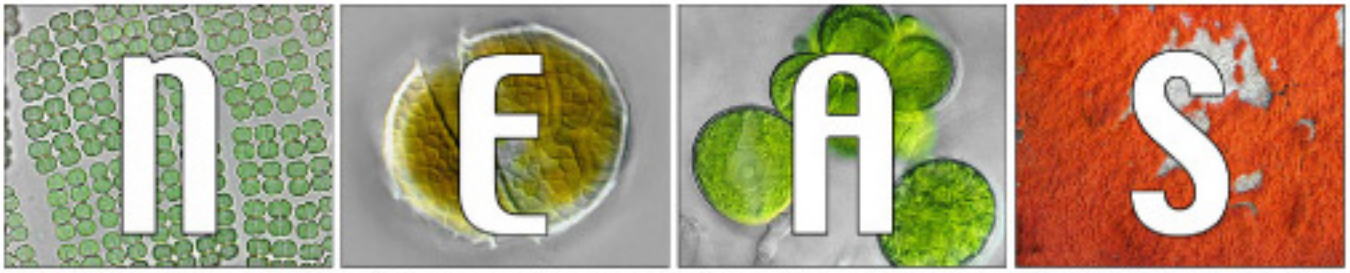


43rd Northeast Algal Symposium • University of Connecticut, Avery Point

2004

Program and Abstracts

Sea Grant Connecticut

Project Oceanology

Welcome Note and Information from the Co-Conveners

We hope you will enjoy the NEAS 2004 meeting at the scenic Avery Point Campus of the University of Connecticut in Groton, CT. The last time that we assembled at The University of Connecticut was during the formative years of NEAS (12th Northeast Algal Symposium in 1973). Both NEAS and The University have come along way. These meetings will offer oral and poster presentations by students and faculty on a wide variety of phycological topics, as well as student poster and paper awards. We extend a warm welcome to all of our student members. The Executive Committee of NEAS has extended dormitory lodging at Project Oceanology gratis to all student members of the Society. We believe this shows NEAS members' pride in and our commitment to our student members.

This year we will be honoring Professor Arthur C. Mathieson as the Honorary Chair of the 43rd Northeast Algal Symposium. Art arrived with his wife, Myla, at the University of New Hampshire in 1965 from California. Art is a Professor of Botany and a Faculty in Residence at the Jackson Estuarine Laboratory of the University of New Hampshire. He received his Bachelor of Science and Master's Degrees at the University of California, Los Angeles. In 1965 he received his doctoral degree from the University of British Columbia, Vancouver, Canada. Over a 43-year career Art has supervised many undergraduate and graduate students studying the ecology, systematics and mariculture of benthic marine algae. He has been an aquanaut-scientist for the Tektite II and also for the FLARE submersible programs. He has done extensive field surveys on the Pacific coast of North America (Mexico to Alaska), Japan, Hawaii, Guam, Philippines, the Mediterranean, Western Europe, Caribbean and the eastern coast of North America (Florida to Newfoundland). Art is an indefatigable worker and has given generously to his students and colleagues. It is only fitting for us to say thanks to Art for his kindness and generosity by being our Honorary Chair at these meetings. A short CV of Art's professional accomplishments can be found at the end of the program.

The theme of our meetings, "Algae and Human Affairs," will be addressed by the Distinguished Speaker, Dr. Patricia Tester (NOAA, National Ocean Service). On Sunday morning, we will have an invited mini-symposium further defining the theme of the meetings. Speakers will include Mr. Erick Ask (FMC Corporation), Dr. Greg Boyer (State University of New York, College of Environmental Science and Forestry), Dr. James Carlton (Director, Williams-Mystic) and Dr. Paul G. Falkowski (Institute of Marine and Coastal Sciences, Rutgers University). We hope you will enjoy the breadth of the presentations.

