva pinnatifida* normally contain

beta-carotene (0.5-5.0mg per 100g dry weight). Vitamin E was not detectable in the samples analysed under conditions where 95% of added vitamin E was recovered from the algal material.

R. BHODAY, S.J. RUSSELL, L.R. JOHNSON, P. GACESA*, P and D.M. JOHN (Department of Botany, The Natural History Museum, London SW7 5BD, UK and *Department of Biochemistry, University of Wales College of Cardiff, Museum Avenue, Cardiff CF1 1ST, UK)

Morphological and molecular species concepts: their degree of congruence in algae traditionally placed in the Chaetophorales (Chlorophyta)

Taxonomic characterisation of infrageneric taxa traditionally assigned to the Order Chaetophorales is based principally on morphological traits. The degree of relatedness of these 'morphospecies' cannot be tested by means of hybridisation experiments when sexual reproduction is unpredictable or remains unknown in most strains cultured thus far. Restriction enzyme analyses of amplified nuclear encoded 18S rRNA genes provides a means of examining genomic variation in such morphologically-defined species. In this study restriction fragment patterns were compared between and within 'species' of *Microthamnion*, *Dilabifilum* and *Pseudendoclonium* isolated from different habitats and geographical regions. The similar restriction patterns found in 29 strains of *Microthamnion* support the view that the genus is monospecific. In contrast, the molecular data (albeit for a small part of the genome) indicates the genera *Pseudendoclonium* and *Dilabifilum* to be more complex than suspected hitherto. Caution needs to be exercised when examining species concepts based on the degree of congruence between morphological and molecular data.

T.H. BIRKBECK and S.GALLACHER (Department of Microbiology, University of Glasgow)

New and alternative methods of screening for toxicity in algae

The principal problems caused by toxic algae in British coastal waters are through paralytic shellfish poisoning (PSP) and diarrhoetic shellfish poisoning (DSP) arising from the ingestion of shellfish which have accumulates PSP or DSP toxins from the algae.

PSP is attributed to saxitoxin and a family of closely related compounds which block sodium channels in nerves. Many countries undertake shellfish toxicity monitoring programmes using the mouse bioassay to detect PSP toxins. Apart from the undesirability of toxicity testing in live animals this method has several disadvantages. Alternative methods, such as HPLC, the use of animal axons, fluorimetry, house fly bioassay, and immunoassays also have some disadvantages which make them unsuitable for large-scale screening programmes. Recently developed tissue culture assays which quantify sodium channel blocking (SCB) toxins should provide a better alternative to the mouse bioassay and are applicable to monitoring programmes.

The DSP toxin, okadaic acid, is currently detected by rat or mouse bioassays. HPLC may also be used but as okadaic acid inhibits protein phosphatases this may provide the basis for alternative DSP assays.

D.A. BIRKETT and M.J. DRING (Marine Station, Portaferry, The Queen's University Belfast)

Longitudinal distribution of phosphate uptake rates along the blade of *Laminaria saccharina*.

Large plants of *Laminaria saccharina* were collected from a sheltered shore in Strangford Lough, Northern Ireland, and held in 100-litre tanks of running seawater (10 exchanges per hour) for 2-6 h during sampling. Paired discs of healthy tissue were cut at 10 cm intervals along the length of each plant and strung on nylon line in such a way that the origin of each disc was known. The discs were held overnight in fast flowing seawater and vigorously aerated to remove exudates prior to pretreatment in a flowthrough system of seawater spiked with 2 µmol PO_4^{3-} l^{-1}. Of each pair of discs, one was pretreated in the dark and the other under a surface light intensity of 120 µmol photons m^{-2} s^{-1} over a period of 22-26 h. Uptake rates for each disc were subsequently measured in 2-h batch experiments.

Phosphate uptake rates reached a maximum 10-15 cm from the blade base but then decreased towards the tip where rates were more than 75% lower. Uptake rates of discs cut from the edges of the blade were 50-100% greater than those of discs cut from the centre part of the blade. Discs cut from the base of the plants increased in diameter by 20-30% during the light pretreatment and by 5% in the dark, but no measurable increase was found for discs cut further than 20-30 cm from the base. Pretreatment in light enhanced the phosphate uptake rates only in discs cut from the edges of the blades, but the enhancement declined along the length of the plants and was absent in the older tissue.

When selecting tissue from large plants for physiological work, care should be taken to standardise the sample location as large physiological differences in response can occur over small areas.

S. LE BOZEC (C.E.V.A. BP 3-22610 Pleubain, Brittany France)

Green Tides on the Brittany Shore: The case of the Bay of Saint-Brieuc

Genus *Ulva* green macroalgal mass blooms (or green tides) have been leading to important beachings on some points of the Breton shore (France) since the 80's because of continental eutrophication. In the Bay of Saint-Brieuc, an operation consisting of removing phosphorous in the waste water treatment plants has been carried out since 1988. Its aim is to diminish the flows of phosphorus entering the bay. In 1992, a simultaneous study of in situ algal growth on one hand, and internal contents in P and N, nutrient flows and

meteorological data on the other hand, clarified the influence of these parameters on algal yield. During June, external nitrogen concentrations limited the algal growth. the fact that N is a limiting factor is confirmed by the study of internal contents and by the correlation between average N flows into the bay in June and the in situ biomass. In situ *Ulva* biomass measurements in 1992 (15000 tons) exceeded those observed in 1990 & 1991, when drought conditions occured. the influence of phosphorus removal has not been discerned. Internal P content has diminished, but not enough for the external concentrations of P to become a limiting factor for the growth rate of *Ulva* in the Bay of Saint-Brieuc.

J.BRODIE (Department of science, Bath College of Higher Education)

Population dynamics of *Chondrus crispus* (Rhodophyta) on a shore in Somerset, England.

Preliminary results of an investigation into temporal changes in population structure of the red alga *Chondrus crispus* have revealed the following: Individual plants consist of a basal disc and from 1 to more than 100 upright fronds which may be unbranched, or dichotomously branched one to several times. Approximately half the plants examined have either visible cystocarps or tetrasporangial sori, but these are only borne on a few of the largest fronds. The ratio of gametophytes to tetrasporophytes in the population is 2:1. The majority of plants are infected with endophytic green and brown algae. These findings are discussed in relation to the success of *C.crispus*, a species which occurs on both side of the north Atlantic where on some shores it may form the dominant algal species.

B. BUCHHOLZ, P.K. HAYES and A.E. WALSBY (Department of Botany, University of Bristol, Bristol BS8 1UG.)

The interaction between GvpA and GvpC in cyanobacterial gas vesicles

Gas vesicles isolated from the cyanobacterium *Anabaena flos-aquae* contain two types of protein, GvpA, a hydrophobic protein of Mr 7397 that forms the main ribbed structure, and GvpC, a hydrophilic protein of Mr 21985. GvpC is located on the outer surface of the gas vesicle and strengthens the structure; it can be removed by rinsing with 6 M urea, leaving the gas vesicles intact but weakened. Recombinant GvpC can be attached to stripped gas vesicles, all GvpC-binding sites are reoccupied and the gas vesicle critical collapse pressure returns to its original value.

The localization of GvpC on the outer surface of the gas vesicle was investigated using immuno-labelling techniques. Anti-GvpC antibodies, labelled with gold, had a similar affinity for both the conical end caps and the cylindrical mid-sections of gas vesicles. The amounts of GvpA and GvpC in gas vesicles have been calculated from amino acid analysis of gas vesicle hydrolysates. The molar ratio of GvpA:GvpC was found to be 25:1 in freshly isolated gas vesicles and 23:1 in stripped gas vesicles saturated with rebound GvpC. This ratio is in agreement with a theoretical model for the interaction between GvpA and GvpC that predicts a molar ratio of 25:1.

S.B. CALDWELL, R.O. MCLEAN and D.S.T. NICHOLL (Department of Biology, The University of Paisley)

Heavy Metal Shock Proteins in filamentous green algae

Klebsormidium rivulare (Kutz) and *Stigeoclonium tenue* (Kutz) were exposed in sterile culture to concentrations of zinc ranging from 2.5 to 100mgl^{-1} for periods ranging from 30m to 48h. AS^{35} labelled methionine/cysteine mix was included in the incubate. Proteins were extracted and separated by S.D.S. gel electrophoresis. S^{35} labelling of protein bands on the gel was detected by fluorography. Proteins produced consistently in the presence of zinc shock were of molecular wight 15KDa, 17-18KDA AND 22kda, with additional inconsistent production at 12KDa and 40-43KDa. These proteins were considered to be shock response proteins, comparing with heat shock proteins and having a possible role in the heavy metal tolerance of the algae. Both organisms have been demonstrated to develop tolerance to zinc by previous authors.

D.J. CONNOLLY AND R.O. MCLEAN (Department of Biology, The University of Paisley)

Optimising Conditions for Callus and Suspension Culture in *Laminaria* sp.

Callus cultures of *Laminaria digitata* (Huds) Lamour were found to grow better at 10C than at 18C and within a period of four weeks on explants produces from the stipes of juvenile plants collected in late winter to early spring. The artificial sea water medium ASP6F2 supported more growth than the supplemented sea water medium F2. Filamentous growth considered to be gametophytic developed on the explant surface with gametangial and sporophytic outgrowths evident by eight weeks. Filaments transferred to liquid medium in 250 ml cultures grew best in ASP6F2 rather than in F2 medium. Growth improved under aeration (240ml min^{-1}), at pH 8, salinity of 40%, 0.16gL^{-1} nitrate nitrogen, 150mgL^{-1} phosphate phosphorus and with illumination at 36ïE m^{-2}.s^{-1} for 16h. The top of the exponential phase was achieved within 10 days *Laminaria digitata* (yield 0.38mgml^{-1} dry weight).

R.J. CRAGGS, P.J.C. MCAULEY, V.J. SMITH (Department of Botany, University of St Andrews, St Andrews, Fife, KY16 9TH)

Screening of Marine Microalgae for Nutrient removal form Primary Treated Sewage Effluent

Microalgal removal of ammonia and phosphate has been investigated in batch and semi-continuous

culture under controlled and environmental experimental conditions. The cultures were make up using 25% and 50% primary effluent diluted with autoclaved sea-water. Sixty-six microalgal cultures were isolated from both the Autumn and Spring phytoplankton blooms of St Andrews bay. These, together with thirty-seven species from the Plymouth culture collection were screened for their ability to remove nutrients from the culture medium, and for their ability to remain in monoalgal culture over several months of semi-continuous experimentation. Ten species with optimal removal of ammonia and phosphate were selected.

The effect of salinity and nutrient concentration of the growth rates of the ten species was investigated. The majority were found to have a wide salinity tolerance over the range 0-100% seawater. Salinity alone could not account for the variation in growth rates of cultures grown on primary effluent made up to the same seawater dilutions, suggesting other properties of the diluted effluent were effecting growth.

K. DAVIDSON, A. CUNNINGHAM and K.J. FLYNN (Physics & Applied Physics, University of Strathclyde; Biological Sciences, University of Wales Swansea)

Mathematical Modelling of Time Lags in Phytoplankton Growth Dynamics

Time lags in the response of cell division to nutrient enrichment have often been observed during studies of phytoplankton growth. We present a mathematical model of single nutrient limited algal derived from ammonium limited batch cultures of *Isochrysis galbana*. The model was capable of simulating the temporal decoupling between carbon fixation and cell division. On application of the model to chemostat data it was found to be capable of simulating both long time lags and changes in cell density without introducing spurious oscillations.

J.D. DODGE (Biology Department, Royal Holloway, University of London, Egham, Surrey, TW20 0EX)

Biogeography of coastal dinoflagellates around the British Isles

For the past 20 years samples have been collected from sandy and muddy beaches, from salt marshes, saline pools and lagoons around the British Isles. Most parts of the coastline have now been covered to some extent. 70 species of dinoflagellate have been identified and their distributions plotted. A small number of photosynthetic species can occur in large numbers such that the sand or mud surface is discoloured or the water is turned golden or brown. Species which cause these phenomena include: *Amphidinium britannicum, A.herdmanae, Gymnodinium splendens, Thecadinium kofoidii* on moist sandy beaches; *Prorocentrum lima, P.marina* on wet mud surfaces; *Amphidinium carterae, Glenodinium foliaceum, Katodinium rotundatum, Prorocentrum minimum* in saline pools and lagoons. As yet, only *P.lima* has been implicated in toxin production (DSP) but others could become a nuisance because of high biomass production. Examples of the distribution of selected species will be illustrated and the overall biogeographical zones will be investigated. This work aims to provide a baseline against which changes which could affect the biodiversity and productivity of these and other coastal organisms can be assessed.

L.F.DONG, N.A.NIMER & M.J. MERRETT (School of Biological Sciences,University of Swansea,Swansea U.K.)

