



SCHEDULE
5TH NORTHWEST ALGAL SYMPOSIUM
WALLA WALLA COLLEGE MARINE STATION
ROSARIO BEACH, ANACORTES, WASHINGTON
OCTOBER 5 - 7, 1990

FRI. OCTOBER 05	1000 - 1300	ARRIVAL AND CHECK-IN
	1200 - 1300	LUNCH
	1400 - 1430	ORIENTATION & ANNOUNCEMENTS
	SESSION I	<u>PHYLOGENETICS</u>
		BREAK
	SESSION II	<u>GROWTH AND DEVELOPMENT</u>
		DINNER
	1800 - 1930	
	1930 - 2000	BUSINESS MEETING
	2015 - 2055	<u>PRESENTATION AND DISCUSSION -</u> SUMMER MONITORING IN PRINCE WILLIAM SOUND: EFFECTS OF OIL AND TREATMENT ON INTERTIDAL COMMUNITIES. Dr. J. Alan Mearns, National Oceanic and Atmospheric Admin.
SAT. OCTOBER 06	0700 - 0800	BREAKFAST
	MINISYMPOSIUM	<u>MARINE CONSERVATION IN THE</u> <u>PACIFIC NORTHWEST COASTAL ZONE.</u>
	0945 - 1015	BREAK
	1015 - 1230	MINISYMPOSIUM - CONTINUED
	1230 - 1330	LUNCH
	SESSION III	<u>ECOLOGY/MACROALGAE</u>
	SESSION IV	<u>POSTER SESSION</u>
		OPEN
	1600 - 1800	
BANQUET HOPE ISLAND INN 1686 CHILBERG AVE LACONNER, WA	1815 - 1900	NO HOST BAR
	1900 - 2030	BANQUET
	2045 - 2130	EVENING TALK: MORRIS BERMAN, author of The Re-enchantment of the World and Coming to our Senses.
SUN. OCTOBER 07	0700 - 0800	BREAKFAST
	SESSION V	<u>ECOLOGY - MICROALGAE</u>
		BREAK
	SESSION VI	<u>PRODUCTIVITY/SYMBIONTS/MICROALGAE</u>
		LUNCH
		DEPARTURE
	1330 - 1400	

PROGRAM
5TH NORTHWEST ALGAL SYMPOSIUM

TIME

EVENT

FRIDAY

1000 - 1300

Arrival & Check-in

1200 - 1300

Lunch

1330 -

Welcome and Orientation

SESSION I - PHYLOGENETICS

1430 - 1445

PHYLOGENETIC RELATIONSHIPS WITHIN THE LAMINARIACEAE: MOLECULAR PERSPECTIVES ON THE GENERA CYMATHERE AND LAMINARIA. Mayes, C. & L.D. Druehl. Simon Fraser University.

1445 - 1500

A RE-EXAMINATION OF THE STATUS OF THE ORDER ECTOCARPALES (PHAEOPHYCEAE) BASED ON 18S RIBOSOMAL DNA SEQUENCES. Tan, J. & L. Druehl. Simon Fraser University.

1500 - 1515

EFFECTS OF LIGHT AND NITRATE ON THE QUANTUM YIELD OF GROWTH OF YOUNG PORPHYRA ABBOTTAE GAMETOPHYTES. Hannach, G. & J.R. Waaland. University of Washington.

1515 - 1530

CHLOROPLAST MONOPHYLY AND ALGAL POLYPHYLY. Cavalier-Smith, T. & P. Allsopp. University of British Columbia.

1530 - 1600

Break

SESSION II - GROWTH AND DEVELOPMENT

- 1600 - 1615 CHARACTERIZATION OF DISTINCT JUVENILE AND ADULT VEGETATIVE PHASES OF ACETABULARIA. Nishimura, N.J. & D.F. Mandoli. University of Washington.
- 1615 - 1630 DEVELOPMENTAL STAGES DURING MATURATION OF TERTIARY NUCLEI IN THE REPRODUCTIVE CYSTS OF ACETABULARIA ACETABULUM. Hunt, B. & D. Mandoli. University of Washington.
- 1630 - 1645 A TEMPERATURE REQUIREMENT FOR SPORE RELEASE IN PORPHYRA ABBOTTAE. Dickson, L.G. & J.R. Waaland. University of Washington.
- 1645 - 1700 CULTIVATION OF NEREOCYSTIS AND MACROCYSTIS FOR FOOD, ECOLOGICAL ENHANCEMENT AND ENVIRONMENTAL MITIGATION. Gillingham, D.M. & J.E. Merrill. Applied Algal Research, Seattle, WA.
- 1800 - 1930 Dinner
- 1930 - 2000 BUSINESS MEETING
- 2000 - ----- PRESENTATION AND DISCUSSION SUMMER MONITORING IN PRINCE WILLIAM SOUND - EFFECTS OF OIL AND TREATMENT ON INTERTIDAL COMMUNITIES. Dr. J. Alan Mearns, Ocean Assessments Division, National Oceanic and Atmospheric Administration,

SATURDAY

0700 - 0800 BREAKFAST

MINISYMPOSIUM

0805 - 0815 INTRODUCTION BY MINISYMPOSIUM ORGANIZER: M. Hawkes.

0815 - 0845 MARINE PARKS, RESERVES, AND SANCTUARIES IN THE PACIFIC NORTHWEST:
CURRENT STATUS AND FUTURE PROSPECTS (WITH COMMENTS ON SEAWEED
CONSERVATION). Hawkes, Michael. The University of British Columbia.

0845 - 0915 HISTORICAL HUMAN IMPACT ON KELP COMMUNITIES OF N.W. VANCOUVER ISLAND,
A NATURAL EXPERIMENT. Watson, Jane. University of California, Santa Cruz.

0915 - 0945 MANAGEMENT OF MACROCYSTIS AND NEREOCYSTIS HARVESTS IN BRITISH
COLUMBIA FOR SUSTAINABILITY. Coon, Michael. B.C. Government, Ministry of
Agriculture and Fisheries.