NEAS 2004 will open with a Society Mixer on Friday evening from 5-9 PM at the historic Branford House of the University of Connecticut overlooking Long Island Sound. On Saturday morning, from 7:30-8:30 AM, on-site registration will continue in the foyer of the Marine Science's building and a continental breakfast will be available. Opening remarks and a welcome from the University of Connecticut will commence at 8:30 AM in room 103 of the Marine Sciences Building. The poster session will be from 3:00-5:00 PM on Saturday on the first floor of the Marine Science's building. Students are asked to be at their posters for the duration of the poster session and should be prepared to give a short 2-3 minute oral presentation to the Judging Committee on their research. Our distinguished speaker, Dr. Tester, will give her presentation at 5:00 PM in the seminar room of Marine Sciences. A mixer will follow from 6:15-7:00 PM in the foyer of the Marine Sciences building.

The banquet will take place at 7:00 PM, Saturday evening, in the dining hall of Project Oceanology. Following the banquet, NEAS will have our annual auction. The auction is a major source of revenue for all of the student activities that NEAS funds and a major source of entertainment for the annual meeting! We hope you all will participate very liberally! Bid early and often. Don't forget to buy your raffle ticket for the Model FM-31 Swift Field Microscope that will fund the Development Committee's Student Fund. This excellent field microscope even includes phase optics!

On Sunday, oral presentations run from 8:30- 12:15 PM. After the oral presentations, a buffet lunch will be available during the annual Business Meeting. Please take time out to vote in the Society elections and attend the Business Meeting on Sunday. NEAS needs your participation. This is your Society and its future is up to you. At 1:30 PM, the workshop on "Molecular Techniques in Phytoplankton Research" will be in room 124 of Marine Sciences.

If you encounter any problems, please contact us so that we can help make your time at NEAS 2004 relaxing and productive. Best wishes for a great meeting!

Louise A. Lewis, Senjie Lin and Charles Yarish
NEAS 2004 Co-Conveners

NEAS 2004 Sponsors

We sincerely thank the following Departments and individuals at the University of Connecticut for their financial support and hard work during the preparation stages or during the meeting: Department of Marine Sciences, Department of Ecology and Evolutionary Biology, University of Connecticut Research Foundation, Shelley Olm, Hilary McManus, Lois Somers, Kathy Tebo, Virge Kask, Ken Tellier, Jang Kim, Lilibeth Miranda, Yubo Hou, Joyce Wood-Martin, Robert DeGoursey, Barbara Mahoney, Dennis Arbige and Paola Batta Lona.

The Connecticut Sea Grant College Program (Ed Monahan) provided a generous financial award that allowed us to bring in the Sunday morning speakers. Project Oceanology (Thaxter Tewksbury and Mickey Weiss) provided the dormitory rooms for students and space for our evening banquet.

Alex Frost at Cryptogamic Botany generously provided the seaweed pressing books that came in your registration packets.

We also acknowledge the support of three corporate sponsors, Rainin Instruments, LLC, Bio-Rad, and Olympus.

Several individuals provided support that made the meeting run more smoothly including Peter Siver and Louise Lewis (logo images), Stephane Marty (design of logo), Paul Lewis (Web abstract form).

General Program: 43rd Northeast Algal Symposium

Honorary Chairperson: Arthur C. Mathieson

FRIDAY, April 23, 2004

5:00-9:00 PM Registration and Mixer, Branford House.

POSTER SET UP in Marine Sciences Foyer, 1st Floor.

SPEAKERS, please see student helpers in Branford House to load presentations onto conference computer.

STUDENTS, please pick up your dormitory assignment at the Registration Desk.

SATURDAY, April 24, 2004

7:30-8:30 AM Registration, Continental Breakfast, Marine Sciences Foyer, 1st Floor.

POSTER SET UP in Marine Sciences Foyer, 1st Floor.

SPEAKERS, please see student helpers in Marine Sciences Foyer to load presentations onto conference computer.

STUDENTS, please pick up your dormitory assignment at the Registration Desk in Marine Sciences.

8:30-8:45 AM Opening Remarks: Charles Yarish and Dean Ross MacKinnon, University of Connecticut, College of Liberal Arts and Siences.

All Oral Sessions will be held in Marine Sciences Room 103.