DIC Utilization and Calcite Production in *E.huxleyi*

The relationship between calcite production and DIC utilization was investigated using high- and low-calcifying strains of *E.huxleyi* aerated with either air (0.03% v/v CO_2) or CO_2-free air. With cultures grown on air calcite production was eight-fold greater in the high-calcifying culture but growth rates for high- and low-calcifying cultures were similar. Growth and calcite production were accompanied by a concomitant decrease in DIC and free CO_2 in the high-calcifying culture showing that HCO_3^- provides inorganic carbon for calcite synthesis. In low-calcifying cultures DIC and free CO_2 were relatively constant confirming that these cells acquire inorganic carbon by the diffusive entry of free CO_2. When cultures were aerated with CO_2-free air the low-calcifying cells were unable to grow. Although the pH of the cultures increased to 8.7, this is still below the upper limit for growth of 9.5. It is concluded that these cells are unable to grow because the free CO_2 concentration is below the $K0.5[CO_2]$. Growth of high-calcifying cells was observed and the calcite yield was little changed from cultures gassed with air (0.03% v/v CO_2). At these minimal CO_2 concentrations HCO_3^- provides inorganic carbon for calcite synthesis and generates CO_2 for photosynthesis allowing growth to occur.

G.E. DOUGLAS, D.M. JOHN and O.W. PURVIS (Department of Botany, The Natural History Museum, London SW7 5BD, UK)

Morphological and molecular studies of variation in *Trebouxia* (Chlorococcales, Chlorophyta) isolated from lichens growing on metalliferous rocks.

The green algal component of lichens growing on metalliferous rocks was isolated and grown on in culture. Isolation of the phycobiont was achieved by transferring a portion of the algal-dominated layer to an enrichment culture medium. Cultures presumed to be unialgal were obtained by repeated subculturing. Initial identification of cultured lichen-algae was based on morphological traits visible under the light microscope and motile cell behaviour monitored by time-lapse video-recording. Observations revealed considerable variation in size and shape in many isolates attributed to the genus *Trebouxia*. The nature of this variation was

investigated using single cell cultures initiated from a cell removed from a lichen or from a young enrichment culture. Preliminary findings suggest that morphological and cytological variability in populations of algal cells within a lichen thallus may indicate more than one 'species' of *Trebouxia* to be present. A molecular approach is being adopted to test this explanation by examining the genetic relationship between cultures of single isolates.

J.D. ECCLESTON and B.S.C. LEADBEATER. (School of Biological Sciences, The University of Birmingham, Edgbaston, Birmingham, B15 2TT, U.K.).

The regeneration of nutrients by heterotrophic nanoflagellates.

The aim of this study was to quantify the release of phosphorus and nitrogen by nanoflagellates whilst feeding on a single bacterial species.Three cultures of the bacterium were maintained in chemostats under different nutrient regimes to yield three qualitatively different bacterial states i.e. "balanced", "phosphorus-rich" and "nitrogen-rich" cells. The three bacterial states were used as sole food sources for four selected nanoflagellates in batch culture feeding experiments. The release of orthophosphate and ammonia was monitored over time and the percentage released was compared to the original internal C:N:P ratios of the bacterial prey. The regeneration efficiencies of the four nanoflagellates were compared and any correlation between this property and the life-cycle strategy of each species was assessed.

H.R. ENGLEDOW, J.J. BOLTON & H. STEGENGA (Botany Department, University of Cape Town)

Biogeographical patterns of the Namibian Seaweed Flora

The Namibian coastline makes up the northern end of the warm temperate phytogeographical province of south-western Africa. It is subject to the upwelling of cool water from the Benguela current, and relatively strong wave action. The 1500 km coastline is composed predominantly of sandy beached, with "islands" of rocky outcrops.

Seaweed diversity has been found to decrease with a decrease in latitude. Causal factors could include temperature patterns, counter current intrusion from the warm Angolan current in the north, increased sand/silt inundation, decrease in habitat heterogeneity, and prehistorical past. The flora is almost completely made up of temperate species also occurring on the west coast of South Africa, with only a few tropical seaweeds occurring at the northern-most reaches of the coast. The relative abundance of these species are however different along the coastline, with turf-like and sand tolerant species predominating in central and northern Namibia. The preliminary results of a two way indicator species analysis have revealed the presence of two sub-provinces, viz. the Namib and Namaqua sub-provinces.

J. FINLAY and M.E. CALLOW. (School of Biological Sciences, The University of Birmingham, Edgbaston, Birmingham B15 2TT, U.K.).

The Evaluation of Amines as Potential Anti-fouling Agents.

The anti-fouling potential of a range of alkyl amines with carbon chains of 7-16 atoms in length has been investigated in laboratory studies using a number of marine test organisms. The amines investigated are amphipathic molecules with surface active properties and classed as cationic surfactants. Algicidal activity was assessed using *Amphora coffeaeformis*, *Dunaliella parva* and *Enteromorpha intestinalis*; activity against fouling animals was assessed using larvae of the brine shrimp *Artemia salina* and the barnacle *Elminius modestus*. With all organisms there is an increase in toxicity with an increase in length of the carbon chain. However, *Amphora* shows a different response, the effect of increasing the chain having a very much smaller influence on toxicity. The results will be discussed in relation to the physico-chemical properties of amines in seawater and their effects on cell membranes.

R.L. FLETCHER (Marine Laboratory, University of Portsmouth)

Green tides: an overview.

Coastal eutrophication, resulting from increased nutrient loading from sewage discharge and agricultural "run-off", is commonly reflected in the occurrence of excessive growth of macroalgae, notably species of the green algal genera *Enteromorpha* and *Ulva*. Their presence in the water column in high densities results not only in the physical abrasion and shading of other benthic algal communities, with a concomitant decrease in species productivity and diversity, but also increased sedimentation, restricted water movement and damage to local fisheries. As they decompose, anoxic conditions also develop which cause marked changes/reductions in the invertebrate fauna. When these excess algal growths are eventually deposited on the shore line, they encourage chironomid flies and necessitate expensive clearance operations. The present paper reviews the phenomenon of "Green Tides" and considers aspects such as their world-wide distribution, environmental requirements, floristic composition, detrimental effects, control methods and utilization of the algal biomass obtained.

K.J. FLYNN (Algal Research Unit, Biological Sciences, University of Wales Swansea)

Toxicity in Dinoflagellates - the role of nutrient physiology

Dinoflagellate toxins and toxin synthesis have been much studied over the past decade. In contrast, their general physiology is less well understood. Growth of dinoflagellates requires stable low-shear conditions. Often growth halts due to some cell-density effect in the presence of excess nutrients. The nutrition of these

organisms is not typical of phytoplankton; mixotrophy (including phagotrophy) is not uncommon and there are often illdetermined micronutrient requirements for good growth. C/N values may be very low, reflecting the considerable amount of nucleic and proteinacous material. Intracellular free amines may be present at high concentrations; arginine may be present at high levels in stationary phase cultures and glutamine/glutamate may be high even during N-deprivation. Arginine is an important precursor of PSP toxins. Events, such as P-stress, which may promote N-cycling or accumulation of free amines are also likely to simulate toxin synthesis. What is not clear is why strains of the same species should have such different toxin levels, and what the role of bacteria may be.

K.J. FLYNN, K DAVIDSON & A. CUNNINGHAM (Biological Sciences, University of Wales Swansea; Physics & Applied Physics, University of Strathclyde)

Cannibilism and Indigestion in the Protist *Oxyrrhis marina*

During studies of the predation of the photo-flagellate *Isochrysis galban* by the protist *Oxyrrhis marina* a level of prey selection by the predator was noted. At low *Isochrysis* densities (<10000 ml^{-1}), canabolism of the *Oxyrrhis* occurs and the protist population contains various size classes including many small individuals and fewer larger cells. However, canabolism may also be induced in the presence of high numbers of N-deprived *Isochrysis*. Occasionally it takes *Oxyrrhis* many weeks to graze down a dense culture of *Isochrysis* even in continuous darkness. Using the presence of a unique non-protein amine in *Isochrysis* to follow *Isochrysis*-N and biovolume to follow *Isochrysis*-C, we calculated the C/N ratio of the prey in mixed populations. At high prey C/N, predation of *Isochrysis* halts perhaps because the high C-content, or different C-composition, makes the cells difficult to digest. It is suggested that the predator recognises that the Isochrysis is no longer a suitable food item and reverts to predating its own kind. The consequences for N-regeneration will be discussed.

G.W. GARNHAM, G.A. CODD and G.M. GADD (University of Dundee, Scotland).

Accumulation of technetium by microalgae and cyanobacteria

This paper describes technetium (as the species TcO^{4-}) accumulation by the microalgae *Chlorella emersonii*, *Scenedesmus obliquus*, *Chlamydomonas reinhardtii* and the cyanobacteria *Synechocystis* PCC 6803, *Synechococcus* PPCC 6301, *Plectonema boryanum*, *Anabaena variablis* and a red *Oscillatoria* sp., and characterizes the influence of concentration, pH, external osmotic potential, monovalent and divalent ions on accumulation. Desorption of accumulated TcO^{4-} from the microalgae and cyanobacteria was also investigated. Accumulation by microalgae and cyanobacteria investigated consisted of a single rapid energy-independent phase (biosorption) and no energy-dependent accumulation was observed. In all cases $99Tc^{4-}$ accumulation was concentration-dependent and followed a Freundlich isotherm within the concentration range 5-100 µM. Accumulation was increased by low external pH and elevated external NaCl concentration. Increased external osmotic potential also increased accumulation of TcO^{4-} by the microalgae and some cyanobacterial species. External concentrations of the cations K^+, Na^+, Cs^+, Ca^{2+}, Mg^{2+} and Sr^{2+} increased accumulation of TcO4- by the microalgae and cyanobacteria. Concentrations of SO•, CO• and HCO decreased accumulation of TcO_{4-} by the microalgae but did not effect the accumulation by the cyanobacteria. Most of the TcO_{4-} accumulated by the microalgae and cyanobacteria was easily desorbed by 10mM concentrations of buffers at various pH values, 0.5 M NaCl, 10 mM Na_2CO_3 or 10 mM Na_2 SO_4.

J. GLADSTONE AND J.M. LOPEZ-REAL (Department of Biochemistry & Biological Sciences, Wye College, Ashford, Kent, TN25 5AH)

Recycling and Composting of Seaweed Wastes

The composting process is an aerobic, microbially mediated, exothermic, biological oxidation of organic materials resulting in the production of a complex humus end product. Over the last decade the process parameters governing the efficiency of the process is intensively investigated primarily in relation to the treatment and disposal of problem wastes such as sewage sludges. The paper will give a brief overview of composting and discuss the application of the technique to the treatment of seaweed from the coastal areas of East Kent where its disposal is an increasing economic and environmental problem. The concept of a regionalised multi-material processing plant will be considered together with the direct use of seaweed on farmland.

R.J. GOWEN (Aquatic Sciences Research Division Department of Agriculture for Northern Ireland Newforge Lane, Belfast, BT9 5PX)

Predicting Marine Eutrophication

With growing concern over the eutrophication of European coastal waters there is clearly a need to understand and predict the response of phytoplankton to anthropagenic nutrients. In freshwater, the empirical approach of Vollenweider has been successfully used as an aid in the management of eutrophication and an analogous approach may be of value in coastal waters. The relationship between nitrate and cholrophyll was investigated using data collected from the Scottish was coast and linear regression analysis used to relate changes in cholorophyll to changes in nitrate with the slope of the regression giving an estimate of q, the yield of chlorophyll from nitrate. Of the 60 data sets analysed two-thirds gave the expected significant inverse

regression of chlorophyll on nitrate concentration. The median value of q was 1.05 mg chl (mmol N)$^{-1}$ but the range was large (0.25 to 4.4). Some reasons for the variation are presented and the use of the q model in predicting the response of phytoplankton to anthropagenic nitrogen is discussed.

A.S.D. HARRIS[1,2], J.M. LEWIS[1], and K.J. JONES[2] (University of Westminster, London [1] and Dunstaffnage Marine Laboratory, Oban [2]).

The occurrence of diatom resting stages in a Scottish sea-loch over the spring bloom period

During the period covering the spring diatom bloom in Loch Creran from February to May 1992 regular sampling trips were carried out. Water column samples were analysed for chlorophyll *a* to provide an indication of the status of the bloom. From the sediment samples using an MPN technique, estimates were made of the numbers of viable resting stages of two species of planktonic diatom: *Skeletonema costatum* and *Thalassiosira minima*. Pre-bloom sediment samples were found to contain viable *S.costatum* resting stage concentrations ranging from 8.6 x 10^3 to 9.25 x 10^5 cells g^{-1} dry sediment. In contrast no viable *T.minima* resting stages were recorded in the sediments. The numbers of resting stages of each species increased over the bloom period. Maximum concentrations of 6.21 x 10^6 and 4.92 x 10^5 cells g^{-1} dry sediment for *S.costatum* and *T.minima* respectively coincided with the onset of summer chlorophyll *a* levels. Three months later no evidence of viable *T.minima* resting stages could be found in the sediments, however *S.costatum* was still present at concentrations of 1.55 x 10^5 cells g^{-1} dry sediments. This suggests two different ecological strategies: *S.costatum* maintains a viable presence in the loch sediments as a potential source of autochthonous 'seed-stock'. In contrast, *T.minima* only has a temporary presence in the sediments suggesting that its 'seed-stock' is allochthonous in origin.

