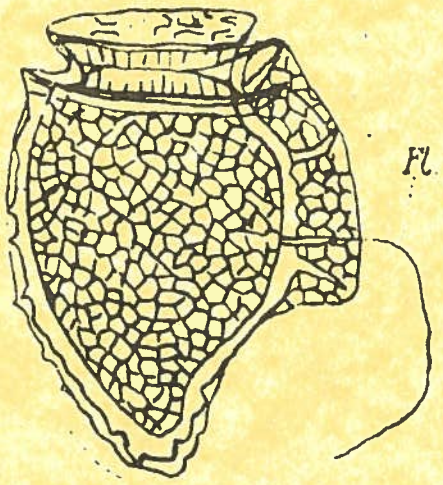
TENTH NORTHWEST ALGAL SYMPOSIUM

PROGRAM AND ABSTRACTS



Oregon Institute of Marine Biology
University of Oregon
Charleston, Oregon
March 15-17, 1996

10NWAS

Tenth Northwest Algal Symposium
Oregon Institute of Marine Biology
Charleston, Oregon 97420

Program

FRIDAY, March 15

1:00 PM **Registration** begins (Dining Hall)
Assemble Posters (Dining Hall Lobby)

6:00 - 7:00 **Dinner** (Dining Hall)

7:30 - 9:00 **SYMPOSIUM:** HARMFUL ALGAL BLOOMS IN THE PACIFIC NORTHWEST (Boathouse Auditorium)

HARMFUL ALGAL BLOOMS: AN UPDATE. Rita Horner. School of Oceanography, Box 357940, University of Washington, Seattle, Washington 98195-7940 U.S.A.

HARMFUL ALGAL BLOOMS: A GOVERNMENTAL AGENCY'S PERSPECTIVE. Deb Cannon. Food Safety Division, Oregon Dept. of Agriculture, Salem, Oregon 97310-0110 U.S.A.

HARMFUL ALGAL BLOOM IMPACTS ON THE DUNGENESS CRAB FISHERY. John C. Wekell. National Marine Fisheries Service, Northwest Fisheries Science Center, 2725 Montlake Blvd. East, Seattle, Washington, U.S.A.

RECEPTOR-BINDING ASSAY FOR RAPID AND SENSITIVE DETECTION OF DOMOIC ACID. Vera L. Trainer. National Marine Fisheries Service, Seattle, Washington 98112 U.S.A.

A BIBLIOGRAPHIC DATABASE ON HARMFUL ALGAL BLOOMS OF MARINE AND ESTUARINE AREAS OF THE WORLD, A PROGRESS REPORT. Gayle I. Hansen. Hatfield Marine Science Center, Oregon State University and U.S. Environmental Protection Agency, Newport, Oregon 97365 U.S.A.

9:00 PM - ? **MIXER** (Dining Hall)
Bring Your Own Beer. Snacks will be provided.

SATURDAY, March 16

7:30-8:30 AM **Breakfast** (Dining Hall)

9-10:15 **Contributed Papers Session 1** (Boathouse Auditorium)

ARBOREAL OLD-GROWTH CANOPIES: A POORLY STUDIED HABITAT FOR EPIPHYTIC, FREE-LIVING ALGAE - PRELIMINARY FINDINGS. M. Taghaoussi and Wm. P. Lucey. Department of Biology, University of Victoria, P.O. Box 1700, Victoria, British Columbia V8P 2Y2 Canada

DIDYMOSPHENIA GEMINATA (LYNGB.) M. SCHM.: A NUISANCE DIATOM IN BRITISH COLUMBIAN RIVERS. Cori L. Barraclough. Department of Biology, University of Victoria, Box 1700, Victoria, British Columbia V8W 2Y2 Canada

FROM THE SIXTH TO THE TENTH NWAS: THE *PORPHYRA REDIVA* STORY. John W. Stiller and J. Robert Waaland. Department of Botany, University of Washington, Seattle, Washington 98195 U.S.A.

10:15-10:30 **Coffee Break**

10:30-12:00 **Contributed Papers Session 2** (Boathouse Auditorium)

PERIPHYTON AND ITS FUNCTION IN A WETLAND: IMPLICATIONS FOR URBAN STORMWATER REMEDIATION AND HABITAT REHABILITATION. V. C. Hawkes, P. C. Furey, K. Martell and E. Hargreave. Department of Biology, University of Victoria, Box 1700, Victoria, British Columbia V8W 2Y2 Canada

EFFECTS OF SHELL -DERIVED COMPOUNDS ON GROWTH AND REPRODUCTION IN KELP GAMETOPHYTES. Terrie Klinger. Friday Harbor Laboratory, University of Washington, Friday Harbor, WA 98250 U.S.A.