0945 - 1015 BREAK

1015 - 1045 COASTAL ZONE BIOLOGICAL INVENTORY AND MONITORING IN WASHINGTON STATE.
Mumford, Thomas F., Jr. Washington Department of Natural Resources, Division
of Aquatic Lands, Olympia, Washington.

1045 - 1115 NATIONAL MARINE SANCTUARY PROPOSALS FOR THE PACIFIC NORTHWEST. Pam
Miller. Washington State Department of Ecology.

1115 - 1145 THE PADILLA BAY NATIONAL ESTUARINE RESEARCH RESERVE: PAST, PRESENT
AND FUTURE RESEARCH SITE. Bulthuis, D.A. Washington State Department of
Ecology, Mt. Vernon, Washington.

1145 - 1230 Discussion

1230 - 1330 LUNCH

SESSION III - ECOLOGY/MACROALGAE

- 1345 - 1400 SEAWEED DEMOGRAPHY - A REVIEW OF THE DATA. De Wreede, R. E.
The University of British Columbia.
- 1400 - 1415 EFFECT OF DENSITY ON MORTALITY AND GROWTH OF A POPULATION OF FUCUS
DISTICHUS. Ang Put, Jr. The University of British Columbia
- 1415 - 1430 ONGOING RESEARCH CONCERNING THE QUESTION OF ECOLOGICAL DIFFERENCES
BETWEEN PHASES OF ISOMORPHIC ALGAE. Shaughnessy, F.J. The University of
British Columbia.
- 1430 - 1445 KELP FIBER AND FORM. Waaland, J.R., D. Gillingham, E.C.S. Duffield
& G. Hannach. University of Washington and Applied Algal Research.
- 1445 - 1500 MARINE PLANT INTRODUCTIONS IN THE NORTHEAST PACIFIC:
ANTITHAMNIONELLA SPIROGRAPHIDIS TO ZOSTERA JAPONICA.
Lindstrom, S.C. The University of British Columbia.

SESSION IV - POSTER SESSION

- 1500 - 1600 IDENTIFICATION BY ELECTRON MICROSCOPY OF MARINE NANNOPLANKTON FROM
SAANICH INLET, BRITISH COLUMBIA. Smith, P. University of Victoria.
- ORIGIN OF THE PHAEOPHYCEAE: THE PROTOTYPICAL BROWN ALGA. Eric C. Henry.
Oregon State University.
- AEOLIAN DUST AS A SOURCE OF NUTRITIONAL IRON FOR THE MARINE
CYANOBACTERIA, SYNECHOCOCCUS AND TRICHODESMIUM. Reuter, J. Portland
State University.
- POLYPHENOL CONTENT IN LAMINARIA SACCHARINA GROWN IN THE PRESENCE OF
 Cd^{2+} and Cu^{2+} . Biggs, S. and A. Wood. University of Puget Sound.
- THE EFFECT OF PLANT GROWTH REGULATORS ON THE GROWTH OF CLOSTERIUM
MONILIFERUM. Christensen, C. Portland State University.
- 1600 - 1800 LOCAL SIGHTSEEING
- 1815 - 2030 BANQUET - Hope Island Inn, 1686 Chilberg Avenue, LaConner.
- 2045 - 2130 EVENING TALK Morris Berman, author of The Re-enchantment
of the World and Coming to Our Senses.

SUNDAY

0700 - 0800

BREAKFAST

SESSION V - ECOLOGY/MICROALGAE

- 0830 - 0845 IMPACT OF AN ORGANOPHOSPHATE HERBICIDE (GLYPHOPHOSPHATE^R) ON PERIPHYTON COMMUNITIES DEVELOPED IN EXPERIMENTAL STREAMS. Austin, A.P., G.E. Harris and W.P. Lucey. University of Victoria.
- 0845 - 0900 POSSIBLE IMPACT OF INTERNAL WAVES ON LIGHT-LIMITED POPULATION OF MARINE SYNECHOCOCCUS SPP. (CYANOBACTERIA) IN THE GULF OF ALASKA. Neuer, S. Oregon State University.
- 0900 - 0915 CHEMOSENSORY BEHAVIOR IN OSCILLATORIA TEREBRIFORMIS, A MULTICELLULAR, GLIDING CYANOBACTERIUM (BLUE GREEN ALGA). Mechling, M. and R.W. Castenholz. University of Oregon.
- 0915 - 0930 SCYTONEMIN: A CYANOBACTERIAL (BLUE-GREEN ALGAL) SUNSCREEN. Garcia-Pichel, F. and R.W. Castenholz. University of Oregon.
- 0930 - 0945 NUTRIENT ASSIMILATIVE CAPACITY IN LOTIC SYSTEMS: BIOASSESSMENT OF SEWAGE-EFFLUENT LOADING ORIGINATING FROM A RECREATIONAL RESORT COMMUNITY (WHISTLER). Lucey, W.P., B. Moore and A.P. Austin. University of Victoria.
- 1000 - 1030 BREAK

SESSION VI - PRODUCTIVITY/SYMBIONTS/MICROALGAE

- 1030 - 1045 PRODUCTIVITY OF SYMBIOTIC ZOOXANTHELLAE IN THE CORAL MONASTREA ANNULARIS FROM SHALLOW AND DEEP REEFS IN BERMUDA. Muller-Parker¹, G., J.W. Porter² and C.B. Cook³. ¹Western Washington University; ²University of Georgia; ³Bermuda Biological Station for Research.
- 1045 - 1100 EFFECTS OF THE PHOTORESPIRATORY PRODUCT GLYCOLLIC ACID ON GROWTH OF THERMOPHILIC MAT BUILDING SYNECHOCOCCUS LIVIDUS. Teiser, M.L.O. and R.W. Castenholz. University of Oregon.
- 1100 - 1115 PHYSICAL AND CHEMICAL FACTORS INFLUENCING THE PHOTOTACTIC STEERING RESPONSE IN LYNGBYA SP. (U-SARA.-L). Mrozek, C., R.W. Castenholz and H.M. Howard. Univeristy of Oregon.
- 1115 - 1130 THE RESPONSE OF TRICHODESMIUM TO SOLUBLE IRON OR DUST. Elardo, K. and J. Reuter. Portland State University.
- 1130 - 1145 IRON NUTRITION OF MARINE SYNECHOCOCCUS. Unsworth, N. and J. Reuter. Portland State University.
- 1145 - 1200 VERTICAL DISTRIBUTION OF ULTRAPHYTOPLANKTON IN THE EASTERN MEDITERRANEAN. Wood, A.M. University of Oregon.