P.K. HAYES, A.E. WALSBY & R. BOJE (Department of Botany, University of Bristol & Institut fur Meereskunde, Kiel)

Gas-vacuolate cyanobacteria in the Baltic Sea.

Colony concentrations were determined in samples taken from a series of vertical profiles spanning a storm-induced mixing event in the Baltic Sea. Wind-induced mixing produced an evenly distributed population of cyanobacterial colonies in the upper mixed layer. In the period of calm weather following the storm the cyanobacterial population moved back towards the surface at an apparent rate of 22 m day^{-1}; this rate is close to the average floating velocity for colonies, measured on board ship.

For gas-vacuolate cells to remain buoyant during mixing events it is necessary for a sufficient proportion of their gas vesicles survive exposure to the hydrostatic pressure generated in the water column. 50 % of colonies remained buoyant after being exposed to pressures that would collapse about 40 to 50 % of their gas vesicles; 50 % gas vesicle collapse occurred at 0.9 - 1.0 MPa for mixed populations of *Nodularia* and *Aphanizomenon*. The gas vesicles are just strong enough to withstand the pressure at the maximum winter mixing depth in the Baltic.

S.I. HEANEY (Aquatic Sciences Research Division Department of Agriculture for Northern Ireland, Newforge Lane, Belfast, BT9 5PX)

A history of UK toxic algal blooms

Toxic algal blooms were first reported from Australia by Francis in 1878. It was not until the late nineteen sixties that toxic algal blooms were recorded in fresh, brackish and coastal waters of the United Kingdom. Since then there have been sporadic records until the late nineteen eighties and early nineties when there was major public concern over toxic blooms of cyanobateria and incidents of shellfish toxicity. This near coincidental increase of both freshwater and marine algal toxin incidents has resulted in the setting up of the Working Groups of the National Rivers Authority (NRA) for England and Wales and the Co-ordinator of Fisheries Research and Development of the UK. The European Commission Shellfish Health Directive (91/492/EEC) has required the monitoring of toxicity in shellfish and for presence of toxic species of plankton. This increase in surveillance in shellfish waters, as well as that for freshwaters, will most likely lead to a greater recorded incidence of toxic algal blooms within the UK.

C.R. HEATH, M.E. CALLOW and B.S.C. LEADBEATER. (School of Biological Sciences, The University of Birmingham, Edgbaston, Birmingham B15 2TT, U.K.).

Control of calcification in algal biofilms.

The deposition of biofilms on a commercial antifouling paint and a non-toxic control paint was studied on panels immersed in a hard water marina during the summer months of 1991. The dry weight of the predominantly algal biofilm decreased with increasing depth. Calcium carbonate was deposited within all biofilms and a significant linear relationship between $CaCO_3$ and organic weight was observed. These results will be discussed in relation to water chemistry and the presence of algae within the biofilm.The precipitation of $CaCO_3$ using a range of algae isolated from calcified biofilms has been observed in batch culture. Precipitation can be modified by the addition of sub-lethal doses of inhibitors of calcification e.g. phosphonates and polypeptides. Inhibition of precipitation is achieved by either controlling the nucleation of calcite crystals and/or by reducing the rate of crystal growth. $CaCO_3$ precipitation reactions are currently being studied in a controlled laboratory system in which pH and conductivity are continuously monitored during algal growth. From the recorded data,

the rate of $CaCO_3$ deposition can be calculated and this apparatus will be used to investigate the effect of inhibitors further. Selected inhibitors will be incorporated into anti-fouling paints in order to see whether calcification within biofilms can be reduced in hard waters.

C.R. HIPKIN (Algal Research Unit, Biological Sciences, University of Wales Swansea)

Inorganic Nitrogen Assimilation In Algae

The relative importance of nitrate ("new" nitrogen regenerated in deep water) versus reduced nitrogen (ultimately ammonium, regenerated in surface waters) in fuelling marine phytoplankton productivity, is currently a key issue in marine ecology. The development of an accurate methodology for estimating the partitioning of primary productivity between these sources of nitrogen depends on a clear understanding of the biochemical processes and intracellular signals that regulate inorganic nitrogen assimilation in unicellular algae. This paper reviews the major features of inorganic nitrogen metabolism in algae and outlines our current understanding of regulatory processes that may control the fluxes of nitrate or ammonium-nitrogen into cellular nitrogen.

B.R. HITCHINGS, B.W. FERRY AND T.W. FORD (Royal Holloway. University of London, England)

Community analysis of phytoplankton populations in water bodies at Dungeness, Kent, in relation to salinity changes

Dungeness, Kent, UK, is the largest apposition shingle beach in Britain and there are a number of water bodies there, largely as a result of gravel extraction. Twelve months of field data were collected on the phytoplankton populations of these water bodies. As it is a coastal site, saline incursions into the ground water are frequent during the winter, and several of the water bodies undergo varied and unpredictable changes in their salinities. The question being asked is how does this affect the phytoplankton communities and how are species able to survive these changes? Two community analysis packages were used to examine the field data; TWINSPAN and CANOCO. Correlations with species distributions and salinity measurements were found. Though none of the pits exceeded 15% sea water throughout the year, one coastal dinoflagellate (*Katodinium rotundatum)* was found frequently in one water body. The phytoplankton communities, however, consisted largely of salt tolerant fresh water species rather than euryhaline marine species. Laboratory culture experiments are also being carried out to investigate morphological changes observed, and to quantify salt tolerance within several algal species found at Dungeness.

R.G. HOOPER AND A. WHITTICK (Department of Biology, Memorial University of Newfoundland)

Effect of thermal effluent on seaweed communities in Newfoundland

An oil fired electricity generating station discharges seawater condenser coolant over the intertidal into the surface water of Conception Bay, Newfoundland. Effluent temperature varies from 10-15°C above ambient. Initial operations were for peak loads in the winter months and seaweed communities were never exposed to water temperatures above normal summer maxima. During initial operation of the station the effluent produces changes in seaweed phenology. Winter species were inhibited and were replaced by species which normally reached maximum biomass and reproductive capacity in the summer. Today the station operates year round and in late summer seaweeds may be exposed to water temperatures ca 30°C. These water temperatures are above the lethal limits for many species. Communities in the immediate outfall area are now dominated by hardy or opportunistic species.

C.L. HURD, P.J. HARRISON AND L.D. DRUEHL* (Department of Oceanography, University of British Columbia, Vancouver, V6T 1ZA and *Bamfield VOR 1BO, Canada)

The effect of current speed on nutrient uptake by morphologically distinct forms of kelp obtained from sheltered and exposed sites

In areas of low water motion, the availability of inorganic nutrients to macroalgae may be limited by the formation of a nutrient-deplete diffusion boundary layer. The aim of this work was to determine if kelp from sheltered sites possess morphological features that create turbulence at the thallus surface, at low current speeds, thereby increasing nutrient availability. Whole blades of *Macrocystis integrifolia* and whole plants of *Nereocystis leutkeana* and *Alaria* sp. (15-30g wet weight) were collected from areas of low and high water motion. Uptake experiments were conducted in a 46-litre recirculation tank that produced laminar flow up to 8 cm s^{-1}; above this speed the flow pattern was turbulent. The removal of nitrate and ammonium from seawater containing initial concentrations of 15 uM was followed over 2-3 h periods at current speeds ranging from 0.5 - 20 cm s^{-1}, at 13°C and an irradiance of 180 nmol m^{-2} s^{-1}. For *Macrocystis* from a sheltered site, nitrate and ammonium uptake rate increased hyperbolically with increasing current speed, reaching a maximum at a flow rate of 4-5 cm s^{-1}. Nitrate and ammonium uptake by *Macrocystis* from an exposed site increased linearly with increasing flow rate. Maximum uptake rates were similar for plants from both sheltered and exposed environments. Sheltered plants may, therefore, possess morphological features that create turbulent flow at low current speeds. Ammonium uptake by *Nereocystis* and *Alaria* from two sites reached a maximum rate at flow of 4-5 cm s^{-1}, however, the maximum uptake rate of sheltered plants was greater than that of plants from an

exposed site. Methods to visualise the movement of water around difference morphologies of kelp are being developed and progress in this area will also be reported.

B.W. IBELINGS (Laboratory for Microbiology, University of Amsterdam and Department of Botany, University of Bristol)

Inhibition of photosynthesis in *Microcystis* surface waterblooms.

Microcystis is a colony forming, buoyant cyanobacterium that forms dense surface waterblooms under conditions of watercolumn stability. At the lake surface the light dose they receive may be supra-optimal, inhibiting photosynthetic production rates. *Microcystis* cells were exposed to a sinusoidal light regime, simulating the conditions in a surface bloom. Photosynthetic performance was studied using various techniques in both continuous cultures and natural populations. Strong indications of photoinhibition were found. Variable fluorescence was quenched. Both Pmax, the maximum oxygen production rate and a, the affinity for photosynthesis, of cells in culture decreased during the light period. This decrease occurred in spite of observed increases in cellular content of the carotenoid zeaxanthin and an increase in the number of PS II reaction centres which convert excess excitation energy to heat. In natural blooms, photoinhibition was manifested as a sharp drop in both oxygen concentration and gross rates of photosynthesis in the upper layer, as measured with oxygen micro-electrodes. Although *Microcystis* proliferates in stable watercolumns, where it will periodically be exposed to high irradiance at the watersurface, it is nevertheless susceptible to photoinhibition. The ability of colonies to lose buoyancy and sink from the surface may provide them with a means of escape before photodamage occurs.

D. JACKSON, E. NIXON, J. SILKE AND B. TAFFE (Fisheries Research Centre, Dept. of Marine, Abbotstown, Dublin 15, Ireland)

DSP in Ireland - An Overview (1990-1992).

DSP monitoring in Ireland is carried out by the Fisheries Research Centre. There are three elements to this monitoring programme; i) Routine phytoplankton sampling for all aquaculture areas, ii) Pre-emptive toxicity testing of areas at risk, iii) Toxicity testing in response to *Dinophysis* spp. in the water samples in other areas. Since 1990 two techniques have been routinely used to investigate toxicity in shellfish. A rat bioassay is used to determine toxicity and HPLC to identify and quantify the toxins. While toxicity has been detected all along the south and west coasts of Ireland the area regularly affected lies on the southwest coast between Cork Harbour and Dingle. Within this area Bantry Bay and the adjacent bays are the most regularly and severely affected. Two toxins have been implicated in causing toxicity , Okadaic acid and DTX-2. Both of these toxins have been detected, though sometimes at low levels, from many sites along the south and west coasts of Ireland.

D. JACKSON, E. NIXON, J. SILKE AND B. TAFFE (Fisheries Research Centre, Dept. of Marine, Abbotstown, Dublin 15, Ireland)

DSP Toxicity in Southwest Ireland.

The incidence of DSP toxicity in 1992 is described with particular reference to two sites in Bantry Bay, southwest Ireland. *Dinophysis acuta* and *D. acuminata* were the main causative agents of DSP recorded. Two toxins, Okadaic acid and DTX-2, were recorded from these sites over the summer period . Where Okadaic acid and DTX-2 were found together they gave rise to higher toxicities than would be expected from the concentrations of Akadaic Acid alone. DTX-2 in the absence of Okadaic acid did not seem to give rise to toxicity. DTX-2 was first recorded in 1991 in Bantry bay and has since been found in other areas.

D.W. JEFFREY (Botany Department, Trinity College, Dublin)

Sources of nitrogen for nuisance macroalgal growths in Dublin Bay, Republic of Ireland

Dublin Bay has been affected by a high biomass of green algae, mainly *Enteromorhpa* species and *Ulva lactuca* for the whole of this century. In two recent years, a new phenomenon, stranding of a high biomass of *Ectocarpus siliculosus*, has adversely affected important bathing beaches. It is considered that excess nitrogen has stimulated both green and brown algal blooms, and evidence is presented which suggests a common nitrogen source for both phenomena. This has implications of the treatment of nitrogen bearing waste discharges.

A.M. JOHNSTON AND J.A. RAVEN. Department of Biological Sciences, University of Dundee, Dundee. DD1 4HN. Scotland.

The role of ß-carboxylating enzymes in eukaryotic algae.

ß-carboxylating reactions can fulfil two roles in plant systems, either the initial carboxylating reactions in C4 and CAM plants or anaplerotic reactions which are used to maintain krebs cycle intermediates. Despite the amount of work done on ß- carboxylation in eukaryotic algae it's role in the overall carbon metabolism is yet to be understood. The catalytic properties of the ß-carboxylating enzymes and their distribution in eukaryotic algae are described. There have been suggestions that the ß-carboxylation activity in algae is consistent with the operation of the C4 inorganic carbon concentrating mechanism. The location and relative activities of the carboxylating enzymes and the 14C labelling patterns are critically reviewed and it is concluded that there is little to support

this hypothesis. Suggestions are made for future study to clarify the role of ß- carboxylation in eukaryotic algae.