UV-B INDUCED SPECTRAL CHANGES IN NITROGEN-LIMITED CULTURES OF *PAVLOVA GYRANS*. Gabriela Hannach. U. S. Environmental Protection Agengy, Hatfield Marine Science Center, Newport, OR 97365 U.S.A.

12:15 - 1:15 **Lunch** (Dining Hall)

1:15-2:15 **Poster Session** (Dining Hall Lobby)

PORPHYRA CONCHOCELIS GROWTH ON DIFFERENT TYPES OF GELS. Ellen C. S. Duffield, Charles R. Williams and J. Robert Waaland. Department of Botany, University of Washington, Seattle, Washington 98195 U.S.A.

A MONITORING PROGRAM FOR HARMFUL ALGAL BLOOMS. James R. Postel and Rita A. Horner. School of Oceanography, Box 357940, University of Washington, Seattle, Washington 98195-7940 U.S.A.

PHAGOTROPHY IN ALEXANDRIUM SPP. Dean Jacobson. Department of Biology, Whitworth College, Spokane, Washington 99251 U.S.A.

EFFICACY OF A PLAQUE REMOVER COMPARED WITH TRADITIONAL TECHNIQUES FOR SCOURING PERIPHYTON FROM HARD SUBSTRATA: TOWARD DEVELOMENT OF A STANDARD PROTOCOL. D. M. A. Lejour and L. A. Greenaway. Department of Biology, University of Victoria, P.O. Box 1700, Victoria, British Columbia V8W 2Y2 Canada

MASS PRODUCTION OF THE CYANOBACTERIUM *LYNGBYA MAJUSCULA* FOR ITS BIOACTIVE NATURAL PRODUCT CURACIN A. James V. Rossi, Mary Ann Roberts, Hye-Dong Yoo and William H. Gerwick, College of Pharmacy, Oregon State University, Corvallis, Oregon 97331 U.S.A.

PERIPHYTON-INVERTEBRATE TROPHIC INTERACTIONS IN DAMAGED COASTAL STREAMS: SHORT AND LONG TERM PRESCRIPTIONS FOR THE REMEDIATION AND REHABILITATION OF SALMONID HABITAT. L. N. S. S. Shama, D. MacKay and K. Foster. Department of Biology, University of Victoria, Box 1700, Victoria, British Columbia V8W 2Y2 Canada

USE OF PERIPHYTON BIOASSAYS FOR MONITORING ECOLOGICAL AND WATER QUALITY RESTORATION OF AN URBAN CREEK: A TEN YEAR RETROSPECTIVE. G. Theobald, J. Thompson and D. Peterson. Department of Biology, University of Victoria, Box 1700, Victoria, British Columbia V8W 2Y2 Canada

CAN POST-CHLORINATION DISINFECTION BY-PRODUCTS BE MINIMIZED MORE EFFECTIVELY BY CONSIDERING RESERVOIR MANAGEMENT AN AQUACULTURE OPERATION? J. Zurba, M. Drummond and J. I. Wier. Department of Biology, University of Victoria, Box 1700, Victoria, British Columbia V8W 2Y2 Canada

DEVELOPMENT AND BIOREACTOR CULTIVATION OF A NOVEL SEMI-DIFFERENTIATED TISSUE SUSPENSION DERIVED FROM THE MARINE PLANT *ACROSIPHONIA COALITA*. Chunxing Zhi[1], Gregory L. Rorrer[1], and Miriam Polne-Fuller[2]. [1]Department of Chemical Engineering, Oregon State University, Corvallis, Oregon 97331. [2]Marine Biotechnology Institute, University of California, Santa Barbara, California 93106 U.S.A.

2:15 - 4:30 **Field Trip** - South Cove (vans and private cars)

Return to OIMB

Open (plankton tow and microscopes available in Dining Hall classroom)

6:00 - 9:00 **Social Hour and Banquet** (Dining Hall)

SUNDAY, March 17

7:30 - 8:30 **Breakfast** (Dining Hall)

9:00 - 10:00 **Business Meeting** (Boathouse Auditorium)

10:00 - 12:00 **Contributed Papers Session 3** (Boathouse Auditorium)

STIMULATION OF 15-LIPOXYGENASE METABOLISM IN LIQUID SUSPENSION CULTURES OF THE MACROPHYTIC BROWN ALGA *LAMINARIA SACCHARINA*. Gregory L. Rorrer[1], Hye-Dong Yoo[2], Christine Hayden[1], and William H. Gerwick[2]. [1]Department of Chemical Engineering or [2]College of Pharmacy, Oregon State University, Corvallis, OR 97331 U.S.A.

