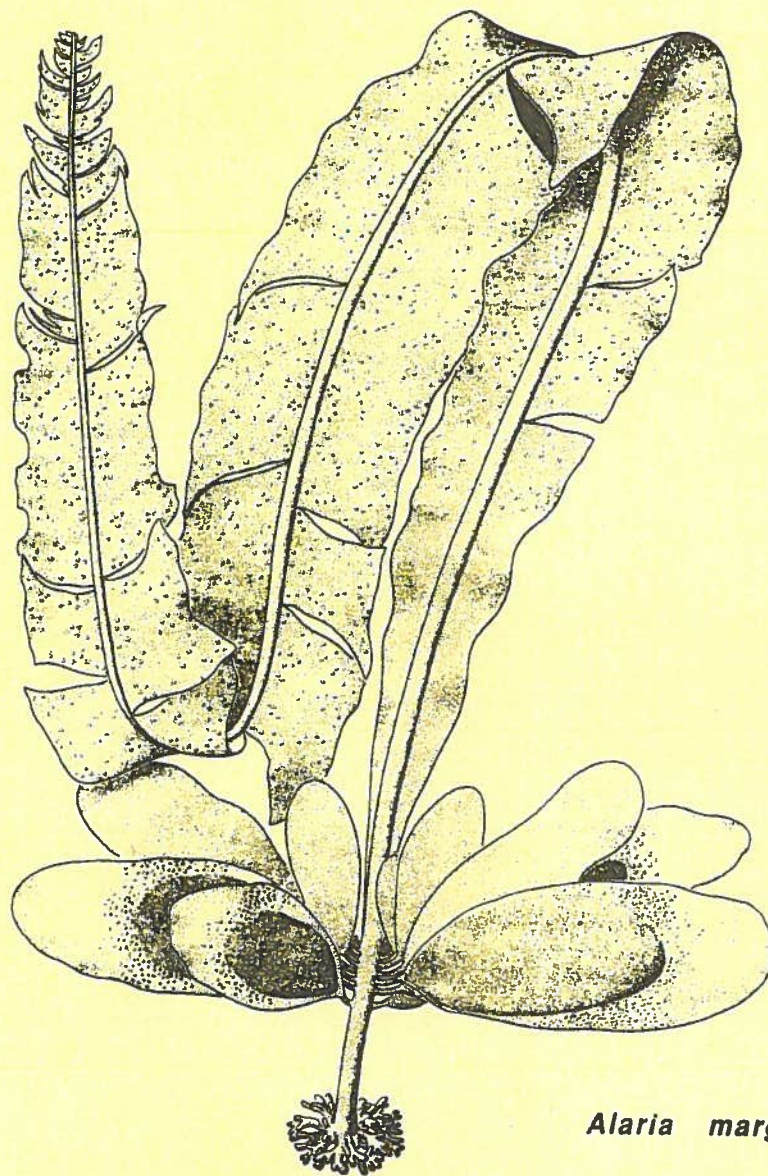


# NINTH NORTHWEST ALGAL SYMPOSIUM



*Alaria marginata*

## PROGRAM & ABSTRACTS

Walla Walla College Marine Station, Rosario Beach  
Anacortes, Washington  
March 31 - April 2, 1995

**SCHEDULE**  
**9TH NORTHWEST ALGAL SYMPOSIUM**  
**WALLA WALLA COLLEGE MARINE STATION**  
**ROSARIO BEACH, ANACORTES, WASHINGTON**  
**March 31 - April 2, 1995**

**FRIDAY, MARCH 31, 1995 -----**

- 1:00 Check-in, Register, Set-up posters**
- 6:00 Dinner**
- 7:00 Welcome, Orientation & Announcements**
- 7:30 Evening speaker: "Biological Invasions in Estuaries" -  
Dr. Annette Olson, University of Washington**
- 8:30 Poster session**

**SATURDAY, APRIL 1, 1995 -----**

- 7:30 Breakfast**
- 8:30 SESSION I - ECOLOGY**
  - 8:30 Graham, Michael H. Effects of wave exposure and disturbance-mediated competition on the shallow limit of giant kelp.**
  - 8:45 Clark, R.P. Shading effects of multiple kelp canopies on understory algal assemblages.**
  - 9:00 Taghaoussi, M. & Wm. P. Lucey. Old-growth forest canopies: a poorly studied habitat for epiphytic and free-living algae.**
  - 9:15 Whitmer, Allison. The population genetic structure and evidence of self-fertilization in *Pelvetia fastigiata (gracilis)*.**
  - 9:30 Stiller, J.W. & J.R. Waaland. Molecular analysis of an enigmatic salt marsh *Porphyra*.**
- 10:00 Low Tide - Tidepooling & Collecting/Poster session**
- 12:30 Lunch**

**SATURDAY, APRIL 1, 1995 (cont.)**

**1:30 SESSION II - MOLECULAR BIOLOGY & PHYLOGENY**

**1:30 Lindstrom, S.C. Molecular phylogeny of the Palmariaceae.**

**1:45 Liptack, Michael K. & L.D. Druehl. rDNA sequencing as an approach to understanding *Macrocystis-Pelagophycus* hybrids.**

**2:00 Tan, I.H. & L.D. Druehl. Molecular phylogeny among the kelp (Laminariales, Phaeophyceae) families.**

**2:15 Mayes, Charlene & Louis D. Druehl. Molecular evolution within the kelp family Laminariaceae.**

**2:30 Lee, Amy M., Richard G. Ivey, Eric C. Henry, & Russel H. Meints. Characterization and mapping of the repetitive elements in the ds-DNA genome of a brown algal virus (FSV).**