**ABSTRACTS OF THE 5TH NORTHWEST ALGAL
SYMPOSIUM**

OCTOBER 5 - 7, 1990

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ANACORTES, WASHINGTON

**THE ABSTRACTS HAVE BEEN PRINTED AS SUBMITTED, AND IN THE
ORDER OF PRESENTATION.**

PHYLOGENETIC RELATIONSHIPS WITHIN THE LAMINARIACEAE:
MOLECULAR PERSPECTIVES ON THE GENERA Cymathere AND
Laminaria

Mayes, C. and L. D. Druehl. Simon Fraser University, Department of
Biological Sciences, Burnaby, British Columbia, V5A 1S6 CANADA

Evolutionary and taxonomic relationships within the Laminariaceae are established on the basis of morphological characters. This approach presents particular problems in the delineation of two laminariacean genera, Cymathere and Laminaria. Initially, the genus Cymathere was created to accomodate a laminarian alga characterized by both a discoid holdfast and a fasciate blade. Subsequently, other species with fasciate blades but hapteral holdfasts were added to Cymathere. Members of the Fasciate Section of Laminaria also have fasciate blades and hapteral holdfasts. Additionally, some species of the Simplicies and Digitate Sections of Laminaria have discoid holdfasts. The lack of consistent morphological features separating these genera necessitates comparison of morphologically independent characters. The application of molecular techniques provides a means to bypass the morphological dilemma. Preliminary data from Restriction Fragment Length Polymorphisms (RFLPs) and Restriction Mapping of the nuclear encoded ribosomal cistron are presented. Phylogenetic relationships and taxonomic affinities of representative species within Cymathere and Laminaria are proposed.

A RE-EXAMINATION OF THE STATUS OF THE ORDER
ECTOCARPALES (PHAEOPHYCEAE) BASED ON 18S RIBOSOMAL DNA
SEQUENCES.

Tan, I. and L. Druehl. Simon Fraser University, Department of
Biological Sciences, Burnaby, British Columbia V5A 1S6 CANADA

The boundaries separating members of the order Ectocarpales from members of the orders Chordariales, Dictyosiphonales and Scytosiphonales are not clearly defined. It has been proposed that all four orders should be merged into one large order: Ectocarpales. The nuclear encoded small-subunit ribosomal DNA (16S-like) of a representative from each order was amplified and sequenced. A preliminary phylogenetic study among these orders was conducted by comparing these sequences. A dendrogram constructed by the alignment of these sequences was compared with established views regarding the phylogeny of these four closely related orders.

EFFECTS OF LIGHT AND NITRATE ON THE QUANTUM YIELD OF GROWTH OF
YOUNG PORPHYRA ABBOTTAE GAMETOPHYTES.

Hannach, G. and J.R. Waaland. University of Washington, Department of Botany, Seattle, Washington, 98195 U.S.A.

Algae acclimate to ambient light levels by adjusting the content and composition of light harvesting pigments. Nitrogen also affects pigment content and may thus influence their ability to photoacclimate. We investigated the significance of light- and nitrate-dependent pigment content for the growth of juvenile blades of Porphyra abbottae.

Gametophytes were grown from spores under a wide range of PFD and nitrate regimes. The quantum yield of growth (ϕ_g) was used as a measure of light use efficiency. ϕ_g ($\text{m}^2 \text{ mol photons absorbed}^{-1}$) was obtained from measurements of growth rate and whole thallus light absorption. N-limited thalli had lower absorptances and lower growth rates, but their ϕ_g was higher than that of N-sufficient thalli. Maximal ϕ_g was obtained at a PFD that is subsaturating for growth ($30 \mu\text{mol photons m}^{-2} \text{ s}^{-1}$). At lower PFDs, increases in pigmentation are no longer sufficient to compensate for the decrease in ambient light, and growth rate declines.

CHLOROPLAST MONOPHYLY AND ALGAL POLYPHYLY.

T. Cavalier-Smith & P. Allsopp, Department of Botany, University of British Columbia, Vancouver B.C. CANADA V6T 2B1.

The growing evidence that all chloroplasts had a single symbiotic origin from a single cyanobacterium and that the different pigment types evolved by divergence from that common ancestor will be outlined. But this does not mean that algae are monophyletic; this is because, once evolved, chloroplasts were transferred laterally several times by the secondary incorporation of photosynthetic eukaryote endosymbionts into protozoan hosts. Such secondary transfer created major new taxa independently at least 3 times: photosynthetic euglenoids, Chlorarachnion and the kingdom Chromista. Our recent 18s rRNA sequences from haptomonads and the cryptomonad Chilomonas are consistent with my earlier thesis that the three chromist phyla (Cryptista, Heterokonta and Haptomonada: see Cavalier-Smith, 1989) diverged from each other in the very earliest phase of chromist evolution. The great pigment diversity within dinoflagellates is of particular interest. There are several cases where they have clearly acquired chloroplasts secondarily from other eukaryote algae. But I shall argue that the two chloroplast types with peridinin--both the typical peridinea that lack phycobilins and those in the Dinophysiales (and also Amphidinium wigrense) which have them--evolved directly by divergence from the ancestral cyanobacterial symbiont that also gave rise to green and red algae and Glaucophyceae. The nature of the hosts and symbionts for each of the postulated endosymbioses will be discussed.

Ref: CAVALIER-SMITH, T. (1989) The Kingdom Chromista. In The Chromophyte Algae. Ed. J.C. Green, B.S.C. Leadbeater & W.L. Diver. pp. 381-407. Clarendon Press, Oxford.

CHARACTERIZATION OF DISTINCT JUVENILE AND ADULT VEGETATIVE PHASES OF *ACETABULARIA*

Nishimura, N.J. and D.F. Mandoli. University of Washington, Department of Botany, Seattle, Washington, 98195 U.S.A.