SESSION 1. Student Presentations I (Moderator: Mark Dixon)

8:45-9:00 Effects of a Putative Male Pheromone on Oogenesis in the Brown Alga *Macrocystis integrifolia*. David Sakoda, Katherine Wells and Raymond J. Lewis

9:00-9:15 Combining Ribosomal RNA Genes to Resolve Phylogenetic Relationships Among the Lineage-4 Orders of Florideophyceae (Rhodophyta): Does a Multi-gene Approach Provide New Insight? Rodney D. Withall and Gary W. Saunders

9:15-9:30 Time-Dependent Changes in Hemocytes of Eastern Oysters, *Crassostrea virginica*, and Northern Bay Scallops, *Argopecten irradians irradians*, Exposed to a Cultured Strain of *Prorocentrum minimum*. Hélène Hégaret and Gary H. Wikfors

9:30-9:45 Trophic Cascading Effects of Mesozooplankton on Primary Production Across Geographical Gradients in Nutrient Availability. Amy Nicole Smith and Hans G. Dam

9:45-10:00 Taddampali had an Inordinate Fondness for the Surirellas: The Ecomorphology of an Unlikely Diversity. Andrew J. Bramburger, Paul B. Hamilton, Peter E. Hehanussa and G. Douglas Haffner

10:00-10:15 Effects of temperature and ammonium on growth, pigment production and nitrogen uptake in four species of *Porphyra* native to the coast of New England. Jang K. Kim, George P. Kraemer, Chris D. Neefus, Ik Kyo Chung and Charles Yarish

10:15-10:30 Break

SESSION 2. Student Presentations II and Contributed Talks I (Moderator: John Wehr)

10:30-10:45 *Lessoniopsis littoralis* (Tild.) Reinke: Permiscuous propagator or kindergarten kelp? Chris E. Lane and Gary W. Saunders

10:45-11:00 Key to Freshwater Algae: A Web-Based Tool to Enhance Understanding of Microscopic Biodiversity. Hannah A. Shayler and Peter A. Siver

11:00-11:15 The Relationship Between *Acrochaetium secundatum* and *A*. *virgatulum*: Resolving Distinct Morphologies in Light of Molecular Identity. Susan L. Clayden and Gary W. Saunders

11:15-11:30 A First Evaluation of Phylogenetic Relationships of Freshwater Brown Algae Using 18S and rbcL Sequences. L. A.R. McCauley and J. D. Wehr

11:30-11:45 Rockweed Harvesting: Effects on the Associated Algal Species. Jill C. Fegley, Robert L. Vadas and William A. Halteman

11:45-12:00 Mortality of the brown seaweed *Ascophyllum nodosum* (Le Joly) produced by cutter rake harvests in southern New Brunswick. Raul A. Ugarte, Bruce Moore, Jacqueline Bettle and Joshua Sharp

12:00-1:15 LUNCH, Marine Sciences Foyer, 1st Floor.

(Executive Committee Meeting, Marine Sciences ROOM 312)

Session 3. Contributed Talks II (Moderator: Raymond Lewis)

1:15-1:30 The Demise of the Chaetosiphonaceae (CLADOPHORALES, CHLOROPHYTA): Morphology and Molecular Phylogeny of *Chaetosiphon moniliformis*, *Blastophysa* spp. and *Wittrockiella* spp. Brian Wysor, Charles J. O'Kelly, Wendy K. Bellows and Jeffrey F. Brown

1:30-1:45 A New Species of *Chondracanthus* from Bermuda – Extinction Before Description? Craig W. Schneider and Christopher E. Lane

1:45-2:00 Cultivation of the Extractive Inorganic Component, *Laminaria saccharina*, and Monitoring of Therapeutants in an Integrated Aquaculture System. Thierry Chopin, Susan Bastarache, Manav Sawhney, Ellen Belyea, Julie MacDougall, Ian Stewart and Patrick Fitzgerald

2:00-2:15 Bioremediation of eutrophic aquaculture effluents by *Porphyra*: Diurnal patterns and influence of stocking density. G. P. Kraemer, D. Snellgrove, R. Pereira, and C. Yarish

2:15-2:30 True Confessions: Lessons Learned and New Research Initiatives in the Microalgal Mass Culture Room at NOAA's National Marine Fisheries Service Milford Connecticut Laboratory. Mark S. Dixon and Gary H. Wikfors

2:30-2:45 Characterization of Two Actin Genes in *Palmaria palmata* (Rhodophyta). Line Le Gall and Cristophe Lelong

2:45-3:00 The Effects of Iron Concentration, Salinity and Male Presence on Oogenesis in *Dictyoneurum californicum*. Raymond J. Lewis and Megan E. Wood

3:00-5:00 POSTER SESSION, Marine Sciences 1st Floor.