FITC-LECTINS & THE CHARACTERIZATION OF SPORE MUCILAGE IN *CHAMPIA PARVULA* (RHODOPHYTA). Martha E. Apple, Marilyn M. Harlin, and Joanna H. Norris. Botany Department, University of Rhode Island, Kingston, Rhode Island 02881 U.S.A.

BIOGEOGRAPHY OF POST-GLACIAL RECOLONIZATION OF THE NORTHEAST PACIFIC COAST. Sandra C. Lindstrom. Department of Botany, University of British Columbia, Vancouver V6T 1Z4 Canada and Jeanine L. Olsen and Wytze T. Stam. Department of Marine Biology, University of Groningen, Haren, The Netherlands

12:00 - 1:00 **Lunch**

Depart

Symposium

Harmful Algal Blooms in the Pacific Northwest

Harmful Algal Blooms: An Update

Rita A. Horner, School of Oceanography, Box 357940, University of Washington, Seattle, WA 98195-7940

Harmful algal blooms (HABs) continue to be a problem on both local and global scales. In the U.S., all the coastal states have HAB problems, but there is no national program to deal with them, instead, individual states devise their own plans and regulatory action. In Canada, the Fisheries Inspection Branch of the federal Department of Fisheries and Oceans is responsible for shellfish monitoring. Furthermore, most of the information on HABs comes from state and provincial regulatory agencies and is based on toxin in shellfish, not on the biology of the causative phytoplankton species.

Paralytic shellfish poisoning (PSP) continues to be a problem along the west coast, but few illnesses and no deaths have been reported in recent years, the major exception being Alaska where, despite warnings, illnesses and often deaths occur most years. Domoic acid poisoning (DAP; also called amnesic shellfish poisoning, ASP) has not been a serious problem since its discovery on the west coast in 1991. However, razor clams still contain domoic acid and, in Washington at least, nearly all harvest seasons have been affected because of the presence of domoic acid. The source of the domoic acid in the Pacific Northwest is still not known with certainty.

Other potentially harmful species continue to occur throughout the west, especially in more protected areas such as Puget Sound, Barkley Sound, and the Strait of Georgia. Species include *Chaetoceros concavicornis, C. convolutus, C. danicus*, and *Heterosigma carterae* that may kill finfish grown in net pens; and *Noctiluca scintillans, Gymnodinium sanguineum,* and *Ceratium fusus* that do not produce toxins, but may kill due to reduced oxygen levels as blooms decay. The *Dinophysis* species that cause diarrhetic shellfish poisoning (DSP) in northern Europe and Japan are present, but no confirmed cases of DSP have been reported.

Harmful Algal Bloom Impacts on the Dungeness Crab Fishery

John C. Wekell, National Marine Fisheries Service, Northwest Fisheries Science Center, 2725 Montlake Blvd. East, Seattle, WA.

Harmful Algal Blooms can not only be devastating to local marine ecosystems but also to human populations that depend on those systems for subsistence and income. The death and sickness of seabirds in Monterey Bay was the initial warning of the 1991 domoic acid outbreak that impacted fisheries on the west coast of the United States. In Monterey Bay, the source of the domoic acid was traced to a bloom of the diatom *Pseudo-nitzschia australis*. Subsequent contamination of razor clams in Oregon and Washington have implicated this organism as the probable cause. Both rock and Dungeness crabs were also found to contain domoic acid, perhaps due to their role as scavengers. In 1991, the Dungeness crab fishery opening was delayed for about 2 weeks in December 1991, representing significant economic losses to the industry and coastal communities. In 1992, analyses of cooked Dungeness crab viscera from Kodiak AK indicated high levels of Paralytic Shellfish Poison (PSP). The source of PSP, presumably *Alexandrium* spp., is suspected as the algal source in these samples. While the sources of these toxins is probably algal, the specific steps in the food web that lead to crab contamination are far from understood. In order to protect public health and ensure safe seafood, this lack of predictive indices and understanding of the food web relationships requires a costly risk management approach.

Receptor-Binding Assay for Rapid and Sensitive Detection of Domoic Acid

Vera L. Trainer, National Marine Fisheries Service, Seattle, WA 98112

Amnesic shellfish poisoning (ASP) is gastrointestinal and neurologic illness associated with human consumption of filter-feeding marine organisms containing domoic acid (DA). This neuroexcitatory amino acid was first detected on the east coast of Canada in 1987 and has subsequently been detected in marine organisms in Washington and Oregon since 1991. The Canadian outbreak was positively correlated to a bloom of the diatom, *Pseudo-nitzschia multiseries*, however the causative organism of ASP in the Pacific Northwest has not yet been conclusively determined.

