1st NORTHWEST ALGAL SYMPOSIUM

10-12 November 1984

Friday Harbor Laboratories, Wa.

PROGRAM AND ABSTRACTS

Convener and Organizer: Gayle I. Hansen

Assisted By: Anne R. Haskins

We would like to thank the following people for their help in the preparation of this meeting:

Adviser: Joyce Lewin

Useful Tips: Claudia Mills, Bob Waaland, Joan Short, Kathryn Hahn

Travel: Thomas Mumford, Paul Gabrielson

A-V Equipment: Beatrice Booth, Thomas Mumford

Projectionists: Steve Herbert, James Bergdahl, Herb Vandermeulen, Steve Fain

T-Shirts: Anne Sylvester

Special Guest Speakers: Paul Silva and Max Taylor

Meals and Socials: Gourmet Galley Catering: Pat DeStaffany, Mary Ann Rock and Binney Haenel

The 1st NWAS is particularly grateful to the Friday Harbor Laboratories for the use of its facilities.

SCHEDULE

1st NORTHWEST ALGAL SYMPOSIUM

Saturday, November 10	10:00-noon	arrival and check-in
	noon-1:15	Lunch
	1:15-1:30	Welcome and Orientation
	1:30-3:10	Session 1
	3:10	C/T break
	3:40-5:00	Session 2
	5:00-6:30	Social
	6:30-8:00	Banquet
	8:00-9:00	Distinguished Lecture -- Paul Silva
	9:00-	Mixer
Sunday, November 11	7:00-8:30	Breakfast
	8:30-9:50	Session 3
	9:50	C/T break
	10:20-noon	Session 4
	noon-1:30	Lunch
	1:30-3:10	Session 5
	3:10	C/T break
	3:30-4:00	Business Meeting
	4:00-6:30	Open
	6:30-8:00	Dinner
	8:00-9:00	Special Movie Presentation -- Max Taylor
	9:00-	Mixer
Monday, November 12	7:00-8:30	Breakfast
	8:30-9:50	Session 6
	9:50	C/T break
	10:20-noon	Session 7
	noon-	Check-out and departures

Check-in and out, lectures, movie, and the business meeting will take place in the Commons. Posters, C/T Breaks, Meals, Social, and Mixers are in the Main Dining Hall.

PROGRAM

1st NORTHWEST ALGAL SYMPOSIUM

Saturday, November 10

10:00-noon Arrival and Check-in -- Commons.

noon-1:15 LUNCH -- Main Dining Hall.

1:15-1:30 Welcome and Orientation -- Commons. Gayle I. Hansen, convener.

1:30-3:10 Session 1. Paul W. Gabrielson, moderator.

1:30-1:50 A CLADISTIC ANALYSIS OF RED ALGAL ORDERS. Paul W. Gabrielson and David J. Garbary, University of British Columbia.

1:50-2:10 THE SPERMATANGIA OF GELIDIUM PURPURASCENS GARDNER (GELIDIACEAE, RHODOPHYTA). Dawn E. Renfrew, University of British Columbia.

2:10-2:30 PHYLOGENETICS IN THE CLADOPHORALES COMPLEX: SOME NEW PERSPECTIVES FROM MACROMOLECULAR DATA. Jeanine Olsen-Stojkovich and J. A. West, University of California, Berkeley.

2:30-2:50 CURRENT STATUS OF THE GENUS PALMARIA (RHODOPHYTA, PALMARIALES) IN BRITISH COLUMBIA. Michael W. Hawkes, University of British Columbia.

2:50-3:10 EVOLUTION AMONG LOCAL GENERA OF THE DUMONTIACEAE (RHODOPHYTA): EVIDENCE FOR TWO DISTINCT LINEAGES. Sandra C. Lindstrom, University of British Columbia.

3:10-3:40 C/T Break -- Main Dining Hall.

3:40-5:00 Session 2. Louis D. Druehl, moderator.

3:40-4:00 WHY DO SOME SEAWEEDS HAVE ISOMORPHIC LIFE HISTORIES? Jane Lubchenco, Oregon State University.

4:00-4:20 MAINTENANCE OF A PREDOMINANTLY GAMETOPHYTIC IRIDAEA CORDATA POPULATION STUCTURE. Georgiana May, University of California, Berkeley.

4:20-4:40 THE DEMOGRAPHY OF FRONDS OF CHONDRUS CRISPUS STACKHOUSE. Debashish Bhattacharya, Simon Fraser University.

4:40-5:00 ON THE LIFE HISTORY OF LAMINARIA GROENLANDICA. Louis D. Druehl, Paul J. Harrison and Katherine E. Lloyd, Bamfield Marine Station and University of British Columbia.

5:00-6:30 Social -- Main Dining Hall.

6:30-8:00 BANQUET -- Main Dining Hall.

8:00-9:00 Distinguished Lecture -- Commons.

NAPOLEON'S CONTRIBUTION TO PHYCOLOGY.
Paul Silva, University of California, Berkeley.

9:00- Mixer -- Main Dining Hall.

Sunday, November 11

7:00-8:30 Staggered Breakfast -- Main Dining Hall.

8:30-9:50 Session 3. Bruce A. Macler, moderator.

8:30-8:50 THE METABOLIC BIOCHEMISTRY OF GELIDIUM COULTERI HARVEY. Bruce A. Macler, University of California, Berkeley.

8:50-9:10 GROWTH IN CULTURE AND RESPONSES TO CD OF SPOROPHYTES OF LAMINARIA SACCHARINA (L.) LAMOUR. AFTER EXPOSURE OF GAMETOPHYTES TO CD. James W. Markham and Klaus-Richard Sperling. Seattle, Washington and Biological Anstalt Helgoland.

9:10-9:30 FORMATION OF ASCORBIC ACID IN SPECIES FROM SEVERAL CLASSES OF ALGAE. Frank A. Loewus, Washington State University.

9:30-9:50 THE NITROGEN NUTRITION OF GELIDIUM PURPURASCENS GROWN IN OUTDOOR CULTURE. W. N. Wheeler, Bamfield Marine Station and University of British Columbia.

9:50-10:20 C/T Break.

10:20-noon Session 4. Robert T. Paine, moderator.

10:20-10:40 ON THE ECOLOGY OF POSTELSIA PALMAEFORMIS. R. T. Paine, University of Washington.

10:40-11:00 EFFECTS OF PHYSICAL DISTURBANCE, HERBIVORY, AND SEASON ON EARLY SUCCESSION IN BEDS OF THE PERENNIAL RED ALGA, IRIDAEA CORNUCOPIAE POSTELS & RUPRECHT (RHODOPHYTA: GIGARTINALES). Annette M. Olson, Oregon State University.

11:00-11:20 RECRUITMENT OF THE INTERTIDAL ALGAE HALOSACCION GLANDIFORME AND ENDOCLADIA MURICATA. Ladd Johnson, University of Washington.

11:20-11:40 SOME SIMILARITIES BETWEEN THE NEREOCYSTIS MERISTODERM AND THE MAMMALIAN TRACHEAL EPITHELIUM. David C. Walker, St. Paul's Hospital, Vancouver, B. C.

11:40-noon SPATIAL, TEMPORAL AND STRUCTURAL ASPECTS OF BENTHIC AUTOTROPHIC ASSEMBLAGES IN EAST PASSAGES, PUGET SOUND. Ronald M. Thom and Richard G. Albright, University of Washington.

noon-1:30 LUNCH -- Main Dining Hall.

1:30-3:10 Session 5. Janet R. Stein, moderator.

1:30-1:50 BIOGEOGRAPHY AND ECOLOGY OF HERIBAUDIELLA FLUVITALIS (PHAEOPHYCEAE). Janet R. Stein and John D. Wehr, University of British Columbia.

1:50-2:10 THE MORPHOLOGICAL COMPLEXES OF EUNOTIA PECTINALIS (BACILLARIOPHYCEAE) AND THEIR SEASONAL DISTRIBUTION PATTERNS IN A RHODE ISLAND STREAM. Alan D. Steinman, Oregon State University.

2:10-2:30 SEASONAL VARIATION IN SOIL ALGAL POPULATIONS IN A COOL DESERT SITE IN THE TINTIC MOUNTAINS, UTAH, USA. Jeffrey R. Johansen and Samuel R. Rushforth. Washington State University and Brigham Young University.

2:30-2:50 THE EFFECT OF LIGHT INTENSITY ON GROWTH AND CHLOROPHYLL CONTENT OF THREE SOIL ALGAE. William R. Rayburn, John Ashley and William K. Kroen. Washington State University.

