40 April 1995

The Phycologist

The Newsletter of

The British Phycological Society

THE PHYCOLOGIST

NUMBER 40 - APRIL 1995

CONTENTS:

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EDITORIAL

Portsmouth was a fine place to have a winter meeting, though being nearly at the other end of the country it was a tricky place to get to from Dundee soon after New Year. You may find it interesting to know it would have been cheaper for me to travel by rail to Portsmouth from Dundee return than it was to travel York-Portsmouth return! One day someone will understand BR's fare structure. Again the meeting was well attended and it was good to meet up with old friends and to be introduced to new ones. It was great that Chris Maggs was able to make the meeting and present Catronia.

I would like to thank Dr Gabrielsen (Algea A/S (Norway)) for sponsoring the buffet and for being so generous at the society's auction.

The special topics were of considerable interest to myself. Valorisation is not a term that I have used much but now I am fully versed with its use I might just try to make some monies out of our lovely algae..... though my dictionary did give the definition of "price fixing" for valorisation! I missed some of the species concept papers as they ran in parallel with the Manton prize papers, but I did catch Stephen Droop's, David Mann's and Jeanine Olsen's papers and found them thought provoking. I plan to have reports on the special topics in the next issue of the newsletter.

A couple of pieces in this newsletter maybe out of date by the time it gets to you but I have kept them in so that you will see what does take place and if you are interested you can find out if they are going to happen next year.

I would like to thank the numerous people who have taken time to write articles for the newsletter. Three of my colleagues in Dundee attended the Seaweed Symposium in Chile and had a very profitable time and Janet Kübler has written about her experiences. I would like to have more items like those of Liz Haworth (British Diatomists) and Gunter Kirst (The German Section of Phycology). Meetings are life blood of science, even if those Super Highway bandits would make you think otherwise, and I would like to publicize any meeting that maybe of interest to Phycologists, British or not! As you will see in Stephen Droop's membership report a sizable portion of the BPS is based overseas!

I hope you are all well. If there is anything you would like to see in The Phycologist do write to me and I am sure it will happen.

Andrew M. Johnston
Dundee.

BPS Membership December 1994.

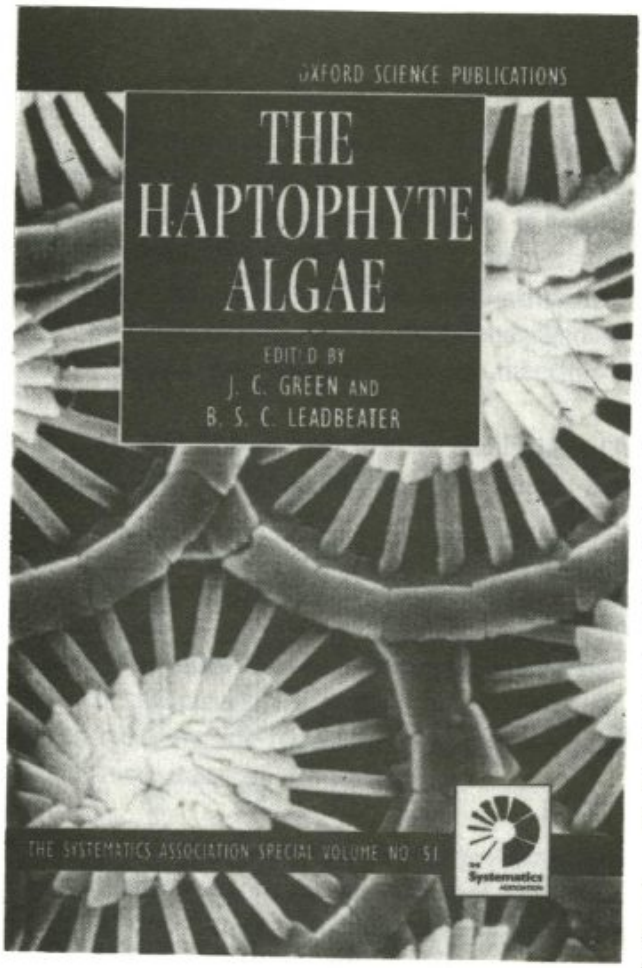
		U	E	N	R	**1994**	1993	1992
NEW 1994	Full	6	8	3	2	19	32	19
	Student	12	2	1	1	16	25	14
	Retired	-	-	-	-	-	-	-
	Assoc.	5	4	-	-	9	3	4
	Re-inst	-	-	3	-	3	4	2
	Total	23	14	7	3	47	64	39
Paid up	Full	135	116	97	78	426	418	431
(inc New)	Student	28	5	3	5	41	51	54
	Retired	14	9	9	7	39	39	34
	Assoc.	38	9	3	3	53	31	28
	Honorary	9	-	-	-	9	8	8
	Total	224	139	112	93	568	547	555
In arrears	Full	13	6	4	7	30	53	35
	Student	11	-	-	2	13	16	21
	Retired	-	-	1	-	1	1	2
	Assoc.	3	-	-	1	4	6	5
	Total	27	6	5	10	48	76	63
Losses	Resigned	4	2	2	2	10	14	14
	Struck off	21	6	11	6	44	39	46
	Bank nt pd	-	-	-	-	-	-	10
	Deaths	1	-	-	-	1	6	1
	Totals	26	8	13	8	55	59	71

Summary

Total Membership on files	251	145	117	103	616	623	618
Total active membership	224	139	112	93	568	547	555
% Membership carried	10.8	4.1	4.3	9.7	7.8	12.2	10.2

1994 figure broken up into: U = UK; E = Rest of Europe; N = North America; R = Rest of World.

S.J.M. Droop, Hon. Membership Secretary.
23rd December 1994.



JUST PUBLISHED!!!

The Haptophyte Algae (ed. J.C. Green and B.S.C. Leadbeater), Systematics Association Special Volume No. 51; 458 pp with halftones, line figures, and tables. Oxford: Clarendon Press/Systematics Association; November, 1994. Price £80.00/$132.00 (25% reduction to members of the Systematics Association; current annual subscription £5.00). ISBN 0-19-857772-9.

Although they have been known for some decades, members of the Haptophyta have received increasing attention in recent years as their economic and ecological significance have become apparent. Phycologists of all persuasions are now actively engaged in research on the group and this book, the **first** monograph on these fascinating organisms, presents an authoritative review of the current state of present efforts.

There are 22 chapters, written by specialists in their subject, covering all major aspects of haptophyte research. These include, for example, systematics, fine structure, physiology, the biochemistry of calcification (coccolith formation), ecology, economic significance, fossil record, molecular genetics, phylogeny and evolution, and more. All contributors have reviewed earlier work as well as the latest developments and the book is invaluable, therefore, as the **only** available comprehensive reference text on the group.

THE WINTER MEETING: THE POST-GRADUATE VIEW.

January 1995, and this years BPS conference was held in the Langstone Centre at the University of Portsmouth. It was the first conference I have attended and it provided me with an opportunity to meet and listen to the work of other phycological scientists.

With a new hire car and a free meal ticket for the following three days, life as a research student suddenly seemed full of rewards. Not being in any rush to relinquish my new toy, I arrived at the University with little time to spare before the beginning of the poster session in the evening. It was a shame perhaps that the distraction of food was placed immediately adjacent to the poster display, but at least there was time enough to browse over them during the following few days. The rest of the evening was spent in the bar, and with a fine selection of beverages to choose from, Tuesday night materialised into Wednesday morning.

A full breakfast was welcomed, especially the orange juice, and entertainment in the form of a magical milk jug that would do anything but stand up, broke the ice for the rest of the meeting. The first presentations that morning were given by C.J. Barwell and D.J. Rogers, leaving me in no doubt that 'valorisation' had arrived at Portsmouth. For the rest of the day I skipped between sessions finding interesting talks every time. Dinner that evening was a rapid affair, perhaps the staff had been warned of the usefulness of knives and forks for laboratory experiments !?!, Or perhaps they were worried that the crockery would find it's way into the auction the following evening.

Thursday morning dawned and with it the Manton prize! With one last rehearsal to my captive audience in the mirror, I carefully arranged my overheads and took my place in the arena! It was encouraging to see that a large number of people stayed throughout the session and listened so intently. The quality of the talks was impressive, and having never given a talk myself, I only hope I came across with the clarity and confidence of my peers. Congratulations to B. Marin on an excellent performance. The BPS dinner was followed by the customary auction. Unfortunately, what I considered to be the best prize of the evening informed me she wasn't for sale!

Although a late night was had by all on Thursday, there was no detrimental effect on Friday's proceedings. There was another full agenda for the morning and the meeting finished with a talk by R.J. Geider, which I thought well worth waiting for.

Congratulations and thank you to the organisers of this year's conference and see you next year!

Gareth Wood.
University of Wales Swansea.

CONSERVATION MATTERS

BPS Conservation Committee

The Committee decided that its mission should be to 'actively promote all aspects of algal conservation through action locally, regionally and globally', and it set itself a number of objectives with realistic target dates for their achievement. During the course of the year members of the Committee were approached and were able to respond to a number of consultative documents (see below).

One of our aims is to strengthen the profile of algal conservation and for this we need the support of the members of BPS. If you have any information, relevant articles or comments then we will be pleased to hear from you. Correspondence should be addressed to Jacqueline O'Mahony (47 Atherley Road, Shirley, Southampton SO1 5DT) or David John (Department of Botany, The Natural History Museum, Cromwell Road, London SW7 5BD).

UK Plant Conservation Strategy

Plantlife are preparing the 'Strategy' (originally 'Plantlife Prospectus') and are liaising with those societies on its 'Plantlife Link Committee' and conservation organisations. It was

agreed at a meeting held on 12 January 1994 in The Natural History Museum between BPS Conservation Committee and Plantlife representatives that algae would be treated in three parts: stoneworts (Dr Hugh Synge), seaweeds (Ian Tittley) and freshwater algae (David John). An outline document was tabled at a meeting of the Plantlife Link Committee held on 28 September 1994 and publication is expected about June this year.

Biodiversity Challenge

Six voluntary conservation organisations prepared 'Biodiversity Challenge: an Agenda for Conservation in the UK', an agenda for conservation action. It was published in December 1993 and set out realistic objectives and precise targets for conservation together with suggestions for policies and actions considered essential for these to be met. The draft of a second edition was corrected by members of the Committee and 12 species of red algae were added based on discussions with Juliet Brodie, Christine Maggs and Linda Irvine. It was launched on 25 January 1994 at a ceremony held at the Natural History Museum, the date deliberately co-inciding with the anniversary of the launch of the UK government's 'Biodiversity: UK National Action Plan'. The BPS was one of several societies that endorsed the document.

Plant Conservation Strategy

We sent a three page response to Margaret Palmer's request to the Committee for comment upon a draft of a document entitled 'Plant Conservation Strategy'. It is to be published early this year and one of its recommendations is to set up a 'Plant Conservation Working Group' comprising members of various non-governmental as well as governmental organisations. We have been invited to join the Working Group and Sue Scott has agreed to represent the BPS on it.

Third Quinquennial Review of Wildlife and Countryside Act

We have been asked by Plantlife to consider whether any species of algae should be recommended for protection under Schedule 8 of the Act.

David M. John and Juliet Brodie, Chairman and Secretary respectively of the BPS Conservation Committee

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XVth INTERNATIONAL SEAWEED SYMPOSIUM
Valdivia, Chile January 8-14, 1995

We arrived in Santiago fresh from the BPS winter meeting, give or take a few hours of flight time from Heathrow. The first (apparently unscheduled) social event of the meeting took place in the departure lounge of Ladeco Airlines as phycologists from all over the world accumulated for the Sunday afternoon flight to Valdivia. On arrival in Valdivia we had our first experience with the excellent logistical organization of the secretariat, under whose guidance we were delivered to our hotels and then to the opening social at the Universidad Austral de Chile where there was more opportunity to get reacquainted with old friends and make new introductions.

Monday, the meeting started in earnest with the opening ceremonies in Spanish with English translation and the beginning of contributed papers. The talks were scheduled for

Professor Alan Pickering and shown many of the internationally renowned facilities, such as the library, the Fritsch Collection of Algal Illustrations and the Culture Collection of Algae and Protozoa.

The meeting concluded with the announcement of a prize for the best presentation during the weekend. The trophy - a small box of diatom slides - has been given to commemorate the life-long interest of the well known amateur diatomist (and Honorary Member of the British Phycological Society), John R. Carter of Hawick, who died in November 1993. The first winner was Elizabeth Ashton, of Sheffield University, Department of Animal and Plant Sciences, for her study on Diatoms and Heavy Metal Pollution in Two Northern Rivers.

Dr. Elizabeth Haworth
The Institute of Freshwater Ecology, Windermere

THE IRENE MANTON PRIZE, 1995

At the January 1995 meeting of the Society at the University of Portsmouth, there were nine contenders for the annual Manton prize for the best paper given by a postgraduate research student. The panel of judges (this year chaired by Dr B.S.C. Leadbeater, in my unavoidable absence earlier in the day) assessed each talk for (i) use of visual aids, (ii) oral clarity, (iii) clarity of science, (iv) quality of the science, (v) timing and (vi) handling of questions. The overall standard was again high, but in the opinion of the evaluators one stood out above all the rest, and this was by Mr Birger Marin from the University of Cologne. His paper was entitled "Phylogeny of prasinophytes inferred from classical markers and ribosomal RNA sequence comparisons".

Birger Marin was born in Remscheid, Germany in 1966. From 1986 to 1991 he studied biology at the University of Cologne, and in 1991 started work in Professor

Melkonian's laboratory, gaining his degree in biology (the German "Diplom") from Cologne University, in 1992. The main subject of his research at that time was the ultrastructure and taxonomy of the prasinophyte genus *Tetraselmis*, with the aim of revising the genus. Although this work is now finished, it is so far largely unpublished.

From 1992-1993, Birger extended his ultrastructural studies to other prasinophyte genera, with particular reference to the evaluation of flagellar hair ultrastructure (Marin & Melkonian 1994 *J. Phycol.* 30: 659-678).

In 1993 Birger started to determine complete nuclear-encoded small subunit ribosomal RNA sequences (18S r-DNA) of several prasinophytes and evaluate their phylogeny, using appropriate methods of analysis, e.g. neighbour-joining, maximum parsimony and maximum likelihood. The work is supported by a *Studeinstiftung der Deutschen Volkes* grant. He plans to complete his PhD this year, and we wish our 1995 prize winner well in his future research career.

Professor L.V. Evans
University of Buckingham

January 1995

NOTES AND NOTICES

David Irvine.

Members will be sad to hear that David Irvine died on the 17th January 1995. I would like to extend the sympathy of the society to Linda. A full obituary will appear in the next issue of the newsletter.

Reduced subscription rates for the Institute of Biology.

The British Phycological Society is an affiliated society to the Institute of Biology. The IOB has recently reduced its subscription rates for members of affiliated societies. They are now doing a special offer of 29 pounds which includes the application fee and the first annual subscription. The conditions are as follows: the reduced subscription will apply to those applying for the grades of Associate, Graduate or Member; applicants must sign a form to confirm current membership of an Affiliated Society; the normal regulation of the IOB will apply in relation to the qualification required for the appropiate grade of membership; the reduced rate will only apply for the first year and fees for the following year will be collected by direct debit mandate; applicants should write to the Membership and Recruitment Dept, Institute of Biology, 20-22 Queensbury Place, London, SW7 2DZ, to obtaind a 'Reduced Membership subscription for Affiliated Societies' pack and then return their completed membership application forms to the Institute.

You should be aware that one of the main benefits of being a member of the IOB is that you are able to hold a professional title as a Chartered Biologist, which can be held at either the Member (CBiol, MIBiol) or Fellow (CBiol or FIBiol) grade. The title is recognised through out the EU under Directive 89/48/EEC.

British Phycological Society Field Meeting, 1995

Phycological Field Course

Date: Friday 28th - Monday 31st July 1995
Location: Isle of Man

The 1995 Field meeting will be based at the Port Erin Marine Laboratory (University of Liverpool), Isle of Man. It is proposed that participants arrive on the evening of Thursday 27th July.

For further information please contact Dr. Juliet Brodie, Bath College of Higher Education, Newton Park, Newton St. Loe, Bath BA2 9BN. Tel: 0225 873701 Fax: 0225 874082.

News from the German Section of Phycology.

The German Phycologists organised in the "Sektion Phycologie" (Section of Phycology) of the Deutsche Botanische Gesellschaft (German Botanical Society) will have their annual meeting form March 6 to 9, 1995 at Hofgeismar. Guest and visitors are welcome (for futher information please contact Prof. Dr. W. Reisser, University of Leipzig, Botany, Talstr. 33, D-04103 Leipzig. Fax: +49 341 960 3099.

The past year 1994 was full of "phycological events". Besides the 5th International Congress in Qingdao (China) the meeting of the German Botanical Society in September at the University of Bayreuth certainly was one of the highlights for the German phycologists. Although the major part of the scientific programme comprised ecology of terrestrial plants and physiology of higher plants as well as applied botany, the phycologists presented a remarkable number of contributions. Two symposia including 15 lectures, some of them given by invited international speakers on "Classical and molecular approaches in taxonomy and phylogeny of green algae" (organised by M. Melkonian and T. Friedl) and on "Physiological diversity of algae" (organised by C. Schnarrenberger and G.O. Kirst) were well attended. Together with 26 poster contributions and numerous presentations on algae within sessions dealing with general botany proved that the interest on research with algae is ever growing. Especially pleasant to recognise was the great number of friends and colleagues from neighbouring countries who not only joined but also contributed to the meeting.

The "Sektion Phycologie" at present has 164 members and invites everybody who is interested in algae to join its activities.