**2:45 Break**

**3:00 SESSION III - CYTOLOGY & PHYSIOLOGY**

**3:00 Oates, B.R. & K.M. Cole. Cytological studies of developing rhizoids and holdfasts in *Bangia vermicularis*.**

**3:15 Roberts, Cassandra. Effects of light intensity and plant orientation on pigment concentrations of *Bossiella californica* ssp. *schmittii*.**

**3:30 Alessa, Lilian. The effect of aluminum on cytoplasmic streaming, growth & the cytoskeleton of *Vaucheria longicaulis*.**

**3:45 Engebretson, Hilary & Gisele Muller-Parker. The effects of light and temperature on translocation of carbon from two algal symbionts to their host, the intertidal sea anemone *Anthopleura elegantissima*.**

**4:00 Edwards, Matthew S. It's the little things: the role of microscopic stages in the recruitment of *Desmarestia ligulata* sporophytes.**

**4:30 Social, No-host bar @ Skyline Marina Clubhouse**

**6:00 Banquet @ Skyline Marina Clubhouse**

**7:30 Evening speaker: "Why Do Algae Live in Animal Cells?" - Dr. Gisele Muller-Parker, Western Washington University**

SUNDAY, APRIL 2, 1995 -----

7:30 Breakfast

8:45 SESSION IV - MICROALGAE

8:45 McQuoid, M.R. & L.A. Hobson. Historical trends in the seasonal occurrence of diatoms in Saanich Inlet, 1902-1991.

9:00 Ruesink, J. Effects of diatom epiphytes on *Odonthalia floccosa*: the importance of extent and timing.

9:15 Williams, Charles R. & G.A. Codd. Immobilization and long-term storage of the nitrogen-fixing cyanobacterium *Anabaena* PCC 7120 on an inorganic biosupport.

9:30 Barraclough, C.L. & R.N. Nordin. Effects of impoundment on the diatom community of Sooke Reservoir, southern Vancouver Island, British Columbia.

10:15 Low Tide - Tidepooling & Collecting/Poster session

12:30 Lunch

1:30 Check-out, Take down posters

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**ABSTRACTS OF THE 9TH NORTHWEST ALGAL SYMPOSIUM**

**WALLA WALLA COLLEGE MARINE STATION**

**ROSARIO BEACH**

**ANACORTES, WASHINGTON**

**MARCH 31 - APRIL 2, 1995**

**THE ABSTRACTS FOR ALL THE PRESENTED PAPERS AND POSTERS  
HAVE BEEN PRINTED AS SUBMITTED, ALPHABETICALLY, BY THE  
AUTHOR'S LAST NAME.**

**The Effect of Aluminum on Cytoplasmic Streaming, Growth and the Cytoskeleton of *Vaucheria longicaulis*.**

**Alessa, Lilian.** University of British Columbia, Dept. of Botany, Vancouver, B.C. V6T 1Z4 Canada.

Plants growing on acid soils suffer from a number of factors including nutrient deficiency and drought intolerance, with aluminum toxicity considered one of the most important plant growth limiting factors. In this study the coenocytic, filamentous alga *Vaucheria longicaulis* was used as a model to observe the effects of aluminum on cytoplasmic streaming and the cytoskeleton using both chemical and antibody probes. Aluminum causes a dramatic change in the cytoplasmic streaming pattern of chloroplasts and mitochondria but not nuclei as well as effecting morphological changes in both the cytoplasm and the overall algal filament. Growth, however, still occurs at approximately 60% to 70% of normal rates. Both microfilaments and microtubules are present in *Vaucheria longicaulis* as long, linear strands which are oriented parallel to the long axis of the cell. Our experiments show that aluminum affects both the microfilament and microtubule arrays but in radically different ways. The depolymerization of actin proceeds steadily until the linear array is no longer present and highly condensed focal areas are observed. However, upon transfer to aluminum free media, a period of recovery eventually leads to re-establishment of a normal microfilament pattern. Cytoplasmic streaming of chloroplasts and mitochondria recovers once the actin network has reformed. The microtubule array does not dissipate but rather displays thinner bundles with slightly less continuity along their length. Microtubules also appear to recover by regaining greater continuity and bundle thickness. This study suggests that these systems may act both independently in function and interdependently in structure. It also offers the potential to develop the *Vaucheria* system as a model testing tool to assess chemicals, phytotoxins and drugs for cytoskeletal activity.

**EFFECTS OF IMPOUNDMENT ON THE DIATOM COMMUNITY OF SOOKE RESERVOIR, SOUTHERN VANCOUVER ISLAND, BRITISH COLUMBIA**

**Barracough, C.L.** and R.N. Nordin. University of Victoria, Department of Biology, Box 1700, Victoria, British Columbia. V8W 2Y2

Following impoundment, reservoirs commonly undergo a rapid increase in planktonic primary productivity, known as "trophic upsurge," followed by a slower return to a more stable level of productivity ("trophic depression"). This upsurge is fueled by a pulse of nutrients, particularly phosphorus, derived from inundated soils and decomposing vegetation. As nutrients and other biologically important elements and substances return to steady-state, planktonic primary production stabilizes at a new equilibrium. The water level of Sooke Reservoir, which supplies drinking water to Greater Victoria on Southern Vancouver Island, British Columbia, will be raised in 1998. It is not known whether this will fuel a trophic upsurge and thus lead to taste and odour problems in the reservoir. The reservoir was created by damming the outflow of Sooke Lake in 1913 and was subsequently raised in 1972. Since historical phytoplankton data are unavailable, a paleolimnological study of sedimentary diatoms was undertaken to examine previous effects of reservoir construction on the phytoplankton community. A trophic upsurge is evident; however, it predates reservoir construction and is thought to be a result of natural phenomena.

SHADING EFFECTS OF MULTIPLE KELP CANOPIES ON UNDERSTORY ALGAL ASSEMBLAGES  
Clark, R.P. Moss Landing Marine Laboratories, Phycology Lab  
Moss Landing, California 95039 U.S.A.