Current methods which are most widely used for monitoring the levels of DA in marine species are HPLC protocols which utilize UV detection and FMOC derivitization using fluorescence analysis. These methods are sensitive and reliable, but time consuming. In contrast, receptor binding assays allow accurate measurement of total toxic potency in multiple samples of seawater and marine species. The rapid processing of large numbers of samples will allow investigators to determine the causative organism of DA outbreaks in the Pacific Northwest and to thoroughly monitor the safety of seafood products.

A Bibliographic Database on Harmful Algal Blooms of Marine and Estuarine Areas of the World, a Progress Report.

Hansen, Gayle I., Hatfield Marine Science Ctr., OSU, and U. S. EPA, Newport, OR 97365

Over the past 20 years, there has been a dramatic increase in the distribution, frequency, and magnitude of harmful algal blooms (HABs) occurring worldwide. This has led to a corresponding increase in the research efforts in this field resulting in a massive proliferation of papers being published. The yearly publication numbers have gone from <50 in 1985 to >400 in 1993, and the numbers are still rising. The literature increase is so overwhelming that it has become difficult, if not impossible, for research scientists and environmental managers to keep up. Commercial bibliographic databases such as ASFA and Biosis help, but none offer complete coverage of the HAB literature because of the limited scope of each. In addition, the starting dates of most do not extend before the late 1960s or 1970s, and even on-line databases are generally 2-3 years behind in cataloging current literature. Therefore, a new database on the world HAB literature has been initiated at HMSC utilizing Papyrus, a bibliographic database available through Research Design Software in Portland (OR). The database has been set up to include abstracts as well as citation information whenever possible. To date, 14 commercial databases have been searched and the results imported into the program. In addition, numerous uncataloged references have been scanned or typed in. The new HAB database will be presented in its ~~preliminary~~ current state of completeness form, and the advantages and disadvantages of using Papyrus will be discussed.

Contributed Papers Session 1

Arboreal Old-Growth Canopies: A Poorly Studied Habitat For Epiphytic, Free-Living Algae – Preliminary Findings

Taghaoussi, M. and Wm.P. Lucey. Department of Biology, University of Victoria, P.O. Box 1700, Victoria, B.C. V8P 2Y2.

Recent studies of northern temperate old-growth rain forest canopies have revealed an extensive, previously undescribed, arboreal arthropod habitat. The habitat forms a refugia for a wide variety of taxonomically discrete arthropod species, many of which include previously undescribed species. The habitat supports a number of immobilized algae, as phycobionts. An examination of the literature reveals, however, that few, if any, free-living algae have been described from arboreal, old growth canopy habitat. We have completed a preliminary, winter study of two mature canopies (Douglas Fir and Hemlock; above 35 m), in the Bamfield Marine Forest Preserve, verifying a previously undescribed algal assemblage. A qualitative assessment of a wide variety of arboreal microhabitats revealed free-living forms including species from the Cyanobacteria, Chlorophyta and Bacillariophyta; the limited diversity likely reflects the cold, January conditions. Soil algae (Chlorosarcinales) were common, as were numerous flagellated forms. We propose to conduct further, detailed inventories of arboreal habitat to compare mature and second growth algal communities; the use of artificial substrata is envisioned to sample arboreal periphyton.

Didymosphenia geminata (Lyngb.) M. Schm.: A Nuisance Diatom in British Columbian Rivers

Cori L. Barraclough, Department of Biology, University of Victoria, Box 1700 Victoria, B.C. Canada. V8W 2Y2.

Didymosphenia geminata (Lyngb.) M. Schm. is a freshwater diatom which grows on mucilaginous stalks attached to firm substrates. In recent years it has bloomed in nuisance proportions in British Columbian rivers. *D. geminata* blooms cause taste and odour problems in drinking water, foul water intakes, clog fish spawning channels and fish gills, alter benthic invertebrate community structure, irritate swimmers' eyes, and may depress dissolved oxygen levels in the river as they die off. The first recorded occurrence of these blooms was in 1988, in the lower Heber River, on Vancouver Island. This diatom has now invaded 15 watersheds on Vancouver Island and two watersheds on the B.C. mainland as well as the Yukon River. Recent reports indicate that this species is also known to be a nuisance in west Iceland. When dried, it resembles toilet paper and is often reported by citizens who believe it to be sewage contamination. This paper is an attempt to raise awareness of this situation throughout the Pacific Northwest and determine the true geographical extent of this problem.

From the Sixth to the Tenth NWAS: the *Porphyra rediviva* story.