Prof G.O. Kirst (Universitat Bremen)

Observatoire Oceanologique de Roscoff.

Erasmus courses 1995.

The Britanny coasts of the Channel, distinguished by the effects of their large tidal range, are characterised by an extreme diversity of natural undisturbed habitats, in conjunction with high diversity of benthic organisms. The Observatoire Oceanologique or "Biological Station"

gives privileged access to these communities. Three intensive ERASMUS courses at the Master's level have been organised there. Intended primarily for students of the participating universities, they are equally open, within limits of available places, to those from French and foregin universities as well as people whose professions require a knowledge of the subject areas involved. Each of these courses leads, after examination, to an ERASMUS certificate. Teaching is in French.

A - Biodiversite en Mer megatidale

Option 1: PHYCOLOGIE FONTAMENTALE (enseignement en francais): du lundi 10 avril au samdi 22 avril (inclus)

Universite organisatrice: UPMC Paris 6; partenaires: Ghent, Trieste.

Initiation a la connaissance systematiqu at ecologique des algues marines, cet enseignement comporte des cours, des seminaires et des etudes pratiques sur le terrain et en laboratoire.

Option 2: ZOOLOGIE ET ECOLOGIE MARINE (enseignement en francais): du lundi 7 aout au mercredi 30 aout (inclus)

Universite organisatrice: UPMC Paris 6; partenaires; Bruxelles, Ghent, Louvain, Mons, Pavia, Santiago de Compostela.

Diversite et particularites des milieux cotiers benthiques et pelagiques en mer megatidale. Elements de faunistique littorale. Variete des plans d'organisation fonctionnelle et des modes de vie dans les principaux groupes zoologiques marins. Initiation aux methodes d'analyse biocenotique.

B - Sediment and biosphere interaction in high energy littoral environments (en allemand): du mercredi 23 septembre au dimanche 12 octobre (iclus)

Universite organisatrice: Marburg; partenaires: UPMC Paris 6, Stockholm. Advanced field and laboratory course on sedimentology, paleontology and ecology of littoral and coastal environments: hydrodynamics, coastal erosion and biogenic production, sediment transport, distribution and desposition, climatic and sea level changes, fossil sedimentary environments.

Renseignements et formulaires de candidature a demander aupres des universites concernees ou directement au: Service - Enseignement - Station Biologique BP 74, 29682 Roscoff Cedex Tel: 98 29 23 23 Fax: 98 29 23 24. A renvoyer a la meme adresse, avec une enveloppe timbree a l'adresse du candidat, avant le 28 fevrier 1995 pour A, avant le 30 avril 1995 pour A2 et B.

Freshwater algae of South East Asia.

I recieved a letter from Dr. Junaida Payne who wrote to offer his help to any members of the society wishing to undertake field work in South East Asia. He works for the World Wild Life Fund For Nature (Malaysia) and is offering to suggest possible sites for study and help approaching relevent government authorities concerned. His address is: World Wild Fund for Nature Malaysia, WDT No 40, 89400 Likas, Sabah, Malaysia. Tel 088-258475 /6/7/8.

Norwegian Algal Collection.

In December 1994 I published a list of benthic macroalgae in the Herbarium of Bergen (Herb. BG), Norway, as a report of the Department of Fisheries and Marine Biology, University of Bergen, Norway, in English. I think it will be of interest for some members

of the Phycological Society to know about it, and ask you to include a note in the next issue of The Phycologist in March 1995.

Regina K. Lein 1994. List of benthic macroalgae (green, brown and red algae) in the Herbarium of Bergen, Botanical Institute, University of Bergen, Norway. - IFM rapport 45. 57 pp. in English.

In Norway algal collections are deposited at the university herbaria in Oslo, Bergen, Trondheim and Tromso, and at the Agder Natural History Museum in Kristiansand. However, no position as curator specialized in algae exists at any university in Norway. Published information about the material in these algal herbaria is scarce.

The algal collections at the Herbarium of Bergen (Herb. BG), Botanical Institute, University of Bergen include several thousand sheets of green, brown and red algae, mostly of marine, but also of some freshwater species, belonging to about 1800 Norwegian and exotic species. Among these there is a lot of old material, in part collected in the last century (e.g. by S. Berggren, M.N. Blytt, P. Boye, M. Foslie, H.H. Gran, F.R. Kjellman and A. Vilke). Old specimens from Norway, and some from Spitsbergen, Greenland and Arctic Russia are indicated for green and brown algae by the name of a collector. The collections at the herbarium contain also encrusting and calcified algae in boxes, bluegreen algae, Bacillariophyceae and Flagellatae mounted on herbarium sheets, microscope slides, and preserved material. These are not included here.

The species names of benthic green, brown and red algae mounted on herbarium sheets are updated to names in current use, based on the literature cited, and arranged alphabetically within each group in the Herbarium. No revision of the material is carried out. As most of the specimens have not been recently studied, a critical revision of the material is badly needed. The aim of this report is to give an account of species names and sampling area of the benthic macroscopic green, brown and red algae in the Herbarium of Bergen.

Availability of the report and the herbarium specimens: Reprints of the report are available at the Department of Fisheries and Marine Biology, University of Bergen, Hoyteknologisenteret, N-5020 Bergen, Norway (E-mail: Tor.Lein@ifm.uib.no). For loan of herbarium specimens please contact the Botanical Institute (Herb. BG), University of Bergen, AllΘgt. 41, N-5007 Bergen, Norway.

Creche at the Lancaster Winter Meeting 1996.

Have you been put off going to the Winter meeting because of difficulties as to what do to with the children? Well next year the Winter Meeting will be held at the University of Lancaster and Dr J.D. Eccleston-Parry, who has recently joined council, told me the creche facilities are excellent. Children from 3 months to 5 years are catered for in the pre-school center which is very well equipped and is open from 8.30 to 6.00 pm. There are about five members of nursery staff so it's all well organised etc. There is a fee but at the moment Jackie is still negotiating for a good deal. If anyone wants to check with Jackie her telephone no is 01524 65201 ext. 3489 and can be e.mailed on J.Eccleston-Parry@Lancaster.ac.uk

Time of the Winter Meeting.

Have you ever been put off coming to the winter meeting because of its place in the

calender rather than its location in the UK? Would you rather it was at some other time of year? The council of the Society is interested to hear your views, one way or the other. Not long ago there was a referendum on the subject but the response was very poor. This subject has come up because the timing of the 1997 Winter meeting is causing some concern as the normal dates (Tuesday to Friday) are very close to New Year in the first week of the year or the start of the Spring term in the second week. Anyone with suggestions of how to get around this should contact the Hon. Secretary, Dr. E. Cox (Tel No: 0171 938 9001).

Remembering the Society.

Though never an easy subject to discuss have you thought what might happen to any of your valuable phycological possessions when you die? Could I suggest that you make some arrangement in your will? It might not seem important now but if you have spent a lifetime working in phycology you may well have accumulated alot of interesting material that may not be disposed as you might wish in the event of your death. You may wish to donate the material to your place of work, a library or the British Phycological Society (to name three).

FORTHCOMING MEETINGS.

CHRYS 95

The Fourth International Chrysophyte Symposium will take place in Denmark (Hosterkob, north of Copenhagen) 22-27 May 1995, followed by an optional four day excursion to Sweden (Aneboda). The programme will include invited lectures, contributed papers and posters. Manuscripts will be published in the Proceedings of the Symposium. Organizers: Gertrud Cronberg (Lund, Sweden) and Jorgen Kristiansen (Copenhagen, Denmark).

For further information contact Jorgen Kristiansen, Botanical Institute, Dept of Phycology, Oster Farimagsgade 2 D, 1353 Copenhagen K, Denmark. Tel: 45 3532 2320, Fax: 45 3532 2321 Email: sporol@vm.uni-c.dk.

First International Congress on Toxic Cyanobacteria (Blue-green Algae) 1995

Since 1986, Nordic Symposia on toxin producing algae have been held every second year. Due to the increased interest from other countries in these meetings and the majority of the topics relating to toxic cyanobacteria not being covered by other international meetings, the organizing committee has decided to make the 1995 meeting the 1st International Congress on Toxic Cyanobacteria (Blue-green Algae).

The Congress will be held on the Danish island of Bornholm in the Baltic on 20-24 August 1995. It will be held in English. We plan to publish the proceedings from the Congress.

Scientific communications to be presented orally or as posters are invited on any aspect of toxic cyanobacteria. Subjects such as ecology, physiology, factors affecting toxin production, management, health hazards, and general aspects of toxic cyanobacteria may serve as a tentative guideline to the scientific sessions intended.

To receive the first circular which included the preliminary registration form, please contact:

Prof. Ø. Moestrup or Cand. scient. Peter Henriksen. Dept Phycology, Botanical Institute, Ø. Farimagsgade 2 D. DK-1353 Copenhagen K. Denmark.

Phone: +45 35 32 22 90 or +45 35 32 22 99
Fax: +45 35 32 23 21
E.mail: moestrup@bot.ku.dk or phenriks@bot.ku.dk

or

Dr. Hanne Kaas, National Environmental Research Institute, Frederiksborgvej 399, P.O. Box 358, DK-4000 Roskilde. Denmark.
Phone: +45 46 30 12 00
Fax: +45 46 30 11 14
E.mail: hmhka@wpgate.dmu.min.dk

Information on sessions, registration fee, accommodation etc, will be announced in the second circular which will be distributed to those who return the pre-registration form.

BPS Field Meeting, 1995.
28th - 31st July, Isle of Man.
(see Notes and Notices).

BPS WINTER MEETING, 1996.
2nd - 5th January, University of Lancaster.

ISEP 11 - AUGUST 1996

The 11th biennial meeting of the International Society for Evolutionary Protistology (ISEP) will convene at the University of Cologne (Cologne, Germany) from August 9-13, 1996. The meeting will be held in conjunction with the 1st European Phycological Congress (August 11-18, 1996).

The primary purpose of ISEP is to provide an exchange of scientific knowledge between protistologists who work in the fields traditionally known as protozoology, phycology and mycology. The scientific program will include general lectures, several symposia, contributed papers and workshops.

1ST EUROPEAN PHYCOLOGICAL CONGRESS.

This international meeting will be held in Cologne, Germany from 11-18 August 1996. It will provide a forum for phycologists (young and established) from all over Europe and overseas for communication and discussion on all aspects of phycology: basic and applied; freshwater and marine; organismic and molecular.

The scientific program will include several plenary and special lectures, symposia, contributed papers, posters, workshops and excursions.

For further information, please contact:
Prof Michael Melkonian, Universität zu Köln, Botanisches Institut, Gyrhosfstaße 15, D-50931. Köln.
Fax: 0049 221 470 5181. E.Mail: MMELKON@BIOLAN.UNI-KOELN.DE

ABSTRACTS OF THE 1995 BPS MEETING.

C.J. BARWELL. (University of Portsmouth, Portsmouth, PO1 2DZ, UK.)

Evaluation of some European marine red algae as sources of biliproteins.

Red marine algae contain photosynthetic pigments, in addition to chlorophyll, which are highly coloured proteins due to bilin prosthetic groups. These are the biliproteins of which there are two major groups, the red phycoerythrins and blue phycocyanins, which have some of the highest molar absorbencies of natural compounds. These natural and probably non toxic pigments have great potential as natural colourants of both foods and cosmetics. If this potential can be realised by appropriate formulation and stabilisation then the market for biliproteins, as colourants, could be worth many millions of pounds annually. When isolated from other pigments the biliproteins are highly fluorescent and exhibit a high quantum efficiency and Stokes shift, for example R-phycoerythrin absorbs strongly at 495 nm and fluoresces at 575 run. These fluorescence properties, together with a high molar absorbency, make biliproteins suitable for use as biomedical diagnostic reagents. As conjugates with monoclonal antibodies they are widely used in medical immumodiagnosis with an annual market in excess of five million pounds sterling.

Two European marine red algae, common in coastal waters of south England, have been evaluated as sources of biliproteins. The cartilaginous nature of *Palmaria palmata* creates difficulties for initial extraction of biliproteins. However, it is a good source of R-phycoerythrin type I, in terms of content. *Griffithsia flosculosa* is readily extracted due to its osmotic fragility. Extracts of this alga contain only very low amounts of phycocyanins which facilitates the purification of its R-phycoerythrin, because phycoerythrins and phycocyanins are not readily separated by protein isolation methods which are suitable for large scale isolation of biliprotein.

C. J. BARWELL & M. BELLOTA. (University of Portsmouth, Portsmouth, PO1 2DZ, UK and Centre for Bioactive Marine Substances, Habana, Cuba.)

Valorisation of Marine algae by evaluation of chemical constituents and biological activities.

Valorise derives from the French, meaning to raise the value of a commodity by artificial means. Valorisation of algae may be understood to mean the application of technical and scientific processes to increasing the value of algae. One clear valorisation of an alga is the processing of *Porphyra* species for use as human food products, which command high prices due to their appearance, texture and flavour, properties not apparent in the fresh alga. Valorisation may also occur by utilising otherwise low value algal biomass as a source of high value natural products such as agars and biliproteins. Algae may also be valorised by evaluation for compounds with novel biological activities such as anti cancer and anti viral agents, since the value of the biomass is increased if it becomes a source of high value products. Once it is established that an alga is a source of high value products it may be desirable to cultivate biomass in order to ensure either continuity of supply or optimum levels of the required constituents.

The Marine Natural Products Research Group, Portsmouth, UK and Centre for Bioactive Marine Substances, Habana, Cuba, have some parallel and other joint programmes concerned with valorisation of marine algae. These involve: screening Caribbean algae for a wide range of biological activities, in particular compounds with antiviral activity and activity within the central nervous system; evaluating both European and Cuban algae as sources of biliproteins; biochemical evaluation of potentially edible algae with the view to utilising them as the basis of high value human food products.

E.G. BELLINGER, S.M. CLAY & D.C. SIGEE (School of Biological Sciences, University of Manchester, Oxford Road, Manchester M13 9PT).

Changes in individual cell phosphorus concentrations during phytoplankton population growth in a freshwater lake.

Algal and lake water samples from Rostherne Mere, Cheshire, were analysed for phosphorus concentrations. Individual cells of *Stephanodiscus rotula*, *Ceratium hirundinella* and *Anabaena circinalis* were analysed using X-ray microanalysis.

Changes in water orthophosphate-P concs. were noted and compared with changes in population cell numbers and single cell P levels from 1988-1990. For *S. rotula* lake ortho-P concentrations were high (>0.2 mg l^{-1}) throughout the growth period. Cellular P levels were highest during population increase and began to decline before population decrease. With *A. circinalis* the pattern was more variable. Cell numbers and P values were generally higher when lake ortho-P concs. were high, and were always greater than for *S.rotula*. *Ceratium* was present when lake concs. were lower (<0.2 mg l^{-1}) but cell levels stayed relatively constant and high - irrespective of population numbers. Further investigations of individual cell P levels may give more information about natural population requirements and responses.

H. BENNION, S. WUNSAM[1] & R. SCHMIDT[1]. (Environmental Change Research Centre, University College London, 26 Bedford Way, London. [1]Institute of Limnology, Austrian Academy of Sciences, A-5310 Mondsee, Austria.)

The validation of diatom-phosphorus transfer functions.

A knowledge of background phosphorus concentrations in lakes can make an important contribution to the design of informed conservation strategies and restoration programmes. However, such information on pre-enrichment lake conditions is rarely available. Weighted averaging (WA) transfer functions have recently been developed that allow epilimnetic total phosphorus (TP) concentrations to be inferred from diatom assemblages preserved in lake sediments. Clearly, however, factors controlling diatom abundance in lakes are multivariate; for example factors such as light, temperature, and nutrient ratios, rather than concentrations of TP alone may be important. Thus, the work presented here provides a rigorous test of the performance and limitations of diatom-TP transfer functions by applying a model derived from a training set of European Alpine lakes, to a high resolution varved sediment core from Mondsee, an Austrian pre-alpine lake with a well-documented eutrophication history, and long-term monitored water chemistry data and phytoplankton records. A direct comparison of the modelled TP values with the measured annual mean TP concentrations for each year over the period 1975-1993, shows that the model parallels the monitored trend in TP values reasonably closely, but that the model underestimates or overestimates the actual measured TP values in some years. The potential error sources will be discussed. The results indicate that many diatom taxa show a clear response along the TP gradient (2-260 $\mu g\ l^{-1}$), and are thus good indicators of lake trophic status. This validation study illustrates that the WA technique can be used to reconstruct TP concentrations with good statistical confidence, and can provide reliable estimates of pre-enrichment TP levels, and an indication of the onset and development of eutrophication for any lake with a suitable sediment record.

G. BLUNDEN, Y. WU, T. JENKINS & S.D. HANKINS[1] (University of Portsmouth, U.K.; [1]Maxicrop International Ltd., Corby, U.K.).

The significance, of betaines in the increased resistance to nematode attack of tomato plants treated with extracts of *Ascophyllum nodosum*.

Extracts of brown algae are used in agriculture and horticulture and many beneficial effects have been recorded with their use. Of particular interest are the claims that treated plants have an increased resistance to pathogen attack. There are several reports that the use of seaweed extract reduces the severity of attack on tomatoes by root-knot nematodes (Meloidogyne species), but the compounds present in the extracts responsible for these effects have not been determined. In this current study, the use of an alkaline extract *of Ascophyllum nodosum* on tomato plants was shown to reduce the number of juvenile stages of *Meloidogyne javanica* and *M. incognita* penetrating the roots; the fecundity of the adult female nematodes was also reduced. Similar effects were produced when aqueous solutions of glycinebetaine, γ-aminobutyric acid betaine and δ-aminovaleric acid betaine were applied at concentrations equivalent to those present in the seaweed extract. It was thus concluded that the increased resistance to nematode attack imparted to tomato plants by application of seaweed extract was due primarily to its content of betaines.