Canopy forming kelps can regulate understory assemblages by shading out some algal species while providing refuge for others. To study these regulatory processes, kelp canopies were cleared in Stillwater Cove, California, an area dominated by a dense two-canopy kelp forest of *Macrocystis pyrifera* and *Pterygophora californica*. Results suggest that classifying understory algae into traditional functional groups does not help understand the ecology of this assemblage. It was necessary to classify fleshy red algae into several separate categories to explain common responses to increased irradiance. *Plocamium cartilagineum* and *Laurencia subopposita* were shade-tolerant, capable of surviving under a variety of canopy conditions. Other fleshy red algae significantly increased in cover when light levels increased. The removal of both *M. pyrifera* and *P. californica* canopies increased irradiance and stimulated dense recruitment of *Desmarestia ligulata*, which then decreased light levels below it, reducing red algal abundance and species diversity. *D. ligulata* also physically abraded branches of *P. cartilagineum*. Since *P. cartilagineum* branchlets can facilitate entanglement of plant fragments in coralline turf (an asexual reproductive method of *P. cartilagineum*), abrasion by *D. ligulata* may reduce asexual reproductive success of *P. cartilagineum*. Red algal diversity and spatial homogeneity were greater within areas of increased irradiance, and growth rates of several red algal species were greater within these areas. While kelp canopies can decrease red algal abundance and diversity, variability in canopy cover may also increase species diversity by creating microhabitats of varying light levels.

Cravens, Jessie, Western Washington University, Bellingham WA, 98225 USA

**THE GREAT ESCAPE**  
**THE EFFECT OF GRADUAL INCREASES IN TEMPERATURE**  
**ON DIVISION AND PHASE OF ZOOXANTHELLAE**  
**IN THE SEA ANEMONE *AIPTASIA PALLIDA***

Zooxanthellae, single-celled algae commonly found in symbiosis with a variety of anemones and corals, have two morphological phases. The non-motile phase is most often found within the host and the motile state is commonly found in the water column. The effect of gradual temperature increases in the tropical anemone *Aiptasia pallida* (from 25°C to 32 °C, raised 1°C every third day) revealed a shift from less than 1 % motile zooxanthellae in the anemone tentacles to over 50 % motile zooxanthellae at 32 °C. Until host mortality at 32°C was reached, no algae were expelled from the host. The phase shift was not accompanied by a difference in algal division; the mitotic index was maintained at an average of 1.5 % in the control anemones held at 25°C, and at an average of 2.01 % in the experimental animals. Therefore, gradual increases in temperature elicit different responses from the algal symbiosis than do temperature shock treatments involving rapid short term changes. Zooxanthellae exhibit the ability to withstand greater temperature than the host and therefore the transition to the motile phase could be an algal response to adverse environmental conditions. Since gradual changes are more likely to be encountered in nature, this study raises questions about the validity of experiments where the response of symbiotic associations to sudden changes in temperature are used to infer environmental responses.

**ECOLOGICAL RESTORATION OF URBAN CREEKS: USE OF PERIPHYTON BIOASSAYS FOR MONITORING LONG TERM ALTERATIONS IN WATER QUALITY.**

de la Cheneliere, N. Grewal, V., C. Levesque, D.C. Parks, R. Redden, and L.F. Veary.  
Department of Biology, University of Victoria, Box 1700, Victoria B.C., Canada.  
V8W 2Y2

In the early 1990's the ecological restoration of urban aquatic and riparian habitat began to receive increased attention from both the scientific community, private sector industry, local, state and provincial governments. The restoration of streams and creeks is a complex process because they frequently flow through multiple jurisdictions and are the receiving environment for a variety of undesirable discharges. Since 1985, fourth year, University of Victoria Phycology students have characterized water quality trends in a local creek, Colwood Creek, using the algal component of the periphyton community. Artificial sampling substrata have been used, as an *in-situ* community level bioassay, to track alterations in the creek's aquatic health. The study has revealed significant changes in the patterns of distribution of the freshwater Rhodophyte *Batrachospermum* sp. Roth. The water quality information obtained has been successfully used to mitigate inappropriate upland development and, through bylaw and administrative changes, significantly reduce point and non-point source pollution. This collaborative program provides a useful case-study for modelling the efficacy of urban stream restoration projects.

**IT'S THE LITTLE THINGS: THE ROLE OF MICROSCOPIC STAGES IN THE RECRUITMENT OF *DESMARESTIA LIGULATA* SPOROPHYTES.**

Edwards, Matthew S. Moss Landing Marine Laboratories, Moss Landing, CA.

How do large brown algae with annual sporophytes persist in the same area from year to year? This study investigates the process by which *Desmarestia ligulata* persists during sporophyte absence and offers insight into the ecology of its microscopic life-history stages. Macroscopic sporophytes of *D. ligulata* recruit in the spring, reproduce in early winter, and then disappear. Field experiments showed that spring sporophyte recruitment was highest in areas where the canopy forming kelps *Macrocystis pyrifera* and *Pterygophora californica* were removed. Recruitment was lower in areas where previous year's sporophytes were removed prior to the onset of fertility. This, along with a spore settlement study, suggested that spore dispersal may be limited. Substrate sterilization experiments and holdfast tagging studies indicated microscopic life stages "over winter" during periods of sporophyte absence and are the sole source of spring recruitment. Fluorescent labeling of newly settled spores demonstrated that filamentous gametophytes are the over wintering life-history stage. Gametophyte growth rates in the laboratory were significantly higher in long day lengths and high irradiances. Gametophytes did not grow when cultured at  $4\mu\text{Em}^{-2}\text{s}^{-1}$  for extended periods (>60 days), but began growing when transferred to  $25\mu\text{Em}^{-2}\text{s}^{-1}$ , suggesting they can remain dormant for long periods under heavy algal canopies and begin growing if the canopies are removed.