H.L.J. JONES, B.S.C. LEADBEATER and J.C. GREEN*. (School of Biological Sciences, The University of Birmingham, Edgbaston, Birmingham B15 2TT, U.K. *Plymouth Marine Laboratory, Citadel Hill, Plymouth, U.K.).

Mixotrophy in *Chrysochromulina brevifilum* (Prymnesiophyceae).

Chrysochromulina brevifilum is a mixotrophic flagellate, obtaining carbon both photosynthetically and by feeding phagotrophically. Experiments were carried out to investigate the ingestion, digestion and assimilation of the prey flagellate *Pedinomonas* (Prasinophyceae) by *C. brevifilum*. Ingestion of Pedinomonas by *C. brevifilum* was dependent on light intensity, prey concentration and on the nutrient status of *C. brevifilum*. Digestion was investigated using transmission electron microscopy; three stages in the digestion process were identified. Assimilation of prey material was demonstrated by an increase in the growth rate of *C. brevifilum* when feeding on *Pedinomonas* in comparison to when *Pedinomonas* was not present. At low light intensities phagotrophy can compensate for the reduction in carbon gained photosynthetically.

K.J. JONES (Dunstaffnage Marine Laboratory, Oban, Scotland)

Harmful Algal Blooms - a global problem requiring international collaboration

The occurrence of harmful algal blooms is a problem which appears to be increasing in frequency and is responsible, worldwide, for considerable loss of human life, severe economic damage to fisheries and aquaculture and loss of amenity. Primarily the problems caused by harmful algae must be tackled by research and development of management strategies at national level in the countries affected. However, frequently nationally available resources and research expertise may be insufficient to develop an adequate understanding of the causes of blooms and effective approaches to their management. The problem therefore demands international collaboration to aid transfer of information, technology and expertise. Current international co-operative research activity into harmful blooms is outlined. Special attention is given to a global Harmful Algal Blooms Programme which has been developed in the last 5-6 years by the Intergovernmental Oceanographic Commission (IOC). The overall objective of this programme is to foster effective management of, and scientific research on, harmful algal blooms in order to understand their causes, predict their occurrences and mitigate their effects. The programme will address not only scientific aspects of the harmful algal bloom problem but also the operational and administrative aspects relating to resource and aquaculture management, monitoring, public health and seafood safety and training and information transfer. The current status of this programme and detail of its component elements is outlined. An overview of the present status of UK activity in the area of research and management of harmful algae and their effects is presented and the scope for UK involvement and participation in the IOC Harmful Algal Blooms Programme and other international research activities in this field is discussed.

K. JONES, A. EDWARDS, J. GRAHAM, C. GRIFFITHS, N. MACDOUGALL, J. RICHARD, R.RAINE*, J. PATCHING*, F.FIGUEIRAS** (Dunstaffnage Marine Laboratory, P O Box 3, Oban Argyll, PA34 4AD; *Dept. of Microbiology, University College, Galway, Ireland; **Instituto Investigacions Marinas, Vigo, Spain)

The effect of transient wind events of the formation of algal blooms in coastal rias

A remote monitoring buoy was used to investigate the relationship between water column stability and phytoplankton assemblages in two rias: Bantry Bay, Ireland and Ria de Vigo, Spain. The focus of the study was to determine the importance of transient wind events on ria circulation and how such processes could affect local phytoplankton populations.

Results from field exercises in Bantry Bay during July and August 1991, and the Ria de Vigo in October and November 1991, have shown that local winds are an important factor in determining the extent to which upwelled water from offshore intrudes and remains within the rias. In Bantry Bay, 70% of the observed current flow could be explained using a two-layer model incorporating axial wind data.

The advection of coastal water into the bays has important consequences for the resident phytoplankton assemblages. High levels of fluorescence were observed during the periods of relaxation following upwelling events in both study areas. In Bantry Bay, this was associated with a bloom of the toxic dinoflagellate *Gyrodinium aureolum*, although in Ria de Vigo the high biomass resulted from diatoms. In both areas the increased biomass is thought to result from the physical transport of cells from adjacent areas rather than *in situ* growth.

P.A. JOSLIN, J.W. EATON*, WEIZHONG ZHENG* and S.M. HUNT** (Babtie Environmental Sciences; **Acer Environmental, Cheshire and *University of Liverpool, England)

The occurrence of blooms of a skeletonless form of the silicoflagellate Dictyocha speculum in the Liverpool docks

Dense planktonic blooms of a naked (skeletonless) form of the silicoflagellate *Dictyocha speculum* were recorded in several of the Liverpool docks in the Spring of 1992.

It was not recognised that this species possessed such a naked form until 1983, when it first occurred extensively in the Western Baltic. Although the skeleton-bearing form has been observed in British waters, mass occurrence of the naked form has not previously been recorded.

Algal densities and a range of physico-chemical variables were monitored at 1-2 week intervals from early February 1992 in Albert and Queen's Docks and from late March 1992 in Salthouse Dock. Blooms of *D.speculum* (naked cell form only) occurred in all three docks over a period of approximately two weeks from the end of April, with the highest densities being recorded on 29 April when more than $40x10^6$ cells per litre were measured in each dock.

Our data suggests that this naked form of *D.speculum* was able to exploit an available ecological niche in the docks as it does not require silicon for skeleton formation. Competition with diatoms (mainly *Coscinodiscus sp.*), which bloomed 3-4 weeks earlier, was reduced as a consequence of silicon depletion, while nitrate and phosphate levels, remained sufficiently high to enable *D.speculum* populations to develop to bloom proportions.

Although previous studies have associated blooms of the naked form of *D.speculum* with fish kills, there was no evidence that any distress was caused to the range of fish species known to inhibit the docks where the blooms occurred. Toxicological tests on samples of the alga showed that it did not exhibit acute interperitoneal toxicity to mice.

M.G. KELLY & B.A. WHITTON (Department of Biological Sciences, University of Durham, Durham DH1 3LE, UK)

Factors controlling algal distribution in streams and rivers

The algal flora of an unpolluted river is governed by a number of physical and chemical factors, including the range of microhabitats available for colonization. This in turn means that there are a large number of possible responses to changes in water quality. For this reason use of algae to monitor changes in water quality has tended to be confined to specific groups of organisms or substrata in order to ease interpretation.

A large database of the chemical and algal composition of streams and rivers has been interrogated in order to examine more closely the extent to which the effect of water quality varies between different microhabitats within a stream or river. Multivariate techniques such as TWINSPAN and Multiple Discriminant Analysis have been used to predict the flora of particular sites. Comparisons are made between predictions based upon different sets of taxa (e.g. macrophytic algae, diatoms) and between these and predictions made by an invertebrate-based system (RIVPACS).

G.M.A. KENNAWAY, I.A.N. LUCAS, P. TETT (University College of North Wales, Menai Bridge, Wales)

Observations on taxonomic diversity and changes in the floristic composition of marine microflagellate blooms

Autotrophic microflagellates were the dominant organisms during periods of high chlorophyll concentrations (>4.0 mg Chl m^{-3}) recorded in Loch Striven during May and June 1990. Physical changes in the water column due to (a) wind driven circulation was associated with two blooms in May and (b) local freshwater run off with the third bloom in June. Comparison of cell counts using bright field microscopy and epifluorescence with abundance estimates from scanning electron microscopy demonstrated that these blooms (1) showed low taxonomic diversity throughout, most organisms belonging to the Prymnesiophyceae and Cryptophyceae, and (2) were dominated by organisms 2-5ïm in size. The hypothesis that each bloom began with a single class and then became more diverse will be tested.

S.H. KUENSTNER AND J. LEWIS (University of Westminster, London)

The distribution of *Alexandrium* sp. cysts on the UK coast of the North Sea

Sediment samples were collected from the Firth of Tay (56•20'N) to Flamborough Head (54•05'N) in order to determine the distribution of *Alexandrium sp.* cysts on the UK coast of the North Sea. Sampling was performed from March through May 1992, when cyst concentrations in the sediment are theoretically highest. Sub-cores of the top 5 centimetres of sediment were collected from a day grab during two separate cruises, and coastal samples were hand-cored at the mean low water mark. Preliminary results indicate that there is a substantial concentration of *Alexandrium cf.tamarense* cysts in the Firth of Forth (56•08'N); a lesser, but discernible concentration in the Tay Firth; and patchy distribution along the English coast. As cysts are often distributed as fine sediment particles, samples were also collected from the Farne deeps. *Alexandrium* cysts were not apparent from any of the deep sites investigated. Preliminary results support the theory that blooms of *Alexandrium* in the North Sea begin near the Firth of Forth and are subsequently transported North and South.

B.S.C. LEADBEATER and J.D. ECCLESTON. (School of Biological Sciences, The University of Birmingham, Edgbaston, Birmingham B15 2TT, U.K.).

Soluble reactive silicate requirements of silica depositing flagellates.

The majority of flagellates that utilise soluble silicate for the deposition of extracellular structures such as scales (members of the Synurophyceae and Paraphysomonadaceae) or loricae (Choanoflagellida) are able to grow without the production of these structures

in media without measurable quantities of silicate.The relationship between soluble reactive silicate in the medium and biogenic silica deposition has been investigated in a loricate choanoflagellate using a combination of batch and continuous culture systems. *Stephanoeca diplocostata* has been grown in media with different silica concentrations and the silica content and morphology of loricae observed. From such experiments the minimum quantity of soluble silicate necessary to ensure the production of an entire lorica has been determined and the effects of silicate concentrations above and below this critical concentration observed.

J. LEWIS (University of Westminster, London)

Dinoflagellate cysts: biology, identification and localisation

In the last two decades the role of dinoflagellate cysts in bloom events has been recognised. This presentation reviewed what is known of their taxonomy and ecology with particular reference to bloom and nuisance species. It will aim to highlight features that are of interest in a management context and to identify gaps in knowledge that merit further research.

A.J. LOVE, B. GUBBINS* and B.S.C. LEADBEATER. (School of Biological Sciences, The University of Birmingham, Edgbaston, Birmingham B15 2TT, U.K. *Anglian Water Services Ltd.,).

Internal phosphorus loading of a reservoir and the development of a cyanobacterial bloom.

Ravensthorpe Reservoir in Northants. is a small, shallow, oligotrophic water body supplying water to Northampton and the surrounding area. The reservoir annually experiences blooms of *Oscillatoria redekei* and *Microcystis aeruginosa* with cell numbers in excess of 1.5 x 106ml^{-1}. Orthophosphate concentrations in the water column never rise above 10ugPl^{-1} - the recognised level to inhibit mass cyanobacterial growth. Hence the question arises as to the origin of cyanobacterial blooms in this reservoir. On the basis of mass balance calculations there appears to be significant seasonal phosphorous dissolution from the sediment, due to low dissolved oxygen concentrations at the sediment surface. The increase of orthophosphate in the water overlying the sediment appears to trigger a subsequent increase in the growth of *Microcystis aeruginosa* present in the sediment. The transition of colonies of *Microcystis aeruginosa* from the sediment into the overlying water was monitored using specially designed traps.

S.C. MABERLY (Institute of Freshwater Ecology, Windermere, Cumbria)

Sources of inorganic carbon in photosynthesis by *Asterionella formosa*

The freshwater diatom *A. formosa* was grown in air-bubbled cultures at 20C. Rates of photosynthetic oxygen evolution were measured as a function of inorganic carbon concentration at four pH values and hence at four ratios of CO_2 to HCO_{-3}. A least-squares regression was used to determine the kinetic values which described the uptake of CO_2 AND HCO_{-3}. Two models were tested and the one with the better fit suggested that CO_2 and HCO_{-3} were taken up in parallel. The $K_{1/2}$ FOR CO_2 was about a hundred times higher than the $K_{1/2}$ FOR HCO_{-3} and the maximum CO_2-dependent rate was about twice the maximum HCO_{-3}-dependent rate. The calculated CO_2 compensation point was 0.86 mmol m^{-3} about 200 times higher than the estimated HCO_{-3} compensation point at 175 mmol m^{-3}. By combining the concentration of CO_2 and HCO_{-3} in the growth medium with the kinetic data, CO_2 was estimated to provide 77% of the gross carbon uptake. The ratio of ^{12}C:^{13}C for the two carbon sources and the organic carbon in the cells was used to calculate source-specific discrimination values and estimate 'leakiness'.