J.L. BRENCHLEY, J.A. RAVEN & A.M. JOHNSTON. (Department of Biological Sciences, University of Dundee)

The effect of reproduction on growth and mortality in two fucoid species with contrasting reproductive strategies.

Fucus serratus and *Himanthalia elongata* form extensive populations in the lower intertidal at St. Andrews and Fife Ness, Scotland respectively. These populations were monitored monthly from February 1993 to December 1994. Both species showed distinct reproductive seasons. *H. elongata* initiates receptacle growth in October, *F. serratus*

in April/May, as reproductive development takes 10 months and 4-5 months respectively, both species reach reproductive maturity in late summer (July/August). The mean reproductive biomass allocation (% dry weight) in *H. elongata* is over 98%. *H. elongata* is capable of only a single reproductive event (semelparous), in contrast *F. serratus* is potentially capable of multiple reproductive events (iteroparous). The mean biomass allocated to reproduction by *F. serratus* in its first reproductive event is 39%, and 51% in the second.

Growth rates (cm/cm/28d) of non-fertile plants are seasonal, with a winter minimum and spring maximum, (0.02 in February compared to 0.17 in June, and 0.02 in November compared to 0.26 in April, in *F. serratus* and *H. elongata* respectively). Fertile plants of *F. serratus* and the fertile button of *H. elongata* display lower growth rates compared to non-fertile plants. Reproduction does not enhance mortality rates in *F. serratus*, and fertile *H. elongata* did not suffer greater rates of mortality during reporductive development compared to non-fertile plants, however post reproductive mortality in *H. elongata* is 100%.

J. BRODIE, G.L.A. BARKER[1] & P.K. HAYES[1] (Applied Sciences, Bath College of Higher Education, Bath BA2 9BN and [1]School of Biological Sciences, University of Bristol BS8 1UG).

A molecular approach to species differentiation in the genus *Porphyra* (Bangiales, Rhodophyta) from Britain.

Members of the genus *Porphyra* are widespread around the coast of Britain. Species of *Porphyra* currently listed in the British flora include *P. amethystea, P. leucosticta, P. linearis, P. miniata, P. purpurea* and *P. umbilicalis.* However, the limits of some of these species needs clarification. Sequence analysis of the *rbc*L-*rbc*S spacer regions has been used successfully for some genera of red algae to distinguish between closely related taxa. Morphologically distinct isolates of *P. leucosticta, P. umbilicalis* and *P. purpurea* have *rbc*L-*rbc*S spacer regions that have pairwise similarity values of between 0.834 and 0.895, which is consistent with variation at the species level. Sequence of this region of the plastid genome thus provides data that can be used to clarify the limits of *Porphyra* species.

S.B. CALDWELL, R.O. M°LEAN & P.G. HARTE (Department of Biological Sciences, University of Paisley)

Production of Monoclonal Antibodies to Heavy Metal Induced Algal Protein.

Partially purified protein extracted from *Klebsormidium rivulare* (Kütz) exposed to zinc over a period of at least three months was used to induce an immune response in rabbits and mice. An ELISA (enzyme linked immunosorbent assay) was developed using long-term induced protein, immune rabbit serum and an horseradish peroxidase conjugated anti-rabbit serum. This ELISA was subsequently used to monitor monoclonal antibody production from mouse (exposed to partially purified long-term protein) spleen/653 mouse myeloma cell fusion. Positive fusion, growth and antibody production were demonstrated. The possibility of utilising this monoclonal serum to detect the presence of metal induced protein in field samples will be discussed.

S.B. CALDWELL, R.O. McLEAN & M.F. CARDOSI (Department of Biological Sciences, University of Paisley)

Shock Proteins in Riverian Green Algae: A Possible Role in Metal Tolerance.

Certain filamentous green algae can develop tolerance to heavy metals. Their mechanisms of tolerance have however not been elucidated. Shock proteins are produced in many organisms and data are summarised for those formed in reaction to heavy metals in two filamentous greens. A possible metal binding function is described. Protein extracts from shocked algae were passed through metal-chelating sepharose resin. Three major fractions were collected with buffer, pH gradient and EDTA washes. The latter contained those proteins which bound strongly to the resin. These were not found in extracts from non-shocked algae. Phast gel electrophoresis employing silver stain of these fractions indicated the presence of high molecular weights equivalent to those of some of the shock proteins found in these algae. A metal binding function is proposed for these.

L.R. CARVALHO, E.J. COX. & P.A. SIMS (Department of Botany, The Natural History Museum)

The importance of diatom taxonomy for salinity and climate reconstructions.

To obtain more accurate reconstructions of past salinities and climate it is necessary to merge regional datasets of diatoms and water chemistry. This allows a fuller understanding of species optima and tolerances, and improves transfer functions where modern analogues of fossil taxa do not occur within the same geographical region. A saline lake

diatom flora is presently being developed for two of these regional datasets, the Great Plains of North America and North and East Africa. To ensure taxonomic consistency, a prerequisite to merging the datasets, all taxa will be tied to type material, or voucher material held at the Natural History Museum when the material is not available. To illustrate this process, investigations within the taxa *Cyclotella, Campylodiscus*, and *Navicula*-lineolatae group will be discussed.

Y.M. CHAMBERLAIN (School of Biological Sciences, University of Portsmouth).

Taxonomic characters in fossil and present nongeniculate, coralline red algae.

The fossil record shows that coralline red algae mainly originated and proliferated in the Cretaceous era and that many of the same taxa are still extant. *Sporolithon* (syn. *Archaeolithothamnion*) is regarded as one of the earliest genera. About 100 fossil species of *Sporolithon* have been described and about 18 species occur today. *Sporolithon* bears tetrasporangia in sori rather than conceptacles. Other fossil genera, such as *Parakymalithon* and *Palaeothamnium*, indicate a possible line of development leading to the multiporate asexual conceptacle structure seen in present genera of the Melobesioideae. It has proved difficult to relate present with fossil species, but it has recently been demonstrated that it is possible to identify cell fusions and secondary pit connections in fossils. This has enabled some of the fossils previously attributed to the subfamily Lithophylloideae to be reclassified in the Mastophoroideae. It has also been shown that the fossil species *Pseudaethesolithon iranicum* from the Miocene is conspecific with the present species *Hydrolithon reinboldii*.

R.M. CRAWFORD. (Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany).

The profiles of morphometric data from populations of the planktonic diatom *Corethron criophilum* in the South Atlantic.

The transapical dimensions (widths) of the valves of the planktonic diatom *Corethron criophilum* were compared over a two-month period in the South Atlantic in the austral Spring. The relative frequency of valves occurring in the different size classes were used to indicate the number and nature of the populations in the assemblage. Sexual populations were immediately recognisable by a small peak around the maximum dimensions for the species and a much larger peak around 1/3 of this size. Comparison of two stations 100km apart and at 5 depths down to 300m at both of these stations indicated remarkable similarity between populations and gave some idea of the scale of such a sexual event. Samples from the same nautical position but at earlier or later dates showed subtle differences in profiles that can be interpreted in terms of the life cycle of the species. Comparisons with samples from other locations on the same cruise show how different the profiles can be and that they may be used to confirm hydrographic and diatom community-structure data on the identity of various water masses.

M.J. DRING (Queen's University of Belfast and Biologische Anstalt Helgoland, Germany)

Untroubled Phycology: 25 Years of algal research in Northern Ireland.

For the last 25 years, Northern Ireland has had an unenviable international reputation for its political "Troubles" but, during the same period, phycological research in the Province has been particularly active, and this lecture will review and celebrate this quarter century of "untroubled" progress. Phycology has been prominent in the research at three academic institutions: Queen's University of Belfast (Dring, Savidge, Maggs), University of Ulster (Wood, Jewson) and the Department of Agriculture's Freshwater Biological Investigation Unit (FBIU, now part of the Agricultural and Environmental Sciences Division; Gibson, R.V. Smith, Foy). The research has covered a wide range of algal types (blue-greens, diatoms, seaweeds) and habitats (planktonic, epipsammic and epilithic flora in freshwater and marine sites), but the main emphasis has always been on aspects of the physiological ecology of the algal species. A variety of adaptations to the natural light climate has been studied, including effects of light quality and photoperiod on planktonic blue-greens and diatoms and on benthic marine macroalgae, and the interactions between light and nutrient supply have also been explored in the same algal groups. Long-term studies of the largest lake in the British Isles, Lough Neagh, convinced the local authorities that tertiary treatment of domestic sewage was necessary to control phosphate supply to the lake, and the results of this control have been monitored since the late 1970s. More recently, taxonomic and biogeographical problems in the red algae and the diatoms have been tackled using molecular techniques.

S.J.M. DROOP (Royal Botanic Garden Edinburgh)
What does morphology tell us about diatom species?

The detection of discontinuities in morphological variation has been the lynchpin of species-level diatom taxonomy almost from the beginning, but recently this simple approach has begun to seem increasingly inadequate, in the light of evidence of phenotypic plasticity, cryptic molecular variation and disagreement about the relative value of different morphological characters. Some authors lump, others split and there seems no objective way of judging which approach is best. So what role is there for morphology in diatom taxonomy at the species level?

Morphometric studies in *Sellaphora pupula* and *Diploneis smithii*, using computer-aided image-analysis, have shown that much of the variation that exists in sympatric populations is discontinuous when several characters are considered together, even though individual characters seem to show little, if any, discontinuity in the same populations. The morphotypes thus delimited are usually found in more than one geographically remote sample, and often show slightly different ecological preferences, as measured by the other diatom species present in the samples.

A "morphological" species concept is the only practical way to approach diatom systematics. But the concept needs to be calibrated by reference to data from other disciplines (e.g. breeding studies, molecular systematics) which, by their very nature, can only investigate the relationships between rather small numbers of taxa.

O.A. ESHTEWI (Biology Department, Faculty of Science University of Seventh April, Tripoli. Libya)
Observations on the regenerative growth of *Mastocarpus stellatus* sporelings after injury.

Discoid sporelings of the red alga *Mastocarpus stellatus* showed effective regenerative growth after various forms of artificial injury, involving removal of part or whole of the peripheral tissue. Subsequent regrowth tended to restore the discoid form with attached sporelings. Detached sporelings produced abnormal growth forms.

T.W. FORD, A.M. PAGE & A.D. STEAD (Department of Biology, Royal Holloway, University of London)
Effects of UV irradiation on the ultrastructure of the unicellular green alga *Chlorella*.

The effects of UV irradiation on the growth and physiology of a range of plants, including several algae, are well documented. Damage resulting from exposure to increasing doses of UV, in particular UV-B, are of current concern in relation to reported reductions in the atmospheric ozone layer. We have developed a system for irradiating monolayers of unicells with defined doses of monochromatic radiation using a beamline at the Synchrotron Radiation Source at the Daresbury Laboratory. Following irradiation, the cells can be recovered and processed for conventional transmission electron microscopy. Our initial experiments have shown varying degrees of injury, to different subcellular components of *Chlorella* cells, which are both dose- and wavelength-dependent. Membranes, in particular chloroplast thylakoids, showed a high sensitivity to UV irradiation and early signs of damage were also detected to cytoplasmic components. These preliminary results will be discussed in relation to reports of metabolic inhibition due to enhanced UV exposure and also to the doses of UV necessary to elicit such damage.

R.J. GEIDER (University of Delaware)
A dynamic model of algal photoadaptation.

The kinetics of photoadaptation are described in terms of changes in the rates of synthesis of three intracellular carbon pools. These pools account for the distribution of cell material between light-harvesting, the biosynthetic apparatus and energy storage. Regulation of the flow of recent photosynthate to these pools is parameterized by the ratio of realized to potential maximum photosynthetic electron flow. The mechanistic basis for this parameterization rests on recent results demonstrating that photoadaptation is regulated by the reduction state of the plastoquinone pool within the photosynthetic electron transfer chain. The responses of growth rate, chlorophyll*a*:carbon ratio (Θ), and chlorophyll*a*-specific light-saturated photosynthesis (P_m^{chl}) to irradiance in balanced growth can be adequately described by specifying five parameters. Three of the parameters can be readily derived from measurements of the initial slope of the PI curve, the maximum growth rate and the maximum value of Θ observed under light limitation. The fourth parameter is the energy efficiency of biosynthesis which can be constrained by basic bioenergetic principles, and the fifth parameter is the maintenance metabolic rate. The time course of photoadaptation of photosynthesis and chlorophyll synthesis are also predicted by the model.

R.F. GLENN, H.A. EPTON & D.C. SIGEE (School of Biological Sciences, University of

Manchester, Oxford Road, Manchester M13 9PT)
Laboratory studies on actinomycete antagonists of blue-green algae.

Four isolates of *Streptomyces* sp. have been shown to limit the growth of the bloom-forming algae *Anabaena cylindrica* and *Microcystis aeruginosa* in liquid cultures and on agar lawns. The laboratory assessment of antagonistic effects depends on a range of parameters, including growth status of antagonist, mode of challenge and monitoring procedures for algal growth. The mode of action involves short range activity of antibiotics, and close association of antagonist and algae within clumps appears to be important. The response of algal cells in terms of changes in elemental composition and fine structure will be discussed.

R.L. GRIFFIN, D.J. ROGERS[1], A.M. MILAD[1] & P.T.N SPENCER-PHILLIPS (Department of Biological Sciences, University of the West of England, Bristol and [1]School of Pharmacy and Biomedical Science, University of Portsmouth).
Demonstration of erythrocyte surface structures by gold-labelled lectin from *Codium fragile* ssp. *tomentosoides*.

The lectin from the green marine alga *Codium fragile* ssp. *tomentosoides* is known to bind N-acetyl-α-D-galactosamine (GalNAc) and to produce powerful agglutination of human A, erythrocytes. In order to study the distribution and arrangement of erythrocyte-surface receptors for the *C. fragile* ssp. *tomentosoides* lectin, we have conjugated colloidal gold to the lectin and examined lectin-binding to the erythrocytes by transmission electron microscopy.

Lectin was purified from aqueous plant extracts by affinity chromatography and coupled to colloidal gold by standard methods. Human A, erythrocytes, 2%, were treated with the labelled lectin and dried on copper grids coated with Formvar and evaporated carbon. The whole cells were examined in a transmission electron microscope at an accelerating voltage of 100 Kv. Distribution of colloidal gold on the thin edges of the erythrocytes could be readily examined. Ring-type arrangements of the colloidal gold, were demonstrated.

V.A. GROSS & D.P. CHENEY (Marine Science Center, Northeastern University, Boston. USA)
Biological and oceanographic causes of a long-standing algal bloom of *Pilayella littoralis* on Massachusetts Beaches.

A persistent algal bloom caused by an unusual free-living form of the filamentous brown alga *Pilayella littoralis* (L.) (Ectocarpales) has been fouling beaches north of Boston for over 100 years. The ball-shaped plants can accumulate on the sandy beaches in amounts up to hundreds of tons per day decaying casts cause production of H_2S and complaints from residents and recreational visitors.

Re-examination of the sources of the algal bloom indicate that it is not caused by a mutant, as previously suggested. Biological and coastal-oceanographic studies; including genetic analysis, detachment experiments, current meter and bottom-drifter observations, indicate that attached plants are the ultimate source of the free-living form. Experiments with attached *P. littoralis plants* demonstrated that they become easily detached and produce fragments that vegetatively reproduce and grow at a high rate. Furthermore, the massive beach fouling caused by algal blooms during summer and fall appear to be due to Nahant Bay hydrography and regional current patterns and coastal upwelling.

M.D. GUIRY & J.M. RICO-ORDÁS (The Martin Ryan Marine Science Institute and Department of Botany, University College, Galway, Ireland)
Species concepts and breeding patterns in the *Gigartinaceae* and *Gelidiaceae* (Rhodophyta).

For any group of organisms there is an adolescent phase of great confusion and uncertainty during which we become unsure of our ability to recognise species. In a young taxonomy, there is vast enjoyment in the collection and description of morphological toys, and in the pursuit of the new and the clarification of the old. In the latter stages of pre-adolescent taxonomy, morphological criteria become insufficient for the separation of a few entities and appetites develop for other species delimitation criteria. These developmental stages are apparent in red algal taxonomy particularly in the widespread and common, commercially important families *Gigartinaceae* and *Gelidiaceae*. The development of reliable culturing techniques has greatly aided in the maturation of rhodophytan taxonomy, and the recently developed ability to cross experimentally "suspicious" entities has been of considerable assistance in species taxonomy. Once morphotaxonomic problems are sorted out, entities with *Polysiphonia*-type life histories generally breed with great facility throughout their biogeographical ranges; however, allopatric breeding populations may be an important feature of species with heteromorphic life histories, perhaps due to independent selection pressures on the two morphological phases. What of the adult phase of taxonomy? Molecular investigations, particularly of

appropriate bits of the genome, can certainly provide valuable clues as to the evolutionary relationships between species. Nevertheless, in the day-to-day grind of species determination, eye and brain are more than adequate for species delimitation in most red algae.

P.K. HAYES, G.L.A. BARKER & A.E. WALSBY (School of Biological sciences, University of Bristol, Woodland Road, Bristol, BS8 1UG).

The distribution and diversity of gas-vacuolate, filamentous cyanobacteria in the Baltic Sea.