John W. Stiller and J. Robert Waaland, Department of Botany, University of Washington, Seattle, WA 98195

In March 1992, at the sixth Northwest Algal Symposium, Dr. Thomas F. Mumford Jr. led an intrepid group of Porphyraphiles to South Slough in Coos Bay to collect an odd and unidentified marsh ecad of *Porphyra* from which reproductive structures had never been reported. When compared with our *Porphyra* data base, subsequent RFLP analysis of rDNA from these samples indicated that the marsh ecad was not conspecific with any common local species. We continued collecting samples in brackish marshes from Puget Sound, WA to Humboldt Bay, CA and found by molecular analysis that all *Porphyra* blades growing in these environments shared identical RFLP patterns in the relatively variable rDNA internal transcribed spacer (ITS) region, indicating that the marsh ecad was the same genetic entity throughout its range. In the fall of 1994, reproductive blades with afairly uncommon sectored pattern of sporangial development were found growing alongside the ecad in Fidalgo Bay, WA. Further molecular analyses revealed that these reproductive blades and the marsh ecad represented alternative morphs of the same, and as yet undescribed species. Here, for the first time, is the full story of *Porphyra rediviva* sp. nov., soon to be available in paperback in a library near you (J. Phycol. Vol. 32, No. 2).

Contributed Papers Session 2

Periphyton And Its Function In A Wetland: implications for urban stormwater remediation and habitat rehabilitation.

Hawkes, V.C., P.C. Furey, K. Martell and E. Hargreave. Department of Biology, University of Victoria, Box 1700, Victoria B.C., Canada. V8W 2Y2

The relative importance of the function and structure of wetland periphyton, compared with that of macrophytes, is only now being recognized. Little information is available on how periphyton can be incorporated into the design and construction of artificial wetlands used for urban stormwater remediation and habitat rehabilitation. Growing urban populations on southern Vancouver Island, British Columbia, are altering the hydrological profile of the upland portions of an urban stream (Colwood Creek). While presently discharged to ground, future increased runoff will be re-directed into the creek, potentially deteriorating creek water quality; we propose to mitigate runoff-based contaminants using an artificial wetland, to be constructed adjacent to the creek. Primary wetland design considerations include reducing sub-catchment peak flows, water quality remediation, and the provision of habitat for a wide range of aquatic organisms including waterfowl, mammals, invertebrates and amphibians. Establishing the link between periphytic algae and amphibian life cycles may be crucial to understanding the connection between amphibian larval mortalities and UV-B modified periphyton. It is anticipated that the wetland will provide an outdoor laboratory within which to study the complexity of trophic interactions in an urban setting; this information will provide a useful feedback loop for future wetland design.

Effects of shell-derived compounds on growth and reproduction in kelp gametophytes

Terrie Klinger, Friday Harbor Labs, Friday Harbor, WA 98250

Compounds derived from the dissolution of Mytilus shells in seawater can significantly affect the germination, growth, and reproduction of kelp gametophytes. Spore germination was enhanced and growth rates more than doubled in the presence of shell-derived solutes. However, sexual reproduction appeared to be totally suppressed. There was no evidence of gametogenesis or sporophyte initiation among gametophytes grown in the presence of shells or shell-derived compounds, even though oogonia, antheridia, and small sporophytes were common in controls. These findings indicate that naturally-occurring compounds could potentially influence the fitness and distribution of gametophyte and sporophyte phases by regulation of growth and reproduction in gametophytes.

UV-B Induced Spectral Changes in Nitrogen-Limited Cultures of *Pavlova gyrans.*

Gabriela Hannach, US EPA, Hatfield Marine Science Center, Newport, OR 97365; hannach.gabriela@epamail.epa.gov

Reduction of stratospheric ozone has focused increased attention on the biological impacts of ultraviolet radiation. UV-screening compounds may play an important role in protecting marine phytoplankton from harmful ultraviolet radiation. The nitrogenous nature of UV-absorbing compounds implies that nitrogen availability could potentially limit their concentration within the cell. The effects of ultraviolet-B (UV-B, 280-320 nm) radiation on growth, light absorption (280-700 nm) and pigment composition of the marine prymnesiophyte *Pavlova gyrans* were studied in relation to nitrogen availability. Semi-continuous cultures were exposed to three levels of UV-B radiation (excluded, moderate, enhanced). Nitrate was supplied at either growth-saturating or moderately growth-limiting ($\mu \sim 0.5\mu_{max}$) rates. Spectrophotometry of methanolic extracts and live cells suggests that acclimation of *P. gyrans* to UV radiation is accompanied by an increase in the content of UV-absorbing compounds. In vivo, these compounds exhibit a broad absorption peak around 338 nm, with little absorption extending into the shorter, UV-B wavelengths. In *P. gyrans*, UV-screening compounds are thus not effective in the region of the solar spectrum most altered by ozone depletion. UV-B induced spectral changes in the UV region were not affected by nitrogen availability at the level of limitation studied.