C. A. MAGGS & B. A. WARD. (School of Biology & Biochemistry, Queen's University, Belfast).

Systematics and origins of introduced red algae in the British Isles

The provenance of distinctive introduced species of brown algae such as *Sargassum muticum* and the kelp *Undaria pinnatifida* is relatively easy to determine. Both originated in Japan and were almost certainly transported to France with cultured oysters; their subsequent dispersal within Europe has been followed in great detail. For the red algae, however, although probable aliens sometimes constitute a large proportion of the flora, there is no example for which either the provenance or the transport vector has been identified. On the contrary, it has never been proved that British Isles populations of any putative alien are introduced rather than relictual. We are now using modern taxonomic methods to investigate several red algae that appear to be introduced. For example, a species of *Polysiphonia* that has recently been discovered in the British Isles and N. France appeared to be morphologically identical to *P. harveyi* Bailey from the east coast of North America. Following DNA extraction and density-gradient centrifugation, plastid DNA was obtained from the upper band. Comparison of plastid DNA restriction patterns of British Isles and North Carolina populations confirms that these are indeed conspecific, although some between-population polymorphisms were noted. The lower band consisted largely of nuclear DNA but putative mitochondrial DNA was visualized after digestion with restriction enzymes and the banding patterns were closely similar in the different populations. This level of similarity between widely separated *P. harveyi* populations strongly suggests that at least one of these populations has been introduced, and both may have been derived from a source population, perhaps from a complex of related species in the Pacific Ocean.

J.H. O'MAHONY (Department of the Marine, Fisheries Research Centre, Abbotstown, Dublin 15, Ireland)

Phytoplankton in a Small Estuary on the West Coast of Ireland

The phytoplankton of a small estuary were studied for 2.5 years. 185 taxa were recorded from 9 algal classes. Species recorded were principally neritic and temperate in origin. Considerable fluctuations were observed in both phytoplankton composition and abundance during the growth periods of each year. Peak concentrations of phytoplankton and chlorophyll a were 2.9×10^6 cells per litre and $42.8 mg/m^3$ respectively. Classical bimodal peaks in abundance/chlorophyll a did not occur in the estuary.

J.O'MAHONY, J. SILKE, D. JACKSON AND J. DOYLE (Fisheries Research Centre, Department of the Marine, Dublin 15, Ireland)

***Gyrodinium cf. aureolum* in Irish waters - implications for aquaculture.**

Noticeable dinoflagellate blooms have been observed off the southwest coast of Ireland since 1976 (Doyle et al., 1984). In the majority of cases, the dinoflagellate *Gyrodinium cf. aureolum* was the principal species invloved. Ther is concern that a continual recurrence of high concentrations of this species (which is both haemolytic and icthyotoxic), will adversley affect the aquaculture industry in Ireland. Time-depth series data of *G cf. aureolum* concentrations at two sites in SW Ireland during 1991 are presented, from Bantry Bay and Roaringwater Bay. In general, *Gyrodinium cf. aureolum* was virtually absent from the water column until late July-early August. High concentrations of this species (max. 1.2 x 10 cells per litre) were recorded by the end of August-early September, and were not recorded in any samples after 27th August (Bantry Bay) and 29th September (Roaringwater Bay). Means of predicting the occurrence of this species are discussed.

P. MALIPHANT (Environmental Sciences Department, University of Hertfordshire)

Monitoring pesticide pollution of watercourses - The evaluation of epilithic diatoms as potential indicators

The effects of pesticide pollution of watercourses is being investigated in a study utilizing both field data and laboratory-based analyses of epilithic diatoms. Four field sites (field drains) were selected for study in collaboration with the Agricultural Development Advisory Service's Soil and Water Research Centre, Cambridge. Samples were taken using artificial substratum during the period from January to June 1992. Sampling will continue once flow resumes at the sites. Field drains were targeted as field sites due to the high levels of pesticides passing through them.

The field data is expected to provide a picture of how the diatom community composition fluctuates with a number of environmental factors including pesticide loadings. A preliminary examination of the data has shown that while initial colonization of the sites is very similar (a small *Achnanthes* dominating all sites), the established population at the less polluted site is more diverse than those occurring in the drains with higher pesticide inputs.

Laboratory-based investigations, including protein analyses and enzyme assays (such as a glutathione-S-transferase assay), are to be carried out in order to study the more specific effects of pesticide pollution on diatom metabolism.

D G MANN (Royal Botanic Garden, Edinburgh, EH3 5LR)

What do we know about pattern formation in diatoms?

Diatoms are well known for their ability to produce highly ornate, patterned cell walls. Each piece (valve or girdle band) of the multipartite cell wall is formed inside a separate silicon deposition vesicle (SDV), before being released through exocytosis. Valve formation has been studied in several species, from widely separated genera, and several common features have emerged. The SDV itself grows and develops as the valve inside is formed. Each SDV is very closely associated with the plasmalemma while silica is being deposited. It is often accompanied by microtubules, microfilaments and other parts of the cytoskeleton, and disruption of these by drug treatments suggests that the cytoskeleton plays an important part in morphogenesis. But there are still many gaps in our understanding, especially about the generation of the exact patterns of regularly-spaced transverse or radial striations present on virtually all diatom valves. In this paper I review what we know and don't know about these, and make some guesses about where we might look for the mechanism that produces the pattern and what that mechanism might be.

B MARIN, C MATZKE & MELKONIAN (Botanisches Institut, Universitat zu Koln, FRG)

Ultrastructure and variation of flagellar hairs of *Tetraselmis* (Prasinophyceae, Chlorophyta)

The genus *Tetraselmis*, which consists of walled, quadriflagellate prasinophytes, is characterized by flagellar hairs, which have never been examined in detail, In the present paper we describe the ultrastructure and the extensive variation of flagellar hairs within the genus as well as the application of flagellar hair ultrastructure as taxonomic and phylogenetic marker. Ultrastructural examination of flagellar hairs of 200 *Tetraselmis* stains revealed (a) the ultrastructural complexity of flagellar hairs, (b) the conservation of flagellar hair ultrastructure within each *Tetraselmis* strain, which is not affected by modifications of external conditions and (c) the extensive variation of flagellar hair ultrastructure within the genus, which allows the

identification of most *Tetraselmis* strains based on flagellar hair examination.
Furthermore, flagellar hairs can be classified into 5 major ultrastructural types and several subtypes, which correlate with different variable characters of *Tetraselmis*, e.g. the ultrastructural types of the pyrenoid (5 types) and the cell wall (theca; 7 types). The correlation with different characters is a proof of the taxonomic significance of the flagellar hair classification and allows the subdivision of the genus *Tetraselmis* into 7 natural groups.
Several prasinophycean genera (e.g. *Nephroselmis, Pseudoscourfieldia, Pyramimonas*) possess flagellar hairs, which correspond to one of the major ultrastructural types of *Tetraselmis*. Since this particular flagellar hair type can be considered as a primitive character within *Tetraselmis*, it is possible, to propose a theory about the phylogeny of *Tetraselmis*.

P. V. McGEOWN & M. J. DRING. (Department of Biology and Biochemistry, Queen's University of Belfast).

Quantum requirements and long term reciprocity for blue light-sensing in the brown alga *Scytosiphon lomentaria*.

Sporelings of the tubular brown alga *Scytosiphon lomentaria* generally grow as sparingly branched uniseriate filaments in red fluorescent light. Irradiation with blue light results in a transition from filamentous to two-dimensional growth. This transition is initiated by longitudinal division of the apical cell and continues with the development of a compact *Ralfsia*-like crust. Sporelings of *S. lomentaria* were grown for 18 days in combined red and blue light fields at total irradiances of 3.5, 7, and 16.5 µmol m^{-2} s^{-1}. The amount of blue light required to induce two-dimensional growth in 50% of the individuals increased with decreasing total irradiance. Blue light did not induce two-dimensional growth in sporelings grown at a total irradiance of 3.5 µmol m^{-2} s^{-1}. In a further experiment, sporelings of *S. lomentaria* were cultured in combined red and blue light fields at a total irradiance of 13 µmol m^{-2} s^{-1} for periods of up to 3 weeks. The blue quantum requirement determined from sporelings cultured for 3 weeks was similar to that of those cultured for only 1 week. This photoresponse, therefore, approximates the Bunsen-Roscoe law of reciprocity over periods of at least 3 weeks.

L MEDLIN, M BAUMANN & T RUTTKOWSKI (Alfred-Wegener-Institute for Polar and Marine Research, Am Handelshafen 12, W-2850 Bremerhaven, FRG)

Genetic Differentiation between *Phaeocystis globosa* and a *Phaeocystis* species isolated from the Weddell Sea

Nine species of *Phaeocystis* have been described in the last 100 years. During the sixties all species names were abandoned in favour of the first one described, *P.pouchetii*. Hence, in subsequent papers reporting the occurrence of *Phaeocystis*, reference was made to *P.pouchetii*. Based on ultrastructual features of the motile phase, *P.scorbiculata* was introduced as a new species in 1979. Today, the existence of at least four species, *P.pouchetii, P.globosa* and *P.scrobiculata* and a fourth from the Antarctic, must be recognized as being valid. The colony shape of this latter species distinctly differs from P.*pouchetii*, which occurs in the Arctic and Subarctic. Its colonies resemble those of P. globosa from temperate regions. We compared *P.globosa* from the North Sea to a clone of *Phaeocystis* from the Weddell Sea and present morphological, physiological and genetic evidence that differences between these are species specific.

F.X. NIELL (Department of Ecology, University of Málaga, Spain)

Mechanisms of Formation of an Unusual Green-Tide of *Gyrodinium cf. aureolum* off North-West Spain.

Gyrodinium species are very difficult to classify. A small *Gyrodinium*, close in appearance to *G. aureolum*, formed a conspicuous green-tide in the inner part of the Ria de Pontevedra in N.W. Spain. Similar accumulations of this organism have been detected off the East coast of Britain. Green phytoplanktonic tides have not previously been described in the Rias, an area of great importance for commercial shell-fish culture. Although the organisms are not reported to be toxic, this unusual occurrence allowed the study of the accumulation in two localities; one in shallow water, the other in deeper (20m) water. At the shallow location, cell densities of more than 70000ml^{-1} with 200 µg Chl.a l^{-1} were detected at the subsurface chlorophyll maximum. In the deeper location, cell densities were lower with the maximum at the bottom of the water column. Possible mechanisms accounting for the accumulation of these organisms at different depths will be discussed.

N.A. NIMER and M.J. MERRETT (School of Biological Sciences,University of Swansea,Swansea,U.K.)

The role of calcification in inorganic carbon acquisition by *E.huxleyi*

The relationship between inorganic-carbon dependent photosynthetic oxygen evolution and calcification was investigated in high- and low-calcifying strains of *E.huxleyi* showing a ten-fold difference in calcification rate. For high- and low-calcifying cells the K0.5[CO_2] i.e. the concentration of CO_2 required for the half-maximal rate of photosynthetic O_2 evolution was between 12 to 20 uM showing carbon dioxide uptake occurs by diffusive entry. Unlike the low-calcifying strain calcifying cultures showed a four-fold increase in inorganic carbon dependent photosynthetic O_2 evolution over the pH range 5.0-8.3 resulting in a 20 fold difference in

photosynthetic rate between the two strains at pH 8.3. Calcifying cells have a high affinity for HCO_3^-, the K0.5[DIC] being 200 uM at pH 8.3. In mid-exponential phase cultures the stoichiometry between $^{14}CO_2$ fixation and calcification was 1:1. The major function of calcification in *E.huxleyi* is to provide CO_2 for photosynthesis.

N.A.NIMER, L.F.DONG & M.J. MERRETT (School of Biological Sciences, University of Swansea,Swansea U.K.)

The role of Nitrate in Calcite Production in *E.huxleyi*

Calcite is the major long-term sink for inorganic carbon and although coccoliths of *E.huxleyi* lack an organic baseplate an absolute requirement of NO_3^- for calcite synthesis was established in high-calcifying cells. Calcite synthesis and growth rate were saturated at 5 uM NO_3^-. By growing cultures with different nitrate concentrations the relationship between nitrate utilization, biomass and calcite production were determined. The stoichiometry between NO3- utilization and calcite production was approximately 1:6.5 (mol/mol). Calcification and growth were tightly coupled, calcite production ceased when cultures entered the stationary phase due to NO_3^- depletion. Adding a pulse of NO_3^- to cultures in the stationary phase restored growth and calcification. Rates of calcification were remarkably constant throughout culture growth at 20g carbon/1014 cells/h. In these cultures, where the photon flux density is the optimum for growth, the initial nitrate concentration is a reliable indicator of final calcite yield.

E. OKUS, H. OPIK, J. HAYWARD (School of Biological Sciences, University of Swansea, U.K.)

Seasonal Variation in Phytoplankton off the Mumbles Sewage Outfall

A study of the phytoplankton communities off the Mumbles Head was carried out during the period February 1990 - April 1992. The sampling station was within 500 m of the Mumbles sewage outfall and sampling was always down-stream from it. Changes of nutrients including ammonium, chlorophylls, total carotenoids, 14C fixation, species composition & biomass and meteorological data were monitored fortnightly. The interrelationships of these parameters are discussed. Whereas other nutrients showed seasonal variation, the levels of ammonium fluctuated considerably throughout the year, reaching maximum values of 4.86 mol l^{-1}. Ammonium is presumed to be largely derived from sewage. Diatoms were present throughout the sampling period with a dominance in spring blooms. In summer an obvious increase in Chlorophyll-a level was observed which was caused by the abundance of flagellates. There are plans to upgrade sewage disposal into Swansea Bay; the data from this study will be useful in gauging the effect of modifications to the sewage disposal on the growth of coastal phytoplankton.