THE EFFECTS OF LIGHT AND TEMPERATURE ON TRANSLOCATION OF CARBON FROM TWO ALGAL SYMBIONTS TO THEIR HOST, THE INTERTIDAL SEA ANEMONE *Anthopleura elegantissima*.

Hilary Engebretson and Gisele Muller-Parker. Western Washington University, Department of Biology, Bellingham, Washington 98225 U.S.A.

The intertidal sea anemone *Anthopleura elegantissima* is symbiotic with two distinct species of algae. It has been suggested that light and/or temperature may play a role in the distribution of the two algal species within and among anemones. This research uses <sup>14</sup>C-labelled bicarbonate to trace the translocation of photosynthetic products from algae to host in anemones held under several light and temperature regimes.

EFFECTS OF WAVE EXPOSURE AND DISTURBANCE-MEDIATED COMPETITION ON THE SHALLOW LIMIT OF GIANT KELP.

Graham, Michael H. Moss Landing Marine Laboratories, Moss Landing, CA.

What regulates the shallow water distribution of giant kelp, *Macrocystis pyrifera*? I studied the effect of wave exposure on variation of the shallow water distribution of *M. pyrifera* by frequently sampling the shallow limit at three sites along a wave exposure gradient. Within-site variability increased with increasing wave exposure. The shallow limit at the protected site varied little throughout the study, but was seasonally variable at the exposed site. The depth of the shallow limit increased with increasing wave exposure during fall and winter, but decreased with increasing wave exposure during spring and summer. Experiments indicate that this reversal is a result of disturbance to algal mats at exposed sites, providing more substrate for recruitment. Plants with surface canopies grew deeper than plants without such canopies, suggesting that removal of surface canopy increases survival in shallower water, probably by reducing drag. Experiments to assess mortality as a function of depth and morphology are in progress, and should provide additional insight about the mechanisms that allow giant kelp to survive in the surfzone. At present, it appears that differences in wave exposure cause between-site differences in the shallow limit of *M. pyrifera* during fall and winter, but that other factors are important during spring and summer.

PURIFICATION AND CHARACTERIZATION OF THE ENZYME PHOSPHORIBULOKINASE FROM THE MARINE ALGA, *HETROSIGMA CARTARAE*.

Tara Hariharan, Paula Johnson and Rose Ann Cattolico. University of Washington, Department of Botany, Seattle, Washington 98195 U.S.A.

Extensive work carried out in this laboratory has led to the finding that both the small and large subunits of the Calvin cycle enzyme Rubisco are coded in the chloroplast of the marine alga, *Heterosigma*. This enzyme differs in substrate utilization and inhibitor response from that of terrestrial plants. As a continuation of this work we are analyzing functional and genetic aspects of the enzyme phosphoribulokinase (PRK).

To date, hybridization analysis using probes from spinach, *Chlamydomonas* and *Rhodospseudomonas sphaeroides* have given negative results. We have now purified *Heterosigma cartarae* PRK enzyme approximately 250 fold. The amino terminal domain will be subject to micro sequencing. This data will allow the generation of an appropriate oligonucleotide that can be then used to identify the coding location of the PRK gene.

Kinetic analyses on the partially purified enzyme indicates that the enzyme is insensitive to NADH. Km values for ATP and substrate have been obtained. The *Heterosigma* PRK enzyme requires a divalent cation preferably Mg<sup>++</sup> for efficient function. From our results, it does appear that the enzyme may be in a complex with other Calvin cycle enzymes.

## TRANSCRIPTS ANALYSIS OF FSV

Yibing Jia , Russel Meints  
Department of Botany and Plant Pathology  
Oregon State University  
Cordley Hall 2082  
Corvallis OR 97331

FSV is a large icosahedral virus with a double stranded DNA genome (180 kb) that persistent infects marine filamentous brown alga *Feldmannia spp.*. Four cosmid clones that cover the entire FSV genome were used as probes for Northern hybridization analysis to detect expression of viral genes. Six major FSV transcripts and at least 10 minor transcripts were identified in sporophytes.

A genetic and ultrastructural analysis of phototactic mutants of *Chlamydomonas reinhardtii*. M.R. Lamb<sup>1</sup>, J. Ihle<sup>1</sup>, J. Milne<sup>1</sup>, N. Rao<sup>1</sup>, C. Quinton<sup>2</sup>, C.L. Dieckmann<sup>2</sup>. 1) Dept. of Biology, University of Puget Sound, Tacoma, WA 98416, 2) Dept. of Biochemistry, University of Arizona, Tucson, AZ 85721.

*Chlamydomonas reinhardtii* phototaxes toward light by means of a light-sensitive organelle, the eyespot. This organelle is made up of signal transduction components in the plasma membrane of the cell and reflective carotenoid pigment layers in an underlying region of the chloroplast. To identify components important for the positioning and assembly of a functional eyespot, a large collection of mutants that fail to phototax was screened to identify those with aberrant eyespots. Four loci were identified and mapped. *ey-1* and *ey-2* mutants have no pigmented eyespots. *mlt-1* mutants have multiple eyespots. *min-1* mutants have smaller than wild-type eyespots. The *min-1*, *mlt-1*, and *ey-2* loci are closely linked on linkage group XV and the *ey-1* locus was mapped previously to linkage group X. The *ey-1* and *ey-2* mutants are epistatic to *min-1* and *mlt-1* mutations; all double mutants are eyeless. A combination of a *min-1* and *mlt-1* mutation in the same strain results in a synthetic phenotype different from either single mutant; the double mutants are eyeless or have very small and misplaced eyespots. Ultrastructural studies reveal that the *min-1* mutants are defective in the physical connection between the plasma membrane and the chloroplast envelope membranes in the region of the pigment granules. A new collection of mutants is being generated by insertional mutagenesis to determine the sequence of the genes involved in eyespot assembly.