2:50-3:10 COMPETITION BETWEEN TWO COMMON CHLOROPHYCEAN SOIL ALGAE OF EASTERN WASHINGTON. John Ashley and William Rayburn, Washington State University.

3:10-3:30 C/T break.

3:30-4:00 NWAS Business Meeting. The location of next year's meeting.

4:00-6:30 Open. Time to tour grounds, collect, socialize, etc.

6:30-8:00 DINNER -- Main Dining Hall.

8:00-9:00 Special Movie Presentation -- Commons.

DINOFLAGELLATES: SON ET VIDEO LUMIERE.
F. J. R. Taylor, University of British Columbia.

9:00-? Mixer -- Main Dining Hall.

Monday, November 12

7:00-8:30 Staggered Breakfast -- Main Dining Hall.

8:30-9:50 Session 6. Thomas F. Mumford, moderator.

8:30-8:50 ACCLIMATION TO LIGHT INTENSITY IN A WINTER AND A SUMMER SPECIES OF PORPHYRA. Stephen K. Herbert and J. R. Waaland, University of Washington.

8:50-9:10 ASPECTS OF THE POPULATION BIOLOGY OF MACROCYSTIS INTEGRIFOLIA BORY IN WESTERN QUEEN CHARLOTTE STRAIT. L. Michael Coon, Ministry of Environment, Victoria, B. C.

9:10-9:30 EFFECTS OF LAMINA HARVEST ON THE BULL KELP, NEREOCYSTIS LEUTKEANA (MERTENS) POSTELS AND RUPRECHT. William G. Roland, Ministry of Environment, Victoria, B. C.

9:30-9:50 SELECTION OF JAPANESE CULTIVARS OF PORPHYRA GAMETOPHYTES FOR NORI AQUACULTURE IN WASHINGTON STATE. Thomas F. Mumford, Jr., Department of Natural Resources, Olympia, Wa.

9:50-10:20 C/T break.

10:20-11:40 Session 7. John Merrill, moderator.

10:20-10:40 PHYCOBILIPROTEIN PIGMENT ANALYSIS IN PORPHYRA COLOR MUTANTS. John Merrill, Bruce Watson, and J. Robert Waaland, University of Washington.

10:40-11:00 A CHARACTERIZATION OF THE CHLOROPLAST RIBOSOMAL RNA GENES OF THE CHRYSOPHYTE OLISTHODISCUS LUTEUS CARTER. Terrence P. Delaney and R. A. Cattolico, University of Washington.

11:00-11:20 STRUCTURAL AND FUNCTIONAL ANALYSIS OF RIBULOSE-1,5-BISPHOSPHATE CARBOXYLASE FROM THE MARINE CHROMOPHYTE OLISTHODISCUS LUTEUS. Scott Newman and Rose Ann Cattolico, University of Washington.

11:20-11:40 TOPOISOMERASE ACTIVITY IN THE MARINE CHRYSOPHYTE OLISTHODISCUS LUTEUS. Steven L. Bressler and Rose Anne Cattolico, University of Washington.

11:40-noon Stand-by talk.

noon- Check-out.

POSTERS

Titles are listed aphabetically by last name of the first author.

PHYTOPLANKTON STANDING STOCK AT OCEAN STATION "P" DURING SUPER, MAY AND AUGUST 1984. B. C. Booth, University of Washington.

SEASONALITY OF MARINE ALGAL SPORE ABUNDANCE AND COMPOSITION IN THE WATER COLUMN. Alice F. Brown, Oregon State University.

AN EXPERIMENTAL STUDY OF THE ECOLOGY OF ALGAL CRUSTS. Megan N. Dethier, Friday Harbor Laboratories.

THE SHANNON POINT MARINE CENTER AND LEONA M. SUNDQUIST MARINE LABORATORY IN ANACORTES, WASHINGTON. Maurice Dube, Western Washington University.

EXTRACELLULAR DIGESTION IN MARINE DINOFLAGELLATES. Gregory Gaines and F. J. R. Taylor, University of British Columbia.

A NEWLY DISCOVERED HOST OF SMITHORA NAIADUM (BANGIOPHYCEAE, RHODOPHYTA). Gayle I. Hansen, Friday Harbor Laboratories.

SEASONAL VARIATION IN MORPHOLOGY, SIZE AND FERTILITY IN PUNCTARIA LATIFOLIA (PHAEOPHYCEAE) FROM THE SAN JUAN ISLANDS. Anne R. Haskins, Friday Harbor Laboratories.

PERIPHYTON MONITORING FOR COMPREHENSIVE WATER QUALITY ASSESSMENT IN SUBARCTIC ALASKA. Jerry W. Hilgert, U. S. Forest Service, Fairbanks, Alaska.

INTERACTIONS BETWEEN MICRO- AND MACROFOULING: THE ATTACHMENT OF THE DIATOM AMPHORA COFFEAEFORMIS TO PREPARED SURFACES. Rita Horner, Saiyed Ahmed, Amy Shoener, and James Staley, University of Washington.

CULTIVATION OF LAMINARIA GROENLANDICA IN BARKLEY SOUND, B. C. Kitty Lloyd and Louis D. Druehl, Bamfield Marine Station.

FARMING EQUIPMENT AND TECHNIQUES FOR PORPHYRA GAMETOPHYTE (NORI) AQUACULTURE IN WASHINGTON STATE. Thomas F. Mumford, Jr., Donald J. Melvin, William J. Byce, Makoto Inayoshi, and Virginia M. Bryant, Washington Department of Natural Resources.

SEATTLE PACIFIC UNIVERSITY'S NEWLY DEDICATED THOMAS B. CROWELY LABORATORY ON BLAKELY ISLAND. Dennis J. Russell, Seattle Pacific University.

AQUACULTURE OF PACIFIC NORTHWEST PORPHYRA FOR NORI. J. Robert Waaland, Leal G. Dickson, E. C. S. Duffield and Thomas F. Mumford, Jr., University of Washington and Washington Department of Natural Resources.

ABSTRACTS

Abstracts for talks are in order of presentation.
Abstracts for posters are arranged alphabetically by first author.

TALKS

A CLADISTIC ANALYSIS OF RED ALGAL ORDERS

Paul W. Gabrielson and David J. Garbary. Department of Botany, University of British Columbia, Vancouver, B.C. V6T 2B1 CANADA and Department of Biology, St. Francis Xavier University, Antigonish, N.S. B2G 1C0 CANADA.

A cladistic analysis of the orders of red algae, run on the PHYSYS program designed by J.S. Ferris and M.F. Mickevich, will be presented. The data matrix contains 40 characters and 17 taxa. Biochemical and ultrastructural features are included as well as traditional features of life histories, vegetative and reproductive morphology and patterns of spore germination. The orders Porphyridiales, Acrochaetiales and Rhodochaetales were each used as outgroups, and the resulting trees will be compared and discussed. Taxa that require further study or that may be polyphyletic will be indicated. Recognition of two classes or subclasses, Bangiophycidae and Florideophycidae, is not supported by the analysis.

THE SPERMATANGIA OF GELIDIUM PURPURASCENS GARDNER (GELIDIACEAE, RHODOPHYTA).

Dawn E. Renfrew. The Department of Botany, University of British Columbia, Vancouver, B.C. V6T 2B1 CANADA.

Spermatangia are reported for the first time in material provisionally identified as Gelidium purpurascens. The specimens, obtained from batch cultures at the Bamfield Marine Laboratory, were originally collected at Hornby Island, B.C. in the Strait of Georgia. The plants are monoecious. The spermatangia occur as a superficial layer covering most of the thallus branch, just proximal to the terminal cystocarps. Spermatangia are evident when viewed with a hand lens as forming a colourless surficial layer, on otherwise darkly pigmented plants. Spermatangia are characteristic of the family Gelidiaceae with anticlinal divisions present between spermatangial mother cells and spermatangia. A comparison of this material with G. purpurascens type material will be reported, and taxonomic implications discussed.

PHYLOGENETICS IN THE CLADOPHORALES COMPLEX: SOME NEW PERSPECTIVES FROM MACROMOLECULAR DATA. Jeanine Olsen-Stojkovich and J. A. West, Dept. of Botany, University of California, Berkeley, CA 94720, USA.

The Cladophorales complex (Cladophorales and Siphonocladales) is comprised of about 20 genera ranging from monotypic to some reportedly containing over 1200 species. Recent phylogenetic investigations have used an ultrastructural approach which has proven powerful at the ordinal level and above but does not seem to be able to resolve differences among genera and species within those orders. Furthermore, morphological simplicity and plasticity among individuals of the same species, and a lack of reliable characters suggests that convergent evolution has occurred thus limiting usefulness of traditional morphologic analyses for phylogenetic reconstruction.