The surface waters of the Baltic are subjected to frequent wind-induced mixing events. Gas-vacuolate cyanobacteria, of the genera *Nodularia* and *Aphanizomenon*, form extensive waterblooms in this area during the summer. Vertical distribution profiles show that after deep mixing events the population of colonies moves up through the water column at a velocity of 22 m day^{-1}, similar to the rate observed for isolated colonies. Upward movements in calm conditions provide a selective advantage to colonial cyanobacteria by enabling them to float into an area of higher irradiance near the surface. The gas vesicles of both *Nodularia* and *Aphanizomenon* in the central basin of the Baltic collapse at a mean pressure of between 0.83 and 0.9 MPa; they appear to have been selected to be strong enough to withstand the pressure generated as a result of winter mixing down to the permanent halocline (60 - 90 m). Nearshore isolates have gas vesicles that collapse at 0.34 MPa, strong enough to withstand the pressure generated by mixing to shallower depths. Clonal cultures of *Nodularia* from widely separated locations within the Baltic have been established. A preliminary description of the diversity of forms represented in this collection of strains will be presented.

R.M. HEAD (Biological Sciences, IEBS, Lancaster University and IFE, Edinburgh)

The use of a trapping technique to assess the recruitment of cyanobacteria from the benthos to the plankton in lake ecosystems.

In lakes, some species of planktonic cyanobacteria 'overwinter' on the benthos as dormant colonies or akinetes (spores). This benthic population may be an important source of recruitment to the phytoplankton for future populations. The migration of cyanobacteria from lake sediments is also a potential means of nutrient translocation, particularly during summer stratification.

A simple technique using traps to catch algae and cyanobacteria moving up from the sediments was used to quantify the migration. The results suggest that algae move upwards through the water column from on, or close to, the sediments. However, there are problems with this method as a means of quantifying a rate of migration from the benthos which will be discussed.

S.I. HEANEY, C.E. GIBSON, N. BONDARENKO, N. GUSELNIKOVA, N. GRANIN & A.I. TANICHEV (Dept of Agriculture, N.I.)

Planktonic diatoms under the ice in Lake Baikal.

Lake Baikal is a huge lake situated in Siberia. Although the lake is nearly 1600m deep, there is a fine scale pattern in the surface layers that needs careful sampling to resolve. During the winter, the lake freezes to a depth of more than 70cm, and a crop of planktonic diatoms may develop under the ice.

Observations are reported of the distribution of *Aulacoseira baicalensis* in the water below the ice in March 1994. Convection driven by solar radiation is important for mixing the water; this and other possible mechanisms for keeping the cells in the surface layers are discussed.

I. HERNANDEZ & R. GARCIA-RUIZ (Department of Ecology, University of Cadiz and Department of Ecology, University of Malaga)

Studies on phosphatase activity of marine and freshwater algae. Reflections and comments.

Studies of alkaline phosphatase activity (APA) on macroalgae and microalgae have suggested that a great proportion of the phosphate liberated from a xenobiotic substrate (pNPP) are not used directly by the algae. However, measurements with a labelled natural phosphomonoester (glucose-6-phosphate) revealed that alkaline phosphatase activity accounted for a significant proportion of the phosphorus requirements in algae. Kinetic studies and the influence of some factors important in the field may suggest future studies on APA of freshwater algae.

T.O. HILL[1,2] & T.A. NORTON[1] ([1]Port Erin Marine Laboratory, University of Liverpool, Port Erin, Isle of Man; [2] JNCC, Monkstone House, City Road, Peterborough. PE1 1JY).

Holding Your Zone: Growth Rates of Competing Seaweeds on the Low Shore.

Recent investigations into the factors controlling the zonation of macroalgae on the low shore have suggested that the role of competition may be important in controlling the upper- as well as the lower-zonal limits of algae.

On a moderately exposed rocky shore on the Isle of Man, the *Fucus serratus* and *Laminaria digitata* zones abut at 1.4 m above LAT. Beneath the mixed canopy in this area, juveniles of both species are common. *In situ* measurements of juvenile growth rates were used to investigate the influence of competition and physical factors on the growth of juvenile canopy algae.

It was found that juveniles of both species grew significantly faster in cleared areas than beneath a mature canopy. During the spring, the growth rate of young *L. digitata* was significantly greater than that of *F. serratus*. When spring tides coincided with sunny weather, however, *L. digitata* showed no net growth as the algae were bleached as fast as they grew.

It is suggested that *F. serratus* is excluded from the sublittoral fringe by the competitive superiority of the laminarians. In addition, the faster growing *L. digitata* juveniles often extend the upper limit of their zone by out-competing young fucoids above. *F. serratus* is only able to recover lost ground when the growth of the uppermost *L. digitata* plants is curtailed by physical factors.

D.M. JOHN (Department of Botany, The Natural History Museum, London, UK)

Species usage, concepts, and problems in Green Algae.

Green algae *sensu lato* are unicellular, colonial, or filamentous and possess chlorophylls *a* and *b*, flattened mitochondrial cristae, and starch contained in double membraned plastids. The large majority of the ca. 15,000 species forming the four green algal lineages are defined explicitly on morphological criteria. So far the biological species concept has been applied to few species since sexual reproduction is rare amongst green algae and clonal cultures are required to test mating compatability. Increasingly the status of a significant number of 'morphospecies' is being brought into question as culture-based experiments reveal that traditionally-used morphological traits are affected by extrinsic factors. Still largely untested experimentally is any variation exhibited by morphological traits as revealed by electron microscopy. Discussed will be the taxonomic implications of culture-based research and the role of restriction analysis and gene sequence data in defining species. The biological and molecular species concept in green algae will be considered along with studies that have shown the morphological concept to be congruent with or more conservative than other species concepts. Further morphological, physiological and biochemical data are needed to more rigorously test the congruence of different species concepts.

A. M. JOHNSTON. (Department of Biological Sciences, University of Dundee, Dundee. DD1 4HN).

The effect of CO_2 concentration on the growth rate and inorganic carbon discrimination by *Phaeodactylum tricornutum*.

CO_2 is one three potential forms of inorganic carbon aquatic photosynthetic organisms can use for photosynthesis. The atmospheric CO_2 partial pressure is about 36.5 Pa CO_2 and increasing at a rate of 0.1 Pa CO_2 per year. The marine diatom *Phaeodactylum tricornutum* was grown in media equilibrated with atmospheric CO_2 partial pressures of 29, 36, 101 and 232 Pa CO_2, a range of values from just below to well above ambient levels. Increasing the CO_2 partial pressure has the effect of decreasing the pH of the media with only a small change in the total inorganic carbon concentration when the alkalinity remains constant. The growth rates were not affected by the differences in CO_2 partial pressure. The photosynthetic rates, measured under the conditions of growth, were the same for all CO_2 partial pressures. The $\delta^{13}C$ became more negative with increasing CO_2 partial pressure. The isotopic composition of source carbon was much more negative (-28 to -34‰) than normal atmospheric CO_2 (-8‰) and varied from cylinder to cylinder. For this reason the level of discrimination is presented as Δ. At 29 Pa CO_2 Δ values of 10.8‰ were observed which increased to 17.3‰ at 232 Pa CO_2. This data is used to determine whether internal CO_2 concentrations can be estimated from Δ values from marine phytoplankton.

R.I. JONES (Biological Sciences, Lancaster University)

Light, not phosphorus, limits phytoplankton development in oligotrophic Loch Ness.

Phytoplankton development in nutrient-poor, north temperate lakes is generally considered to be limited by the availability of phosphorus. Concentrations of dissolved inorganic phosphorus in Loch Ness are invariably below the limit of detection of standard analytical methods, while on the basis of its very low concentrations of phytoplankton (maximum chlorophyll*a* around 1.5 mg m^{-3}) Loch Ness would be classed as oligotrophic. However, a variety of evidence leads to the view that the restricted development of phytoplankton is principally a reflection of the exceptionally unfavourable underwater light climate in the loch, which imposes very slow growth rates

on the component species within the phytoplankton community. In consequence, although the available concentrations of nutrients, and particularly of phosphorus, in the loch are low and consistent with the classification of Loch Ness as an oligotrophic lake, even these low nutrient concentrations cannot be fully exploited during the growing season by the phytoplankton.

R.E. KORB[1,2], A.M. JOHNSTON[1], J.A. RAVEN[1] & J.W. LEFTLEY[2]. ([1]University of Dundee, [2]DML).

Continuous cultures: a tool for investigating $^{12}C/^{13}C$ ratios in marine diatoms.

Marine algae exhibit a wide range of isotopic values (from -11 to -39‰). In the marine environment stable carbon isotopes of plankton are often used as a proxy for past and present ocean CO_2 concentrations and biological productivity. However, a number of investigators have argued that factors such as phytoplankton fixation pathways, species composition, or growth rates significantly influence the $\delta^{13}C$ of marine phytoplankton. The effect of such factors on the $^{12}C/^{13}C$ ratios of marine algae need further investigation if $\delta^{13}C$ values are to be correctly interpreted in marine geological records.

In batch cultures, $\delta^{13}C$ values have been found to vary as much as 6‰ in species of marine diatoms grown repeatedly under constant conditions. Batch cultures experience a constantly changing environment as nutrients are consumed and waste products released which may influence the degree to which phytoplankton discriminate against ^{13}C. In an attempt to standardise growth conditions and achieve constant $\delta^{13}C$ values, the diatoms *Chaetoceros calcitrans* and *Ditylum brightwelli* are being grown in continuous culture. These are constant volume cultures provided with a continuous inflow of new medium and a corresponding outflow of culture. Dilution rates equals specific growth rates and cell density remains constant. Cultures are maintained at a low cell density, ensuring light and nutrients are not limiting. $\delta^{13}C$ values were not stablised in the continuous culture system. Varying CO_2 concentration was indicated as the probable cause of the fluctuations in $\delta^{13}C$ values.

J.E. KÜBLER & J.A. RAVEN, (Department of Biological Sciences, University of Dundee, Dundee, Scotland DD1 4HN UK)

Carbon acquisition of red seaweeds grown under dynamic light regimes.

Palmaria palmata, which is able to use HCO_3^- as a carbon source for photosynthesis and *Lomentaria articulata* which is dependent on diffusive uptake of dissolved CO_2, were grown under constant light and light with sunflecks designed to model canopy movements and wave-induced fluctuations of near-shore underwater light. Both species exhibited significantly increased stable carbon isotope discrimination (more negative values of $\delta^{13}C$ relative to PDB) when grown with sunflecks. More negative $\delta^{13}C$ values were associated with decreased growth rate of *P. palmata* but not of *L. articulata*. Fluctuating light increased rates of dark respiration measured during the light period, suggesting that the decreased growth rates were due to lower net carbon acquisition during the day. For *P. palmata*, in which the effectiveness of HCO_3^- uptake has been previously demonstrated to be dependent on growth light level, effectiveness of carbon uptake was inversely proportional to light fleck length and the period of light variations. These results suggest that measurements made under constant light in the laboratory may overestimate the actual rates of carbon uptake under the dynamic light environment in nature.

M. LANGE & L.K. MEDLIN (Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany)

Genetic diversity in the genus *Phaeocystis*.

Sequence data from the 18S small subunit ribosomal RNA gene have been used to support the species status of three colony-forming species of *Phaeocystis* Lagerheim (Prymnesiophyta). Two of these correspond to the well-established species, *Phaeocystis globosa* Scherffel and *Phaeocystis pouchetii* (Hariot) Lagerheim. The third species originates from antarctic waters and is referred to *Phaeocystis antarctica*, described by Karsten at the turn of the century. Morphological and physiological data support the separation of these three species. Differences in DNA content as measured by flow cytometry indicate that *Phaeocystis globosa* is a species complex. A fourth species is also reported from the Mediterranean, but this species has only been found in the haploid flagellated stage. Phylogenetic trees generated from the sequence data suggest that the Mediterranean species diverged prior to the 3 colony forming species. The warm water lineage diverged prior to the separation of the cold water lineage. Tectonic events and climatic changes during the middle to late Cenozoic provide mechanisms by which speciation events could have occurred as both polar oceans were being formed.

B.S.C. LEADBEATER, A. KITE, A.J. KARLEY[1] & K.R. WOOD. (School of Biological Sciences, University of Birmingham, [1]Churchill College, University of Cambridge).

'Bottle brush' development of plurilocular sporangia in *Ectocarpus siliculosus* (Dillw.) Lyngb.

From freshly collected wild material a series of cultures of *Ectocarpus siliculosus* was established from released zoospores and thallus fragments. Most cultures produced plurilocular sporangia in the normal fashion which, when mature, released zoospores into the medium. However, in one culture a proportion of plurilocular sporangia consistently failed to release spores but instead developed a mass of filaments giving the sporangium a 'bottle-brush' appearance. Electron microscopy of developing 'bottle-brush' sporangia reveals that the early stages of sporangial development proceed normally but that at a later stage the spores fail to develop flagella or flagellar hairs. An eyespot, which is usually associated with motility, develops as usual within each spore. Instead of mature bottle-brush sporangia dehiscing to release motile spores, the non-motile cells remain within the sporangium and some, but not all, germinate *in situ*. Mature bottle-brush sporangia, which eventually fall off the parent filament, grow and produce new plurilocular sporangia that develop and release spores normally.

S.C. MABERLY, D. PLANAS[1] & J.E. PARKER (Institute of Freshwater Ecology, Windermere, UK; [1]Universite du Quebec a Montreal, Canada)

Phosphorus availability for *Cladophora glomerata* in Windermere.

Cladophora glomerata has become abundant in the South Basin of Windermere since 1989 but less so in the less productive North Basin. Nutrient analysis showed that *Cladophora* from the South Basin had higher average contents of N than *Cladophora* from the North Basin and the suggested rate-limiting content (1.3% dry weight) was never reached. In contrast, the average P-content was about 0.24% dry weight in both basins and the suggested rate-limiting P-content (0. 16%) was reached in 31 % of samples from the South Basin and 37% from the North Basin. Nutrient-uptake experiments showed that the maximal rate of PO_4-P uptake was generally very high in both basins and typical of P-limited plants. Ambient pelagic concentrations of PO_4-P would only allow between 0.1% and 1.1% of maximal uptake rates but these were just sufficient to support the observed increase in P-standing stock. Similar calculations for NO_3-N gave uptake rates which were 21 to 30% of maximum and these were between 4-times (N Basin) and 25-times (S Basin) greater than the observed increase in N standing stock. Overall the data suggest that P is the primary nutrient limiting *Cladophora* biomass in both basins.

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

Comparative molecular, morphological and life-history studies of the genus Pikea (Dumontiaceae, Rhodophyta) in the Atlantic and Pacific Oceans.

An abundant population of a *Pikea* species attributed to *Pikea californica* Harvey was discovered in 1983 in the Isles of Scilly, Cornwall, where it has been established since at least 1967. Otherwise, this species was believed to be confined to the Pacific Ocean, in Japan and from Alaska to Baja California, Mexico; it was suggested that the English population could have been introduced from California by war-time flying boats.

The life history of *P. californica* from Scilly is identical to that of a Californian isolate, with crustose tetrasporophytes and dioecious erect gametophytes. In contrast, *Pikea* thalli from Banda, Japan, which initially appeared to be cystocarpic, were found to have tetrasporangial nemathecia growing over the "cystocarps". The thalli were monoecious and the tetraspores grew directly into erect thalli. Japanese *Pikea* thus forms tetrasporoblasts, in a life history strikingly different from that of the Scilly and Californian populations, and undoubtedly belongs to a different, undescribed, species.

Taxonomists differ with regard to the number of species of *Pikea* that occur in California, some floras including *P. pinnata* Setchell and/or *P. robusta* Abbott in synonymy with *P. californica.* Material from near Golden Gate, San Francisco, the type locality of both *P. pinnata* and *P. californica*, appeared morphologically to consist of two separate forms, corresponding to the type specimens of these two species. Analysis of plastid DNA restriction fragment banding patterns clearly indicates that these species are distinct from each other and from the Japanese one; DNA from the Scilly and Californian *P. californica* gave almost identical patterns, supporting the hypothesis of a Californian origin of the English population. *P. robusta* appears to be a synonym of *P. pinnata,* but there may be one or more undescribed *Pikea* species along the coasts of Pacific North America.

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

Gamodemes and genodemes in diatoms: the biological species concept in action.

Detailed analyses of morphological, molecular or any other characteristics will always reveal discontinuities or unevennesses in the pattern of variation, but which of these correspond to boundaries between varieties, which to those between species and which to those between genera? The biological species concept is variously assumed to be impractical, undesirable, irrelevant, the only species concept, or the only concept that can be objective. The value of the biological concept will be explored with reference to raphid diatoms, where mating patterns can be studied fairly readily in mixed semi-natural populations. In the genus *Sellaphora,* most species and populations that have been examined exhibit allogamous sexual reproduction during the formation of the auxospore. Closely related species, such as *S. bacillum, S. laevissima* and *S. pupula*, which often grow together in nature, have proved to be reproductively isolated. So also, however, are morphologically distinct, sympatric populations of *S. pupula.* These differ with respect to continuously varying, quantitative characters, such as striation density, striation pattern, central area shape, valve shape. Similar behaviour occurs in other genera. The biological species concept can perhaps be viewed as a practical guide to interpretation of the variation pattern and to the equivalence of the species category between different plant and animal groups. On this basis, *S. pupula* and similar diatom "species" should be split and the total number of diatom species increased to perhaps 2×10^5.

B. MARIN (Universität zu Köln, Botanisches Institut, Gyrhofstr. 15, 50931 Köln, Germany)

Phylogeny of prasinophytes inferred from classical markers and ribosomal RNA sequence comparisons.