CHARACTERIZATION AND MAPPING OF THE REPETITIVE ELEMENTS IN THE  
DS-DNA GENOME OF A BROWN ALGAL VIRUS (FSV)

Amy M. Lee, Richard G. Ivey, Eric C. Henry, and Russel H. Meints. Dept. of Botany & Plant Pathology, Oregon State University, Corvallis, OR 97331-2902 USA.

We will describe the repetitive sequences found in the two size classes of the genome of *Feldmannia sp. Virus (FsV)*. The repetitive sequences were first identified based on the cross-hybridization among five fragments, B1b (band #1b), B6, B14a, B18, and B19 of *Bam*HI-digested FsV DNA. Sequence analysis of the B18 fragment revealed the presence of 173 bp direct repeats. Restriction maps of the cross-hybridizing *Bam*HI-fragments in the two size classes of the FsV genome show that the repeats occupy one localized region of the virus genome. We estimate the number of 173 bp repeats in the 182 kbp genome to be about 115 and in the 165 kbp genome to be about 62. In the 182 kbp genome, the repeats are dispersed over a 22 kbp region, which is about 12% of the virus genome, and in the 165 kbp genome the repeats are dispersed over a 10 kbp region, which is about 6% of the genome. The difference in the number of repeats can account for 50% of the size difference between the two size classes of the FsV genome.

MOLECULAR PHYLOGENY OF THE PALMARIACEAE. Lindstrom, S. C. University of Groningen, Marine Biology Department, 9750 AA Haren, The Netherlands, and University of British Columbia, Department of Botany, Vancouver, BC, Canada V6T 1Z4

The ITS1 and ITS2 regions of the nuclear ribosomal repeat unit were sequenced in ten species of the red algal family Palmariaceae and in *Rhodophysemma georgii* (the type species of the family most closely related to the Palmariaceae). The sequences in all species of Palmariaceae were completely alignable. Among these species, 203 out of 854 sites were variable, and 87 of these sites were potentially phylogenetically informative. The sequences in *Rhodophysemma georgii* were alignable over most of the ITS2 but over only somewhat more than half of the ITS1 region. A parsimony analysis of the data rooting it with *R. georgii* suggests the recognition within the Palmariaceae of four clades that radiated at about the same time. A more recent radiation appears to be occurring in one of these clades based on relatively few base pair changes among the species.

**rDNA SEQUENCING AS AN APPROACH TO UNDERSTANDING  
MACROCYSTIS-PELAGOPHYCUS HYBRIDS.**

Michael K. Liptack and Louis D. Druehl.. Bamfield Marine Station, Bamfield B.C. Canada V0R 1B0.

DNA sequencing of the ITS1 region of the ribosomal cistron (rDNA) was performed on male and female gametophytes from *Macrocystis pyrifera*, *Pelagophycus porra*, and a putative *Macrocystis-Pelagophycus* hybrid. Multiple sequencing runs were performed in both directions from a fragment encompassing parts of both the 18S and 5.8S subunits and the ITS1. Resulting sequences were hand aligned prior to phylogeny generation using PHYLIP 3.5c. Bootstrapped Neighbor Joining and Parsimony trees were generated. The hybrid was found to be more closely related to *M. pyrifera* than to *P. porra*. Implications will be discussed.

**GROWTH OF THE MACROALGA *Ulva expansa* FROM PADILLA BAY, WASHINGTON IN RESPONSE TO NUTRIENT ENRICHMENT**

MacDonald, Brian. Western Washington University, Bellingham, Washington.

Nutrient enrichment experiments were conducted to determine the growth rate, morphological, and biochemical responses of *Ulva expansa* to ammonium and phosphate. Algae collected from Padilla Bay, Washington in July 1994 were cultured for twelve days at an average light intensity of 309  $\mu\text{mol/m}^2/\text{s}$  in continuous-flow chambers under laboratory conditions. Ammonium:phosphate additions (in  $\mu\text{M}$ ) of 0:0, 10:1, 20:2, 50:5, and 150:15 were supplied to the algae. Growth of the algae exposed to the lower four nutrient treatments was not significantly different among the treatments (average of 250% increase in area over 12 days). Growth of the algae in the 150:15 treatment, however, was significantly higher (average of 1500% increase in area over 12 days) than under the other four treatments. No significant difference in chlorophyll concentration was found for *Ulva* cultured at the four lowest nutrient treatments (average chl a = 1.4  $\mu\text{g}/\text{cm}^2$ , average chl b = .9  $\mu\text{g}/\text{cm}^2$ ). Chlorophyll content of the algae in the 150:15 treatment was significantly higher (average chl a = 2.0  $\mu\text{g}/\text{cm}^2$ , average chl b = 1.4  $\mu\text{g}/\text{cm}^2$ ) than the content of the algae in the other treatments. The carbon:nitrogen (C:N) ratio of the algae decreased with nutrient enrichment from 36:1, in the 0:0 treatment, to 12:1 in the algae grown in the 150:15 treatment. Dry weight of *Ulva expansa* decreased as the ammonium and phosphate levels increased, from an average of 1.6  $\text{mg}/\text{cm}^2$  for the 0:0 treatment to an average of .79  $\text{mg}/\text{cm}^2$  for the 150:15 treatment. From this work it is apparent that large increases in the ammonium and phosphate levels in Padilla Bay are likely to result in increases in growth and changes in the biochemical composition of the macroalga *Ulva expansa*.