To provide a new and independent line of inquiry within the order, a survey is now underway utilizing macromolecular data. Immunological distance data test current ideas about relationships among species and genera. Unlike more traditional immunological methods, solid phase radioimmunoassay (RIA) is both highly quantitative and sensitive to low levels of protein. Antibodies produced in response to soluble protein fractions of whole plant extracts are used in both standard cross-reaction and inhibition experiments. Phylogenetic trees are then constructed using the Fitch and Margoliash method, a modified UPGMA clustering algorithm producing a minimal length tree. To date, 48 antibodies have been prepared against 31 species.

Several patterns of relationships among taxa are already apparent: Dictyosphaeria is more closely related to Siphonocladus than Valonia; Cladophoropsis is closely related to Boodlea and Struvea, and not Cladophora; Cladophora appears to be a form genus with C. rugulosa closely allied with Microdictyon and Anadyomene rather than other Cladophora species; Valonia may have to be subdivided; and biogeographic counterparts exhibit considerable intraspecific variation but less than interspecific variation. Closer inspection of species relationships within Dictyosphaeria and Valonia are also underway. In summary, trends in these data support a fusion of the two orders because segregative division is insufficient evidence to warrant ordinal separation,

CURRENT STATUS OF THE GENUS *PALMARIA* (RHODOPHYTA, PALMARIALES) IN BRITISH COLUMBIA

Michael W. Hawkes. Department of Botany, University of British Columbia, Vancouver, B.C. V6T 2B1 Canada

During the course of a larger project documenting the Palmariales flora of British Columbia and northern Washington two undescribed *Palmaria* species were encountered. *Palmaria* sp. nov. #1 has thick, coriaceous, linear or lobed thalli and a characteristic encrusting base. Tetrasporophytes and male gametophytes are reproductive during the Winter. *Palmaria* sp. nov. #2 is dichotomously, trichotomously or irregularly branched with a habit superficially resembling that of some *Callophyllis* species. *Palmaria* #2 grows in the mid-intertidal zone (higher than any other *Palmaria* species) typically on the barnacle *Semibalanus cariosus*. Tetrasporophytes and male gemetophytes are reproductive during the Spring and Summer. These two new *Palmaria* species have a localized distribution in British Columbia, being a characteristic component of the flora along northern coasts. *Palmaria palmata* f. *mollis*, the third species of *Palmaria* in our flora, has a distribution range which extends the length of our coast. Preliminary culture study indicates that both *Palmaria* #1 and #2 have a microscopic female gametophyte in their life history.

EVOLUTION AMONG LOCAL GENERA OF THE DUMONTIACEAE (RHODOPHYTA): EVIDENCE FOR TWO DISTINCT LINEAGES

Sandra C. Lindstrom, Department of Botany, University of British Columbia, Vancouver, B.C., Canada V6T 2B1

The red algal family Dumontiaceae is represented in the north-eastern Pacific by more than half of the 16 or so genera attributed to the family. *Thuretellopsis* is the only primitive representative in local waters. The remaining genera represent two distinct lineages which differ significantly in their pattern of vegetative branch development. In one lineage, which locally includes *Cryptosiphonia*, *Dumontia*, *Dilsea*, and *Neodilsea*, sporangia are relatively large, cruciately divided, and female reproductive filaments can bear numerous laterals. In the other lineage, which locally includes *Farlowia*, *Pikea*, *Weeksia*, *Constantinea*, and an undescribed genus from SE Alaska, sporangia are relatively small, usually zonately divided, and distal cells of the female reproductive filaments enlarge greatly in more advanced genera. The convergence of some of these and other characters between the two lineages demonstrates the importance of a phylogenetic analysis before assuming relationships among taxa based on one or a few characters. Both lineages are found on both sides of the North Pacific, but the *Dumontia* lineage shows greater diversity in the western N Pacific whereas the *Farlowia* lineage is more diversified in the eastern N Pacific.

WHY DO SOME SEAWEEDS HAVE ISOMORPHIC LIFE HISTORIES?

Jane Lubchenco. Department of Zoology, Oregon State University, Corvallis, OR 97331 USA.

The following questions are posed and discussed: Why do seaweeds with isomorphic life histories persist? Are there important ecological differences between gametangial and sporangial phases? What does "isomorphic" really mean? A call is issued for more studies addressing ecological differences between the free-living phases of isomorphic algae. Preliminary data on some aspects of these questions are presented for Neorhodomela larix (Turner) Masuda in particular and also for six other species of isomorphic reds from the central Oregon coast.

MAINTENANCE OF A PREDOMINANTLY GAMETOPHYTIC *IRIDAEA CORDATA* POPULATION STRUCTURE

Georgiana May
Botany Dept., U.C. Berkeley

An *Iridaea cordata* (Turner)Bory population at Rubin Tarte St. Park (San Juan Is.) was observed to be dominated by gametophytic plants. The proportion of tetrasporophyte and gametophyte plants (ca. 84% gametophytes) did not change significantly over the period of time from summer 1981 to Spring 1983.

Hypotheses of differential growth and mortality rates were excluded as explanations of the population's observed structure. It was found that on a year-to-year basis, the maintenance of a predominantly gametophytic population structure can be explained primarily on the basis of vegetative propagation from perennating holdfasts. For this population, it is estimated that less than 10% of new spring blades arise from spores and greater than 90% arise from holdfasts.

THE DEMOGRAPHY OF FRONDS OF CHONDRUS CRISPUS (STACKHOUSE)

Debashish Bhattacharya. Department of Biological Sciences, Simon Fraser University, Burnaby, British Columbia, V5A 1S6 CANADA.

A demographic analysis was done of an intertidal stand of Chondrus crispus Stackhouse at Pubnico Point, Nova Scotia. The distribution of gametophytic and tetrasporophytic fronds was assessed. Size-specific measurements for fronds are presented. Haploids dominated the stand. Fronds in Size-Class 2 exhibited high survivorship. Survivorship fell sharply when fronds entered Size-Class 3 and Size-Class 4. Fronds became fertile and highly branched when in the third and fourth size-classes. It was suggested that these two factors contributed to the higher mortality rates of such individuals.

Monthly spore release rates m^{-2} for gametophytes and tetrasporophytes were measured. The annual release rate of carpospores exceeded the annual release rate of tetraspores by a ratio of 4.7 : 1. Rates did not fall below 10^6 spores released m^{-2} mo^{-1} for either phase.

Life TABLES de.

ON THE LIFE HISTORY OF LAMINARIA GROENLANDICA

Louis D. Druehl, Paul J. Harrison and Katherine E. Lloyd. Bamfield Marine Station, Bamfield, B. C., CANADA V0R 1B0; Institute of Oceanography, University of British Columbia, Vancouver, B. C., CANADA V6T 2B1.

Growth characteristics were determined for three year classes of Laminaria groenlandica Rosenvinge maintained on rope structures in Barkley Sound, B.C., Canada. First year plants, which bacame macroscopically visible in March, obtained maximum size in June-July and second and third year plants which initiated growth in January were largest in April-May. The second year plants dominated the other year classes in blade dimensions and few plants survived their third year of growth. The extended growth period of first year plants into the season of poor nutrient availablility may be accounted for by their superior ability to take up nutrients (9 μmol NO_3g dry wt^{-1} h^{-1}) relative to second (3 μmol NO_3g dry wt^{-1} h^{-1}) and third (1 μmol NO_3g dry wt^{-1} h^{-1}) year plants.

THE METABOLIC BIOCHEMISTRY OF GELIDIUM COULTERI HARV.

Bruce A. Macler. University of California, Berkeley, California 94720

The metabolic intermediates and end-products of carbon fixation and subsequent carbon flow in G. coulteri were determined by analyzing the radioactive products of ^{14}C-bicarbonate incorporation. Plants were grown in the light and in the dark, with and without several nitrogen sources.

For plants grown in the light, ^{14}C-label in the sugar mono- and diphosphates indicated reductive pentose phosphate (Calvin) cycle activity. Label also appeared in the intermediates of the tricarboxylic acid (Krebs) cycle. When nitrogen was present, label appeared in amino acids, particularly aspartate, glutamate, asparagine and glutamine. After incubation periods of 0.5 to 2.0 hrs, most intermediates reached a "steady state" of constant labeling. Several compounds however continued to accumulate label as long as the experiments lasted. These included citrate, gluconate, ribulose, agar and the insoluble polyglucose of the cell wall.

Plants grown in the dark fixed ^{14}C-bicarbonate at less than 5% of the rate seen in the light. The principle labeled products were of the Krebs cycle and amino acids, suggesting carbon fixation through phosphoenol pyruvate carboxylase or carboxykinase.