J.L. OLSEN, W.T. STAM, W.H.C.F. KOOISTRA AND M.J.H. VAN OPPEN. (Dept. Marine Biology, University of Groningen, Post Box 14, 9750 AA Haren, NL).

Intraspecific phylogenetics and biogeography in benthic macrophytes.

Recognition of global disjunctions and cosmopolitanism in marine algae has intrigued phycologists since the turn of the century. Some disjunct distribution patterns mirror the great break-up of the continents and the closure of the Tethys Sea, while other patterns suggest temperature vicariances brought about by ice ages, shifting current patterns, and periodic contractions of the tropical belt which would allow north-south passage between the hemispheres. It is now possible to weigh the relative importance of vicariance and dispersal in specific examples by testing for congruence between phylogenetic hypotheses based on molecular data and geographic area cladograms. We present evidence from two contrasting examples, Cladophoropsis membranacea (circumtropical) and Acrosphonia arcta (amphipolar). Our results show that rDNA-ITS sequences are very useful in distinguishing biogeographic relationships within a species, that vicariance has played the major underlying role in the tropical belt with an overlay of dispersal events, and that dispersal has played the major role in both circumtropical and amphitropical distribution patterns. Finer scale population studies in both species are underway using RFLP studies of the rDNA-ITS spacer region and with RAPD markers.

T.S PAGE, J.R. GALLON, C.R. HIPKIN, R.R. EADY & R.N. PAU (School of Biological Sciences, University of Swansea; AFRC-IPSR Nitrogen Fixation Laboratory, Brighton)

Molybdenum-independent nitrogenase in cyanobacteria

A number of diazotrophic cyanobacteria have been shown to tolerate 1mM sodium tungstate in their growth medium and also to reduce acetylene to both ethylene and ethane when grown in scrubbed medium lacking molybdenum. These include *Anabaena cylindrica* CCAP 1403/2A, *Anabaena variabilis* ATCC 29413, *Anabaena sp.* PCC 7120, *Calothrix sp.* PCC 7601, *Mastigocladus laminosus* CCAP 1447/1 and *Scytonema javanicum* CCAP 1473/1. It is possible therefore that these organisms produce molybdenum-independent nitrogenases under conditions of molybdenum deprivation. If so, this ability may be widespread among cyanobacteria, though not universal since the following diazotrophic cyanobacteria neither grew nor reduced acteylene in the presence of tungstate or absence of molybdenum: *Anabaena flos-aquae* IC-1 (obtained from Prof. W.W. Carmichael, Wright State University, Dayton, Ohio, USA, Aphanizomenon flos-aquae CCAP 1401/1, *Calothrix scopulorum* CCAP

1410/5, *Gloeothece sp.* ATCC 27152. and *Oscillatoria spp.* UCSB 8 and UCSB 25 (own isolates). The two cyanobacteria, *Anabaena sp.* UCSB 26 and *Nostoc sp* UCSB 7 (also own isolates), grew and reduced acetylene in the presence of 1mM tungstate but did not generate ethane. These strains therefore do not appear to produce molybdenum-independent nitroganeases but can probably assimilate molybdenum in the presence of tungstate. None of strains studied produced molybdenum-independent nitrate reductase. They either died or continued to grow diazotrophically (with ethane production from acetylene) when given nitrate under molybdenum-deficient conditions.

J.A. RAVEN (Department of Biological Sciences, University of Dundee).

Calcification and Inorganic Carbon Assimilation by Algae

At least 90% of the inorganic C assimilated by algae is routed through ribulose 1,5 bisphosphate carboxylase-oxygenase (RUBISCO) whose immediate substrate is CO_2. Rarely (e.g. in the calcifying marine Ulvophycean *Udotea*) a prior carboxylation, catalysed by phosphoenolpyruvate carboxykinase, occurs in series with fixation by RUBISCO; here again the substrate is CO_2. Parallel carboxylations, catalysed by phosphoenolpyruvate carboxykinase (CO_2 as substrate) or phosphoenolpyruvate carboxylase and carbamyl phosphate synthetase with HCO_3^- as substrate, account for less than 10% of total assimilated net C. Calcification has no unique quantitative role in CO_2 fixation (points 1-3 below).

(1) Calcification does not obviate the need for carbonic anhydrase when HCO_3^- is the exogenous inorganic C source and the rate of CO_2 fixation exceeds the uncatalysed rate of CO_2 production;

(2) algae which calcify do not have higher photosynthetic rates than co-occurring non-calcifiers (although in some environments calcifying Characeans are the only significant macroalgae);

(3) Even in inorganic C-limiting environments, there are no known examples of dark calcification/light decalcification as a mechanism of increasing total CO_2 fixation in 24h periods.

Furthermore, calcification decreases dissolved alkalinity, and thus reduces the net CO_2 flux from the atmosphere to the ocean. Accordingly, sedimentation of 'new' productivity involving calcified algae does not increase (and may decrease) net CO_2 removal from the atmosphere relative to sedimentation of a non-calcified alga.

J.A. RAVEN (Department of Biological Sciences, University of Dundee).

Interactions between unidirectional and tidal water movement and benthic algae

Unidirectional (e.g. in freshwater streams) and tidal (e.g. waves on rocky shores) water movements show important differences as well as similarities in their effects on benthic algae. Frictional interactions tend to detach or fragment algae in moving water. Limits on algal resource allocation to structural elements which permit the organism to tolerate the mechanical effects of water. (Semi-)erect macroalgae are generally flexible. In contrast to the continual stress on algae in streams, wave action involves alternation of rapid flow in breaking waves and a slower reverse flow in backwash extension of the algae in the rapid flow stores mechanical energy which is released as the thallus relaxes in the backwash. Net nutrient uptake is enhanced by water flow reducing diffusion boundary layer thickness. However, water flow reduces the effectiveness of catalysed chemical transformations at the algal surface which help to make nutrients such as organic P, HCO_3^-, and Fe(III) available as Pi, CO_2 and Fe(II). Photon absorption as a function of depth in a benthic algal community shows a more determinate pattern in unidirectional flow than in wave-dominated environments, since individual flexible thalli are in less predictable positions in the radiant energy field in wave-dominated environments. Accordingly, acclimation of photosynthesis to light by different strata of a population and vertical zonation in the canopy of variously light-adapted species, could be greater in the less stochastic unidirectional flow environments where plants maintain relatively constant positions.

J.A. RAVEN (Department of Biological Sciences, University of Dundee)

Metabolic implications of the low osmolarity of certain freshwater algae

A number of freshwater algae have osmolarities in the range 50-100 osmol m^{-3}. In the case of flagellate or amoeboid organisms in which volume regulation involved hypo-osmotic water expulsion via contractile vacuoles or analogous mechanisms the low intracellular osmolarity can be rationalised in terms of minimizing the water influx down the osmotic gradient through a given plasmalemma hydraulic conductivity, and hence the rate of energy-dependent water efflux and a lowe minimum energy input per unit water efflux. Large, vacuolate wall cells have a larger fraction of cell C in the cell walls than do smaller, less vacuolate cells (Laplace relationship) for given turgor-containing properties, and larger cells have lower turgor. The lowe intracellular osmolarity thus has energetic advantages but may lead to metabolic problems. One relates to th high glutamate concentration required to attain a hig ammonium affinity for glutamine synthetase. It may b significant that *Chlamydomonas* glutamine synthetas needs a lower glutamate concentration to saturate th enzyme than do glutamine synthetases from other cell tested. Another problem relates to the large ascorbat concentration needed to maximize its capacity t detoxify O species. A smaller role for ascorbate in th specific role of H_2O_2 removal in certain algae i indicated by the lower ascorbate concentration and th

greater expression of glutathione peroxidase relative to ascorbate peroxidase in some microalgae than in higher plants. Other constraints apply to the concentration of UVB-screening compounds and to the accumulation of inorganic C in cells of low total osmolarity.

J.A. RAVEN (Department of Biological Sciences, University of Dundee).

Sensory perception and mineralisation in algae

Minerals in graviperception. $BaSO_4$ crystals are part of the graviperception apparatus in rhizoids of Characeae. Their high density is not used to the extent which might have been expected due to association with polysaccharide which brings the effective density of statoliths to a value closer to the density of higher plant amyloplast statoliths. How the Characeans handle the toxic element Ba is not clear. The function of the $BaSO_4/SrSO_4$ crystals in desmids (also in the Charophyceae *sensu lato*) is not clear.

Intracellular calcification and the signalling function of Ca^{2+}. $CaCO_3$ crystallisation in the Golgi apparatus of coccolithophorids requires a substantial Ca^{2+} efflux across the plasmalemma, the cytosol, and the coccolith vesicle or Golgi membrane. The free Ca^{2+} activity in the cytosol of eukaryotes is kept very low (less than 10 umol m^{-3}) and increases in this activity are used in intracellular signalling. Does the free Ca^{2+} gradient from plasmalemma to Golgi imply a mean cytosol free Ca^{2+} activity in excess of the usual value in eukaryotes, thus interfering with any signalling function? Calculations show that the required flux can be sustained by diffusion of free and (mainly) buffered Ca^{2+} without requiring excessive mean cytosol free Ca^{2+}.

P C REID (Department of the Environment)

The Paris Commission Working Group on Nutrients

The Declaration of the 1987 Ministerial Conference on the North Sea called for substantial reductions (of the order of 50%) of inputs of phosphorus and nitrogen into areas of the North Sea where nutrient inputs are likely, directly or indirectly to cause pollution and requested the Paris Commission on nutrients to develop a co-ordinated approach to this task.

While only two small estuarine sites are identified as being affected on the British North Sea coast, the UK Government has still taken on active part in PARCOM NUT discussions. A PARCOM co-ordinated programme for the reduction of nutrients has been established which covers the sectors, agriculture, waste water treatment plants, industry, aquaculture, combustion of fossil fuels and detergents. Progress reports on National action plans for the reduction of nutrient and a report on eutrophication symptom and identified problem areas have been published. An 'Expert Group' on nutrients under the auspices of PARCOM has also submitted a report on nutrient and eutrophication to the North Sea Task Force for the 1993 Quality Status Report on the North Sea. Aspects of the work of the Paris Commission Working Group on nutrients will be presented together with information on the large research programme on nutrients and algal blooms funded by the UK Government as a contribution to the work of PARCOM NUT and the North Sea Task Force.

D.J. ROGERS, U. MOCKLER AND I. HOOK (School of Pharmacy and Biomedical Sciences, University of Portsmouth, England and School of Pharmacy, Trinity College, Dublin, Ireland)

Lectins from *Ulva* species.

Two reports have appeared describing the characteristics of lectins extracted from *Ulva lactuca* collected from the coast of Israel and North America. These reports are contradictory in that the lectins appear to have specificity differences viz L-fucose (Israel) or lactoferrin (N. America). In an attempt to help resolve these differences, we have examined the lectins extracted from *U. lactuca (?)* collected at Southsea, Hampshire, U.K. in January 1992.The proteins, in phosphate buffered saline (PBS) extracts of fresh plants, were precipitated by 75% ammonium sulphate at 4°C. Precipitated material was dialysed against PBS before testing. The extract produced powerful haemagglutination of human erythrocytes which was inhibited by the glycoprotein, porcine stomach mucin, but not by simple sugars such as L-fucose. Trisodium EDTA (10 mM) abolished haemagglutination. There is obviously a lack of similarity between these findings and those from *U. lactuca* from Israel and N. America. One possible explanation for this is the known taxonomic difficulties which exist with *Ulva* species. Could it be that the results described here, and previously, represent investigations of taxonomically different plant material.

D. SANTILLO and B. THAKE (School of Biological Sciences, Queen Mary and Westfield College, University of London)

Comparative chemostat studies with marine *Synechococcus sp.*(DC2) and *Pavlova lutheri*

Prokaryotic picophytoplankton of the genus *Synechococcus* is now recognised as important in marine primary production, and in *oligotrophic* waters can account for 80% of the total carbon fixed. Physiological and biochemical studies have been carried out using material from nutrient-rich batch and continuous cultures, but never under the severely nitrogen-limited growth attainable in chemostats.

Small flagellates are the most abundant eukaryotic cells in the sea, especially in coastal waters where nitrate is the dominant form of inorganic nitrogen. *Pavlova lutheri* has been grown in chemostat culture, most notably in Droop's classical studies with vitamin B_{12} and phosphorus. In this study, different degrees of nitrogen limitation were achieved using an inflow NO_3-N concentration of 25uM and mean doubling times of 0.9-10 days. Cell density remained constant, while cell

chlorophyll, nitrogen and productivity increased with growth rate.

Synechococcus sp., in contrast, showed little conformity with such established kinetics. Steady states were never achieved when nitrate was the sole nitrogen source. At an inflow concentration of 25uM NH_4^+-N, and doubling times of 1.6-5.8 days, larger populations of less productive cells tended to be generated at higher growth rates. Cell chlorophyll and nitrogen quota varied inversely with cell density. Phycoerythrin per cell remained constant at all rates of nitrogen supply and was tightly coupled with photosynthesis indicating that it was not acting as a nitrogen store.