**MOLECULAR EVOLUTION WITHIN THE KELP FAMILY  
LAMINARIACEAE (Laminariales, Phaeophyta)**

Charlene Mayes and Louis D. Druehl,  
Simon Fraser University, Burnaby, B.C. V5A 1S6  
and Bamfield Marine Station, Bamfield, B.C. V0R 1B0

Phylogenetic relationships among the genera of an advanced kelp family, the Laminariaceae, were inferred from rDNA sequence data. Approximately 600 nucleotides, spanning the 3' region of the 18S gene, the Internal Transcribed Spacer 1 and the 5.8S gene of the nuclear encoded ribosomal cistron, were determined for representative species from 10 genera of this family. Molecular inferred relationships will be compared to the traditional taxonomy and current geographic distributions of these algae.

## HISTORICAL TRENDS IN THE SEASONAL OCCURRENCE OF DIATOMS IN SAANICH INLET, 1902-1991.

McQuoid, M. R. and L. A. Hobson. University of Victoria, Department of Biology, PO Box 1700, Victoria, B.C. CANADA V8W 2Y2

To understand interannual changes in biological communities it is important to have a long-term record of the regular variability of the community. Long-term data sets are time consuming and sometimes costly to collect, and in some cases changes in techniques make it difficult to compare old data with new information. Laminated sediments provide a quick way to identify changes and cycles in diatom populations at an annual and seasonal level. Diatom frustules were prepared and enumerated from two frozen cores of Saanich Inlet sediments. Several species and genera show a regular seasonal pattern of abundance and some species exhibit shifts or cycles. *Thalassiosira* and several *Chaetoceros* species have peak abundances in the lower portion of the light layer indicating deposition in the early spring. *Skeletonema costatum* regularly shows peaks in the upper portion of the light layer indicating deposition in the late spring and early summer. *Rhizosolenia* spines are found mainly in the dark layers deposited in fall and winter. Interannual differences are also observed for some species. These seasonal data may provide useful indications of past changes in environmental conditions such as temperature and salinity of surface waters or even climatic events such as El Niño Southern Oscillation.

## A COMPARISON OF AMMONIUM UPTAKE RATES AND CHLOROPHYLL CONTENT OF *Ulva* sp. FROM TWO INTERTIDAL LEVELS AT SHANNON POINT MARINE CENTER, ANACORTES, WA

Morello, T. A. Western Washington University, Biology Department, Bellingham, Washington 98225 U.S.A.

Algae that live at high intertidal levels may be nutrient limited relative to low intertidal algae, due to a shorter period of submergence in water. Ammonium uptake rates and chlorophyll concentration of *Ulva* sp. from two intertidal levels (-0.30 m below MLLW and 1.06 m above MLLW) at Shannon Point, Anacortes, Washington, were studied in October 1994. Ammonium uptake rate was saturated at all concentrations tested (20-100  $\mu\text{M NH}_4^+$ ) for both algal populations, and averaged 1.76  $\mu\text{M NH}_4^+/\text{g/hr}$  for the algae from the high intertidal level and 6.79  $\mu\text{M NH}_4^+/\text{g/hr}$  for the algae from the low intertidal level. There was no significant difference in these two uptake rates; tidal height did not affect  $\text{NH}_4^+$  uptake of *Ulva*. Either the algae were already fully saturated by the nitrogen supply, were experiencing little or no growth, or the lowest initial ammonium concentration (20  $\mu\text{M}$ ) was at or above the saturation uptake rate for *Ulva* sp. The chlorophyll concentrations were 120.8  $\mu\text{g chl a/g alga}$  and 73.9  $\mu\text{g chl b/g alga}$  for the high intertidal algal population, and 190.2  $\mu\text{g chl a/g alga}$  and 119.1  $\mu\text{g chl b/g alga}$  for the *Ulva* from the lower intertidal height, and the concentrations between the two algal populations were significantly different. Although *Ulva* from the lower intertidal level contained more chlorophyll a and b, there was no significant difference in the chlorophyll a:b ratios (both were 1.63). In this study, it appears that tidal height does not affect the ammonium uptake rate of *Ulva* sp., but that it may have an influence on the amount of chlorophyll this alga contains.

CYTOLOGICAL STUDIES OF DEVELOPING RHIZOIDS AND HOLDFASTS IN  
*BANGIA VERMICULARIS*.

Oates, B. R. and K. M. Cole. Department of Botany, University of British Columbia, Vancouver, British Columbia, V6T 1Z4, Canada

Despite the importance and ubiquitous occurrence of unicellular and multicellular rhizoids in the algae, very little is known about these specialized cells, that function primarily in attachment and also may be involved in nutrient absorption. In the Rhodophyta, reports on ultrastructure and function of rhizoids are limited to 2 host-penetrating species: *Polysiphonia lanosa* and *Harveyella mirabilis*. To date, there have been no studies on rhizoids that attach to inorganic substrata. Our investigations have followed rhizoid development from the germinating spore to the mature thallus. We have concentrated on details of the differentiation process commencing with the primary rhizoid cell that is determined prior to the first division of the spore, and cellular activities associated with the attachment function. A number of cytological changes have been observed in the differentiating rhizoids of *Bangia*. They include changing positions of the chloroplast and nucleus, build up of ER and ER vesicles, production and distribution of starch and development of secondary rhizoids and the holdfast. Cytoskeletal inhibitors have been used to determine the role of these cytological structures in germination, development of cell polarity and cell division.

ABUNDANT CHROMOPHYTE PLASTID 16S RIBOSOMAL RNA GENES FOUND IN A  
CLONE LIBRARY FROM ATLANTIC OCEAN SEAWATER

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In recent years, ribosomal RNA genes cloned from natural picoplankton communities have been used to identify previously unknown marine bacterioplankton. There are similar uncertainties regarding the identities of small eukaryotic phytoplankton which, like bacterioplankton, can be difficult to cultivate and can have few defining morphological characteristics. In this study, Bacterial-specific 16S rDNA primers were used to PCR amplify genes from picoplankton collected on 0.2 µm filters by filtration, from a depth of ten meters in the pelagic region over the continental shelf off Cape Hatteras, North Carolina. Nucleic acid sequencing and probe hybridization revealed that chromophyte plastid genes comprise 25% of the cloned 16S rRNA genes in a library of 170 clones. The clones belonged to two groups within the Chromophyta: the Prymnesiophyceae and the Bacillariophyceae. In previous applications of similar methods to plankton samples collected in the Sargasso Sea, no plastid clones were detected. These results provide evidence that abundant, previously uncharacterized Chromophyte plastid 16S rRNA genes are present in the water over the continental shelf off Cape Hatteras. The results also suggest that plastid 16S rRNA genes may provide suitable genetic markers for studying phytoplankton biodiversity and biogeography.