GROWTH IN CULTURE AND RESPONSES TO CD OF SPOROPHYTES OF LAMINARIA SACCHARINA (L.) LAMOUR. PRODUCED AFTER EXPOSURE OF GAMETOPHYTES TO CD.

James W. Markham and Klaus-Richard Sperling. 6147 NE Radford Dr., Seattle, WA 98115 USA and Biologische Anstalt Helgoland, Laboratorium Sülldorf, Wüstland 2, D-2000 Hamburg 55, FEDERAL REPUBLIC OF GERMANY.

Gametophytes of Laminaria saccharina growing vegetatively under red light were exposed to sublethal concentrations of cadmium for various lengths of time, then transferred to white light and allowed to become fertile and produce sporophytes. Growth of these sporophytes was measured in culture for 11 weeks, after which their response to Cd was tested over 6 days. Sporophytes produced by Cd-exposed gametophytes (T plants) exhibited slower growth and poorer attachment than those produced by control gametophytes (K plants). The growth of T plants was relatively less inhibited by higher concentrations of Cd, but Cd uptake was greater than for K plants. These experiments have implications for questions of relative tolerance of plants from chronically polluted habitats.

FORMATION OF ASCORBIC ACID IN SPECIES FROM SEVERAL CLASSES OF ALGAE

Frank A. Loewus. Institute of Biological Chemistry, Washington State University, Pullman, WA 99164-6340 USA.

L-Ascorbic acid (AA) is regarded as a ubiquitous constituent in higher plants. Its pathway of biosynthesis in plants differs markedly from that found in AA-synthesizing animals. The former involves oxidations at carbon 1 and carbons 2 (or 3) plus an epimerization at carbon 5 of D-glucose. The latter involves a reduction of carbon 1 and oxidation at carbon 6 and carbon 5 (or 4) which results in an inversion of the carbon chain sequence between glucose and AA. Recent studies with algal species from several classes revealed that some utilize the "animal" pathway while others utilize the "plant" pathway. The basic requirement for acquiring similar information concerning AA biosynthesis in classes still unexamined is a heterotrophic capacity to use D-glucose. Such information will be most welcome. Phytogenetic assignment of algal classes by "plant" as opposed to "animal" pathway of AA biosynthesis may yield new information regarding evolutionary development and may assist in classification according to a biochemical taxonomy.

The nitrogen nutrition of *Gelidium purpurascens*, grown in outdoor culture

W.N. Wheeler. Bamfield Marine Station and Department of Botany, University of British Columbia, Vancouver, B.C. V6T 2B1 CANADA.

The purpose of this study, which continues, is to understand the nitrogen requirements of growth and agar production in *Gelidium*. To do this I have divided the nutrition into an uptake phase and an assimilation phase. This paper deals primarily with the uptake phase. The maximum rate of uptake of nitrate observed through this past growing season was 14.8 umol N gfw^{-1} h^{-1}. The mean rate of uptake over 29 separate experiments was 8.0 $\pm$ 3.5 umol N gfw^{-1} h^{-1}. These numbers can be converted using the relations: 1gfw = 180 cm^2 = 0.25 gdw. There appears to be a short-term effect of darkness on uptake - reducing rates by about 15%. Temperature effects uptake, but with a Q_{10} (10-20° C) of only 0.4, in the light.

The uptake of ammonium is also being studied. It has been taken up at a maximum rate of 26.5 umol N gfw^{-1} h^{-1} with a mean uptake measured over 15 experiments of 14.7 $\pm$ 3.4 umol N gfw^{-1} h^{-1}. Darkness also affects the uptake of ammonium - rates after 1 h in the dark are about 60% of those in the light. Temperature, as with nitrate, appears to have little effect. The Q_{10} is about 0.4. Experiments in which nitrate and ammonium were added together rarely showed any effect on uptake rates of the opposite species.

On the ecology of Postelsia palmaeformis.

R. T. Paine. Department of Zoology, University of Washington, Seattle, WA 98195.

The monotypic genus Postelsia is widely acclaimed as an indicator of exposed, wave-swept shores. New evidence will be given: 1) to support the observation that effective spore dispersal range is a few meters at best; 2) to identify via experimental transplants of the sporophyte the optimal habitat; and 3) to indicate that this species requires disturbance of a certain magnitude and frequency, and that its local distribution and abundance are determined by such events. The paradox of local persistence and broad geographical distribution, given these ecological traits, will be discussed.

EFFECTS OF PHYSICAL DISTURBANCE, HERBIVORY, AND SEASON ON EARLY SUCCESSION IN BEDS OF THE PERENNIAL RED ALGA, IRIDAEA CORNUCOPIAE POST. & RUPR. (RHODOPHYTA: GIGARTINALES)

Annette M. Olson. Oregon State University, Corvallis, OR 97331.

Results of field experiments indicate that the intertidal alga, Iridaea cornucopiae, rapidly recovers (3 - 5 mo) when disturbances remove upright blades but leave the hardy, perennial crust intact. When disturbance destroys the crust, however, recruitment from spores is slow (5+ mo). Seasonal differences in recovery occurred when crusts died in spring-initiated clearings (presumably due to heat and desiccation), slowing recovery relative to fall-initiated clearings where crusts survived. When the dominant herbivores (limpets) are experimentally excluded, recruitment by Iridaea cornucopiae is inhibited. Competitive exclusion by ephemeral algae is one suggested mechanism of this inhibition, because establishment of ephemeral algae is enhanced in both spring- and fall-initiated exclosures and inhibited in controls where limpet grazing is allowed. However, seasonal differences in recruitment of Iridaea in control plots suggest that recruitment is also controlled by seasonal factors, such as patterns in herbivory, physical stresses, and spore availability.

Recruitment of the intertidal algae Halosaccion glandiforme and Endocladia muricata.

Ladd Johnson Department of Zoology NJ-15, University of Washington, Seattle, WA 98195 USA

Herbivorous molluscs are well known to control the distribution of marine benthic macroalgae. Experimental research on the outer coast of Washington has shown that both increased surface rugosity and the exclusion of limpets facilitates the colonization of artificial substrata by the red alga Halosaccion glandiforme. In contrast, while increased surface rugosity also enhances colonization by Endocladia muricata, grazing by limpets is required as well, presumedly to remove competitively-superior algae such as H. glandiforme.

The control of H. glandiforme appears to occur through the fatal consumption of sporelings by limpets. Although H. glandiforme disperses spores from late summer through spring, the period of vulnerability to limpets occurs during the winter (Dec.-Mar.). Thus, interactions between limpets and the early stages of this alga during a limited period of time eventually determines the ultimate distribution of the adult stages.

SOME SIMILARITIES BETWEEN THE NEREOCYSTIS MERISTODERM AND THE MAMMALIAN TRACHEAL EPITHELIUM

David C. Walker, Pulmonary Research Laboratory, UBC Pathology Department, St. Paul's Hospital, Vancouver, B.C.

Light and electron microscopic observations have been made on the meristoderm and tracheal epithelium of Nereocystis and guinea pigs respectively. Both cell layers are at the organism/environment interface. An unstable or transient surface appears to discourage the residency of potential pathogens or colonizers on both surfaces. Mucus plays an important role in protecting both surfaces from a variety of insults. The surfaces of Nereocystis and the tracheal epithelium are both provided with systems of cellular renewal as a mechanism for dealing with cell injury and/or exfoliation. These observations will be illustrated and discussed.

SPATIAL, TEMPORAL AND STRUCTURAL ASPECTS OF BENTHIC AUTOTROPHIC ASSEMBLAGES IN EAST PASSAGE, PUGET SOUND.

Ronald M. Thom and Richard G. Albright. School of Fisheries, University of Washington, Seattle, Washington USA.

A comprehensive baseline study of the oceanography of south-central Puget Sound included sampling of benthic plants between May 1982 and March 1984. The major benthic autotrophes consisted of eelgrass (Zostera marina), sediment associated microflora, and seaweeds. Eelgrass generally occurred at depths between +1 and -10 ft (MLLW), and reached greatest density in embayments. Sediment microflora and seaweeds were distributed throughout the intertidal zone and down to a depth of at least -20 ft. The greatest standing stocks of seaweeds, microalgae and eelgrass occurred during summer (July-August), with minimum values recorded in winter (January-February). Species richness in seaweed assemblages was greatest in spring. Peak seaweed biomass values were on the order of 170 g dry wt/m^2. Chlorophyll a concentrations were greatest in low intertidal sand sediments as compared to low intertidal cobble, high intertidal cobble and high intertidal sand sediments. Peak chlorophyll a levels occurred in April and August 1983, and were 322 and 424 $\mu g/cm^2$, respectively. Eelgrass density, plant length and biomass showed consistent increases from spring (March) through late summer (September). Total primary production calculated over a 1 hectare plot in the intertidal zone showed a peak in July (840 kgC/ha/mo) and a low in January and February (ca. 10 kgC/ha/mo). Total annual production for the plot was estimated at 11,716 kgC/ha. Drift vegetation along the shore reached greatest biomass in August. Maximum values recorded were in excess of 1700 g dry wt/m^2.