Juvenile and adult phases of vegetative development have been distinguished in *Acetabularia acetabulum*. The juvenile phase is characterized by 1) high cell death rates; 2) narrow stalk width; 3) low complexity both in entire whorls and in branch patterns of the hairs that make up those whorls; 4) short half-life of the whorl hairs and 5) a slower overall growth rate than in the adult vegetative phase. Growth in these two phases occurs both by growth immediately below the apex and by elongation of the extant interwhorls. The transition between the juvenile and adult vegetative phases is characterized by 1) a very short interwhorl length; 2) more hairs at subsequent whorls and 3) occurs at the fifth interwhorl in all of the cells of the two inbred cell lines examined. Regardless of cell height at the time of cap formation, all cells were all the same height at the end of the juvenile phase and all had the juvenile-adult transition at the fifth interwhorl. Thus, cells which differ in height and whorl complexity express these differences only during the adult portion of the life cycle whereas the juvenile phase is relatively invariant.

Developmental stages during maturation of tertiary nuclei in the reproductive cysts of *Acetabularia acetabulum*.

Hunt, B. and D. Mandoli. University of Washington.
Department of Botany, Seattle, Washington, 98195 U.S.A.

A rapid, reliable method for decontaminating intact caps of *Acetabularia acetabulum* has been developed. This method has reduced cyst dormancy from 17 weeks to less than 1 week, which represents a 40% reduction in the life cycle of the cell, and has enabled us to distinguish seven visible stages of tertiary nuclei maturation in the reproductive cysts. These developmental stages have been characterized and ordered temporally in a population of axenic cysts.

A TEMPERATURE REQUIREMENT FOR SPORE RELEASE IN *PORPHYRA ABBOTTAE*

Dickson, L.G. and J.R. Waaland, Department of Botany, University of Washington, Seattle, WA 98195 U.S.A.

Among northeast Pacific species, *Porphyra abbottae* is regarded as a very good candidate for nori aquaculture. Control of conchospore release for net seeding is of obvious concern. Here we report that *P. abbottae* has both a photoperiod and an absolute temperature requirement for conchospore release. While photoperiod is critical (it is a LD response), it alone is ineffective unless accompanied by a temperature of 8°C or less. Although this response is temperature dependent, lowering the temperature alone is also ineffective. Conchocelis pretreated at 6-8°C, followed by the 16L:8D photoperiod will release conchospores within 14-21 days which is 2 to 3 times earlier than when the LD and lowered temperature are given simultaneously. To our knowledge *P. abbottae* is the first northeast Pacific species reported to have a specific temperature requirement for spore release. These specific photoperiod and temperature combinations appear to ensure timely release of conchospores under natural conditions.

CULTIVATION OF NEREOCYSTIS AND MACROCYSTIS FOR FOOD, ECOLOGICAL ENHANCEMENT AND ENVIRONMENTAL MITIGATION.

Gillingham, David M. and John E. Merrill, Applied Algal Research, P.O. Box 31104, Seattle, Washington, 98103, U.S.A.

Techniques have been established to cultivate the kelp species Nereocystis luetkeana and Macrocystis integrifolia in Puget Sound using a method similar to the long-line cultivation methods used in Japan. Markets have been established for Nereocystis in the Japanese wakame (Undaria) market and for Macrocystis in the roe-on-kelp market. Additional markets are being developed for the cultivation technology. Cultivated Macrocystis is being used by the Port Gamble Klallam Tribe for the dual purpose of herring population enhancement and herring roe-on-kelp production. We have received considerable interest from diverse sources regarding the potential utilization of our cultivation techniques for a broad array of environmental applications including habitat improvement, mitigation of environmental damage, and bioremediation.

MARINE PARKS, RESERVES, AND SANCTUARIES IN THE PACIFIC NORTHWEST: CURRENT STATUS AND FUTURE PROSPECTS (WITH COMMENTS ON SEAWEED CONSERVATION).

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

Parks and reserves are essential components of any coastal conservation strategy. In British Columbia, no areas of the coast have been set aside as complete sanctuaries where all organisms (edible and inedible) are protected. In Washington State, only Protection Island and the City of Edmonds Underwater Marine Park protect all marine organisms from harvest. Substantial areas of three of the five marine regions in British Columbia are partially protected by the marine component of Pacific Rim National Park Reserve (155 km)² on the outer coast of Vancouver I., and Gwaii Haanas/South Moresby National Marine Park Reserve (3,050 km², but boundaries tentative) on the southern portion of Haida Gwaii (Queen Charlotte Is.). Federal Marine Parks policy allows for commercial and sport fishing inside park boundaries. There are eleven Provincial Ecological Reserves that have marine components and offer varying levels of protection to the organisms. Most reserves are small (50-350 hectares) and bring up the question of minimum reserve size necessary to maintain viable populations. There are a number of Provincial marine parks, but their primary focus is recreational boating not preservation of representative marine ecosystems or biota.

Tidelands in Washington State, controlled by the National Park Service (e.g. Olympic National Park), are under State management for classified species, and Park management for all other organisms. In Washington State Parks, the intertidal is open to recreational harvest of edible species. In the San Juan Islands there are five small preserves that protect all marine life for 200 m offshore (with the exception of salmon). Marine sanctuary proposals are pending for both Washington and British Columbia. An important factor that has probably impeded the establishment of marine parks and reserves is that there are several jurisdictions, both Federal and Provincial/State, involved in the marine environment.

Management of renewable resources should ensure both sustainability of the resource and maintenance of maximum biodiversity. However, present approaches to conservation of the marine environment are fragmented, often fisheries have been managed to maximize economic returns, frequently with inadequate knowledge of the biology of harvested species or consideration of the effects of harvesting on the rest of the ecosystem. Before rational conservation policies can be produced an ecosystem approach to coastal zone conservation will have to be adopted along with adequate inventory, mapping, and monitoring of the biota.