Poster Session

Porphyra Conchocelis Growth on Different Types of Gels

Ellen C. S. Duffield, Charles R. Williams and J.Robert Waaland, Department of Botany, University of Washington, Seattle, Washington 98195.

Axenic *Porphyra* yezoensis conchocelis growth was tested on both algal-derived and "gellan" gum gels. Storing and cleaning cultures is facilitated on such gels; however, some gels appear to inhibit growth. Growth of conchocelis was very good on 0.7% SeaPlaque agarose (FMC), followed by 0.7% SeaKem Le agarose (FMC), 0.5% GELRITE (Scott) and 0.5% Gelgro (ICN). Some growth occurred on 1.0% A 8678 washed agar (Sigma) and very little growth appeared on 0.85% and 0.5% Ion agar (Colab), 0.7% A 1296 agar (Sigma), 0.7% Select agar (Gibco) and 1.5% Bacto agar (Difco). The gellan gum gels had to be poured very hot ecause of rapid gelling and this caused a major moisture problem on the surface of the gel. The 0.7% Sea Kem Le's surface was hydrophobic so that it was difficult to evenly spread the conchocelis over the gel's surface. On a cost benefit basis, we would recommend SeaKem Le agarose as a cost effective gel when isolating or urifying algal cultures on solid media.

A Monitoring Program for Harmful Algal Blooms

James R. Postel and Rita A. Horner, School of Oceanography, Box 357940, University of Washington, Seattle, WA 98195-7940

Washington state has a long history of harmful algal blooms as indicated by the presence of toxic shellfish and mortalities of pen-reared almonids. While selected areas are monitored for toxins in shellfish by the Washington Department of Health (WDH; PSP since 1957, domoic acid since 1991), little information is available on the temporal and spatial distribution of the causative algal species. Further, the species that kill fish, *Heterosigma carterae, Chaetoceros convolutus* and *C. concavicornis*, are not now known to produce toxins so the best way to determine their presence before fish die is by routine phytoplankton monitoring that can also detect the presence of toxin producers, often before the shellfish become toxic.

In 1990, in response to requests from local fish growers, a system was designed so the growers could monitor their own sites. This consisted of training for sample collection and phytoplankton identification, a picture guide to the harmful and common nonharmful species in local waters based on the published literature, and rapid field support when a bloom occurred. A phytoplankton hotline was started for participants to call in their results, which are summarized so that anyone calling the hotline can obtain the information.

When domoic acid first occurred in Washington, the program was expanded to include shellfish growers, state, and federal agencies, Native tribes, and the general public. An additional 45 people were trained and the field guide expanded. Workshops were also given in California, Oregon, and Alaska. A recent one-year project at 20 of the 33 sites monitored for shellfish toxins by WDH helped predict domoic acid in Hood Canal mussels in the fall of 1994. State agency personnel now collect samples and/or call when there are kills of either wild or penned fish and when blooms are apparent. The telephone hotline is still in operation and we contine to provide taxonomic expertise and field assistance.

Efficacy of a plaque remover compared with traditional techniques for scouring periphyton from hard substrata: toward development of a standard protocol.

Lejour, D.M.A. and L.A. Greenaway. Department of Biology, University of Victoria, P.O. Box 1700, Victoria, B.C. V8W 2Y2 Canada

The wide variety of methods uncritically used to remove periphyton from hard substrata has hindered development of a standardized removal protocol. Since few studies have been undertaken to ascertain which method consistently demonstrates superior efficiency and effectiveness, we compared the efficacy of removing periphyton, attached to clay tiles, glass slides and natural river-cobble, using commonly reported methods (scraping with a razor blade, scouring pad and tooth-brush) with that of a previously untried technique (a battery powered, Braun® plaque remover). Periphyton was cultured on substrata contained in a Pacific Northwest mesotrophic, urban stream (Colwood Creek). Periphyton removal effectiveness was measured by i) comparing post-removal chlorophyll *a*, *b*, *c* and phaeophytin substrata concentrations and ii) post-removal, photo-microscopic records of the glass slides to determine the quality and extent of the adnate guild remaining. Periphyton-substratum species composition was determined to characterize the scraped community. Preliminary results indicated effectiveness and efficiency of periphyton removal from all three substrata were ordered plaque remover> tooth-brush> scouring pad> razor blade.