BIOGEOGRAPHY AND ECOLOGY OF HERIBAUDIELLA FLUVITALIS (PHAEOPHYCEAE).

Janet R. Stein and John D. Wehr, Department of Botany, University of British Columbia, Vancouver V6T 2B1, Canada and Department of Plant Sciences, University of Western Ontario, London N6A 5B7, Canada

A survey of 122 reaches on streams and rivers in the Pacific Northwest established 26 populations of the encrusting freshwater phaeophycean alga Heribaudiella fluviatilis. Its basically noncoastal distribution indicates it is not an "escaped" marine organism. Typical streams in which it grows have a rapid current velocity (>65 cm/s), a moderately alkaline pH (7.0-8.6), a broad range of conductivities (52-385 umho/mm) and Ca concentrations (10.5-66 mg/L), moderate temperature range (10-20 C), and little restriction regarding shade/sun locations. In some communities, Heribaudiella was the dominant species. Biogeographical and ecological data from throughout the world indicate it may be a common, but often overlooked component of running waters.

THE MORPHOLOGICAL COMPLEXES OF EUNOTIA PECTINALIS (BACILLARIOPHYCEAE) AND THEIR SEASONAL DISTRIBUTION PATTERNS IN A RHODE ISLAND STREAM.

Alan D. Steinman, Department of Botany, Oregon State University, Corvallis, OR 97331

The filamentous diatom, Eunotia pectinalis (O.F. Müll.?) Rabh., is a prominent component of the periphyton in Rhode Island streams. Previous work has shown that despite considerable morphological plasticity in the taxon, three main complexes could be delineated based upon valve configuration. This morphological variability led to an investigation of the seasonal distribution patterns of both the three complexes and the taxon in general. A biweekly sampling regime that began in autumn, 1981 and continued through autumn, 1982 at two sites in Moscow Brook, R.I. revealed a bimodal distribution pattern, with maximal cover estimates occurring in spring and autumn. However, limited populations were present during the summer and winter months, representing potential "seed" pools. The complexes treated as E. pectinalis var. pectinalis and var. ventricosa (Grun.) were the most abundant forms, and were present in fairly equal percentages at the two sites, while var. minor (Kutz.) Rabh. was relatively rare.

SEASONAL VARIATION IN SOIL ALGAL POPULATIONS IN A COOL DESERT SITE IN THE TINTIC MOUNTAINS, UTAH, USA.

Jeffrey R. Johansen and Samuel R. Rushforth. Bacteriology and Public Health, Washington State University, Washington 99164-4340 USA and Department of Botany and Range Science, Brigham Young University, Provo, Utah 84602 USA.

An arid land soil algal community was studied by means of direct counts under fluorescence microscopy September 1982 to August 1983. A total of 30 algal taxa were observed during the study. Blue-green algae were dominant throughout the collection period and had the greatest diversity, 15 species being present. Diatoms were second in importance with 9 species. Green algae occurred in densities comparable to the densities of diatoms, but were consistently less abundant. Our data indicate that algal growth was not related in a linear manner to precipitation. Growth increased until a threshold amount of soil moisture was reached. Moisture beyond this amount did not increase growth. Algal response to high air temperatures was negative and rapid, particularly when accompanied by dryness. Algal numbers were highest in late fall and early spring.

THE EFFECT OF LIGHT INTENSITY ON GROWTH AND CHLOROPHYLL CONTENT OF THREE SOIL ALGAE.

William R. Rayburn, John Ashley and William K. Kroen. Department of Bacteriology and Public Health and Department of Botany, Washington State University, Pullman, WA 99164 USA.

Centrosphaera, Neochloris and Stichococcus, isolated from Eastern Washington soils, were inoculated onto sterile soil contained in 20 cm^2 plastic flats. Replicate flats with each alga were kept moist at 20 C and exposed to either 50, 100, or 175 $\mu Ein \cdot m^{-2} \cdot s^{-1}$ of photon flux from cool white fluorescent lamps on a 16hrL:8hrD cycle. Cell densities and chlorophyll content per cm^2 were determined at 0, 7, 14, 21 and 28 days. Growth rates of all three algae were positively correlated with light intensity. Final cell densities were similar with all treatments. Chlorophyll content of cells was negatively correlated with light intensity for all three algal species. Measurements of chlorophyll fluorescence have been used for many years to estimate phytoplankton abundance in natural waters. This method could provide a relatively rapid method for estimating algal abundance on soil surfaces. However, in laboratory experiments care must be taken to assure uniform light conditions when chlorophyll content is used as a measure of growth by soil algae.

COMPETITION BETWEEN TWO COMMON CHLOROPHYCEAN SOIL ALGAE OF EASTERN WASHINGTON.

John Ashley and William Rayburn. The Department of Botany and Department of Bacteriology and Public Health, Washington State University, Pullman, Washington, 99164.

Two naturally occurring soil algae of eastern Washington soils, Neochloris and Stichococcus were used to inoculate soils in a competition study. Flats of sterile soil were inoculated with either Neochloris or Stichococcus or combinations of the two. Initial cell densities for each species were 10^3 and 10^4 cells cm^{-2} and for combinations inoculation ratios were: 1:1, 1:10, 10:1 and 10:10. Cell densities and chlorophyll content per cm^2 soil were determined at 0, 7, 14, 21 and 28 days. Growth rates and chlorophyll content were similar throughout the experiment regardless of initial cell densities. Final cell densities also were very similar among all combinations. Competition between Neochloris and Stichococcus appeared to be lacking.

ACCLIMATION TO LIGHT INTENSITY IN A WINTER AND A SUMMER SPECIES OF PORPHYRA.

Stephen K. Herbert and J. R. Waaland. The Department of Botany, University of Washington , Seattle, Washington 98195.

Winter-annual gametophytes of Porphyra torta and summer-annual gametophytes of Porphyra perforata were cultured in the laboratory under both high and low light intensities and then examined for photosynthetic response to light intensity.Results allow classification of the former as a shade plant and the latter as a sun plant. These results suggest a possible role of genotypic differences in the photosynthetic mechanisms of these two species in their differing seasonalities and in their original speciation. They are also to the process of species and strain selection for Porphyra aquaculture in Pacific Northwest waters.

ASPECTS OF THE POPULATION BIOLOGY OF MACROCYSTIS INTEGRIFOLIA BORY IN WESTERN QUEEN CHARLOTTE STRAIT.

L. Michael Coon. Fisheries Branch, Ministry of Environment, 780 Blanshard Street, Victoria, British Columbia, V8V 1X5.

Stratified random sampling was carried out at intervals between March 1980 and September 1981 to characterize seasonal changes in the vertical distribuition of Macrocystis biomass and frond lengths within the study area as well as in plant size class distribution, plant and frond density, mean weight per frond and standing crop. Distribution of biomass through the water column showed a broad maximum between 4 m below and 1 m above Mean Water Level from May through September 1980; this pattern was repeated in 1981 although biomass at all depths was reduced. Monthly frond density values were reduced at most depths in 1981. Plant density declined from a winter-spring maximum to a minimum in June, paralleling the change in proportion of plants having 10 or fewer fronds. Frond density varied between 3-5/m^2 and paralleled the seasonal change in plant density. Standing crop varied from winter-spring minima of about 1 kg/m^2 to August maxima of 3-4 kg/m^2. Mean frond weight varied similarly, with December and March values of 0.3 kg/frond or less increasing to as much as 1 kg/frond in August. Standing crop was reduced in 1981 compared to 1980, with May through August values being about 1 kg/m^2 less than those observed in 1980. Standing crop changes were largely a function of changes in frond weight. Repeated observations of tagged plants in three 100 m^2 quadrats between January and September 1981 revealed no periods of either high recruitment or mortality and that holdfast splitting was the most important form of recruitment in mature beds.