Scaly green flagellates (prasinophytes) display a great variety of structural characters (e.g. cell shape, flagellar apparatus, scales, flagellar hairs). Though it is generally accepted that prasinophytes are the most ancient green algae, the phylogenetic relationships among prasinophytes and their affinities to advanced green algal classes (Charophyceae, Chlorophyceae, Ulvophyceae, Microthamniales) have been controversially discussed and obviously cannot be resolved by ultrastructural characters alone.

Complete nuclear-encoded small subunit ribosomal RNA sequences were determined for several prasinophytes and used to analyze the phylogeny of these taxa and their relation to other green algae by neighbour-joining, maximum parsimony and maximum likelihood phylogenetic analysis. This study demonstrates that all advanced green algal classes are derived from different prasinophyte lineages. The class Prasinophyceae (*sensu* Moestrup and Throndsen) is therefore not a monophyletic taxon. Since most interrelations between prasinophyte genera are resolved by this analysis, the phylogeny of different ultrastructural characters, especially the flagellar apparatus, scale types, flagellar hairs and eyespot apparatus, can be discussed in detail.

L.K. MEDLIN (Alfred Wegener Institute for Polar and Marine Research, Bremerhaven Germany)

Can molecular techniques enhance our understanding of a species concept?

Speciation is one of the more controversial issues in biology. Molecular techniques help to define species limits, especially when these studies can be coupled with other techniques. rRNA sequences are often used in studies of taxonomic affinity because they are highly conserved; sequence identity indicates a longstanding relationship, whereas sequence differences indicate ancient divergences. Polymorphisms in rRNA sequence data among strains with no morphological distinctions can indicate a "species complex", although local population variation cannot be ruled out. Examples are provided from the diatoms, haptophytes, dinoflagellates, protozoa, and macroalgae to illustrate the detection of a species complex with molecular techniques. Comparisons are made with studies of local population variation.

L.K. MEDLIN, R. GERSONDE, W. KOOISTRA, P. SIMS, & U. WELLBROCK (Alfred Wegener Institute for Polar and Marine Research, 27570 Bremerhaven Germany)

The paraphyletic origins of the centric diatoms.

In a preliminary analysis of diatom phylogeny based on rRNA sequence comparisons, evidence was presented to suggest that the centric and araphid pennate diatoms were not monophyletic. An intensive sequencing program of centric taxa has confirmed this initial observation. The diatoms diverged early into two groups. However, these two groups do not correspond to the traditional centric and pennate diatoms. One group is defined by the groups of the Coscinodiscales, Rhizosoleniales, Melosirales. The second group contains bipolar centric taxa, centric taxa with strutted processes, and the pennate diatoms. Thalassiosiraceae is one of the youngest groups to diverge. Support for this split in the diatoms comes

from the earliest best preserved diatom deposit, the ODP Leg 113 from Antarctica.

M. MELKONIAN (Universität zu Köln, Botanisches Institut, Lehrstuhl I, Köln, Germany)
Current trends in green algal systematics: from species to class level.

In recent years the systematics and phylogeny of green algae has been strongly affected by the application of molecular techniques. Diverse molecular markers (e.g. nuclear and plastid encoded ribosomal RNA, ITS sequences, protein coding genes like actin or centrin, RFLP and RAPD markers) have been used to address questions of green algal systematics and phylogeny ranging from species to class level. A review will be given about the current status of molecular phylogenetic analyses in green algae both at the species and at higher taxonomic levels. The species concept in the scaly green flagellate *Tetraselmis* based on morphological and molecular analyses of over 250 strains will be discussed. The putative origin of the major green algal classes from scaly green flagellates will be outlined and the discovery of a flagellate related to the ancestry of the embryophyte land plants will be reported.

NETO, A.L. & FARNHAM, W.F. (Dept de Biologia, Universidade dos Azores, Marine Laboratory, University of Portsmouth).
Structure and seasonal variation of benthic algal communities on Sao Miguel island (Azores).

This paper presents the preliminary results of an ongoing investigation into the subtidal benthic marine algal communities at two sites on the island of Sao Miguel (Azores). The northern site (Sao Vicente) is more exposed to wave action than the locality on the south coast (Sao Roque).

The composition of the algal communities was examined in terms of percentage cover and biomass of component species over the period September 1994 to October 1995 at three depths (5, 10 and 15m).

Biodiversity was variable at both sites according to depth and time of year. At S. Roque, which had the greatest species diversity, the number of species generally decreased over spring and summer from peaks in autumn-winter, while at S. Vicente, the numbers of the species were more consistent throughout the year at 10 and 15m but were variable at 5m. Biomass determinations, from dry weights obtained from random, cleared quadrats ($0.25m^2$), also showed differences between the two sites. At S. Roque, biomass was consistently low at 10 m and 15m, while at 5m it was higher but more variable. The north site showed the opposite trend: lower but steady dry weights at 5m over the year, with higher but more variable values at 10 and 15m depths. The dominant species also varied between sites. At S. Roque, erect corallines were most abundant at shallow depths with *Halopteris scoparia*, *Dictyota* spp., *Zonaria tournefortii* and *Asparagopsis armata* dominant deeper, while at S. Vicente, there was a greater variety of abundant species at all three depths.

Many of the algae showed a marked seasonality in their occurrence: *Hypnea musciformis* most abundant in the summer, *Gigartina acicularis* found mainly in the autumn and *A. armata* most abundant in the winter-spring.

The two sites are continuing to be monitored to find whether these variations are typical and how they are caused.

F.X. NIELL, J. VILLALOBOS & J.A. FERNANDEZ[1]. (Department of Ecology and [2]Department of Plant Physiology. Faculty of Sciences. University of Malaga. Spain)
Differential use of phosphate by two epilimnetic communities.

There is frequent the presence of two Chlorophyll maxima in the Epilimnion of the stratified reservois the depth and two times depth the secchi disk. The use of phosphorus by both aggregations of algae are discussed in terms of uptake and release of P04 activities related with some functional and physiological characteristics of the cells, as surface/volume ratio, internal phosphorus content and the disponibility of sustrata. The performances are very different in both aggregation of cells, the strategies in terms of efficiency are presented and discussed.

S. NOTODIMEDJO & B.O. GABRIELSEN (Fac. of Ag. Brawijaya Univ. Malang, Indonesia, Algea A/S, P.O. Box 68, N-3401 Lier, Norway)
The effect of seaweed extract on the growth and production of apples in Indonesia.

Two field trials were carried out in two consecutive years to study the effect of seaweed extract (Algifert from Algea A/S, Norway) on the growth and production of apple varieties Rome Beauty and Manalagi grown under tropical conditions in East Java, Indonesia. The experiments started in 1992 and finished in 1994. In the first trial 5 different concentrations of a 25% solution of Algifert were used, namely 0, 2, 3, 4, and 5 ml l^{-1} of water on the Rome Beauty variety. The second experiment was carried out on the Manalagi variety with 4 different concentrations of

Algifert, (0, 3, 4, and 5ml l^{-1} water). A total of 8 applications were made by foliar spray, the first after bud break and the last, two weeks before harvest. The results showed a significant increase in leaf area in Rome Beauty which was not seen in Manalagi. The apples were graded according to size, A, B, C; A being the largest and C the smallest. In Rome Beauty there was a significantly higher proportion of grade A in the group which received 4 ml Algifert l^{-1}. In the Manalagi there was a significantly higher number of grade B in the 3 and 5 ml Algifert l^{-1}.

In the organoleptic test of Rome Beauty, the skin colour and aroma was significantly better for all treatment groups whereas there was an improvement for hardness of the pulp and taste in the 3, 4 and 5 ml Algifert l^{-1} group. In the Manalagi experiment the only observation was a significantly higher score for the hardness of the pulp in the group which received 5 ml Algifert l^{-1}

J.L. OLSEN & W.T. STAM (Department of Marine Biology, University of Groningen, Biological Centre, P.O. Box 14, 9750 AA Haren, The Netherlands)

Phylogenetic species concepts, molecular data and taxonomic decision making.

Molecular data of various types are providing a wealth of new information about phylogeny in all of the major algal lineages. Most studies are still concentrating on higher order relationships based on 18S and *rbc*L sequence data. Studies at the family, genus and species levels are still relatively sparse. At the last level moderately fast evolving spacer sequences such as the rDNA internal transcribed spacers, the rubisco spacers and cpDNA-RFLPs are proving useful. At the species level itself, however, molecular data can be both powerful and misleading. Species must be recognized on the basis of monophyletic groups. That seems simple enough. But is it? This talk will explore the interacting problems of inadequate classical taxonomy, effects of taxon sampling, the choice of molecular data (DNA sequences and RAPDs for example) and data analysis. The question is, "How much genetic variation is necessary before recognizing a new phylogenetic species?" Examples from our own laboratory and the published literature will be used to illustrate the four factors and how they drive the decision making process. The take-home-lesson is caution. The fact that two samples are different *may or may not* be justification for species recognition.

B. PANKRATZ & L.E. SHUBERT (Department of Biology, The University of North Dakota USA and Department of Botany, The Natural History Museum)

Periphyton Response in a Contaminated Saline Wetland.

Kellys Slough, a wetland area surrounded by natural prairie and agricultural land, was studied during the 1994 growing season for the growth and distribution of periphyton on artificial substrates in relation to physical, chemical and climatic factors. Kellys Slough is of ecological importance since it is used as a spring and fall migration stopover for ducks, geese and other aquatic birds. The receiving water was supplied from a drainage canal that was contaminated with a variety of inorganic and organic substances originating from sewage discharges, oil spills, and non point sources. Conductivity was lowest at the site (#1) where the drainage canal discharged into the wetlands (900-1200 μS cm^{-1}) compared to distal sites (2000-10000 μS cm^{-1}). The pH of site #l was 7.5, and the other sites were higher (pH 8-9). Phosphate and nitrate were not limiting. At all sites, periphyton biomass (measured as chlorophyll *a*) and primary productivity (measured as the uptake of $H^{14}CO_3^-$) increased throughout the growing season, peaking in late July. Periphyton responded positively to the drainage canal discharge, since the highest chlorophyll *a* biomass (mean 0.51 mg cm^{-2}) and primary productivity (mean 0.55 mg C mg^{-1} Chl*a* hr^{-1}) occurred at site #l throughout the growing season. At the other sites, algal biomass ranged from 0.19 - 0.44 mg cm^{-2} and productivity ranged from 0.07 - 0.12 mg C mg^{-1} Chl*a* hr^{-1}. The wetland ecosystem will be characterized by CCA to determine the relationship of periphyton to abiotic factors, demonstrating the use of algae as ecological indicators.

G. PEARSON & I.R. DAVISON. (Dept. Plant Biology, University of Maine, Orono, ME 04469, USA).

Photoinhibition in Intertidal Brown Algae.

Two species of fucoid macroalgae, which are structurally dominant members of the rocky intertidal communities on the coast of Maine, were studied to characterize their responses to photoinhibition (Pi). The relative importance of repair and photoprotective mechanisms were studied using inhibitors of chloroplast protein synthesis (streptomycin), and the xanthophyll cycle inhibitor dithiothreitol (DTT), respectively. Photosynthesis-irradiance data indicated that Pi occurred in lower shore *Fucus evanescens* at the highest irradiance tested (1800 μmol photons m^{-2} s^{-1}), but not in

upper shore *F. spiralis*. Following 3 h at 1500 μmol photons m^{-2} s^{-1}, light-saturated photosynthesis (P) was unaffected in both species. However, light-limited P declined, and the extent of recovery was lower in DTT treated plants, particularly *F. spiralis*. Streptomycin had no effect on photosynthesis or chlorophyll fluorescence kinetics during recovery from Pi in either species. Addition of DTT to the medium caused a large decline in fluorescence quenching (q). The decline in q was greater in *F. spiralis* than in *F. evanescens*. Recovery of F_v/F_m following 3 h Pi was similar in both species, most recovery occurred within 2 h and values reached control (non-photoinhibited) levels within 6 h of a return to low light. When DTT was present, F_v/F_m did not fully recover in either species, although this may be due to different mechanisms: in *F. spiralis* F_o increased, without a significant decline in variable (F_v) or maximum (F_m) fluorescence, whilst in *F. evanescens* the converse occurred and a decline in F_v was responsible for decreased F_v/F_m. The results are discussed with reference to possible photoprotective mechanisms occurring in fucoid algae.

J. PLUMB & J. BRODIE (Applied sciences, Bath College of Higher Education, Newton Park, Newton St. Loe, Bath, BA2 9BN)

Endophytic flora of the red alga *Chondrus crispus* from Britain. Some endophytic morphological change with the addition of nutrients.

The red alga *Chondrus crispus* Stackhouse is host to numerous pigmented endophytic green and brown filamentous algae. Species belonging to the genera *Acrochaete* Pringsheim and *Streblonema* Pringsheim have successfully been isolated from both sporophytic and gametophytic intertidal plants of *C. crispus* from Britain. Endophytic algae, isolated from plants of *C. crispus* from Lilstock in Somerset, were studied in unialgal culture over a range of nutrient concentrations, under laboratory conditions. Unialgal cultures were incubated at 15°C, 16:8h light:dark regime in pasteurized seawater, enriched with Von Stosch nutrient medium at 5, 10, 20 and 30 ml l^{-1} of seawater. The morphology of a species assigned to the genus *Streblonema* was shown to be influenced by nutrient concentration. Variation in cell size and shape, together with varied production of true phaeophycean hairs and plurilocular sporangia were shown to occur as a result of nutrient enrichment. Such morphological change in relation to nutrient concentration raises the problem of identification of these endophytic brown algae, and thus their taxonomic status.

R.T. PRICE[1,2], B.S.C. LEADBEATER[1], T.R. BOTT[2] & B. GUBBINS[3] (Schools of [1]Biological Sciences and [2]Chemical Engineering, University of Birmingham, and [3]Anglian Water Services Ltd).

Ozonation of *Oocystis* cultures in relation to water treatment processes.

Algal cells and their polymeric extracellular products have been shown to interfere with chemical clarification during water treatment. The severity of this interference is related to the concentration and species of algae present. One possible method of overcoming this problem is to ozonise raw water prior to treatment. This has the multiple effect of killing algal cells, oxidising algal extracellular products and improving subsequent chemical treatment. A laboratory study has been carried out using the green alga *Oocystis* sp. (CCAP 257/7), an alga known to interfere with chemical water treatment processes. *Oocystis* cells have been found to produce soluble extracellular material consisting mainly of carbohydrate and a small quantity of protein. Polysaccharide material has been isolated from cultures at various stages in the culture cycle, and the monosaccharide composition of this material has been determined using capillary gas-chromatography.

Using a specially constructed apparatus, *Oocystis* cells and their extracellular material have been treated with various concentrations of ozone for selected periods of time. The rates of ozone consumption for different concentrations of algal material have been determined. The viability of cells following ozonation has been studied and the effects of ozone on cell ultrastructure have been investigated using electron microscopy. The subsequent effects of the ozonised algal material on chemical clarification have been determined.

J.A. RAVEN[1,2,3], J. BEARDALL[1], A.M. JOHNSTON[3], J.E. KÜBLER[3] & I. GEOGHEGAN[3] ([1]Department of Ecology and Evolutionary Biology, Monash University, Clayton, VIC 3168, Australia . [2]Department of Environment Biology, Research School of Biological Sciences, Institute of Advanced Studies, The Australian National University, Canberra, ACT 2601, Australia. [3]Department of Biological Sciences, University of Dundee, Dundee DDI 4HN, UK. (Permanent address of JAR).)

Inorganic carbon acquisition by *Hormosira banksii* (Phaeophyta: Fucales) and its epiphyte *Notheia anomala* (Phaeophyta: Fucales).

Measurements of parameters related to photosynthesis were made on the obligate epiphyte

Notheia anomala and on its most usual basiphyte, *Hormosira banksii* from natural populations from Flinders, VIC and Casey's Bay, Batehaven, NSW, Australia. No significant differences were detected between rockpool and 'emersed at low tide' populations of *Hormosira banksii* for any of the characteristics tested, i.e. photosynthetic rate as a function of incident photon flux density, external inorganic C concentration and plant N content; capacity to use HCO_3^-; 'CAM-like' behaviour; rates of dark ^{14}C-inorganic C fixation; $\delta^{13}C$ values of plant organic C. The inorganic C acquisition properties *of Hormosira banksii* more closely resemble those of the Fucaceae than those of other brown macroalgae which have been investigated.

Notheia anomala has a higher photosynthetic capacity on a fresh or dry weight basis than its basiphyte *Hormosira banksii,* possibly due to its larger surface area per unit mass and/or to a smaller allocation of resources to chemical defences. Restriction of overgrowth of *Hormosira* by *Notheia* may he a function of delay of *Notheia* infestation until the basiphyte is reproductively active, and by more grazing of the *Notheia* than of the better-defended *Hormosira.* Photosynthesis by *Notheia* resembles that of 'emersed at low tide' Fucales (including *Hormosira)* rather than 'invariably submersed at low tide' brown algae.

G. REID, R. HUXLEY & D.M. WILLIAMS (Department of Botany, The Natural History Museum)

Further considerations towards a diatom type catalogue: *Fragilariforma virescens* and its varieties.

Currently, *F. virescens* is recognised either as the type of the genus *Fragilariforma* or a species of *Fragilaria.* The species has 54 subspecific entries along with at least 7 synonyms for the species. We previously presented some of the technicalities involved in constructing type catalogues. In this presentation we will present further data on type material of the varieties of *F. virescens* and document their correct nomenclature and identification.

D.J. ROGERS, A.H. SAMPAIO[1], YU QI, A.M. MILAD & L.J. SWAIN (School of Pharmacy and Biomedical Science, University of Portsmouth and [1]Federal University of Ceara, Brazil - CNPQ).