Mass Production of the Cyanobacterium *Lyngbya majuscula* for its Bioactive Natural Product Curacin A

James V. Rossi, Mary Ann Roberts, Hye-Dong Yoo and William H.Gerwick, College of Pharmacy, Oregon State University, Corvallis, Oregon 97331

Marine organisms from several different classes are yielding exciting new leads in the search for more potent and selective pharmaceuticals. Often these compounds possess unique structures not seen in terrestrial or fresh water counterparts. In order to fully exploit these lead compounds through secondary testing, an adequate supply of the raw material must be readily obtained. However, marine organisms are often not available for recollection because natural populations may be limited in size. Large scale cultivation is a possible answer for resupply. In this respect, we developed a scaled-up batch culture system of a *Lyngbya majuscula* isolated from Curaçao in 1993 that produces the antiproliferative compound 'curacin A'. Strain 19L was selected for scale-up from analysis of 29 strains for curacin A content as well as several growth characteristics. In the scale up experiment 137.0 mg of curacin A was produced in a six week time period. This is superior to the current synthetic production of curacin A, which consisted of 21 steps giving only a 0.6% overall yield. With this reliable source of resupply, further studies on the anticancer potential of curacin A as well as elucidation of the biosynthetic pathway of this novel metabolite, are currently being undertaken.

Periphyton–Invertebrate Trophic Interactions In Damaged Coastal Streams: short and long term prescriptions for the remediation and rehabilitation of salmonid habitat.

Shama, L.N.S.S., D. MacKay and K. Foster. Department of Biology, University of Victoria, Box 1700, Victoria B.C., Canada. V8W 2Y2

The rehabilitation and protection of coastal stream habitat with a resident salmonid fishery, within logged watersheds, is a resource management priority of many State and Provincial governments. Traditional fishery restoration projects incorporate hydraulics, fisheries biology and engineering, which have generally failed to restore damaged fish stocks. We have proposed a rehabilitation alternative using an ecological diagnosis which characterizes aquatic biological responses as a function of complex interactions amongst geology, climate, hydrology and water quality. The biological responses occur within the periphyton, invertebrate and fish communities. A trans-disciplinary project to rehabilitate approximately twenty-five streams, within two large, heavily logged, coastal watersheds (Lillooet and Squamish), in south-western British Columbia, is described. A conditional assessment of 150 streams correlated water quality parameters with periphyton and invertebrate populations and assessed their hydrological suitability to sustain a healthy salmonid fishery. Aquatic triage yielded a shortlist of candidate streams for rehabilitation; remediation measures will require a detailed, thorough periphyton and invertebrate inventory, coupled with additional water quality monitoring.

Use of Periphyton Bioassays For Monitoring Ecological and Water Quality Restoration of an Urban Creek: a ten year retrospective

Theobald, G., J. Thompson and D. Peterson. Department of Biology, University of Victoria, Box 1700, Victoria B.C., Canada. V8W 2Y2

In the mid-1980's the ecological restoration of urban aquatic and riparian habitat received increased attention from both the scientific community, private sector industry, local, state and provincial governments. Restoration of streams is a complex process because they receive a variety of undesirable inputs and frequently flow through multiple jurisdictions. Since 1985, University of Victoria phycology students have used contained periphyton communities, cultured on artificial substrata, as an *in-situ* bioassay, to characterize water quality trends in Colwood Creek, Southern Vancouver Island, British Columbia. The aquatic health of the creek has been used as a sensitive measure of appropriate upland stewardship. Traditional physical and chemical measures of water quality are being correlated with periphyton structure to identify indicator and keystone algal species. A remote sensing sond complex recently installed in the creek provides localized, continuous monitoring of flows, temperature, conductivity, turbidity, together with meteorological data. The study has revealed significant changes in the patterns of distribution of the freshwater Rhodophyte *Batrachospermum* sp. Roth. Ecological information available on the creek has reduced point and non-point source pollution, through bylaw and administrative changes, modified creek-side construction projects and provided a template for re-designing urban stream restoration projects.

Can post-chlorination disinfection by-products be minimized more effectively by considering reservoir management an aquaculture operation?

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Recently revised Canadian guidelines and U.S.E.P.A. standards for drinking water require purveyors to treat potable water which does not comply with the standards. In the last decade, studies of chlorine disinfected water have revealed many contain a suite of chemicals, commonly termed post-chlorination disinfection by-products (PCDBP), which are potentially carcinogenic. Concerns about the long term health of those drinking this chemical cocktail has resulted in a search for treatment protocols which will reduce the disinfection by-products, while maintaining the microbiological safety of the water in the distribution system. Some algal species, from reservoirs, are known potential PCDBP precursors. Traditional approaches to reducing PCDBP concentrations center on new and improved treatment processes. An alternative strategy would be to firstly develop an ecologically-based management scheme, for upland and reservoir habitats, and secondly to produce algal communities low in abundance and which yield minimal PCDBP precursors. This scheme is conceptually equivalent to viewing raw water reservoir supplies as aquaculture operations, where quality water is the end-product; thus, the reservoir becomes the culture vessel in which plankton, with appropriate biochemical profiles, are cultured. The water supply for Greater Victoria, on southern Vancouver Island, British Columbia, is presented as a case study potentially amenable to being so managed.