Using the U.B.C. Phycological herbarium data base, an attempt was made to assess the conservation status (rare or vulnerable) of the marine flora. The red algae *Arthrocardia silvae*, *Antithamnion kylinii*, *Bonnemaisonia geniculata*, *Hollenbergia nigricans*, *Thuretellopsis peggiana*, and *Whidbeyella cartilaginea* are known from six or fewer localities and typically have extremely small populations. The latter two species are noteworthy as local endemics. Other rare taxa include the chlorophyte, *Codium ritteri*, and the kelps *Laminaria farlowii*, *L. longipes*, *L. sinclairii*, *Dictyoneurum californicum*, and *Dictyoneuropsis reticulata*. Other kelps, while relatively abundant, have patchy distributions and/or narrow habitat requirements and would be especially vulnerable to harvesting or oil pollution.

HISTORICAL HUMAN IMPACT ON KELP COMMUNITIES OF N.W. VANCOUVER ISLAND, A NATURAL EXPERIMENT

Watson, Jane. University of California, Santa Cruz, CA., U.S.A. 95064

By the early 1900's, sea otters had been hunted to extinction in British Columbia. From 1969-1972, 89 sea otters were reintroduced to Checleset Bay on N.W. Vancouver Island. From this introduction the population has increased to almost 500 animals and is expanding along the west coast of Vancouver Island. Sea otters feed on shellfish, and by removing major herbivores, notably sea urchins, they promote the growth of fleshy algae. The geographic expansion of sea otters into areas unoccupied by sea otters for the last 100 years provides the opportunity to examine the effect of sea otter foraging on nearshore ecosystems. Data from a four year study in British Columbia Ecological Reserve #109 (Checleset Bay) is used to examine the impact that the sea otter fur trade had on shallow rocky nearshore ecosystems in British Columbia, and demonstrates the importance of marine conservation.

MANAGEMENT OF MACROCYSTIS AND NEREOCYSTIS HARVESTS IN BRITISH COLUMBIA FOR SUSTAINABILITY.

Coon, L.M. Ministry of Agriculture and Fisheries,
Victoria, British Columbia, V8W 2Z7, Canada

In British Columbia, kelp is recognized as a vast and essentially unutilized resource that with appropriate management and conditions of demand and operational economics could contribute to regional economies on a perpetual basis. This paper will discuss the legislative and regulatory basis for kelp management in B.C., then describe the types of information that were generated to define resource management and development strategies for Macrocystis and Nereocystis.

COASTAL ZONE BIOLOGICAL INVENTORY AND MONITORING IN WASHINGTON STATE.

Mumford, Thomas F., Jr. Washington Department of Natural Resources, Division of Aquatic Lands, EX-12, Olympia, WA 98504 U.S.A.

Nearshore wetland habitats serve a number of ecological, economic and research functions, including nesting, breeding or refuge areas for wildlife, fisheries, food web support, sediment trapping, nutrient cycling, etc. Estuarine and marine habitats have only been poorly or incompletely inventoried. EPA's Region 10 Estuary Program and EMSL and the Washington State Department of Natural Resources have jointly funded a research program to: 1) Determine the most cost and program effective methods to inventory marine and estuarine habitats of Puget Sound, and to 2) routinely monitor the distribution and types of marine and estuarine habitats of Puget Sound.

New remote sensing data of nearshore habitats at six test sites in Puget Sound at a tidal level of -1.0' or less during July/August 1988 was acquired by color infrared photography at three scales 1:6,000, 1:12,000, 1:24,000) and aircraft-based multispectral scanner at minimum resolution of 5 m.

We compared spatial and classification accuracy of these two methods. We recommend that 1) Acquire aircraft-based multi-spectral scanner digital images, 2) Plane equipped with GPS, and IGS or gyroscope for simultaneous positional data recording, 3) Digital data georeferenced to ± 1 pixel, 4) Acquire during June-July when tide is at least at -1.0 ft datum, 5) Acquire at 4-5 meter pixel resolution, 6) Acquire simultaneous color infrared 9" color positive photographs with 60% overlap for stereopairs, 7) Use Dethier's Regionalized Cowardin Classification.

National Marine Sanctuary Proposals for the Pacific Northwest

Pamela Miller
Washington State Department of Ecology

In 1988, Congress directed the National Oceanic and Atmospheric Administration (NOAA) to designate a National Marine Sanctuary off the Olympic coast and to develop a prospectus for a sanctuary surrounding the San Juan Islands. The terms of the designations, including boundary alternatives and the types of activities subject to regulation, are based on public involvement as mandated by the National Environmental Policy Act (NEPA). Title III of the Marine Protection, Research, and Sanctuaries Act of 1972 authorizes the Secretary of Commerce to designate discrete areas of the marine environment as National Marine Sanctuaries to ensure comprehensive management and protection of their conservation, recreation, ecological, historical, research, education or aesthetic resources or qualities. Scoping hearings for both of the sanctuaries generated widespread interest and support, with over 1500 people attending. Prevention of oil and gas activities, additional regulation of transportation of hazardous substances, and military activities within the sanctuary are major issues of concern. This paper reviews the history of the sanctuary program with special attention to Washington state, potential benefits sanctuaries afford, and involvement by the scientific community in the designation process.

THE PADILLA BAY NATIONAL ESTUARINE RESEARCH RESERVE: PAST, PRESENT AND FUTURE RESEARCH SITE

Bulthuis, D.A. Padilla Bay National Estuarine Research Reserve, Washington State Department of Ecology, 1043 Bay View-Edison Rd., Mount Vernon, Washington 98273 U.S.A.

Padilla Bay National Estuarine Research Reserve is one of nineteen reserves established throughout the United States for the purposes of research, education and public information. The reserves are managed by the states or territories with the system as a whole coordinated by the federal National Oceanic and Atmospheric Administration as part of the federal-state Coastal Zone Management Program. Research by universities, government agencies and private research groups is encouraged. Limited support for such research is provided by overnight facilities, field equipment, boat use and laboratory space. Padilla Bay is a 4000 hectare bay, most of which is intertidal sand and mudflats with extensive beds of the seagrasses, Zostera marina and Zostera japonica. The watershed is predominantly agricultural and rural but also contains two major oil refineries. The Reserve provides an excellent setting for research on seagrasses, seagrass communities, sand/mudflat communities, hydrocarbons and agriculture-estuary interactions.