5:00-6:00 Distinguished Speaker: Dr. Patricia Tester, National Oceanic Atmospheric Administration Beaufort Laboratory. "Copepodology for the Phycologist with Apologies to G. E. Hutchenson."

6:15-7:00 Mixer. Marine Sciences Foyer.

7:00-? Banquet and Auction. Project O Dining Hall.

Sunday, April 25, 2004

7:30-8:30 Continental Breakfast, Marine Sciences Foyer, 1st Floor.

Session 4. Minisymposium. Algae and Human Affairs: Making Connections from Genes to Ecosystems (Moderator: Charles Yarish)

8:30-9:00 Occurrence of Cyanobacterial Toxins in the Laurentian Great Lakes. Gregory L. Boyer

9:00-9:30 Why is the Land Green and the Ocean Red? Paul G. Falkowski

9:30-10:00 Marine and Estuarine Seaweeds: Global Biogeographic Assumptions and Cryptogenic Species. James T. Carlton

10:00-10:30 A Modular Training Program for Commercial Eucheuma Farming Technicians – An Effective and Efficient Approach. Erick Ask

10:30-10:45 BREAK

Session 5. Contributed Talks II. (Moderator: Thierry Chopin)

10:45-11:00 The MBLWHOI Library Digital Herbarium. Joseph M. deVeer and Amy Stout.

11:00-11:15 Large-Volume Microalgal Culture in a Greenhouse Environment. Barry C. Smith and Gary H. Wikfors

11:15-11:30 The value of a marine protected area for a unique population of *Chondrus crispus*. Irish Moss,Prince Edward Island, Canada. Glyn Sharp and Robert Semple

11:45-12:00 Spatial and Seasonal Variation in Dinoflagellate Diversity in Long Island Sound Analyzed with Mitochondrial Cytochrome B. Huan Zhang, Yubo Hou, Lilibeth Miranda and Senjie Lin

12:00-12:15 Phytoplankton Patterns in the Lower Hudson and East Rivers, N. Y., 1996-2003: The Information Content of Categorical Data. E.-W. Kim, M. Park and M. Levandowsky

12:15-1:00 Lunch / Business Meeting Room 103

1:30-3:00 Workshop. Marine Sciences Room 124.

"Molecular Techniques in Phytoplankton Research" Senjie Lin.

POSTER PRESENTATION SUMMARY

Undergraduate Presentations (President's Award)

1. ISLAND BIOGEOGRAPHY AT A MICROSCALE: SPECIES – AREA RELATIONSHIPS BETWEEN DIATOM TAXA IN PENNS CREEK, PENNSYLVANIA. Sidra Blake, Thomas Leonard, Sarah Kiemle, Jack R. Holt and Jeffrey Graham
2. DETERMINING THE AFFINITIES OF AN UNUSUAL FORM OF *FUCUS VESICULOSUS* L. USING MICROSATELLITE MARKERS. M. Blodgett, A. L. Wallace, A. S. Klein, and A. C. Mathieson
3. ACID-MINE AND SEWAGE EFFLUENT: INFLUENCE AND PERSISTENCE OF THE PLUME FROM SHAMOKIN CREEK INTO THE SUSQUEHANNA RIVER IN CENTRAL PENNSYLVANIA. Meagan E. Brennan and Jack R. Holt.
4. RESOLVING THE PHYLOGETIC AFFINITIES OF CRUSTOSE GENERA OF THE RED ALGAL ORDER GIGARTINALES EMPHASIZING THE NORTH ATLANTIC. Melissa Brooks and Gary W. Saunders
5. EFFECTS OF SALINITY AND MALE PRESENCE ON GROWTH AND REPRODUCTION OF GAMETOPHYTES OF THE BROWN ALGAE *MACROCYSTIS, PELAGOPHYCUS*, AND *PTERYGOPHORA*. Molly K. Chambers, Melinda E. Coburn and Raymond J. Lewis.
6. IDENTIFICATION OF FLAGELLAR PROTEINS IN *CHLAMYDOMONAS REINHARDTII*. Roshan Karki, S. Chettri and K. Dragon.
7. DIGITAL IMAGE BANK AS A TEACHING RESOURCE. Jennifer McInnis and Carl W. Grobe.
8. IMPACT OF THE INVASIVE ALGA *GRATELOUPIA TURUTURU* (HALYMENIACEAE, RHODOPHYTA) ON THE NATIVE ALGA *CHONDRUS CRISPUS* (GIGARTINACEAE, RHODOPHYTA). James Torbett, Tony Fuda, Francis Piercey, Martine Villalard-Bohnsack and Marcie Marston