Development and Bioreactor Cultivation of a Novel Semi-Differentiated Tissue Suspension Derived from the Marine Plant *Acrosiphonia coalita*

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A semi-differentiated tissue culture consisting of linear filaments in liquid suspension was established from *Acrosiphonia coalita*, a cold-water green macroalga known to express pharmacologically active oxylipins deriving from lipoxygenase metabolism of linolenic acid. The tissue was vegetatively propagated by blending the filaments down to 1-5 mm length prior to subculture. The filamentous *A. coalita* tissue suspension was successfully cultivated in an illuminated, 3 L stirred-tank bioreactor at 12 °C, 0.46 vvm aeration rate, 250 rpm mixing speed, and incident illumination intensity of 77 $\mu E\ m^{-2}\ s^{-1}$. The mean specific growth rate over the exponential phase was 0.185 day^{-1} and a final cell density of 1083 mg DCW L^{-1} was achieved within 15 days of cultivation from an initial cell density of 200 mg DCW L^{-1}. The addition of 3500 ppm CO_2 to the aeration gas provided a maximum CO_2 transfer rate of six times the maximum CO_2 consumption rate and stabilized the pH to 8.0 during the light phase of growth, but did not improve biomass productivity.

Contributed Papers Session 3

Stimulation of 15-Lipoxygenase Metabolism in Liquid Suspension Cultures of the Macrophytic Brown Alga *Laminaria saccharina*

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Several species of macrophytic marine brown algae within genus *Laminaria* contain pharmacologically-active oxylipins deriving from 15-lipoxygenase metabolism of arachidonic, linoleic, and linolenic acids. Suspension cultures established from the microscopic gametophytic life phase of *Laminaria saccharina* biosynthesized the eicosanoid 15-HETE and 18-carbon oxylipins 13-HOTDA and 13-HODE at baseline yields of 70, 180, and 550 mg / kg dry biomass respectively. In the attempt to stimulate 15-lipoxygenase metabolism in vitro, four precursors, including arachidonic, linoleic, α-linolenic, and γ-linolenic acid were added to the medium on the 20th day of cultivation and then allowed to incubate with the culture for 10 days. The addition of linoleic and γ-linolenic acid increased the oxylipin yield 1.5 to 3 times over controls, whereas the addition of α-linolenic acid or arachidonic acid proved toxic to the culture. These results suggest that stimulation of 15-lipoxygenase metabolism in cell cultures of *L. saccharina* leading to enhanced production of bioactive oxylipin products is possible.

FITC-lectins & the Characterization of Spore Mucilage in Champia parvula (Rhodophyta)

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The adhesive mucilage of Champia parvula tetraspores which were attached to cover-slips was probed with a variety of fluorescein isothiocyanate (FITC)-labelled lectins. We detected α-D-mannose, α-D-glucose, β-D-galactose, and N-acetylgalactosamine with FITC-lectins specific for those sugar haptens; N-acetylglucosamine and α-L-fucose were not detected. The extracellular mucilage of attached tetraspores, rhizoids, and developing holdfasts stained for sulphated and carboxylated polysaccharides. With scanning electron and light microscopy, we observed that the mucilage of C. parvula spores is smooth and uniform in appearance although it consists of several classes of molecules which include sulphated polysaccharides and the sugar moieties of glycoproteins.

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Biogeography of post-glacial recolonization of the northeast Pacific coast

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The red alga *Palmaria mollis* was sampled at fourteen sites, extending from northern Washington to the Alaska Peninsula. This area has experienced repeated glaciation during the past 1.6 million years. DNA from one to five individuals from each population was amplified using ten 10-base primers. The resulting Random Amplified Polymorphic DNA (RAPD) bands from each individual were compared to determine the pattern of relatedness among populations. Individuals from a single population were most closely related. However, relatedness among populations did not reflect their geographic proximity. Rather, the populations fell into three groups, representing outer, intermediate, and inner coastal sites. We propose that the current of distribution of genotypes (1) reflects the pattern of post-glacial recolonization of the northeast Pacific coast since the last Ice Age and/or (2) represents the extent to which populations have changed genetically and/or interbred since relatively rapid recolonization from a single panmictic source population.