SEAWEED DEMOGRAPHY - A REVIEW OF CURRENT DATA

De Wreede, R. University of British Columbia, Department of Botany, Vancouver, British Columbia, V6T 2B1 Canada.

Demographic data about seaweeds are scarce, and are usually difficult to obtain. However, quantitative demographic data, such as birth rates and mortality rates, provide information about both the specific populations to which they apply, as well as comparative data between populations. Most of the extant data comes from studies of either Laminarialean or Fucalean algae.

A review of both new data and those in the literature has provided useful ecological information. Demographic studies on kelps show some to be relatively long lived (to 20+ years), with age dependent reproductive output and, after the first year, with age independent mortality. Fewer data are available for the Fucalean algae, but similar trends can be seen. Age structure varies with ecological characteristics of the site, wave exposed sites showing a high proportion of juvenile thalli, while in more moderately exposed sites the longer lived algae show an age structure brought on by episodic recruitment.

Demographic data are also necessary to construct quantitative population models.

EFFECT OF DENSITY ON MORTALITY AND GROWTH OF A POPULATION OF *FUCUS DISTICHUS*.

Ang, P. Jr. Department of Botany, University of British Columbia, Vancouver, B.C., Canada, V6T 2B1

Effect of density on plant mortality and growth were monitored bimonthly or trimonthly on settling blocks seeded initially with 3 different densities of *Fucus* germlings and outplanted in the field, as well as on cleared quadrats that were settled naturally with different densities of recruits. Regression analyses indicate that in the settling blocks, density and mortality were initially negatively correlated but became weakly positively correlated in the subsequent months. Growth was not significantly correlated to density.

Among the recruits in the cleared quadrats, mortality was positively correlated to density, but only during the early months of development. with some exception, growth was not significantly correlated to density. Multiple regression analyses indicate that growth was more closely correlated to plant length than to plant density.

ONGOING RESEARCH CONCERNING THE QUESTION OF ECOLOGICAL DIFFERENCES BETWEEN PHASES OF ISOMORPHIC ALGAE.

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The isomorphic algae being examined are all in the Gigartinales and include Iridaea splendens, I. lineare, I. heterocarpa, Rhodoglossum affine and R. californicum. The first step in this study has been to quantify the population abundance, growth and reproduction of each phase along temporal and spatial gradients (seasonal, intertidal vs subtidal, wave pounded vs sheltered). The next step has been the construction of artificial populations of I. splendens in order to get, for both genets (i.e. holdfast + blade) and ramets (i.e. just blades), individual growth rates, fecundity and survivorship data of each phase. During the process of sampling populations a second question arose concerning the distinction between I. splendens, I. lineare and I. heterocarpa. Blade morphology is one of the main criteria used in identifying these taxa but it was noted that blade morphologies change along clines of wave exposure and elevation. The three taxa were transplanted into a common garden. Morphometric measurements have yet to be made however cursory observations suggest that each taxon maintained its morphology in the common garden.

KELP FIBER AND FORM

Waaland, J.R.¹, D. Gillingham², E.C.S. Duffield¹ and G. Hannach^{1, 2} ¹University of Washington, Department of Botany, Seattle, Washington, 98195; ² Applied Algal Research, P.O. Box 31104, Seattle, Washington, 98103, U.S.A.

Many species of kelps are known for their useful products. Native Americans prepared fishing line from the long stipe of Nereocystis luetkeana. They also used the pneumatocysts of this kelp to store edible oil extracted from the eulachon or candlefish. The washed and dried fibrous parts of thick and leathery seaweeds, particularly the large kelps such as N. luetkeana can be woven and used like many other plant fibers in the construction of baskets and similar items of both practical and esthetic uses. The natural tannins of brown algae and conditions during drying impart a wide range of interesting colors to the washed, dried kelp fiber. Variations in texture result from variations in the age and condition of the kelp at the start of drying and differences in conditions during the washing and drying process. Several types of baskets constructed by the authors are available for inspection.

MARINE PLANT INTRODUCTIONS IN THE NORTHEAST PACIFIC:
ANTITHAMNIONELLA SPIROGRAPHIDIS TO *ZOSTERA JAPONICA*

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Sargassum muticum and *Zostera japonica* are the two most studied examples of marine plant introductions in the northeast Pacific. These distinctive species can dominate areas of rocky and muddy shores, respectively. But other, less well-known species have also invaded northeast Pacific shores. *Antithamnionella spirographidis*, *Gelidium vagum*, and an undescribed species of *Porphyra*, formerly confused with *P. pseudolanceolata*, have been identified recently as probable invaders. *Antithamnionella* likely was introduced with boating or shipping as it is usually found growing on docks. The *Gelidium* and *Porphyra* probably came with oyster introductions. The *Antithamnionella* and *Gelidium* have only recently been identified with species from other areas on the basis of careful morphological comparisons, particularly of reproductive material. *Porphyra* "*pseudolanceolata*" was identified on the basis of distinct protein banding patterns using starch gel electrophoresis before distinguishing morphological features were recognized. Knowledge of earlier introductions and recognition of the preceding species as "invaders" suggest that human activity may be leading to significant alteration of the benthic marine algal flora of local coastal waters.

ORIGIN OF THE PHAEOPHYCEAE: THE PROTOTYPICAL BROWN ALGA

Eric C. Henry, Department of Botany & Plant Pathology, Oregon State University, Corvallis, OR 97331-2902, U.S.A.

The origin of the brown algae from simpler chrysophyceae ancestors is universally accepted, but the characteristics of the earliest brown algae remain unknown. It has been suggested that Ectocarpaceae, or alternatively, simple parenchymatous Phaeophyceae represent the most primitive types extant today. I present evidence that of all Phaeophyceae yet discovered, *Waerniella lucifuga* (Kuckuck) Kylin most nearly resembles a prototypical brown alga, because it possesses a very simple filamentous organization, small cells, and unilocular sporangia producing only 4 small motile spores. I also present an undescribed marine Chrysophyte with seemingly very advanced (e.g. "phaeophyceae") characteristics.