EFFECTS OF LIGHT INTENSITY AND PLANT ORIENTATION ON PIGMENT CONCENTRATIONS OF *BOSSIELLA CALIFORNICA* ssp. *SCMITTII*.

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In situ effects of light intensity on pigment concentration are critical to understanding how natural conditions affect photosynthetic pigments. *Bossella californica* ssp. *schmittii* (Manza) Johans. has a unique dorsi-ventral orientation that allows for manipulations of plant orientation as well as light levels. Natural collections were used to investigate changes in phycoerythrin between plant surface with depth. Plants were collected at shallow (18m) and deep (27m) depths for phycoerythrin analysis of the dorsal and ventral surfaces. The surfaces varied significantly in phycoerythrin fluorescence at both depths, but there were no significant differences between pigments of the same surface with depth. To investigate the hypothesis that pigment (chlorophyll a and phycoerythrin) levels change over time (5 and 10 weeks) and at different light intensities, shaded (0.4%  $I_0$ ) and unshaded (4.0%  $I_0$ ) blocks with both surfaces of the plant exposed were placed at 16m. Plant surfaces under shaded conditions significantly increased both pigments after ten weeks. This study provides evidence that for *B. californica* ssp. *schmittii*, pigments do increase with decreasing irradiance over a period of ten weeks, and that plant orientation appears to effect patterns of pigment distribution on the plant.

Cultured *Lyngbya Majuscula* as a Source for the Antimitotic Drug Curacin A

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Sources for new pharmaceuticals are being sought because of the need to replace drugs in current use that have become ineffective and to find new drugs that work in novel ways. Although some terrestrial sources are still to be explored, the marine environment is a rich and underdeveloped source of novel pharmaceuticals. The remarkable variety of plants and animals in the oceans and their interactions suggests many new possible avenues of pharmaceutical drug discovery. We are pursuing this line of investigation by sampling and analyzing marine macro and micro algae from around the world for their potentially novel natural products. The Cyanophyta are one group of algae which have proven to be an abundant source of new biomedicinals. In particular, a field collected and cultured *Lyngbya majuscula*, from Curaçao has yielded a new antimitotic, brine shrimp toxic, and antiproliferative compound named curacin A. Ongoing culture studies are focusing on the parameters necessary for increased production and on the biosynthetic pathway of this novel compound.

EFFECTS OF DIATOM EPIPHYTES ON *Odonthalia floccosa*: THE IMPORTANCE OF EXTENT AND TIMING.

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Epiphytes clearly contribute to the overall productivity of coastal marine and estuarine systems. However, controversy lingers over whether they cause the productivity of their hosts to decline. Some studies have shown reductions in host photosynthesis due to shading or interference with nutrient absorption, while others demonstrate no effects on hosts under most natural light conditions. I addressed the consequences of epiphytism for *Odonthalia floccosa*, a branched red intertidal alga frequently colonized by the diatom *Isthmia nervosa*. Based on measurements of  $O_2$ -evolution in bottles, diatoms did not affect host photosynthesis until comprising at least 25% of dry weight. Furthermore, even heavy diatom cover was inconsequential for *Odonthalia* demography as long as epiphytes appeared late in the summer, after completion of host growth and reproduction.

Predicted survivorship of *Mazzaella splendens* and *Mazzaella linearis* thalli based on modeled hydrodynamic forces. Shaughnessy F.J., R.E. De Wreede, B. Phillips & E. Bell. University of British Columbia, Dept. of Botany, Vancouver, B.C. V6T 1Z4 Canada.

Why is the wide-bladed *M. splendens* never found at high wave exposure sites of the narrow-bladed *M. linearis*? The present study addresses the hypothesis that drag and acceleration forces are high enough to prevent *M. splendens* thalli from becoming established at a high wave exposure site. Surface areas of long (i.e. 15.0 - 25.0 cm) *M. splendens* are significantly greater than those of *M. linearis* and blade widths of short (i.e. < 5.0 cm) *M. splendens* are significantly wider than those of *M. linearis*. This means that at a given water velocity drag and acceleration will always be greater for *M. splendens*. For long thalli, the force required to break the stipe from the holdfast does not differ significantly between the two species. When the total hydrodynamic force (i.e. drag + acc.) for each species is considered against the force required to break thalli, percent survivorship of long thalli of *M. splendens* should be 0.0% at high water velocities but short thalli of *M. splendens* should persist. The latter prediction contradicts the fact that natural stands of *M. linearis* lack even short thalli of *M. splendens*. Survivorship predictions from this model have been verified by transplanting *M. splendens* to a high wave exposure site of *M. linearis*. Thus, the present hypothesis must be rejected and another hypothesis, such as attachment failure by spores of *M. splendens*, may be the reason it never gets established.

**MOLECULAR ANALYSIS OF AN ENIGMATIC SALT MARSH *PORPHYRA***  
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For years a putative *Porphyra* ecotype of unknown taxonomic affiliation has been observed growing in salt marshes along the coast of the Pacific Northwest. Specimens of this so-called "ecad" usually were found drifting in the high intertidal or snagged on *Salicornia* (pickleweed), but no reproductive structures had been reported. It therefore remained unclear whether this entity was conspecific throughout its range and whether it represented a distinct taxon or an aberrant form of an open water species which drifted into the brackish marshes. Here we report the first observations of attached, reproductive blades and results from molecular analysis which indicate that, despite morphological differences, the reproductive and drift populations are conspecific and represent a widespread and hitherto undescribed species.