Recent advances in the production and utilisation of algal lectins.

Lectins from algae have not been applied so far to the extensive range of uses in biochemistry and biomedicine, to which lectins from land plants have been applied. one of the main reasons for this is the relatively low yield of lectins from algae and the necessity to purify them by expensive and time consuming affinity chromatographic methods. The development of more general chromatographic methods of purification based on guar-gum gel or mannan-cellulofine has contributed significantly to overcoming this problem.

Lectins from algae such as *Codium fragile* ssp. *tomentosoides*, purified by cheaper and more rapid methods, have been conjugated to colloidal gold or biotin and used to study lectin binding to cell and tissue surfaces by visible light and electron microscopy. Work is in progress on labelling algal lectins, with R-phycoerythrin to extend further their possible uses.

G. RUSSELL (Department of Environmental & Evolutionary Biology, University of Liverpool)

Pyrolysis mass spectrometry in brown algal systematics.

PyMS has confirmed infraspecific differences between Baltic and Irish Sea populations of *Pilayella littoralis* (L.) Kjellm. and of *Fucus vesiculosus* L. At the species level, the results also demonstrate the likelihood of introgression between Irish Sea populations of *F. vesiculosus* and *F. serratus* L. The location of *Microspongium globosum* Rke. in the family Ectocarpaceae and of *Pilayella littoralis* in the order Tilopteridales is questioned.

Problems in discrimination of taxa at various levels in the hierarchy have been tested and it is concluded that PyMS is a potentially powerful analytical tool in brown algal systematics.

P.J. SAVILLE & A.M. JOHNSTON. (Department of Biological Sciences, University of Dundee, U.K. DD1 4HN)

Factors affecting isotopic discrimination of inorganic carbon during photosynthesis in marine phytoplankton.

A clear understanding of the factors controlling the relationship between dissolved CO_2 concentration and isotopic discrimination of inorganic carbon, ($\delta^{13}C$), in marine phytoplankton is required if $\delta^{13}C$ values from the sedimentary record are to be used to reconstruct past variations in sea and atmospheric CO_2 levels.

A range of $\delta^{13}C$ values are presented for the marine diatom *Skeletonema costatum,* an important bloom forming alga, grown in batch cultures with a range of environmental conditions. The $\delta^{13}C$ values varied by up to 10‰, (-13 to -23‰), and were correlated with factors such as culture age,

pH, total inorganic carbon, temperature and growth rate. The data suggests that the relationship between phytoplankton $\delta^{13}C$ and dissolved CO_2 concentration is far from simple, and dependent on the inorganic carbon assimilation characteristics during photosynthesis, leading to the production of new organic matter.

R. SCHMID[1] & M.J. DRING[1,2] (Queen's University of Belfast and [1]Inst. f. Allg. Botanik, Friedrich-Schiller Universitat Jena, [2]Biologische Anstalt Helgoland)

Changes in the light-dependence of carbon acquisition in the Fucales after emersion.

In all brown algae tested so far, the system of carbon acquisition for photosynthesis was active only in the presence of blue light. Blue light is thought to operate by releasing CO_2 from an internal pool of malate. In the Fucales, loading of the pool was also under the control of blue light. A more detailed investigation with *Ascophyllum nodosum* showed that inorganic carbon was taken up in darkness over long periods (> 10 h) provided that the preceding photosynthetic irradiation contained blue light and that the plants were continually submersed. This indicates a long "memory" for blue light. If the plants were emersed, however, this "memory" was soon lost, and carbon acquisition had to be activated again by blue light. The blue-light-induced activating mechanism itself was sensitised by blue light, and its sensitivity to blue light varied with time after a first pulse of blue light. After induction, the mechanism of carbon acquisition was active for several hours but the rates of carbon uptake in the dark were lower than under submersed conditions. These differences in sensory physiology and carbon uptake between submersed and emersed plants indicate that emersion induces rapid and extensive changes of overall physiology. It is not clear how the plants sense emersion, but nutrient supply might be a possible trigger.

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

The seasonal occurrence and succession of fouling blue-green algae in Langstone Harbour, south coast of England.

The contribution made by blue-green algae to marine fouling communities has been monitored over a two year period in Langstone Harbour, south coast of England, from-1992-94. Inert plastic panels were immersed from a test raft and replaced at intervals of 2 weeks, 1 month, 3 months, 6 months, 9 months and 12 months. Samples of blue-green algae were also obtained from a range of other substrata, including pilings, buoys, harbour walls and antifouled panels. Particular attention was given to monitoring the seasonal occurrence and succession of the algae. In general, it was revealed that blue-green algae play an important pioneering role in the colonisation of substrata with the number and abundance of species declining as immersion time increased. The short term panel studies also revealed blue-green algae to possess a marked seasonal distribution with many species being common during the autumn and winter months.

D.C. SIGEE (School of Biological Sciences, University of Manchester, Oxford Road, Manchester M13 9PT)

Electron probe X-ray microanalysts - a technique to determine phosphorus levels within individual algal cells.

X-ray microanalysis (XRMA) has been used in various studies on P levels in algal cells and has considerable potential for future work. The technique has a number of useful capabilities, including high spatial resolution (probe spot less than 0.3 μm diameter), high element delectability (down to 10^{-18}g) and simultaneous determination of a range of elements (permitting assessment of elemental correlations). XRMA may be used in various modes, including transmission electron microscopy of cryosections (determination of intra-cellular composition) and conventional scanning microscopy (whole cell analyses -freeze-dried and cryopreparations). The recent development of the environmental scanning electron microscope permits visualisation and analysis of algal cells (including P determinations) in the wet state. These different techniques will be considered in relation to both laboratory-cultured and environmentally-sampled algae.

D.B. STENGEL & M.J. DRING (Queen's University of Belfast)

Seasonal and spatial variation of growth, pigments and photosynthesis in a population of *Ascophyllum nodosum* from Strangford Lough, Northern Ireland.

The lengths of the tips of marked plants were monitored over 29 months at several shore levels within an *Ascophyllum* population. Growth rates were greatest in the middle of the vertical distribution of the species and lowest on the upper shore. At all shore levels, plants grew most rapidly in early summer and in early autumn, and different correlations between growth and various climatic

factors were recorded in different seasons. Chlorophyll a concentrations in the tips and 1-year-old thallus parts of plants from both the upper and lower distribution limits decreased during the spring and summer. In older parts of the thallus, closer to the holdfast, chlorophyll *a* concentrations were high at all times of the year. There was little variation in pigment concentrations between shore levels for plant tips, but older plant parts from the lower shore contained higher pigment concentrations than corresponding parts from the upper shore. The maximum photosynthesis (P_{max}) of tips, measured in the laboratory at 15°C, decreased in spring and summer and increased in autumn and winter, but there were no seasonal changes in the P_{max} of older plant parts, which was always lower than that of plant tips. Changes in the pigment contents and photosynthetic responses of tips to different temperatures during culture experiments suggested that a seasonal acclamation of pigmentation and P_{max} occurred *in situ* in response to the ambient environmental conditions in the micro-habitat at different shore levels and along the plant thallus.

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

The effect of nutrients on the growth of some selected "Green Tide" algae.

Some preliminary studies have been made of the effect of nutrients on the growth of selected marine macroalgae collected from the eutrophicated Langstone Harbour, south coast of England. Vegetative material of three "Green Tide" algae, *Ulva curvata* (Kütz.) DeToni *Percursaria percursa* (C. Ag.) Rosenv. and *Chaetomorpha linum* (O.F. Mull.) Kütz. was collected from intertidal mudflats and isolated into unialgal culture.

The growth of the material was then investigated in different concentrations and combinations of the nutrients nitrate, nitrite, ammonia and phosphate. In the 'single' nutrient studies, the following concentration ranges were used: 0-2000 μM NO_3; 0-1000 μM NO_2; 0-100 μM NH_4; 0-400 μM PO_4. For all four nutrients, significant growth of the algae occurred at the lower and mid range of concentrations investigated. Tolerance to the higher nutrient concentrations varied, however, and the concentration of each nutrient promoting maximal growth also differed significantly for each species.

In the studies involving different nutrient combinations, the following four nutrient regimes were used: low N, low P (LNLP); high N, low P (HNLP); low N, high P (LNHP) and high N, high P (HNHP). Phosphate was the source of phosphorus in all experiments whilst NO_3, NO_2 and NH_4 were used as the nitrogen sources. The three algae showed significantly different growth responses in the four nutrient regimes tested.

I. TITTLEY & A.I. NETO (The Natural History Museum, Universidade dos Acores, Spain)

Marine algae of the Azores: biogeography and ecology.

Studies on the marine algae of the Azores go back just over a century and a half. Although in comparison to mainland Europe the Azores marine flora is less well known, its isolated position has encouraged a recent resurgence of algal interest resulting in many new algal records. Several hypotheses have been proposed as to the floristic relationships of the Azores marine flora, some point to Atlantic Europe, to West Africa and Macaronesia, others to the Mediterranean and America; results from numerical analysis of North Atlantic distributional data are inconclusive. Endemism is low on the Azores, and species not recorded elsewhere are of taxonomically difficult groups.

In many parts of the archipelago intertidal and subtidal algal communities are characterised by dense turf formations externally uniform in appearance an comprising mainly articulated Corallinaceae together with other filamentous and filiform species. Communities dominated by large macroalgae occur only infrequently. Numerical methods provided the best means of comparing site samples in order to assess similarities and differences. Man's impact on the flora is suggested by changes in local ecology and by introduced species.

G.J. WOOD, K.J. FLYNN & C.R. HIPKIN. (Algal Research Unit. Marine and Environmental Research Group, University of Wales Swansea, Singleton Park, Swansea. SA2 8PP UK.).

Growth of *Heterosigma akashiwo* on nitrate and ammonium at three photon flux densities: Evidence for N-stress in nitrate growing cells.

The Raphidophyte *Heterosigma akashiwo* was grown in N-limiting batch cultures at photon flux densities (PFD's) of 50, 200, and 350 μmol m^{-2} s^{-1} in a 12h/12h light/dark cycle, using either nitrate or ammonium as the N-source. During exponential growth, when compared with nitrate grown cells, ammonium grown cells attained higher growth rates, had a larger biovolume/cell, contained more N with a lower C/N ratio, had higher concentrations of intracellular amino acids (InAA's), and higher ratio's of glutamine:glutamate

(Gln:Glu) and asparagine:aspartate (Asn:Asp). PFD did not affect the Gln:Glu or Asn:Asp ratio for a given N-source. At the high and middle PFD there were no differences in the total INAA pool for a given N-source, while at the low PFD, the total concentration remained higher for longer. Carbon content could be estimated from biovolume, but not reliably from pigment content. The results suggest that nitrate growing cells are more N-stressed than those using ammonium.

W.T. STAM, J.L. OLSEN, M.J.H. VAN OPPEN, H. KLERK & M. DE GRAAF (Department of Marine Biology, University of Groningen, Biological Centre, P.O. Box 14, 9750 AA Haren, The Netherlands.)

RAPDs and reds: assessing the limits for population level studies.

Much has been written about the horrors of RAPDs but there are some applications in which they perform well as judged by independent molecular data sets. These include genetic mapping, taxonomic sorting, and large-scale biogeographic studies. RAPDs are most limited in the realm of population genetics which is, unfortunately, the very application that many have hoped for. In order to investigate the species/subspecies limits of RAPDs we examined diploid and haploid individuals of *Lophocladia trichoclados* (Ceramiales), their natural and synthetic offspring, new gametophytes arising from tetraspores of the tetrasporophytes and from a selfing tetrasporophyte. Ploidy of life history stages was quantified cytophotometrically. Results show that assessment of homologous bands, the presence of *de novo* bands, the absence of expected bands, and the non-independence of bands all contribute to the problem of noise in the data. We were also interested in investigating whether or not ploidy matters. Since RAPD markers are dominate mendelian markers, their use in mixed populations of isomorphic diploid and haploid plants should not make a difference. We conclude that properties of the data **do** change as one crosses the boundary from phylogenetics to population genetics. Noise can swamp the signal. RAPDs are "fuzzy" multi-locus fingerprints, hierarchical structure can no longer be assumed and ploidy ***may*** matter very much.

J.M. YELLOLY & B.A. WHITTON (Department of Biological Sciences, University of Durham)

Comparison of phosphatase activities of cyanobacteria and *Ralfsia verrucosa* using two different organic phosphate substrates.

A comparison was made of the phosphatase activities of various P-limited algae to two widely used organic phosphate substrates, p-nitrophenylphosphate (pNPP) and 4-methylumbelliferyl phosphate (4-MUP).

The organisms used were four cyanobacteria - two field populations (freshwater and marine) *Rivularia* and two laboratory cultures (*Calothris parietina* and *Dichothris*) - and field material of the brown alga *Ralfsia verrucosa*. A comparison, which included Michaelis-Menten kinetic studies, showed marked differences between the two substrates.

POSTERS.

S.J. BALL (Biological Sciences, Lancaster University)

The seasonal distribution of picoplankton in Windermere.

The seasonal distribution of picophytoplankton and bacterioplankton in both north and south basins of Windermere were recorded, using epifluorescence microscopy, from March to October 1993. This size fraction (0.2 - 2.0 μm) of the plankton community was made up of orange and red autofluorescing algal cells and of bacteria. Picophytoplankton densities ranged from 0.1×10^4 cells ml^{-1} up to a maximum in late summer in the upper layers of the water column of 5.7×10^4 cells ml^{-1} in the north basin and 7.0×10^4 cells ml^{-1} in the south basin. Bacterioplankton densities fluctuated between 0.8×10^6 cells ml^{-1} and 3.5×10^6 cells ml^{-1} in the north basin and between 0.1×10^6 cells ml^{-1} and 3.5×10^6 cells ml^{-1} in the south basin. The vertical distribution of picoplankton was strongly correlated with the vertical temperature/density gradient in the water column, but no relation was found between picoplankton density and seasonal water temperature. These results are discussed in the context of other published studies.

G.W. BEAKES, A.L. CLEARY[1] & T.A. BOOTH[2]. Department of Biological and Nuitritional Sciences and [1]Biomedical Electron Microscope Unit, The University of Newcastle upon Tyne, NE1 7RU, UK and [2]Plant Cell Biology Group, Research School of Biological Sciences, Canberra, ACT 2001, Australia.

The use of Confocal Scanning Laser Microscopy to study living cells of freshwater algae.

The Confocal Scanning Laser Microscope enables temporal changes or the precise 3D spacial

morphology of cellular organelles to be observed in living algal cells. The strong autofluorescence of chlorophyll means that algal plastids can be visualized without the need for the use of lipophilic vital stains needed to observe organelle systems such as mitochondria and endoplasmic reticulum. To date most of the published accounts of CSLM on algal cells have been using the instrument to determine the spacial dynamics of cytoskeletal components in algae such as *Nitella* (Wasteneys et al. Cell Motil. Cytoskel. 1993). In this study we have used the BioRad 600 CLSM system with a Krypton-Argon laser, to carry out dual wavelength studies (520 nm for Rhodamine 123 and $D10C_6$ and 585 nm for chlorophyll autofluorescence) on a range of living planktonic and filamentous algae, including *Asterionella, Botryococcus, Spirogyra, Melosira, Micrasterias, Oscillatoria, Volvox* and *Zygnema*. Z-series reconstructions of cells showing plastid morphology is particularly spectacularly shown in *Botryococcus* and the filamentous green algae. In addition, merging of dual fluorescence images reveals the precise spacial relationship between plastids and mitochondria. This is again well illustrated in *Botryococcus*, where a single reticulate mitochondrion can be seen to surround the beautiful petaloid plastids. Where possible the laser was used on its lowest energy setting to reduce fluorescence quenching, since we wished to avoid using antifade agents which may adversely affect the viability of living cells. The laser beam interacts with $DI0C_6$ and specimens have to be examined and images recorded quickly. Algal cells were often immobilized in agarose to keep them in position during the collection of Z-series.

N. CLARKSON (Dunstaffnage Marine Laboratory, PO Box 3, Oban, Argyll, PA34 4AD, UK)

Water Quality Bioassays Using the Cage Culture Turbidostat.

The Cage Culture Turbidostat is a continuous algal culture system developed from dialysis culture utilising porous membranes to contain the algae and turbidostat electronic control of the flow rate of medium through the cage. A population of algae is retained behind a membrane permeable to the dissolved constituents of the growth media and the soluble metabolites excreted by the organisms. A constant nutrient supply is maintained by pumping fresh medium through the porous membranes. The turbidity within the growth chamber is continuously measured by detection of transmitted light through the culture and when turbidity rises above a pre-set value a dilution pump is activated to maintain a constant turbidity. The system is controlled by data acquisition developmental software using an iconic programming language optimised for instrument control utilising PC plug in cards. Computer control allows efficient use of operator time including control of connected equipment, acquisition and storage of data and analysis and result display. As a bioassay system medium containing test pollutants is continuously added to the growth chamber and the effect on the population growth is monitored. In continuing experiments the effects of a range of pollutants on algal growth will be measured and the potential of the Cage Culture Turbidostat for use as a bioassay system assessed against comparative bioassays.

G.E. DOUGLAS, D.M. JOHN & O.W. PURVIS (Department of Botany, The Natural History Museum, London).

The identity of phycobionts from lichens in the *Acarosporion sinopicae* alliance.