AEOLIAN DUST AS A SOURCE OF NUTRITIONAL IRON FOR THE MARINE CYANOBACTERIA, SYNECHOCOCCUS AND TRICHODESMIUM.

Rueter, John. Department of Biology, Portland State University, Portland, OR 97207-0751.

Iron limited cultures of Synechococcus strain WH6501 were used as a bioassay for the rate at which iron becomes available from aeolian derived particulate (dust). The growth rate and the characteristics of the growth response for cultures with dust added were similar to those with iron added on a daily basis. No dust was observed to adsorb onto the surface of cultures of Synechococcus. Dust as added to colonies of Trichodesmium collected from the open ocean. The adsorption of these dust particles were observed. The importance of dust to the iron nutritional status of these species in the ocean is discussed.

**Polyphenol Content in *Laminaria saccharina*
grown in the presence of Cd^{2+} and Cu^{2+} .**

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Laminaria saccharina was grown in the laboratory for five weeks in the presence of different concentrations of Cd^{2+} and Cu^{2+} . The polyphenol and metal content in both blade and meristem tissue were determined during the growth period. Over time, the polyphenol level decreased while metal content in tissue increased. The uptake of Cu^{2+} was greater than the uptake of Cd^{2+} . And more metal was taken up in tissue which had a higher polyphenol level.

**The Effect of Plant Growth Regulators on the Growth of
Closterium moniliferum.**

Christensen, C. Portland State University. Department of Biology, Portland, Oregon, 97207 U.S.A.

Physiologic responses to Gibberellic Acid (GA), 1-Napthalene Acetic Acid (NAA), Benzylaminopurine (BAP), and Absciscic Acid (ABA), suggest that Closterium moniliferum has the ability to utilize these plant growth factors. The growth promoters NAA and GA both increased growth when added to the media. The Cell division regulator BAP (a synthetic cytokinin), also had a promotive effect on growth. Absciscic Acid was found to be inhibitive to growth.

IDENTIFICATION BY ELECTRON MICROSCOPY OF MARINE NANPLANKTON FROM
SAANICH INLET, BRITISH COLUMBIA.

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Nanoplankton collected from April to August 1990 from surface waters of Saanich Inlet, British Columbia was examined in the transmission electron microscope following shadow casting with gold. Examination of approximately one half the material at this time has revealed 6 Prasinophytes, 4 Chrysophytes, 6 Choanoflagellates and 10 Prymnesiophytes. Several of these species are recorded from this area for the first time.

IMPACT OF AN ORGANOPHOSPHATE HERBICIDE
(GLYPHOSATE^R) ON PERIPHYTON COMMUNITIES DEVELOPED IN
EXPERIMENTAL STREAMS.

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Few studies have been conducted in lotic habitats to determine the fate of glyphosate on primary producer and herbivore/carnivore trophic relationships. Low concentrations of the herbicide were applied to periphyton communities grown in nutrient limited, experimental stream-troughs, in two overlapping experiments. Glyphosate addition (1-300 ppb) did not produce detectable toxic effects after 7 weeks of periphyton development in either experiment. Community architecture and composition was not different between experimental and control troughs. In the first study, troughs receiving 300 ppb glyphosate exhibited highest biomass accrual, whilst nutrient supplemented controls had unexpectedly low growth. In the second study, no observable differences were detected between control+nutrient troughs and those receiving nutrients+glyphosate (1 to 90 ppb). Replacement of P with glyphosate (90 ppb) resulted in growth patterns similar to the P enhanced control suggesting glyphosate could act as a phosphorus source, promoting eutrophication of oligotrophic aquatic habitat, in the coastal Pacific North-west.

POSSIBLE IMPACT OF INTERNAL WAVES ON LIGHT-LIMITED POPULATIONS OF MARINE SYNECHOCOCCUS SPP. (CYANOBACTERIA) IN THE GULF OF ALASKA

Neuer, S. Oregon State University, College of Oceanography, Corvallis, Oregon 97331 U.S.A.

Vertical distribution and growth rates of planktonic marine Synechococcus spp. were investigated during three diel cycles in September 1987 in the Gulf of Alaska. Cells of Synechococcus spp. were concentrated in and below the pycnocline (40-60 m). The depth of the pycnocline fluctuated due to internal waves which had an amplitude of about 15 m. The population of Synechococcus spp. at that depth was elevated with the wave for approximately 4 hr during the morning and early afternoon hours. The light available for these populations increased approximately three fold at the wave crest. Using photosynthesis-irradiance relationships for Synechococcus spp., I will estimate the effect of the internal waves on production rates of the oscillating communities.

CHEMOSENSORY BEHAVIOR IN *OSCILLATORIA TEREBRIFORMIS*, A MULTICELLULAR, GLIDING CYANOBACTERIUM (BLUE GREEN ALGA)

Mechling, M. and R.W. Castenholz. University of Oregon, Department of Biology, Eugene, Oregon, 97403 U.S.A.

Trichomes of *O. terebriformes* were embedded in soft agar and exposed to various chemical gradients. Within two hours, masses of trichomes formed macroscopic "attraction" or "repulsion" patterns in response to some chemicals. Investigation of the chemosensory responses that result in these patterns was done with microscopic time lapse video recordings. Trichomes move away from encroaching repellents, but have not been seen to move toward "attractants." Behavioral responses to "attractants" are cessation of gliding at high concentrations and increased speed with increased frequency of reversals ("shunting") at moderate concentrations. The role of chemosensory behavior in the natural diel migratory pattern of *O. terebriformis* is considered.

SCYTONEMIN : A CYANOBACTERIAL (BLUE-GREEN ALGAL) SUNSCREEN.

Garcia-Pichel, F. and R.W. Castenholz. University of Oregon, Department of Biology, Eugene, Oregon 97403 U.S.A.

Scytonemin is the yellow pigment that develops in the extracellular sheaths of some cyanobacteria. A knowledge of its universality and physiological role was lacking. We characterized the pigment in some 40 species (cultures and field material) of cyanobacteria and studied its possible physiological significance. The pigment was spectroscopically and chromatographically indistinguishable among members of all major taxa of cyanobacteria. Its absorption maximum was in the UV-A (370 nm *in vivo*) with a long tail extending to the infrared. Fluorescence quenching *in vivo* and direct microspectrophotometric measurements of sheaths demonstrated that scytonemine can act as an efficient shield against UV-A/blue radiation but not against green or red light. Moreover, scytonemine was synthesized under high light conditions but not under low light. UV-A radiation was very efficient in eliciting the synthesis of scytonemin, whereas visible light was not.