## OLD-GROWTH FOREST CANOPIES: A POORLY STUDIED HABITAT FOR EPIPHYTIC AND FREE-LIVING ALGAE.

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Recent studies of northern temperate old-growth rainforest canopies have revealed an extensive, previously undescribed, arboreal arthropod community. The habitat forms a refugium for a wide variety of arthropod species, including numerous, previously undescribed, species. The habitat also supports a number of immobilized algae, including lichens. An examination of the literature reveals that few, if any, free-living algae have been described from this old-growth canopy habitat. The objective of this study is to sample a number of microhabitats within the old-growth canopy in the Carmanah Valley on Vancouver Island, and to ascertain whether or not there exists an algal flora. The presence of epiphytic algae could also provide the host with an important source of supplemental nutrients. Preliminary arthropod and botanical studies of this northern temperate forest habitat indicates that loss of the trees through harvesting could result in the destruction and possible extinction of species presently unknown to science.

## MOLECULAR PHYLOGENY AMONG THE KELP (LAMINARIALES, PHAEOPHYCEAE) FAMILIES.

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Complete 18S rDNA sequences were determined for two primitive kelp: *Chorda tomentosa* (Chordaceae) and *Saccorhiza polyschides* (Phyllariaceae). Comparisons of these two sequences, nine published advanced-kelp sequences and ten non-kelp sequences provided insights into kelp ancestry and phylogeny. The rRNA tree, inferred by distance matrix method, suggested that the order Laminariales is polyphyletic. *Chorda* and *Saccorhiza* formed an assemblage with the Sporochnales, separated from the Alariaceae, Laminariaceae and Lessoniaceae clade. Our results suggested that the Laminariales, Sporochnales and Desmarestiales are closely associated, albeit not fully resolved.

The Population Genetic Structure and Evidence of Self-Fertilization in  
*Pelvetia fastigiata (gracilis)*.

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*Pelvetia fastigiata (gracilis)* is an intertidal fucoid alga common in the California Channel Islands. Characteristics of the species as well as hypotheses based on current theories of dispersal and resulting genetic structure of populations in terrestrial plants predict genetic structuring of *Pelvetia* populations over small spatial scales or clinal genetic variation over short distances. This study was designed to test the hypothesis that genetic structuring of *P. fastigiata (gracilis)* populations occurs on a scale of less than 30m. 75 individuals were sampled at four sites on Santa Catalina Island, CA. Allozyme electrophoresis was used to estimate allele frequencies and calculate conformance to Hardy-Weinberg equilibrium (HWE). Three of the four resolvable enzymes were monomorphic at all sites. The malate dehydrogenase enzyme system was polymorphic at one site with significant deviation from HWE and an excess of heterozygotes. Wright's  $F_{ST}$  equaled .231 and was used to estimate  $N_m$  at 0.83. Additionally, preliminary experiments on inbreeding depression indicate that self-fertilization may be an important method of reproduction for this alga. These results indicate that short-range dispersal and selfing may have pronounced effects on the genetic structure of *P. fastigiata (gracilis)*.

PROGRESS WITH THE UBC HERBARIUM DATABASE.

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I have transferred this database from *Knowledgeman* to Microsoft *Access* in order to embed distribution maps and coloured illustrations of the common species. Information can be retrieved by species, locality or ecology.

## Immobilization and Long-Term Storage of the Nitrogen-Fixing Cyanobacterium *Anabaena* PCC 7120 on an Inorganic Biosupport

Charles R. Williams<sup>1</sup> and G.A. Codd<sup>2</sup>

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### Abstract

Microspheres composed of interconnecting needles of kaolinite proved suitable for immobilization by natural adherence of the cyanobacteria *Anacystis nidulans* PCC 1402-1 and *Anabaena* PCC 7120. Growth appeared normal and in some instances was greater for immobilized cultures. *Anabaena* grown under nitrogen-free conditions demonstrated significantly greater immobilization than nitrate-grown cells possibly due to increased extracellular polysaccharide levels. Further increases in immobilized biomass were achieved by sonicating *Anabaena* to reduce filament size.

*Anabaena* was exposed to different storage conditions to assess the potential of cell immobilization as a method for delivery of nitrogen-fixing cyanobacterial biofertilizers. Immobilization promoted increased recovery over free-living cells as measured by chlorophyll *a* content, colony growth, acetylene reduction, and oxygen evolution. Cells cryopreserved or air-dried with subsequent cold storage demonstrated high recovery but lyophilization proved ineffective. Recovery was found to be inversely related to storage temperature and a large reduction in activity over the first 7 days of storage indicated that initial cell damage during the cooling and desiccation of samples was likely responsible for much of the loss in recovery. Reconstitution may also have played a large part in damaging cells.

**CULTIVATION OF *Acrosiphonia coalita* TISSUE CULTURE IN A 3 L STIRRED-TANK BIOREACTOR.** Zhi, C., Ramanan, S., and Rorrer, G. L., Oregon State University, Department of Chemical Engineering, Corvallis, Oregon 97331 U.S.A. Semi-differentiated tissue cultures derived from green macroalga *Acrosiphonia coalita* were cultivated in PES medium within an illuminated 3 L stirred-tank bioreactor at 12 °C and 12,000 lux incident light intensity using CO<sub>2</sub> in air as the sole carbon source for growth. Photolithotrophic cultivation of this culture resulted in a maximum cell density of 1,200 mg DCW/L and a specific growth rate of 0.14 day<sup>-1</sup> within a 20 day cultivation period. In comparison, flask cultures only attained 500 to 600 mg DCW/L at similar conditions.

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