EFFECTS OF LAMINA HARVEST ON THE BULL KELP, *NEREOCYSTIS LUETKEANA* (MERTENS) POSTELS AND RUPRECHT

William G. Roland, Marine Resources Branch, Ministry of Environment, Parliament Buildings, Victoria, British Columbia
V8V 1X5

Sporophytes of *Nereocystis luetkeana* having laminae harvested 30 cm distal to the lamina base either once or three times at monthly intervals showed overall survivorship comparable to unharvested plants. A single harvest of laminae in early June significantly reduced lamina growth rate. After 10 weeks the mean lamina length of single harvested plants was only 55% of that of the control plants and mean lamina lengths of multiple-cut plants were maintained at even shorter lengths. Lamina production was significantly reduced by harvesting as was the proportion of blades bearing sori. Monthly lamina harvests always yielded less than 50% of the initial mean yield per plant. Harvesting in this manner should not effect the use of kelp beds as aids to navigation. Increasing the harvest distance from the lamina base should reduce any negative effects on the canopy habitat and on lamina growth and production which could effect associated food chains. Entire beds should not be harvested at one time until effects on recruitment are studied. Staggered harvesting of different plants throughout the year should have a minimal impact on sustained yield and recruitment.

SELECTION OF JAPANESE CULTIVARS OF *PORPHYRA* GAMETOPHYTES FOR NORI AQUACULTURE IN WASHINGTON STATE.

Thomas F. Mumford, Jr. Division of Marine Land Management, Department of Natural Resources, Olympia, Washington 98504 U.S.A.

Five commercial cultivars of Japanese species of *Porphyra* (*P. yezoensis* vars. "Susabi #10", "AKA-1", "U-51", and an un-named variety from M. Inayoshi, and *P. tenera* var. "Izumi") were obtained and tested in Washington marine waters. The varieties were seeded in southern Puget Sound and grown in a variety of sites in Puget Sound and the San Juan Island region. Standard Japanese floating culture methods were used. Only *P. yezoensis* var. "U-51" grows well. The other varieties have grown poorly, become wrinkled, or been damaged by fungal disease. Second generation cultures of *P. yezoensis* var. "U-51" are now being tested as well as two more varieties of *P. yezoensis*.

Phycobiliprotein pigment analysis in Porphyra color mutants. John Merrill, Bruce Watson, and J. Robert Waaland, Botany Department, University of Washington, Seattle.

Phycobiliprotein pigments from three color mutant strains and one genetic recombinant type strain of Porphyra yezoensis chonchocelis phase were partially purified in order to characterize in greater detail the specific nature of their pigmentation differences. Variations in three characteristics were found to result in the gross color differences: 1) the relative content and ratio of phycoerythrin types PE I (high molecular weight) and PE II (low molecular weight); 2) the relative content of the phycourobilin chromophore (496nm absorbance) in phycoerythrin; 3) presence or absence of phycoerythrobilin chromophore (540nm peak absorbance) in addition to the main phycocyanobilin chromophore (617nm peak) in phycocyanin. Since PE II content can vary independently from PE I, the findings imply that PE II has a functional role other than as a PE I precursor. The presence of more than one probable lesion in at least one of the mutant types suggests that more careful examination should reveal additional recombinant forms in F1 progeny of crosses.

A Characterization of the Chloroplast Ribosomal RNA Genes of the Chrysophyte Olisthodiscus luteus Carter. Terrence P. Delaney & R.A. Cattolico. Department of Botany, University of Washington; Seattle, WA 98195

The chloroplast genome of the marine chrysophyte Olisthodiscus luteus has been characterized in our laboratory and has been found to be novel with respect to both organization and gene complement. Through the mapping of restriction sites, we have determined that the genome is similar to higher plant chloroplast genomes in that the circular DNA molecule consists of two single copy regions separated by two repeated regions which lie in an inverted orientation. In order to place genes on this restriction map we utilized heterologous DNA probes to screen restriction digests of chloroplast DNA. Upon examination it became clear that the O. luteus inverted repeat contains genes not present on higher plant inverted repeats. The protein coding genes for both subunits of ribulose bisphosphate carboxylase as well as the 32 kilodalton "photogene" are present on the O. luteus inverted repeat,and are thus present at two or more copies per genome, in contrast to one copy per genome in higher plants (Reith & Cattolico; Biochemistry, in press).

To characterize the ribosomal RNA (rRNA) genes on the O. luteus chloroplast genome, heterologous rDNA probes from Euglena have been used to map this algal DNA. Within an 8000 base pair resolution, O. luteus ribosomal genes have been observed to lie on the inverted repeat. Through molecular cloning a finer resolution map is being prepared of the inverted repeat. This map, in conjunction with the use of specific rRNA species as hybridization probes will allow the following questions to be answered: i) How many copies of the 23s, 16s, and 5s rRNA genes are present on each of the repeat units? ii) What is the sequence of genes within the rRNA gene array? iii) What is the actual length of the repeat unit?

The answers to these questions will provide an interesting comparison of chloroplast genome organization relative to evolutionary distance between higher plants and the algae. The novel features of the O. luteus chloroplast genome makes its investigation important in the understanding of chloroplast function and phylogeny.

STRUCTURAL AND FUNCTIONAL ANALYSIS OF RIBULOSE-1,5-BISPHOSPHATE CARBOXYLASE FROM THE MARINE CHROMOPHYTE OLISTHODISCUS LUTEUS.

Scott Newman and Rose Ann Cattolico. Department of Botany, University of Washington, Seattle, Wa. 98195

Ribulose-1,5-bisphosphate carboxylase is a multimeric enzyme consisting of 8 large catalytic subunits(LS) and 8 small subunits (SS) of unknown function. In chlorophytic plants (chlorophyll a,b), the LS is a chloroplast DNA encoded gene product and the SS is nuclear DNA encoded. However in the chromophytic (chl. a,c) alga Olisthodiscus luteus both the LS and SS are coded for by chloroplast DNA. Since the coding capacity of the chloroplast genome of O. luteus is different than that seen in other plants, we have examined the structure and function of RuBPCase from this chromophytic alga. Our study represents the first detailed research on this important photosynthetic/photorespiratory enzyme from a non-chlorophytic plant species. Following purification to homogeneity, the size of the holoenzyme (17.9 s, 588 kd) was determined by sedimentation analysis and the size of the subunits (55 kd, 15 kd) ascertained by analytical SDS gel electrophoresis. Our data predict an 8:9 ratio of the LS:SS in the holoenzyme although we cannot exclude an 8:8 ratio. An amino acid analysis reveals that as expected the O. luteus LS is highly conserved whereas the SS shows little amino acid homology when compared with the chlorophytic plant peptides. Several catalytic optima (temperature, pH and Mg^{2+}) have been determined for the O. luteus RuBPCase as well as the parameters for "activation" (the pre-catalytic incubation with HCO_3^- and Mg^{2+} which is necessary for maximal activity). The Michaelis constants for the substrates of the carboxylation reaction (CO_2 and RuBP) were shown to be 45 and 48 μM, respectively. Competative inhibition by oxygen of RuBPCase-catalyzed CO_2 fixation was also demonstrated.

TOPOISOMERASE ACTIVITY IN THE MARINE CHRYSOPHYTE OLISTHODISCUS LUTEUS.

STEVEN L. BRESSLER AND ROSE ANN CATTOLICO.
DEPARTMENT OF BOTANY, UNIVERSITY OF WASHINGTON, SEATTLE, WA. 98195.

The purpose of this study is to purify and characterize the topoisomerases found in isolated nuclei and chloroplasts of the marine chrysophyte, Olisthodiscus luteus. Topoisomerases are enzymes which affect the topological conformation of DNA without altering its primary structure. These enzymes have been shown to be important in such cellular processes as DNA replication, recombination and transcription. Topoisomerase activity has been reported in three species of higher plants: spinach, cauliflower and wheat.

Cells from O. luteus, a naturally wall-less alga are gently broken and after Triton X-100 treatment, the lysate is placed over a sucrose pad. The unbroken nuclei are pelleted, resuspended in extraction buffer and then lysed in high salt. The DNA is precipitated and the clear supernatant is poured over an hydroxyapatite column. Topoisomerase activity elutes at 0.4-0.5M KH_2PO_4. The active fractions are then pooled and poured over a phosphocellulose column. Topoisomerase activity is eluted using a linear 0.2-0.8M KH_2PO_4 gradient. The recovered activity is highly concentrated and stable for as long as 2-3 weeks at $4^{o}C$.

Two different types of topoisomerase activities are found in the nuclei preparations. A type I topoisomerase which can catalyze the relaxation of covalently closed circular DNA (consisting of purified supercoiled pBR322 molecules) into a classical ladder of topological isomers and a type II topoisomerase which can decatenate kinetoplast DNA, a highly catenated DNA substrate from the trypanosome, Crithidia fasciculata. Since the nuclei preparation is composed of nuclei and chloroplast nucleoids (chloroplast DNA and assorted DNA-binding proteins) an attempt was made to distinguish and localize each of these topoisomerase activities to one or the other organelle. To achieve this goal we have developed a method to separate chloroplasts from nuclei on a discontinuous sucrose step gradient.