The crustose lichens *Rhizocarpon oederi, R. furfurosum* and *Acarospora sinopica* belong to a distinctive community referred to as the *Acarosporion sinopicae* alliance, the distribution of which is strongly dependent upon a specialised mineralogical environment. In this research lichens were collected from Parys Mountain, a disused copper mine in North Wales, where lichens dominate much of the exposed rock. The phycobionts were isolated, and single cells transferred to enrichment culture. All the isolated algae were identified as belonging to the genus *Trebouxia* and four species recognised. Each lichen species contained a variable combination of the identified algal species, and on several occasions, individual thalli were found to have up to three different *Trebouxia* species as phycobionts. The implication of these findings are presented in relation to the specificity of the symbiotic relationship in this well-defined group of lichens.

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

The effect of light, temperature, salinity and nutrient enrichment on the growth rate of *Chaetomorpha linum* (O.F. Mull) Kütz.

Vegetative material of the important "Green Tide" forming alga *Chaetomorpha linum* (O.F. Mull.) Kütz., collected from Tortali Lagoon, Sardinia has been isolated into culture and the growth of segments described under different conditions of temperature, irradiance, salinity, nitrate concentration and phosphate concentration. The segments showed a broad tolerance to all five environmental parameters, with growth recorded

from 10 to 30°C, 9 to 175 μmol m^{-2} s^{-1} irradiance, 3.4 to 34 PSU salinity and in seawater medium containing 0 to 2mM additions of nitrate and 0 to 200 μM additions of phosphate. Maximum growth occurred at 20°C, 175 μmol m^{-2} s^{-1} irradiance, 27.2 PSU salinity and in seawater medium containing 500 μM nitrate addition. No significant differences in growth were recorded in media containing the range of phosphate additions. The results are discussed in relation to world-wide reports of the alga's excessive abundance in eutrophicated waters and its potential use in waste-water treatment.

B.Ó. GABRIELSEN (Algea A/S, P.O. Box 68, N-3401 Lier, Norway)

Mechanical harvesting of seaweed in Norway.

Algea A/S has utilized the natural resources of *Ascophyllum nodosum* on the Norwegian coast since 1937. For the last 25 years, the harvesting has been done with mechanical equipment developed and purpose built by the company.

The harvesting machine combines cutting and suction, and the cut seaweed is collected in nets which contain almost one metric ton of fresh material. The nets are left floating in the sea until they are picked up by tug boats for transportation to the factory for further processing. In contrast to traditional raking on high or low tide which often includes removal of the whole plant, this harvesting method leaves a portion of the plant behind allowing it to form new shoots. This secures a faster regrowth than by removal of the whole plant. The seaweed resources in Norway are owned by the local land owners, and the resource management is done in cooperation between the harvesting crew and the land owners. The owners are paid by the ton, and the regrowth period of the seaweed is usually 4 years.

I. HERNANDZ & R. GARCIA-RUIZ. (Department of Ecology, University of Cadiz, Department of Ecology, University of Malaga)

Studies on phosphatase activity of marine and freshwater algae. Reflections and comments.

Studies of alkaline phosphatase activity (APA) on macroalgae and microalgae have suggested that a great proportion of the phosphate liberated from a xenobiotic substrate (pNPP) are not used directly by the algae. However, measurements with a labelled natural phosphomonoester (glucose-6-phosphate) revealed that alkaline phosphatase activity accounted for a significant proportion of the phosphorus requirements in algae. Kinetic studies and the influence of some factors important in the field may suggest future studies on APA of freshwater algae.

C. HILSE, C. WILHELM, J.A. RAVEN[1], A.M. JOHNSTON[1] & J. KESSELMEIER[2] (Institut fur Allgemeine Botanik, University of Mainz, Germany, [1]Department of Biological Sciences, University of Dundee, [2]Max-Planck Institut fur Chemie, Mainz, Germany)

DMSP Content of the Marine Alga *Prymnesium parvum*.

Marine algae synthesize the sulphur compound dimethylsulfoniumpropionate (DMSP). DMSP is the precursor of marine dimethyisulfide (DMS), which is the most important reduced sulphur compound conveying sulphur from the ocean to the atmosphere in the global biogeochemical sulphur cycle. DMSP and DMS are part of a hypothetical climate regulation mechanism that could influence the global temperature.

We detected the DMSP content of the marine phytoplankton alga *Prymnesium parvum* growing under different conditions in the laboratory. The results have shown that the DMSP content per cell is independent of the incident light intensity, decreases with rising temperature and increases with the age of the cultures. Furthermore we found the DMSP content per cell is negatively correlated to the growth rate of the cultures. We take the growth rate as a measure of the cell viability, and therefore we conclude that the DMSP content per cell is increasing with declining cell viability.

W. HIGMAN & J. LEWIS. (Applied Ecology Research Group, University of Westminster, 115 New Cavendish Street, London W1M 8JS)

An Investigation of the Distribution of *Alexandrium* cf *tamarense* Cysts in the Sediments of the Firth of Forth.

The toxic dinoflagellate *Alexandrium tamarense* has been identified as being responsible for paralytic shellfish poisoning along the north east coast of Britain since 1968. Previous investigations have identified the Firth of Forth as a possible source of *A. tamarense* motile cells from the *Alexandrium* cysts present in the sediments. Sediment samples taken from the Firth of Forth show a concentration of *A. tamarense* cysts within the outer firth and the adjacent North Sea (25-400 cysts/ml sediment). The distribution of cysts within the firth seems to be controlled by sediment type and water circulation, with deposition of cysts in fine sediments or in areas of suspected slowed current. Cysts of an unidentified species (U1), possibly *A. minutum*, are also found in their highest numbers in the outer firth (13-840 cysts/ml

sediment).

R.G. HOOPER, & F.M. CUTHBERT (Biology, Memorial University of Newfoundland)

Relative fecundity and gonad quality of green sea urchins, *Strongylocentotus droebachiensis* feeding on different species of seaweeds.

Sea urchins were fed on *six species* of seaweed: *Agarum clathratum*, *Alaria esculenta*, *Ascophyllum nodosum*, *Fucus vesiculosus*, *Laminaria digitata* and *L. longicruris*. At the start of the experiments, the sea urchins had spawned recently and had low gonad indices and quality. Experiments were replicated at ambient seasonal temperatures (c. 0 to 18°C) and at continuous temperatures (c. 0 to 2°C). *Laminaria digitata*, *L. longicruris* and *Ascophyllum* were consumed at the highest rates, while *Fucus*, *Alaria* and *Agarum* were eaten more slowly. *L. digitata* was, by far the best food. Improvement in gonad index and quality was much greater than with any other diet. *Ascophyllum* and *L. longicruris* were not as effective. The remaining species produced no significant growth or quality improvements. Aquaculturists should be advised to use the former and not the latter species. Natural populations of sea urchins living with *Laminaria* have the highest gonad yield quality which agrees with the experiments. The natural abundance of *Agarum* and *Alaria* is high and their survival may be related to their poor food value to Newfoundland's voracious sea urchins.

R.G. HOOPER[1,2], A. WHITTICK[1] & W.F. FARNHAM[2] ([1]Biology, Memorial University of Newfoundland [2]Marine Laboratory, Biological Sciences, University of Portsmouth)

Subtidal zonation of benthic communities in Newfoundland.

Benthic seaweed community zonation was compared between sites varying with respect to wave exposure, temperature stratification, herbivore abundance, sea ice and substrata. Exposed sites were characterized by a prominent upper subtidal surf-zone community. A sharp boundary starts the next depth zone which is barren, dominated by sea urchins and coralline algae. This zone shifts gradually to a diverse coralline-invertebrate association which may support beds of *Agarum* and *Ptilota*. In ice scoured locations, the surf zone is dominated by *Saccorhiza*, *Alaria* and other opportunistic species such as *Chordaria*, *Pilayella*, *Dictyosiphon* and *Ceramium*. Sheltered fjord communities are much more distinctly zoned. A shallow zone corresponds in depth to the low salinity layer which occurs under winter ice, while other zones correspond to thermal stratification which develops in fjords in summer. Deepest zones are continually frigid and comprise biota with arctic affinities. Intermediate zones include a puzzling combination of temperate and northern species. We have found that internal waves alternately bathe these zones with warm and cold water 20 to 30 times per day.

HOPLEY, A., LEFTLEY, J.W[1]. & MACKIE, I.M. (Central Science Laboratory, Torry, Aberdeen & [1]Dunstaffnage Marine Laboratory, Oban)

***Prorocentrum lima*, CCAP 1136/9, a UK DSP toxic alga.**

A unialgal UK strain of *Prorocentrum lima* (CCAP 1136/9) has been analysed by HPLC and the presence of okadaic acid and DTX-1 confirmed, these toxins being implicated in outbreaks of diarrhetic shellfish poisoning (DSP). This is the first report of a toxic strain of *P. lima* isolated in UK waters.

Differences have been observed in the toxin profile of this strain of *P. lima* compared to two Spanish strains *(P. lima* CCMP 685 and NEPCC 712). All three strains have been used in intoxication experiments with mussels. Results of these studies together with HPLC profiles of the algae will be presented.

T. HORI & J.C. GREEN (Institute of Biological Sciences, University of Tsukuba, Japan; Plymouth Marine Laboratory)

The occurrence of MTOCs on mitochondrial surfaces during cell division in a haptophyte.

The first sign of cell division in motile cells of *Phaeocystis* aff. *globosa* is the multiplication of the chloroplasts, followed by duplication of the basal bodies and haptonema. Replicate Golgi bodies, however, do not appear until metaphase. In cells with four replicated chloroplasts, localised electron-dense material, from which spindle MTs extend towards the pre-prophase nucleus, appears on the outer surface of two mitochondrial profiles, one each side of the Golgi body. Observations suggest that the position and formation of the MTOCs may be regulated by MTs extending from the flagellar apparatus. During metaphase, the development takes place of both chromosomatal MTs and continuous MTs, the latter extending between the polar MTOCs and passing through the metaphase plate. In some cells, the two MTOCs are found at each end of one long mitochondrial profile extending along the spindle. This may indicate that the polar positioning of the MTOCs in later stages

of nuclear division is accompanied by extension of part of the mitochondrial network. Both sets of daughter flagellar apparatus are located close to the spindle, laterally with respect to the longitudinal axis. Even in late anaphase, the MTOCs can still be observed on the mitochondrial profiles. Cytokinesis is effected by a combination of furrowing of the cell membrane and vacuole extrusion.

A.P. HUNT & J.D. ECCLESTON-PARRY (Biological Sciences Div., Institute of Environmental and Biological Sciences, Lancaster University, Lancaster. LA1 4YQ)

The colonisation dynamics of a riverine biofilm.

The effects of river velocity and substratum roughness on diatom-dominated epilithon development were investigated. Fast and slow flowing sites were chosen on the river Conder, Lancaster. Silicon carbide sandpaper coupons were used as experimental substrata. Different grades of sandpaper coarseness were used to simulate substratum roughness. The coupons were exposed for either two or fourteen weeks. Epifluorescence microscopy was used for quantitative analysis, while scanning electron microscopy was used to give a non-destructive overview.

Results indicated that river velocity was an important factor controlling initial colonisation of the coupons. Epilithic communities grown under fast-flowing current regimes showed significantly higher numbers of organisms than those grown in the slow current areas. River velocity was also a major determinant of long-term diatom density, diatom numbers were significantly lower under fast current regimes. However, substratum roughness did not appear to significantly affect either initial colonisation nor long-term structure.

L. JONES, W.F. FARNHAM, J.M. GOROSTIAGA[1], & A. SANTOLARIA[1], (The Marine Laboratory, University of Portsmouth, [1]Dep. Biologia Vegetal y Ecologia. Fac. Cinencias, Univ. Pais. Vasco, Apdo.644 Bilbao, 48080, Spain,)

A comparative study of *Fucus chalonii* J. Feldm. and *Fucus vesiculosus* (L.) f. *linearis* (Huds.) Powell.

Field studies on two populations of *Fucus* were carried out in an attempt to clarify the true taxonomic entity of *Fucus chalonii* J.Feldm. which had been described as an exposed ecotype of *Fucus vesiculosus* (L.) f. *linearis*. (Huds.) Powell.

Work was carried out simultaneously on a population of *F. chalonii* on the Spanish Basque coast (N.Spain) and on *Fucus vesiculosus* (L.) f. *linearis* at Southsea (S.England). Comparative phonological, demographic and morphometric studies were performed on both populations on the basis of destructive sampling at monthly intervals. Preliminary results show pronounced differences in the studied aspects between both populations.

The investigations demonstrated that reproductive timing differs between the two species, fertility in *Fucus chalonii* being attained during the summer and autumn months, whereas *Fucus vesiculosus* becomes fertile in winter and spring. Frond density was significantly higher in *F. chalonii*. Other morphological parameters related to the basal disc, frond and receptacle form together with the presence/absence of vesicles also show a strong divergence.

These differences are discussed, with the conclusion that the Basque population is specifically different from *Fucus vesiculosus* (L.) f. *linearis*.

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

Long term survival of marine phytoplankton in stored sediment samples.

Sediment samples from Scottish coastal sites, taken for a variety of projects over the last nine years, were stored in airtight containers at 5°C. Slurry cultures were used to determine the survival of phytoplankton in these sediments. A range of diatom and dinoflagellate species were found to survive for at least 22 months in these stored samples. Notable results were survival times of 73 months for *Skeletonema costatum* and 108 months for *Lingulodinium polyedrum* and *Scrippsiella* sp. Survival times previously recorded in the literature for marine diatom resting stages vary from 4 - 21 months and for marine dinoflagellate cysts from 12 - 66 months. A single sample was stored and repeatedly cultured for diatoms over a period of 16 months. The number of species which could be cultured from the sediment declined over this time and numbers of those species surviving decreased. The percentage hatching success was determined for *Lingulodinium polyedrum* by isolation of "full" cysts. Cysts isolated from sediments collected at least 18 months previously gave hatching success of 97% and those isolated from a nine year old sample gave a hatching success of 3%. The study indicates the potential importance of coastal sediments as a source of phytoplankton to their overlying waters.

G.E. MEDINA-RAMÍREZ, E. D. ANDRADE, A. CARABOT-CUERVO, G. BLUNDEN[1] D.J.

ROGERS[1] & A.H. SAMPAIO[1] (Faculty of Pharmacy, University of Los Andes, Mérida, Venezuela; [1]School of Pharmacy and Biomedical Science, University of Portsmouth, U.K.).

Lectins in Venezuelan marine algae.

Marine algae from Venezuela have been screened for the presence of lectins active against human, rabbit and goat erythrocytes. Of particular interest was the activity of *Gracilaria mammillaris* extracts, which agglutinated papainised human erythrocytes of blood groups A, B and O; the titre appeared to be higher for blood groups B and O cells (1:16) than A cells (1:4).

Haemagglutination was inhibited by N-acetylglucosamine, N-acetylgalactosamine, bovine mucin, porcine mucin and *p*-nitrophenyl-N-acetyl-ß-D-galactosaminide. Preliminary fractionation of the proteins extracted from *G. mammillaris* by passage through a Sepharose CL-2B gel column led to the isolation of three fractions with erythrocyte agglutinating properties. Two of these fractions agglutinated human A, B and O cells equally, whereas the third fraction appeared to agglutinate only B cells. The molecular weight of this fraction, determined by chromatography on a Biogel P-100 column was shown to be 80 kDa. The activity of this fraction is undergoing further study to verify its apparent specificity.

J.A MOORE & J.R PRESS (The Natural History Museum, London).

Charophyte Database Project.

The European Plant Information Centre (a part of the Department of Botany at The Natural History Museum) has recently set up a new Charophytes Database Project. Primarily specimen-backed, but also incorporating records from literature, the database covers all species of Characeae which occur in Europe and the Mediterranean basin. The first stage of the project will draw together basic data and will culminate in the production of a series of reports summarizing our current knowledge of the species, together with a detailed distribution map for each one. The project is intended to be collaborative and we request that any European colleagues who have species lists or other data contact us to discuss possible co-operation.

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The structure and properties of agar from *Gracilaria bursapastoris* and *G. mammillaris*.

From NMR and FT-IR spectroscopic data, the agar extracted from *Gracilaria bursapastoris* was shown to have an unusually high content of 4-sulphate D-galactose units. This feature gives the agar a chemical similarity to 1κ-carrageenan. In fact, intrinsic viscosity measurements showed a typical polyelectrolytic behaviour and gelation was promoted by the addition of both monovalent and divalent cations. Such a similarity is reflected in the mechanical properties of aqueous gels. The viscoelastic spectrum of a 1% (w/w) aqueous system (without added salts) reveals a gel-like behaviour, and an increase in the ionic strength enhances the mechanical properties of the gel. As the sulphate substitution is only about 50% of that of 1κ-carrageenan, it is possible that two gelation mechanisms exist, one related to the κ-carrageenan-like component and the other to the agarose component.

Like *G. bursapastoris*, the agar extracted from *Gracilaria mammillaris* had quite a poor gelling ability because of the presence of alkali-stable sulphates as 4-0-sulphate-D-galactose. However, although the extent of such a sulphation was lower than that of *G. bursapastoris*, the gel strength was considerably enhanced by the addition of potassium chloride to a concentration up to 1M.

T.J. NICHOLLS, D.J. ROGERS, D.J. COOK, K.L. GREEN & J.D. SMART. (School of Pharmacy and Biomedical Science, University of Portsmouth, Portsmouth PO1 2DZ) 5DF)

An investigation of the toxicity of the lectin from *Codium fragile* ssp. *tomentosoides*.

The lectin from *Codium fragile* ssp. *tomentosoides* (*C. fragile*) has been investigated as a means of 'anchoring' a drug delivery system to tissues within the precorneal region by binding to mucin and cell surface oligosaccharides. This could facilitate the prolonged delivery and enhanced absorption of ophthalmic drugs. In this study the cytotoxic and inflammatory properties of this lectin were investigated.