We suggest that marine phytoplankton is metabolically as well as morphologically diverse and the growth kinetics of individual species cannot be applied to multispecific communities.

C. SCOTT AND R.L. FLETCHER (Marine Laboratory, University of Portsmouth)

Studies on fouling blue-green algal communities in Langstone Harbour, south coast of England.

Blue-green algae are described as components of marine fouling communities on a wide range of immersed structures throughout the world, including ships, buoys and offshore platforms. They are well known pioneering organisms on newly immersed structures, are quite resistant to toxic antifouling coatings and are particularly important as fouling organisms in tropical/subtropical waters and in heavily polluted environments. A field sampling programme carried out in Langstone Harbour has enabled identification and quantification of the diverse coccoid and filamentous forms of blue-greens which occur on the various artificial structures and materials present. In addition, examination of both fixed and floating structures using belt transects has yielded valuable information on patterns of blue-green algal zonation. A test panel programme is also underway to elucidate the tolerance of blue-greens to copper-based surfaces whilst non-toxic perspex control panels are being used to monitor their seasonal distribution. Finally, attention is being given to the mechanisms of attachment of blue-greens and their role in the formation of the primary film and hence in the fouling succession

K. SCOTT, H.G PETERSON[1], N. CHRISTOFI[2] AND H. FALLOWFIELD[2] (Department of Biological Sciences, Napier University, Edinburgh EH10 5DT [1].Saskatchewan Research council, Saskatoon, Saskatchewan, Canada S7N 2X8 [2].Scottish Agricultural College, Auchincruive, Ayr KA6 5HW)

Nutrient Management of Stormwater Retention Ponds in Western Canada

Urban stormwater retention ponds are designed to temporarily detain precipitation runoff prior to discharge to receiving waters. Such lakes are also often incorporated as part of land developments to provide an amenity and landscape feature. Seven lakes in two cities in Saskatchewan have been monitored since January 1992 to assess nutrient management requirements to improve or maintain water quality. The lakes are all shallow (1.5-3.0m), have surface areas in the region of 2.5 hectares, and range from 1-15 years old. The oldest can already be classed as hypereutrophic, being characterized by severe algal blooms during the growing season (max.Chl a >0.35mg/L), and a daytime pH 9-10. N_2 fixing blue-greens frequently dominate the midsummer phytophankton. Ortho-P levels remain high during the summer (Max. PO_4^3-P>0.45mg/L), while dissolved inorganic N becomes barely detectable. Extended winter ice-cover (4-5 months) leads to the onset of anoxic conditions and consequent release of PO_4^3-P from reduced Fe complexes in the sediments. Significant reduction of external P loading is not possible, and in-lake chemical and biological methods to reduce P during winter and summer seasons are being investigated with the aim of controlling algal growth.

R.G. SHEATH*, M.L. VIS*, A. WHITTICK* and K.M. COLE+ (*Memorial University of Newfoundland, Canada; +University of British Columbia, Canada)

***Rhododraparnaldia oregonia* (gen. nov., sp. nov.), a new freshwater rhodophyte from Oregon (USA)**

An undescribed red alga was found in streams of the Coastal Range and Cascades from Oregon, USA. This alga has a distinctive main axis, composed of large barrel-shaped cells (mean diameter 22 *um*), giving rise to alternate and opposite lateral branches with cells which are much smaller in size (mean diameter 6.7 *um*). Branching is dense at the apex and sparse at the base of the plant. Unique spermatangial hairs produce two cell types at their tips. The alga has a typical acrochaetalian carpogonium and carposporophyte, but produces a "chantransia" - like phase when carpospores germinate and the gametophyte is produced directly attached to this phase. The carpospores have twice as much DNA as the axial cells, spermatangia hair cell tips and spermatangia. Pit plugs have two caps layers, the outer of which may or may not be domed. Ultrastructure of cell division shows an anaphase which is intermediate among the red algae, with one layer of perinuclear E.R., polar gaps and a typical polar ring as the nucleus-associated organelle (NAO). The phylogenetic and taxonomic status of this alga will be discussed.

R. SCHMID, M.J. DRING (School of Biology and Biochemistry, Queen's University of Belfast)

Photocontrol of light saturated photosynthesis and external pH in brown algae.

Capacity of photosynthesis of most brown algae investigated so far is lower in red light than in blue light. Depending on the species, short pulses of blue light on a red light background stimulate photosynthesis by up to five times the original rate, with a lag of 10s to

4min and with maximum rates occuring 5 to 20min later.

Blue light seems to affect photosynthesis at the level of uptake or supply of CO_2. A simple possibility for aquatic plants to increase the CO_2 level is to acidify the apoplastic space. We have found pH-shifts induced by blue light on a similar time scale to that of photosynthetic stimulation. An action spectrum shows that the pH shifts are true blue light effects. The pH-response, however, seems not to be connected with the photosynthetic response. The threshold for blue light of the two responses is different by about two orders of magnitude in most brown algae. Furthermore, the pH-response is not affected by flavin inhibitors, while stimulation of photosynthesis is sensitive to KI. Thus, the CO_2 supply is regulated by mechanisms other than acidification of the apoplast. The differential inhibition by KI and the different fluence-response relationships of the two responses point to the action of two independent photoreceptor systems for blue light.

D.B. STENGEL and M.J. DRING. (Division of Environmental and Evolutionary Biology, The Queen's University of Belfast).

Variation in growth characteristics, in photosynthesis and pigment contents of *Ascophyllum nodosum* from Strangford Lough - field and culture studies.

Ascophyllum nodosum shows a wide range of morphology between different sites in Strangford Lough, and, within these sites, at different positions on the shore. In the present study the growth characteristics of *Ascophyllum nodosum* and the ecad *A.nodosum mackaii* are being examined. Along a vertical shore transect growth rate of individual plants were measured at regular intervals during the year, and bladder and receptacle initiation monitored. Length increase varied widely among plants from different levels on the shore, being highest in plants from the lower shore and very much lower at the top of the *Ascophyllum* zone. Also, bladder production was found to be reduced at the top level, some plants appeared not to produce any bladder. Here, however, reproduction took place earlier in the season than in lower shore plants.

Seasonality in growth rates could be established and was found to vary among different shore levels. Stress, due to desiccation or photodamage, leading to death of apical meristems and consequently affecting length increase, determines the amount of secondary branching and therefore the overall appearance of plants.

In culture, *A. nodosum* shows a direct growth response to light intensity under constant temperature conditions. At present photoperiodic experiments are being carried out, testing short day effects on growth rate, bladder initiation and reproduction.

Photosynthetic capacities of plants from different locations on the shore were determined and pigments extracted, the results indicating an adaptation to high and low irradiance levels similar to sun and shade plants, caused by variation in time of water cover among plants from different heights. A mutant green plant containing high chl c and low fucoxanthin levels was discovered and included in growth and photosynthesis measurements.

J.A. TAYLOR, G.A. CODD*, S.I. HEANEY & J. CORRY** (*University of Dundee, Department of Agriculture, Northern Ireland, Belfast. ** Institute of Freshwater Ecology, Ambleside, Cumbria)

Immunodetection of freshwater cyanobacterial picoplankters by continuous flow cytometry

The autofluorescence of cyanobacterial picoplanters has been fundamental to their characterization. Fluorescence microscope examination distinguishes these organisms from heterotrophs due to the orange/red emission of phycoerythrin and chlorophyll when excited by light of wavelengths 450-490 nm and 532-560 nm. Flow cytometry allows for the excitation of cellular pigments and fluorochromes at 488 nm and the simultaneous detection of light emitted at three wavelength sets, 500-560 nm (as emitted by fluorescein isothiocyanate, FITC) 549-601 nm (as emitted by phycoerythrin) and 640-680 nm (as emitted by chlorophyll). This allows for the detection of autofluorescant and FITC labelled cyanabacterial picoplankters and it is this facility which has allowed the qualitative study of immunolabelled *Synechococcus* cells from natural samples. The aim of this research was to study *Synechococcus* species from Scottish, Irish, English and world-wide freshwaters and to characterize them by virtue of their cross-reactivities with specific polyclonal antisera raised against *Synechococcus* reference strains. Reference cultures. isolates obtained from lake water and mixed lake water populations were investigated. Evaluation of cross-reactivity was performed by fluorescence microscopy and continuous flow cytometry. The spatial, geographical and seasonal diversity of these organisms was assessed.

M.L. VIS*, R.G. SHEATH* and K.M. COLE+ (*Memorial University of Newfoundland, Canada; +University of British Columbia, Canada)

Stream macroalgae of the Hawaiian Islands: a preliminary study

Thirty stream segments sampled on the four large islands had relatively high water temperatures (20-27•C), neutral to alkaline pH (6.7-8.0) and relatively low ion content (300-200ïS cm^{-1}). Of the 97 populations of stream macroalgae collected, 27 species were identified, of which 13 were Chlorophyta, 8 were cyanobacteria, 4 were Rhodophyta and 2 were Chrysophyta. The most widespread species was the cyanophyte *Phormidium retzii*, being found in 16 stream segments. In terms of reproductive status of the populations sampled, 77% were vegetative, 22% were asexual and 1% was sexual. The flora of the oldest island, Kauai, was the most similar to the other islands; the flora of the youngest island, Hawaii, was most dissimilar. Only one new

species was collected, a *Batrachospermum* belonging to the section *Contorta* with unique specialized spermatangial branches. Seventy-eight percent of the species have been identified from streams in North America.

B.A. WARD & C.A. MAGGS (School of Biology & Bichemistry, Queens University of Belfast)

A comparison of plastid DNA restriction patterns in the "*Ceramium diaphanum/strictum* complex" (Rhodophyta) in the British Isles

Previous work on the *Ceramium rubrum* complex suggested that a molecular approach is useful for resolving the numerous taxonomic difficulties experienced within the genus *Ceramium*. We have now extended our study to the second group of species in this genus, usually termed the "*C.diaphanum/strictum* complex". Specimens in this complex have incompletely corticated mature axes, with straight-bordered cortical bands that are even in width, separated by ecorticate internodes. In the British Isles, there appear to be four intertidal or predominantly intertidal species in this complex: *C.diaphanum* (Lightfoot) Roth, *C.flaccidum* (Kützing) Ardissone, *C.deslongchampii* Duby and *C.strictum sensu* Harvey. *C.diaphanum* may be distinguished by its swollen cortical bands which protrude from the internodal axial cells, and by its single tetrasporangia protruding laterally. *C.flaccidum* is flaccid and has alternate branching at the apices and unicellular rhizoids. In contrast, *C.deslongchampii* and *C.strictum* are fairly cartilaginous; they have multicellular rhizoids and pseudodichotomous branching. They can be differentiated from each other by their tetrasporangia. *C.deslongchampii* has naked, protruding tetrasporangia, borne singly or several per node. *C. strictum* forms covered, non-protruding tetrasporangia in rings on every node. Initially, we compared this morphological data with plastid DNA restriction banding pattern analysis of *C.deslongchampii* and *C.strictum* collected at different sites in the British Isles. Two different banding patterns were obtained which correlates with the morphological data, confirming that they are indeed two separate species.

D.M. WILLIAMS. (Department of Botany, The Natural History Museum, London SW7 5BD, UK).

The perizonium of *Fragilariforma virescens*: Missing elements or missing data?

To date very little is known concerning the perizonium structure of the auxospores in diatoms, with almost nothing known of its structure in araphid diatoms. I will present some preliminary observations on the perizonium from the auxospore of the freshwater araphid diatom species *Fragilariforma virescens*. In descriptions of the perizonium from diatom auxospores, two kinds of girdle element have been noted: longitudinal bands, which occupy the length of the auxospore, and transverse bands which circle both the auxospore and the longitudinal bands. In *Fragilariforma virescens* the transverse bands appear to be absent: many specimens have been observed yet no transverse bands have ever been observed. These observations may go towards explaining the bizarre shapes which the auxospore and post- auxospore valves undergo prior to assuming their more "typical" vegetative structure.

P.J. WRIGHT, J.R. GREEN and J.A.CALLOW (School of Biological Sciences, University of Birmingham, P.O. Box 363, Birmingham B15 2TT).

Induction of cell wall release from unfertilised eggs of *Fucus* by a sperm extract.

A KCl extract of *Fucus serratus* sperm can block fertilisation in a species-preferential manner. Binding of biotinylated egg plasma membrane vesicles to the sperm extract has previously been shown to be gamete-specific. This binding can be blocked by some sulphated polysaccharides but not others. Further studies of the sperm KCl extract, solubilised in K_2SO_4, have identified components which can induce cell wall release from unfertilised eggs. Following High Performance Gel Filtration (HPGF) a fraction corresponding to a molecular weight of between 60-70 KDa was found to have high egg plasma membrane binding activity. Furthermore, this fraction also had the ability to induce cell wall release from eggs.