Preliminary hybridization experiments using as a probe the structural gene which encodes for the β-subunit of gyrase (involved in ATPase function of the type II topoisomerase found in E. coli and other procaryotes) was shown to have homology with restriction fragments of ctDNA from O. luteus and not with nuclear or mitochondrial DNA. It is interesting that this procaryotic gene hybridizes to the chloroplast genome which lends support for the endosymbiont theory of organelle biogenesis.

POSTERS

Phytoplankton Standing Stock at Ocean Station "P" during SUPER, May and August 1984

B.C.Booth,
(School of Oceanography, University of Washington, Seattle, WA 98195)

Standing stock of phytoplankton size classes and taxa was estimated using epifluorescence microscopy. On May 2, Synechococcus dominated total phytoplankton carbon (TPC) with a maximum at 70 m. By May 11, Synechococcus had increased by 4x and it was still dominant but with a maximum at 30 m. By May 16, Synechococcus biomass had returned to the May 2 level; flagellates and coccoids 2-5 um were now dominant with maxima at 10 and 30 m. Larger flagellates and small pennate diatoms contributed to TPC, but eukaryotes 2 um (picoplankton) did not.

In August a similar shift from picoplankton to nanoplankton occurred. On August 3, a Synechococcus maximum occurred at 50 m. By August 20 flagellates and coccoids 2-5 um predominated with maxima higher in the water column. Larger forms were less important than in May.

Identification of the species within the size classes is underway.

SEASONALITY OF MARINE ALGAL SPORE ABUNDANCE AND COMPOSITION IN THE WATER COLUMN.

Alice F. Brown. Department of Zoology, Oregon State University, Corvallis, Oregon 97331.

A year-long study is close to completion in which the abundance and composition of viable seaweed spores in the water column of central coastal Oregon are investigated. The goals of this study are to determine the variation in diversity of spores able to grow into propagules in the lab through both time and a depth gradient. Water samples were collected monthly from 1m, 2m, and 3m below the surface at high tide, filtered, and cultured in sea water for one month. Preliminary results show little or no change in diversity with depth. However, there is an apparent fluctuation in propagule abundance through time. During the study period (Nov. 1983-Aug. 1984), the number of Chlorophyte propagules peaked in late fall/early winter and reached lowest values during the spring. Rhodophyte propagule abundance peaked in early spring and gradually declined through the summer. The number of Phaeophyte propagules remained low throughout the study period. More specific taxonomic identifications are currently being established.

AN EXPERIMENTAL STUDY OF THE ECOLOGY OF ALGAL CRUSTS.

Megan N. Dethier. Friday Harbor Laboratories, Friday Harbor, WA. 98250.

Field and laboratory observations and experiments are being used to examine the ecological consequences of being crustose (as opposed to filamentous, bladed, or another morphology). Parallel studies are being performed by Robert Steneck in Maine to examine convergent patterns in the 2 floras. A model predicts that crusts are particularly abundant (relative to other algal forms) in high disturbance-high potential productivity environments and in low-disturbance, stressful environments. We are also testing how crusts of different morphologies perform under different environmental conditions. Quantitative field surveys and transplants of 8 species of intertidal crusts (7 fleshy and 1 calcified species) have been done along an intertidal gradient (representing a gradient of potential productivity). Disturbannce levels are manipulated by controlling access of herbivores to the transplants and by brushing some of the crusts at regular intervals with steel or nylon brushes. After one year, transplants are just beginning to grow significantly. Growth is faster lower in the intertidal and appears to be enhanced on north faces. Crusts vary radically in their response to brushing; 2 species of intertidal lichens, for instance, are very susceptible to both brushing regimes, while Petrocelis is quite resistant. Lab experiments show that limpets eat crusts, and have distinct preferences. Data after another year of growth should provide answers as to why crusts are such a successful functional group and what anatomical features are necessary to survive certain environmental stresses.

THE SHANNON POINT MARINE CENTER AND LEONA M. SUNDQUIST MARINE LABORATORY IN ANACORTES, WASHINGTON

Maurice Dube, Western Washington University, Bellingham, Wa.

Shannon Point Marine Center was opened in 1974 and is administered by Western Washington University. The laboratory serves the Shannon Point Marine Center Consortium of Central Washington University, Eastern Washington University, Edmonds Community College, Everett Community College, Evergreen State College, Skagit Valley College and Western Washington University.

The 11,000 sq. ft. facility includes two large instructional and eight smaller individual laboratories. It is designed to serve undergraduate and graduate instruction as well as visiting investigators.

Courses offered Spring term 1985 include Biology of Lower Organisms, Marine Ecology, Algae, Introductory Statistics/Probability, Marine Biology, Marine Ecosystems Analysis, Marine Invertebrate Zoology, and Fisheries Management.

Summer 1985 offerings include Invertebrate Zoology, Ichthyology, Oceanography, Natural History of the Northwest, Marine Biology, Fish Physiology, Algae, and Environmental Education.

EXTRACELLULAR DIGESTION IN MARINE DINOFLAGELLATES

Gregory Gaines and F. J. R. Taylor. Department of Oceanography, University of British Columbia, 6270 University Blvd., Vancouver, B. C. V6T 1W5 CANADA.

Individuals of the common coastal marine dinoflagellate genus Protoperidinium have been found to perform extracellular digestion of chain-forming diatoms by means of a pseudopodial 'feeding veil.' This mechanism of feeding explains the absence of food particles in these non-photosynthetic, thecate organisms, and seems to be an adaptation for opportunistic feeding.

A NEWLY DISCOVERED HOST OF SMITHORA NAIADUM (BANGIOPHYCEAE) RHODOPHYTA

Gayle I. Hansen, Friday Harbor Laboratories, Friday Harbor, Wa. 98250

Smithora naiadum is a common epiphyte of the sea grasses Zostera marina and Phyllospadix scouleri along the west coast of North America. This alga had been reported to occur exclusively on sea grasses until Harlin (1973) discovered that it would also grow on polypropylene strips resembling grass blades. Although the non-obligate nature of the host-epiphyte association was demonstrated, S. naiadum, to date, has not been found to occur on any other natural hosts.

While examining summer collections of Plocamium cartilagineum from the San Juan Islands, I noted that small cushion-like pads resembling the basal system of Smithora naiadum were frequently scattered over the outer branches of the algal thalli. Closer examination revealed that a number of the pads also bore small, erect, monostromatic blades. Although the basal pads averaged only 2 mm in length and the blades were less than 1 cm in height, the tiny plants were identical in structure, cell size and chloroplast morphology to the larger thalli of the sea-grass epiphyte Smithora naiadum.

Plocamium cartilagineum is a logical secondary host for Smithora naiadum. It is a common understory plant in the beds of Phyllospadix scouleri that occur in exposed localities, and it is frequently exposed to spore packets released from the Smithora attached to the canopy grass blades. In addition, its location in the understory insures that both P. cartilagineum and its epiphytic Smithora are exposed to many of same exogenous biochemicals from sea grasses as the canopy Smithora.

The smaller size of the Smithora thalli epiphytic on Plocamium compared to those on grasses can partially be attributed to the lower light intensities and reduced amount of water movement, nutrient dispersion and gas exchange in the understory environment. Nutrient translocation may also have some influence since it has been reported to occur between sea grasses and Smithora. If translocation also occurs between Plocamium and Smithora, it is likely that it would be less efficient than in the vascularized sea grasses and account for some of the size variation in the epiphyte.

SEASONAL VARIATION IN SIZE, MORPHOLOGY AND FERTILITY IN *PUNCTARIA LATIFOLIA* (PHAEOPHYCEAE) FROM THE SAN JUAN ISLANDS

Anne R. Haskins, Friday Harbor Laboratories, Friday Harbor, Washington 98250 USA

Punctaria latifolia Greville, a brown alga of wide distribution was collected and examined over a one year period at 3 locations on the south end of San Juan Island, Washington. The smooth, membranous, golden-brown blades were visible in the field from late February through September as successive overlapping generations of plants. Variations in the blade size, thickness and fertility occurred as the generations matured under different seasonal conditions. The early spring blades were sterile, 3-30 cm in length and 1-2 cells thick. Summer plants were fertile with plurilocular sporangia, 3-10 cm in length and 3-4 cells thick. Fall blades were either sterile or fertile with plurilocular, unilocular, or both unilocular and plurilocular sporangia. The fronds were 2-15 cm in length and 1-3 cells thick. During the spring and summer, *P. latifolia* was found to epiphytize only the seagrass *Zostera marina*. However, in the fall the blades were found to occur on a much wider variety of hosts including *Odonthalia floccosa*, *Gigartina papillata*, and large degenerating blades of *Costaria costata*.