NUTRIENT ASSIMILATIVE CAPACITY IN LOTIC SYSTEMS: bioassessment of sewage-effluent loading originating from a recreational resort community [Whistler].

Lucey, W.P., B. Moore and A.P. Austin. University of Victoria, Department of Biology, Victoria, British Columbia, V8W 2Y2 Canada

A three year field study, in experimental streams, quantified the nutrient contribution of sewage effluent to the Cheakamus River, British Columbia, with particular reference to phosphorus. Fisheries and aesthetics are adversely affected at algal biomass values exceeding 2500 ug/cm²; this will occur given an increased river ortho P of 0.2 ug/L. The latter, projected to occur in the summer of 1990, is equivalent to an increased sewage-effluent discharge of 5339 to 5884 m³/day. The rivers limited nutrient assimilative capacity, in view of proposed new development, necessitates either 1) additional effluent discharge into an adjacent watershed, 2) design and implementation of a more effective tertiary sewage treatment system, or 3) cancellation of further commercial and domestic growth.

Muller-Parker, G.¹, J.W. Porter² and C.B. Cook³

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EFFECTS OF THE PHOTORESPIRATORY PRODUCT GLYCOLLIC ACID ON GROWTH OF THERMOPHILIC MAT BUILDING SYNECHOCOCCUS LIVIDUS.

Synechococcus lividus, the main or sometimes sole primary producer of alkaline hot springs microbial mats above 60°C, was grown in bubble tube cultures at various concentrations of glycollic acid and inorganic carbon substrate to determine the effect of exogenous glycollic acid on the growth rate. The growth rate decreased with increased glycollic acid concentrations. At normal air CO₂ concentrations the highest inhibition was reached at glycollic acid concentrations of 0.5 mM where the growth rate was 60% of maximum growth rate. The relative inhibition was even greater for a given glycollic acid concentration when available carbon substrate concentrations decreased. It is possible that S. lividus growth rate may be severely limited by its own photorespiratory glycollic acid production in its natural environment.

PHYSICAL AND CHEMICAL FACTORS INFLUENCING THE PHOTOTACTIC STEERING RESPONSE IN *LYNGBYA SP.* (U-SARA.-L)

Mrozek C., R.W. Castenholz and H.M. Howard.
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The thermophilic, filamentous, rotating, gliding cyanobacterium *Lyngbya sp.* (U-Sara.-L) exhibits a phototactic alignment of its filaments and a true steering behavior when grown on plates under unidirectional light. If changes in the light direction occur, *Lyngbya sp.* (U-Sara.-L) steers towards the light source to realign. Several factors that could influence this steering ability and the general phototactic response have been investigated, among them four different quenchers of singlet oxygen (1O_2), DABCO [1,4-diazabicyclo(2,2,2)octane], NaN_3 , KI and dl- α -tocopherol (vitamin E). dl- α -tocopherol, NaN_3 and KI disturb the phototactic signal, either by not establishing the alignment of the filaments towards the light source or by reversing the positive phototactic signal to a negative one. This is the first report that a member of the family Oscillatoriaceae shows true phototactic steering.

THE RESPONSE OF TRICHODESMIUM TO SOLUBLE IRON OR DUST

Elardo, Karen and John Rueter. Department of Biology, Portland
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Nitrogen fixation in the marine cyanobacterium Trichodesmium has been shown to depend on many factors including iron nutrition. The response of the proteins and pigments of Trichodesmium to the addition of dust as either $FeCl_3$ or contained in amorphous crustal particulate (dust) was examined. There are subtle changes in the chlorophyll and phycobilin content. There are also changes in the protein complement of the cells that can be detected with gel electrophoresis. These responses may indicate that Trichodesmium responds differently to these two sources of iron.

IRON NUTRITION OF MARINE SYNECHOCOCCUS.

Unsworth, Nancy and John Rueter. Department of Biology, Portland State University, Portland, OR 97207-0751.

Several strains of marine Synechococcus (WH6501, WH7803 and WH8018) were grown in defined medium with a range of available iron. The growth was monitored by following cell number. Comparison of the biochemical content of these cultures was made while they were all in exponential growth phase for protein and pigment content. The physiological state of these cells was examined with short term ^{14}C uptake measurements. Iron-replete cells had higher carbon fixation rate in both the light and in the dark. However, actively growing iron-limited cultures had relatively higher enhancement of dark carbon fixation with the addition of ammonia. These responses to iron stress in these marine clones will be compared to the response from other strains of Synechococcus.

VERTICAL DISTRIBUTION OF ULTRAPHYTOPLANKTON IN THE EASTERN MEDITERRANEAN

Wood, A. M. University of Oregon. Dept. of Biology, Eugene, Oregon 97403 U.S.A.

The Eastern Mediterranean is a unique environment for the study of environmental factors defining the realised niche of marine ultraphytoplankton. The highly oligotrophic waters are extremely transparent (0.1% light level at approximately 180-220m). Circulation in the upper 500 meters is dominated by a highly energetic eddy field composed of both cyclonic and anti-cyclonic features. Because isobaric surfaces rise in the centers of the cyclonic features and are depressed in the center of the anticyclonic features, there is a concurrent variation in nutrient availability with effective "upwelling" in cyclones and "downwelling" in anticyclones. Data from a cruise sponsored by the Group for Aquatic Productivity (GAP) and the Israeli Oceanographic and Limnological Research Organisation (IOLR) show that, when both nutrients and light are available at depths exceeding 180 meters, eucaryotic ultraphytoplankton and prochlorophytes appear to be able to grow *in situ*, but chroococcoid cyanobacteria do not. This result is interpreted as a preliminary indication that the lower limit for growth of cyanobacteria in the sea is ultimately determined by light quality, rather than light intensity, nutrient availability, or competitive interactions with other taxa.

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