Polyacrylamide gel electrophoresis (SDS-PAGE) showed that this fraction contained two proteins with molecular weights of 64 and 60 KDa. Overall the results suggest that either, or both, of these proteins are involved in activation of the egg during fertilisation and that they recognise sulphated fucose residues on the egg surface.

J.R. YOUNG (Palaeontology Dept, The Natural History Museum, London, SW7 5BD, UK)

Coccolith biomineralization - adding a taxonomic perspective evolution

Coccoliths have been widely used for investigations of biomineralization and these studies have provided invaluable understanding of the growth and formation process - coccolithogenesis. They have, however, necessarily concentrated on a very few species (above all *Emiliania huxleyi*). We have recently combined this understanding with knowledge of the phylogeny and taxonomic diversity of coccoliths to produce a synthetic model for the nucleation phase of coccolithogenesis (Young et al 1992). This has advanced our knowledge of both biomineralization and evolutionary processes in the group. It provides a challenge to develop a similar understanding of the crystal growth phase of coccolithogenesis, as will be discussed.

Reference: Young J.R., Didymus J.M., Bown P.R., Prins B. & Mann S., 1992. Crystal assembly and phylogenetic evolution in heterococcoliths. Nature, 356, 516-518.

NEWS OF MEMBERS

BRIAN WHITTON - PRESIDENT OF THE BRITISH PHYCOLOGICAL SOCIETY 1992 - A PROFILE

Brian Whitton studied botany at Oxford University at a time when there were not many more students in a year than lecturers often now have in individual tutorial classes. He then went on a four-month expedition to (British) Guiana, where he developed a craving for exploring the tropics. This was followed in 1959 by Ph.D. research on blue-green algal extracellular materials at University College London under Prof. G. E. Fogg. UCL was an excellent place to meet other phycologists at this time, both because of the number of students working with Prof. Fogg and the many visitors. Among the former students of Prof. Fogg's he met at meetings, Dr Gerald Boalch and Dr Joanna Jones (then Joanna Kain), have since been presidents of the British Phycological Society. Brian's main dealing with the Society then was an attempt to get its name changed to the British Algological Society - a move to stop banks confusing us with psychologists. This was firmly rejected at an AGM by the late Dr R. W. Butcher because of the mixed Latin and Greek roots to the word algology.

He moved - on the day President Kennedy was assassinated - to a lectureship in Durham and has been there ever since. His research has focussed mostly on algae in flowing waters, especially 'extreme' environments such as zinc-rich and acidic streams. An interest in the ecology of cyanobacteria belonging to the Rivulariaceae started when Dr J. W. G. Lund pointed out the abundance of Rivularia in Upper Teesdale streams: none of the accepted explanations for the rare arctic-alpine higher plant flora in the region seemed to apply to *Rivularia*. A project in Bangladesh during the 1980s on cyanobacterial nitrogen fixation in deepwater rice-fields showed how important it is to consider the whole aquatic ecosystem when trying to improve the nutrient status of the fields, rather than simply applying agricultural methods developed for terrestrial crops. Brian is a member of a number of committees dealing with methods for monitoring rivers and is currently developing methods for monitoring tropical rivers jointly with the Instituta Botanica in Sao Paulo. Many of his former Ph.D. and project students have obtained jobs in water management and some have had the opportunity to apply and develop algal-based methods for monitoring rivers. He chairs the British Phycological Society's freshwater flora committee and is involved in the initiative to set up a European Phycological Federation. He is editor of the Journal of Applied Phycology.

Congratulations to Professor A.E.Walsby, FRS.

I am sure that all BPS members would like to join us in congratulating Tony Walsby in being elected a Fellow of The Royal Society at a meeting of the Society on 11 March 1993.

"Distinguished for his research on freshwater and marine plant microorganisms - cyanobacteria (blue-green algae) and other phytoplankton in particular. His work has led to new understanding of the means of control of buoyancy, and of the mechanisms of nitrogen fixation and has shown the ways in which phytoplankton respond to environmental conditions".

BOOK NOTICES AND REVIEWS

GUIDE DES ALGUES DES MERS D'EUROPE, Manche Atlantique:- Jacqueline Cabioch, Jean-Yves Floch, Alain Le Toquin. Méditertanée: - Charles-Francois Boudouresque, Alexandre Meinesz, Marc Verlaque. Delachaux et Niestlé, Lausanne. 1992. pp 231. ISBN 2-603-00848-X

For anyone who is interested in marine botany, the Guide des Algues des mers d'Europe is a book that should prove to be invaluable. The work does not pretend to be an exhaustive flora, but it does cover about 700 Atlantic and 1000 Mediterranean species of blue-green, green, brown and red algae and also marine angiosperms. The appeal of this book is two-fold, containing 245 colour photography illustrations as well as a considerable amount of background information about marine algae.

The first part of the book is a wide ranging introduction covering many aspects of marine algae in a concise and accessible manner. The algae are defined and the different growth forms described. The three main groups of algae, the greens, brown and reds, are dealt with in a little more detail. In addition, there is a section on the physical factors required by the algae, including light, substrata, hydrodynamic factors, temperature and salinity. The introduction draws to a close with a section on how algae have been used in the past and their present day uses. A description of how to collect and conserve algae provides useful and sufficient information for anyone wishing to build up a herbarium.

The guide is then split into two parts, the first dealing with the Atlantic flora and the second with the species from the Mediterranean. The opening section of each part reflects the contrast between the open Atlantic ocean and the virtually closed Mediterranean sea. The species described and illustrated in the guide are set out in a distinct format. The name of the species is followed by the order and family to which it belongs, plus an explanation of the etymology. There is a concise description of each plant, and, where appropriate, a mention of the utilisation of the species.

On the whole, the photographic illustrations are of a high standard. In the Atlantic section, the illustrations on page 81 (Figs 60, 62 & 63), which give an indication of habitat, are particularly striking. However, many of the pictures in this part have "bubbly" backgrounds, and although this does not spoil the general appearance of the algae, it does detract from the overall effect. The illustrations in the Mediterranean section, in contrast to those in the Atlantic part, are largely a combination of successful underwater shots and less pleasing pressed herbarium specimens. The guide therefore lacks pictorial uniformity, but by providing a variety of styles this does put the algae in some different perspectives.

It takes a little while to really find ones way around this guide and to get used to the arrangement and numbering of the plates. The system of referring to pictures of a species from the index can be a bit confusing at first. Each illustration is referred to by page number which does not exist on the plate page (presumably to avoid confusion with the plate numbers). However, this is simply a case of familiarising oneself with the system.

Although the book is in French, this is not a handicap, but there is good reason for an English translation of this attractive guide, as it would make it more accessible to a much wider audience.

Juliet Brodie

FREE-LIVING FRESHWATER PROTOZOA - A Colour Guide. D.J. Patterson and S. Hedley. Wolfe Publishing Ltd 1992 ISBN 0 7234 1683 4

The authors choose to refer to this book as a colour guide. This is appropriate since the book is based on a collection of colour photographs taken over a period of time and the object of the book is to guide experts and beginners alike towards a knowledge and understanding of the common taxa that comprise free-living, freshwater protozoa. An introduction of nine pages provides useful background information on the Protozoa and on the equipment and expertise required to take high quality colour photographs of Protozoa. A brief discussion on where to find, how to collect, culture and preserve specimens is also provided. This information is very practical and can be followed equally well by amateurs as professionals with a minimum of elaborate apparatus apart from a microscope. A brief outline classification of the Protozoa is included. The main section of the book is based on a collection of nearly 250 colour photographs of Protozoa which are arranged within a relatively straightforward dichotomous key. Each stage of the key is called a 'step' and at each step the reader is provided with a choice of A or B. Page layout has been carefully thought out. The arrangement of the key, colour photographs, line drawings and text are optimised for quick and easy use. A 15mm margin on the outer edge of each page of the key is grey and within this margin step numbers are indicated with the appropriate preceding step number in brackets below. This is a helpful arrangement for it allows the reader to retrace steps quickly, in case of error, without having to start all over again. For each step, descriptions of the choices A and B are in bold text and extend for the width of the page. Generic names are given in upper

case accompanied with the appropriate figure number. Text and descriptions of taxa are in normal text which is arranged in two columns. Illustrations of taxa are presented in standard format which again is optimised to facilitate easy understanding. Each colour photograph is 67mm x 45mm and is accompanied by a smaller labelled line drawing of the specimen and field illustrated in the photograph. Underneath is a legend in which the specimen and labelling are explained. The effect is entirely satisfactory in that it allows the reader to see the photograph of the specimen without an obscuring clutter of labelling and yet all the salient features can be clearly indicated. Also within the text there is a series of superbly executed line drawings. The overall effect of the layout of text and illustrations not only makes for easy use of the key but is also aesthetically pleasing. The key, which is only concerned with genera, includes approximately 65 flagellates, 45 amoebae, 70 ciliates, 9 Heliozoa and 4 Suctoria. I tested the key out on a number of organisms including *Synura* (Chrysophyceae) which involved 7 steps, *Amphidinium* (12 steps), *Euglypha* (13 steps) and *Spirostomum* (13 steps). I found the key relatively easy to use, descriptions were clear and concise and if I did lose my way I was able to retrace my steps quickly. A glossary of some 350 terms providing good concise definitions of scientific terms is more than adequate for the key. Towards the end of the book there is a series of drawings illustrating consortia of taxa found in (i) planktonic (ii) attached benthic (iii) organically rich benthic (iv) anoxic benthic and (v) sewage treatment plant habitats. A bibliography and index are included. The authors acknowledge the limitations of their guide. Taxonomic identification is only taken to generic level; the range of organisms included is not comprehensive and in particular for the algae and ciliates numerous other more comprehensive and detailed keys are available. However, in spite of these limitations this is a very attractive book which will, for the time being, fill a gap in the literature on these microscopical organisms. In particular, there is no really satisfactory key for colourless heterotrophic flagellates and this book makes a start in this area. The excellent colour photographs of living specimens also makes this book of particular value when trying to identify unfamiliar taxa. Publication is of a high standard with good reproduction of illustrations on good quality paper. In summary, I can strongly recommend purchase of this book to phycologists, protozoologists, limnologists, professional scientists working in the area of freshwater biology, water or sewage treatment and to amateurs fascinated by the microscopical world of freshwaters. I would also see this book as being of great value to teachers and students in Universities, Schools and Field Centres with interests in freshwater biology.

B.S.C. Leadbeater

THE TURF ALGAL FLORA OF THE GREAT BARRIER REEF. PART I. RHODOPHYTA. Ian R. Price and Fiona J. Scott. James Cook University, Townsville, 1992. xii + 266 pp. (including 81 figs). Softcover.

Available form: The Bookshop, James Cook University, Townsville, Qld 4811, Australia [Phone (077) 814 812, Fax, (077) 251 209]. Price AUS$61.95 (by surface mail within Australia or overseas). Cheques should be made payable to "James Cook University Bookshop". for credit card payment please specify whether Bankcard, MasterCard or Visa, give card number, expiry date and name of card-holder, and include your signature.

This volume deals with the turf-forming species of red algae occurring on the Great Barrier Reef. It provides descriptions and illustrations of 74 recorded species, with emphasis on vegetative features. Data on nomenclature, type material, voucher specimens, habitat, seasonality and distribution are given. Genus descriptions, keys to genera and species, a glossary and taxonomic index are included. This is the first detailed treatment of the taxonomy and distribution of the turf algae which occur on coral reefs Although written for Australia's Great Barrier Reef, the work should prove useful throughout the tropical Indo-Pacific region.

SILICOFLAGELLATE BIBLIOGRAPHY AND INDEX. Compiled by Stacia Spaulding, 1992

The International Nannoplankton Association has recently published a bibliography and bibiographic index of taxa for living and fossil silicoflagellates including virtually all references and hopefully all taxa described since the publication of the Loeblich et al. (1968) *Annotated index of fossil and recent silicoflagellates*. The bibliography includes a topic code system and an index to these codes. The taxonomic index gives full citations; pate and plate references; basionyms of new combinations and type locality information for new taxa.

The bibliography is a 60 page (A4, soft covers) special issue of the INA Newsletter. Since it is of potential interest to workers outside the INA we have printed some extra copies and these can be obtained for:

- **UK£9 or US$18** (including air mail) from:
- *Jeremy Young, Palaeontology, the natural History Museum, London, SW7 5BD.*
- Please include a self-addressed adhesive envelope label.
- Cheques should be payable to: *International Nannoplankton Association*

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All articles, reports, notes etc. for THE PHYCOLOGIST, can be submitted on computer floppy disc and by electronic mail. Our publishing system is IBM compatible MS-DOS Microsoft word 5. Both 5.25 and 3.5 inch floppy discs can be handled and it is probable that most common word processing languages are acceptable, but please always include an ASCII file of your article on the disc as well. It would be best if the original is as simple as possible in layout (ie. avoid justification etc. This reduces the amount of editing. Electronic mail can be sent via the UK JANET network to the following.address:
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