Cultures taken from field plants were grown under winter, spring-fall and summer temperatures and daylengths. Thalli maintained under spring-fall conditions reached much larger sizes than those under summer conditions agreeing with field observations. The more rapid onset of fertility and degenerative sporing of the summer blades might account for these size differences.

In the past, species distinction in the genus *Punctaria* has relied heavily on size, shape and thickness of the mature frond. It is important that seasonal variations in these characteristics also be considered.

PERIPHYTON MONITORING FOR COMPREHENSIVE WATER QUALITY ASSESSMENT IN SUBARCTIC ALASKA.

Jerry W. Hilgert. Institute of Northern Forestry, U.S. Forest Service, Pacific Northwest Forest and Range Experiment Station, Fairbanks, Alaska, 99701.

The periphyton community of an undisturbed research watershed (110 km^2) in central Alaska has been monitored from 1978 to present as part of a comprehensive physical, chemical, and biological study. Periphyton standing crop biomass from rocks in riffles at 9 to 11 sites was measured every three weeks during the ice-free season. Species composition and community structure were determined, providing baseline biological data for comparison to nearby streams currently impacted by placer mining activities, and to future landscape manipulations (logging, clearing, and prescribed burning) planned for portions of the watershed. Standing crop biomass, determined as ash-free dry weight, peaks in late August/early September, with substantial growths retained under ice cover into winter. Smaller streams are dominated by a pennate diatom flora throughout the season. Higher-order streams are also dominated by pennate diatoms in spring and summer, with comparitively lush growths of Chlorophytan filamentous algae Cladophora glomerata and Ulothrix zonata dominating in the fall. Plexiglass plates and ceramic spheres were evaluated as artificial substrates. The ceramic spheres were found to minimize fouling and maximize retrieval, while providing adequate accumulation of biomass. Development of an "indicator flora" of undisturbed sites within the river continuum will aid resource managers in interpreting water quality changes which result from increasing impacts on subarctic lotic systems.

INTERACTIONS BETWEEN MICRO- AND MACROFOULING: THE ATTACHMENT OF THE DIATOM AMPHORA COFFEAEFORMIS TO PREPARED SURFACES.

Rita Horner, Saiyed Ahmed, Amy Schoener, and James Staley. School of Oceanography, University of Washington, Seattle, WA 98195.

Substrates submerged in seawater are reported to undergo a discrete series of events leading to the development of a marine fouling community. The process begins with the formation of a biopolymer film that attracts motile bacteria. Diatoms supposedly colonize substrates only after the organic and bacterial films are well-established and invertebrate larvae settle last. We wanted to determine whether molecular (organic films) and microfouling (bacteria and diatoms) films were necessary for macrofouling (invertebrate) growth.

In a series of laboratory experiments using high and low molecular weight seawater organic fractions and a phytoplankton organic fraction, neither the organic fractions nor the presence or absence of bacteria was significant for the settlement of Amphora coffeaeformis. On specially treated surfaces, highest diatom settlement occurred on hydrophobic, low energy surfaces, and the presence or absence of bacteria was not significant.

This suggests that preparatory stages for diatom fouling are not necessary, that whichever species can grow faster on a particular substrate will be involved in the formation of the fouling film. Our results disagree with those of Mitchell and Kirchman (1984) who found that high energy surfaces have maximum microbial film formation, while low energy surfaces are supposed to be more resistant to film formation and accumulation and should therefore be easier to keep clean.

Cultivation of Laminaria groenlandica in Barkley Sound, B. C.

Kitty Lloyd and Louis D. Druehl, Canadian Kelp Resources, Bamfield Marine Station, Bamfield, B. C., Canada V0R 1B0

Laminaria groenlandica Rosenvinge was cultivated on long line systems im Barkley Sound, on the west coast of Vancouver Island, B. C. Canada. The effects of spacing and thinning of plant clusters, and geographic location of long lines on the harvestable biomass of L. groenlandica were investigated. Plant clusters spaced at 30 and 50 cm intervals on the long lines showed no significant differences in plant dimensions between spacings, but the harvested yield per meter of long line was substantially greater for plants at 30 cm intervals. When plant clusters were thinned after one year's growth, plants attained significantly greater dimensions at harvest time but the yield per meter of long line was substantially greater for unthinned clusters. The effect of geographic location on yield of L. groenlandica was tested by locating long lines in a variety of sites which were monitored weekly for temperature, salinity, irradiance and nutrient concentration. The parameter that correlated best with plant yield was surface NO_3 concentration with greatest yield obtained at sites characterized by high summer NO_3 levels.

FARMING EQUIPMENT AND TECHNIQUES FOR PORPHYRA GAMETOPHYTE (NORI) AQUACULTURE IN WASHINGTON STATE.

Thomas F. Mumford, Jr., Donald J. Melvin, William J. Byce, Makoto Inayoshi, and Virginia M. Bryant. Division of Marine Land Management, Department of Natural Resources, Olympia, Washington 98504 U.S.A.

Under the guidance of M. Inayoshi, floating-style culture equipment and techniques were constructed and tested for the culture of Porphyra gametophytes in Washington marine waters. Seeding of nets with conchospores was done by the "half-sheet" and "full-sheet" methods. The nursery phase was performed in the Inayoshi-style floating equipment. This equipment allows the seeded nets to be raised from the water and dried periodically to prevent disease, kill competing organisms and improve quality. Production growth was in floating six-net sets. It has been found that the nets must be continued to be dried to control disease, and a modified emmersion style production set has built and used. Floating debris has been a problem in all sites tested. A trash fence around the Wycoff Shoal site was built from 3" netting. This expensive and cumbersome fence proved effective in keeping logs, sticks, eelgrass and ulvoids from the production and nursery frames. These production techniques has proven successful and nori has been grown for two seasons in a variety of locations in Puget Sound.

Seattle Pacific University's Newly Dedicated
Thomas B. Crowley Laboratory on Blakely Island

Dennis J. Russell. Biology Department, Seattle Pacific University, Seattle, Washington 98119 USA.

In 1976, Seattle Pacific University received a gift of 1,000 acres of land from Thomas B. Crowley, on Blakely Island. The university's property includes two lakes, a 40 kw hydroelectric plant and rugged highland wilderness. Crowley provided a laboratory, offices, library, dining facilities, dormitory, director's residence, diving locker, boats, equipment, books, transportation and staff.

The facilities were dedicated on May 5, 1984, when Blakely residents, Crowley Maritime Corp. executives, county commissioners, and SPU officials joined Senator Slade Gorton, Lt. Governor John A. Cherberg, and Crowley in the ceremonies. The laboratory supports 32 students and faculty to study a variety of biological subjects.

During summer 1984, 90 students used the new facility, although classes have been conducted under more primitive conditions since 1977. Biology courses taught there are: Aquatic Ecology, Marine Algology, Marine Ecology, Natural History of Blakely Island, Vascular Plants of the San Juan Islands, and Vertebrate Animals of Blakely Island.

Faculty research includes limnology, ecology of Armitage Bay and Thatcher Bay, algal pathology, algal taxonomy, ecology of freshwater submerged plants and taxonomy of higher plants. Students, faculty and research professionals from Friday Harbor Laboratories have been invited to use the facility.

AQUACULTURE OF PACIFIC NORTHWEST *PORPHYRA* FOR NORI.

J. Robert Waaland, Leal G. Dickson, E.C.S. Duffield and *Thomas F. Mumford, Jr. Department of Botany, University of Washington, Seattle, Washington 98250 USA and *Washington Department of Natural Resources, Olympia, Washington 98504 USA

Of the seventeen native Pacific Northwest *Porphyra* species, five have been selected for further investigation as candidates for aquaculture to produce the edible seaweed product nori: *Porphyra torta*, *P. abbottae*, *P. perforata*, *P. pseudolanceolata*, and *P. nereocystis*. This paper summarizes the results of studies of the environmental control of conchocelis growth, conchosporangium induction, and conchospore maturation and release. The effects of photon fluence rate, photoperiod, and temperature were emphasized in these studies. Even though these species occur in the same geographical region, there are significant differences among them in the light and temperature levels which support optimum conchocelis growth and in the combinations of photoperiod and temperature which induce conchosporangium formation and control conchospore maturation and release. Field growth tests are being conducted in those species in which dependable, large-scale conchospore production has been obtained.