Cultured human conjunctival epithelial cells (1-5c-4) were exposed to various concentrations of *C. fragile* lectin for 3 h and 24 h. Cytotoxicity indices were then calculated relative to the positive and negative controls. *C. fragile* lectin in saline was also intradermally injected into an anaesthetised rabbit at various concentrations and the injection site examined for inflammation over a period of 3 h.

A significant cytotoxic effect was observed

between 3 h to 24 h. No inflammatory response was observed on the rabbit skin after 3 h. It was concluded that a potential cytotoxicity problem exists with this lectin that might limit its use in ocular drug delivery.

N.A. NIMER, Q. GUAN & M.J. MERRETT (School of Biological Sciences, University of Wales, Swansea)

The Development of Extracellular Carbonic Anhydrase in a High-Calcifying Cells of *Emiliania huxleyi* (Lohmann) Hay & Mohler.

External and internal enzymes of carbonic anhydrase are an essential component of the dissolved inorganic carbon (DIC) concentrating mechanism in microalgae that elevates the intracellular CO_2 concentration around Rubisco to suppress the oxygen inhibition of photosynthesis. Although cells from stationary and exponential phase cultures were morphologically indistinguishable DIC transport was fundamentally different. Stationary phase cultures showed a sharp decline in calcification rate and the expression of extracellular carbonic anhydrase (CA_{ext}). Photosynthesis was saturated at lmM DIC and the intracellular carbon pool exceeded the extracellular DIC concentration, a result not observed with exponential phase cells. Dextran bound sulphonamide (DBS), a membrane impermeable inhibitor of CA was used to investigate the role of CA_{ext} in inorganic carbon uptake. The results suggest a change from HCO3- influx in the calcifying cell to CO_2 transport in the stationary phase cell.

N.A. NIMER & M.J.MERRETT (School of Biological Sciences, University of Wales, Swansea)

The utilization of dissolved inorganic carbon by the marine microalgae *Phaeodactylum tricornutum* and *Emiliania huxleyi*.

The light-induced alkalization of the medium in a closed systen for exponential and stationary phase cultures of *Phaeodactylum tricornutum* and *Emiliania huxleyi* was investigated. Both species develop extracellular carbonic anhydrase (CA_{ext}) in statationary phase cultures. The inhibitor dextran bound sulphonamide (DBS) was used to probe the presence of CA_{ext} and if present its role in alkalization. 3,3,4-dichlorophenyl-1,1 dimethylurea (DCMU) a potent inhibitor of the light reactions of photosystem II was used to investigate the role of light and photosynthesis in the alkalization of the medium and dissolved inorganic carbon (DIC) utilization. Possible mechanisms for DIC uitilization in the two species are presented.

K. PYE. R.L. FLETCHER, D. FONTANA[1] & D. LOWTHION[2] (The Marine laboratory, University of Portsmouth; [1]Department of Geography, University of Portsmouth; [2]National Rivers Authority, Southern Region)

The effects of eutrophication on the marine benthic flora of Langstone Harbour, south coast of England: a reassessment.

Work is currently in progress to reassess the effects of sewage input on the marine benthos of Langstone Harbour, south coast of England. Particular attention is being focused on determining the factors responsible for the extensive mats of green algae (predominantly *Enteromorpha* and *Ulva* spp.) which cover much of the intertidal mudflats throughout the year. Water column samples are regularly obtained from 11 stations and analysed for levels of nutrients (nitrate, nitrite, ammonia and phosphate), chlorophyll and suspended particulate matter (SPM). Detailed qualitative and quantitative studies are also being made of the macroalgal community and data obtained on local distribution patterns, standing crop and seasonal fluctuation of the main components. Algal tissue samples are also regularly analysed for their carbon, nitrogen, phosphorus and chlorophyll content. The present paper summarizes some of the initial results obtained and draws comparisons with some earlier studies.

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Extraction and analysis of α-carotene and ß-carotene from marine macroalgae.

The carotenoids, α-and ß-carotene, act as precursors of vitamin A (retinol). However, the α - and ß-isomers are not equivalent as dietary sources of vitamin A, ß-carotene being twice as effective as α-carotene. Marine macroalgae are known to contain pro-vitamin A carotenoids. Some brown algae are used as animal feed supplements. Some brown and red algae are used either as human foods or as sources of human food products and these foods and food products may be promoted on the basis of their pro-vitamin A carotenoid content. Therefore, in order to analyze the algae and food products, it is important to use methods which quantitatively extract carotenoids from algal material and analytical procedures which separate and quantify both α- and ß-carotene. We have developed conditions for extraction and analysis of α- and ß-carotene to facilitate our evaluation of some edible European marine algae.

An extraction procedure which consisted of soaking overnight (14-16 h) 1g fresh algae *(Palmaria palmata)* in 20 ml methanol, followed by homogenisation with an Ultra Turrax homogeniser gave optimum extraction of both α- and ß-carotene. Following saponification, carotenoids were partitioned into n-hexane. Using 2 ml n-hexane per 10 ml saponified methanolic extract more than 95% of the carotenoids was recovered. An HPLC system consisting of PhaseSep, Spherisorb S5 ODS2 (250 x 4.6mm), acetonitrile-methanol-dichloromethane (75:20:5 by vol) at 2 ml min^{-1}, resolved α- and ß-carotene with retention times of 20 min and 22 min respectively.

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Evaluation of some European marine algae for digestive enzyme inhibitors, pharmacologically active amines and pro-vitamin A carotenoids.

Studies by this Group have revealed that some marine algae, used for animal feed and human consumption, contain digestive enzyme inhibitors and pharmacologically active amines. The digestive enzyme inhibitors were found to be high molecular weight polymers of phloroglucinol, which act as non selective inhibitors of α-amylase, lipase and trypsin. The pharmacologically active amine was N,N-dimethyl tyramine which was found be an inhibitor of uptake of nor-adrenaline into pre junctional neurones.

Pacific countries such as China and Japan produce high-value human food products from marine algae, which are imported into Europe. Some European marine algae have an appearance and texture similar to Pacific algae and could be used as the basis of a European algal food industry. Such algae should be normally free of digestive enzyme inhibitors and pharmacologically active amines and ideally should contain nutritionally beneficial constituents such as fat soluble vitamins.

The brown alga *Laminaria digitata* and red alga *Palmaria palmata* were collected during each month of the year and assayed for trypsin inhibitors, tyramine and its N-methylated derivatives and provitamin A carotenoids. Neither alga contained digestive enzyme inhibitors. The pharmacologically active amines, tyramine, N-methyltyramine and N,N-dimethyltyramine were not detectable (less than 1 μg per g dry weight). Each sample of *P. Palmata* contained both α- and ß-carotene (40 - 100 μg per g dry weight). Some samples contained lutein at levels which were similar to the α- and ß-carotene. *L.digitata* contained ß-carotene (50 - 200 μg per g dry weight) but not α-carotene.

A.H. SAMPAIO, D.J. ROGERS[1] & C.J. BARWELL[1] (Federal University of Ceara, Brazil - CNPQ; [1]School of Pharmacy and Biomedical Science, University of Portsmouth).

Molecular weight of the lectin from the red alga *Ptilota filicina*.

The haemagglutonating lectins from *Ptilota filicina*, *P. plumosa* and *P. serrata* are all divalent cation dependent and bind α-D-galactose. Of the three lectins, only that from *P. plumosa* shows blood-group B specificity while the other two lack blood group specificity. We are attempting to explain this difference in blood-group specificity by examining structural features of the three lectins which may govern this property. We report here a comparison of the MW of the *P. filicina* lectin with those of the lectins from *P. plumosa* and *P. serrata.*

The lectin from *P. filicina* was purified from a phosphate buffered saline (0.17M, pH 7.3) extract of the alga by affinity chromatography on guar gum gel. SDS PAGE of the lectin, following heating with 2Me, showed a single band of 19.4 kDa. This MW is similar to the *P. serrata* lectin (18.4 kDa) but distinct from the MW recorded for the blood-group B specific lectin from *P. plumosa* (65 kDa).

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Seasonal variation in production of lectins by *Ulva* species.

There are conflicting reports concerning the occurrence and properties of lectins from the green marine alga *Ulva* lactuca. Some authors consider the lectin to be fucose-galactose specific with preference for human O blood group. Results obtained by other workers show that the lectin is not inhibited by mono- and polysaccharides, but inhibited by the glycoprotein lactoferrin. This lectin agglutinated rabbit erythrocytes, but showed no agglutination whatsoever against human red blood cells. It has been suggested that these differences may be due to seasonal variation in lectin production during the life cycle of the alga or due to problems of identification of plant material examined.

In an attempt to resolve this situation we have studied the presence and properties of lectin from *Ulva lactuca* collected monthly from a well-defined area from March to October 1994. The results

show greatest lectin production by the plants during March, April and August. No lectin detected in any month showed fucose specificity, but inhibition was observed with the glycoproteins bovine mucin or porcine mucin.

J.D. SMART & S.A. MORTAZAVI (School of Pharmacy and Biomedical Science, University of Portsmouth)

An evaluation of the mucosal-adhesive properties of sodium aliginate.

Natural and synthetic macromolecules that hydrate and become adhesive in an aqueous environment are of interest in pharmaceutical research. These can be included in dosage forms in order to promote their retention on mucosal surfaces thus facilitating extended localised drug delivery. The aim of this investigation was to evaluate the adhesive properties of sodium alginate (BDH) as a potential candidate for inclusion in such a drug delivery system, and to compare it to the established mucosal-adhesives Methocel K 1OOM and Carbopol 934P.

50 mg samples of the powdered test material were compressed into 6.2 mm flat faced discs using a force of 1 tonne for 5 s. One surface of the compact was placed onto the mucosal surface of rat small intestine, in pH 6.0 phosphate buffered saline at 37°C, for a period of 2 min to allow adhesion to occur. The tensile force required to break the adhesive joint, measured in terms of the total work of adhesion and the maximum detachment force, was found using a modified Diastron rheometer. In a further study the durability of the adhesive joint was tested by applying a constant 0.085 N tensile force until joint failure occurred. All studies were completed on five occasions with each material.

Sodium alginate formed a strong adhesive joint with the mucosal surface (maximum detachment force 0. 196 N, S.D. 0.047, total work of adhesion 71.3 μJ, S.D. 14.15), which was intermediate between that formed by the two established mucosal-adhesives. However when subjected to a constant tensile stress the adhesive joint failed after 1.82 h (S.D. 0. 13), in comparison to the much longer times of 9.78 h and 19.84 h for Carbopol 934P and Methocel K 100M respectively. Joint failure was observed to be adhesive failure within the hydrating alginate gel. It is evident that sodium alginate shows promise as a potential adhesive component of a drug delivery system. Further work will need to examine some different grades of alginates that may promote extended mucosal-adhesion by allowing restricted hydration or the the formation of stronger gel networks.

L.J. SWAIN, D.J. ROGERS, R.V. GIBBS & B.G. CARPENTER (School of Pharmacy and Biomedical Science, University of Portsmouth)

The existence of a tetrameric form of the lectin from *Codium fragile* ssp. *tomentosoides*.

Molecular weights of lectins from the green marine algal genus, *Codium* have been documented from 13 kDa to 86 kDa. In particular, the lectin from *Codium fragile* ssp. *tomentosoides* has been reported as both a monomeric structure of approximately 13 kDa and a tetrameric structure of 60 kDa. As part of a detailed study on this lectin, we have performed the necessary biochemical characterisation to resolve this controversy.

The purified lectin from *C. fragile* ssp. *tomentosoides* was found to have a molecular weight of approximately 55 kDa determined by HPLC- and soft gel-size exclusion chromatography. Using SDS-PAGE systems to determine subunit composition, a single band of approximate molecular weight 13 kDa was observed. These findings suggest that this lectin does indeed exist as in a tetrameric form composed of four equal subunits.

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New lectins from *Codium* species.

Lectins have been identified from several species of the green marine algal genus, *Codium*. Of these, lectins from *C. fragile* ssp. *tomentosoides*, *C. bursa* and *C. vermilara* preferentially bind N-acetyl-D-galactosamine (GalNAc). Studies on GalNAc-binding lectins are in progress for their potential biomedical uses and, as such, lectins from *Codium* species may be useful biochemical tools. In view of this, we have identified and partially characterised lectins from five previously uninvestigated *Codium* species.

Aqueous extracts of *C. adherens*, *C. effusum* (Las Palmas, Canary Islands), *C. platylobium*, *C. capitatum* (Natal, RSA) and *C. lucassii* (Port Elizabeth, RSA) produced powerful agglutination of native and papain-treated human erythrocytes. None of the five lectins demonstrated divalent cation dependence. Of the monosaccharides tested, GalNAc preferentially inhibited each of the five lectins. The glycoproteins porcine stomach mucin and fetuin also inhibited the haemagglutinating activity of the five extracts.

Y. QI, D.J. ROGERS, L.J. SWAIN, T.J.

NICHOLLS & D.J. COOK (School of Pharmacy and Biomedical Science, University of Portsmouth).
Biotinylation of the lectin from *Codium fragile* ssp. *tomentosoides* for use as a histochemical reagent.

The lectin from *Codium fragile* ssp. *tomentosoides* binds to the surfaces of human erythrocytes causing agglutination of the cells. In order that the binding of this lectin to other tissue cells could be assessed it was necessary to label the lectin with an indicator system detectable by microscopy.

Lectin from C. *fragile ssp. tomentosoides* was purified from aqueous extracts by affinity chromatography on Sepharose 6B-N-acetyl-α-D--galactosamine resin and conjugated to biotin. Labelled *Codium* lectin was applied to the surfaces of unfixed rat cornea and conjunctiva. Bound lectin was detected by adding streptavidinperoxidase which bound to the biotinylated lectin. Peroxidase was detected using the substrate 3.,3-diaminobenzidine tetrahydrochloride (DAB).

Sections of the treated tissues were examined by light microscopy and a brown precipitate (DAB) was present in areas of the tissue to which biotin-labelled lectin had bound.

M. STEENTOFT, L.M. IRVINE[1] & W.F. FARNHAM (University of Portsmouth Marine Laboratory, Hayling Island. [1]Natural History Museum, London).
Two terete species of *Gracilaria* and *Gracilariopsis* (Rhodophyta) in Britain.

Gracilaria gracilis comb. nov. and *Gracilariopsis longissima* comb. nov. have been confused, latterly as *Gracilaria verrucosa* (Hudson) Papenfuss (=*G. confervoides* (Stackhouse) Greville 1830), these species frequently occurring together both inter- and subtidally. They differ however in field characters and in vegetative and reproductive anatomy, distinctions between the two species being made on the basis of thallus-by-thallus collection and examination, sectioning in standard planes, and observation of reactions with Lugol's iodine and of metachromatic reactions with toluidine blue O and methylene blue. Toluidine blue O reacts with sulphated polysaccharides to produce a short-lived red reaction colour in those of gracilarioids, but a persistent one in the gonimoblast of *Gracilaria gracilis*. The red reaction colour of methylene blue is even more persistent in the same tissue, but both dyes react only slightly (at most) with the gonimoblast tissue of *Gracilariopsis longissima*. When cystocarps of the two species could be distinguished, it followed that vegetative axes, also in male and tetrasporic plants, could be distinguished.

T.J.M. TYLOR, J.M. LEWIS & S.I. HEANEY[1] (Applied Ecology Research Group, University of Westminster, [1]Aquatic Sciences Research Division, Department of Agriculture Northern Ireland)
A Study of the Vertical Distribution of *Alexandrium sp.* Hypnocysts in the Sediment of Belfast Lough, 1994.

As part of a study of *Alexandrium* sp. dinoflagellates in Belfast Lough, the vertical distribution of *Alexandrium* hypnocysts in the top 8-10 cm of the lough sediment was examined at three sites in June 1994. At each site numbers of intact hypnocysts were smallest near the surface, at one site increasing eight times from 280 cysts g^{-1} wet sediment in the top 0-2 cm to 2220 cysts g^{-1} at 6-8 cm. The greater cyst concentrations below the surface may be due to a large quantity of cysts produced in a period of large vegetative cell populations being buried under sediment, or to the sediment losing volume over time through decomposition of organic material or through settling. Cysts may also be removed from the upper sediment as mixing processes bring them to the surface where exposure to light and oxygen allows them to germinate.

A. WHITTICK, (Department of Biology, Memorial University of Newfoundland, St. John's , Newfoundland Canada.)
Nuclear behaviour and development in *Membranoptera* sp. (Delesseriacae, Rhodophyta).

A small (<2cm) member of the Delesseriaceae growing epiphytically on *Ptilota serrata* Kütz in Bay Bulls, Newfoundland, Canada was identified as a member of the genus *Membranoptera*, it was sufficient distinct in morphology from *M. alata* to warrant further examination. Nuclear behaviour in tetrasporophytes and female gametophytes of this species were examined by haemotoxylin staining and DAPI staining and UV epifluorescence was used to quantify DNA levels in individual nuclei. Mitotic cell division in the tetrasporophytes showed 2n=64 and in the gametophytes n=32. Meiosis appeared regular with 32 distinct pairs of chromosome in late prophase I and 32 individual chromosomes in phase II. Sporophyte nuclei contained twice the amount of DNA than the nuclei of the gametophytes. Non dividing nuclei, and the cells in which they occurred, were significantly larger in tetrasporophytes than the equivalent nuclei and cells in gametophytes. Nuclear size in both phases did not increase with cell size, instead the

cells became multinucleate. There was a regular geometric increase in number due to synchronous nuclear division in the multinucleate cells.