Graduate Presentations (Wilce Award – Poster)

9. QUANTITATION OF CORE BIOCHEMICAL COMPLEXES IN FIELD SAMPLES AND DIVERSE PHYTOPLANKTON TAXA.USING GLOBAL ANTIBODIES. Christopher M.Brown, Douglas A. Campbell and Amanda M. Cockshutt
10. IMMUNE RESPONSES IN THE EASTERN OYSTER, *CRASSOSTREA VIRGINICA*, EXPOSED TO BENTHIC DIATOMS CONTAMINATED WITH POLYAROMATIC HYDROCARBONS. April Croxton, Gary H. Wikfors and Richard D. Gragg III
11. MOLECULAR CHARACTERIZATION OF MICROCYSTIN PRODUCTION IN ONEIDA LAKE, NEW YORK, USA. Amber Hotto, Michael Satchwell and Gregory Boyer
12. ANALYSIS OF DIFFERENTIALLY EXPRESSED PROTEINS IN PFIESTERIA PISCICIDA IN SEARCH OF GROWTH-RELATED PROTEINS. Yubo Hou and Senjie Lin
13. EXPLORATION OF MORPHOLOGICAL AND GENETIC VARIATION WITHIN THE FAMILY HYDRODICTYACEAE (SPHAEROPLEALES, CHLOROPHYCEAE). Hilary A. McManus and Louise A. Lewis
14. PHYTOPLANKTON COMMUNITY STRUCTURE, ABUNDANCE AND DIVERSITY IN LONG ISLAND SOUND FROM 2002-2003. Lilibeth Miranda, Huan Zhang, Paul Hargraves and Senjie Lin
15. POPULATION GENETIC STRUCTURE OF *FUCUS VESICULOSUS* L. WITH RESPECT TO HYDRODYNAMIC REGIMES. Jessica F. Muhlin and Susan H. Brawley
16. CELLULOSE SYNTHASE (CESA) GENES FROM *VALONIA VENTRICOSA* AND *COLEOCHAETE SCUTATA*. Alissa A. Neill and Alison W. Roberts
17. WHAT'S IN THE BOX? THE SEARCH FOR A PHLOROTANNIN MOLECULAR MARKER IN THE BROWN ALGA *FUCUS VESICULOSUS*. Karen N. Pelletreau and Nancy M. Targett
18. THE EFFECT OF pH ON THE STABILITY OF THE CYANOBACTERIAL NEUROTOXIN, ANATOXIN-A. Xingye Yang, M.F. Satchwell and G. L. Boyer

Contributed Posters

19. A FLOW-CYTOMETRIC METHOD FOR COUNTING MICROALGAL AND BACTERIAL CELLS IN THE SAME SAMPLE. Jennifer H. Alix and Gary H. Wikfors
20. Effects of toxic *Alexandrium fundyense* on *Acartia hudsonica* include altered sex ratio. David E. Avery, Lihua Chen and Hans G. Dam
21. THE EFFECTS OF HABITAT PATCHINESS ON DISPERSAL AND POPULATION GENETIC STRUCTURE OF *FUCUS DISTICHUS* L. Melinda A. Coleman and Susan H. Brawley
22. THE CELL WALL OF THE DESMID, *PENIUM MARGARITACEUM* (CHLOROPHYTA). David S. Domozych and Catherine E. Domozych
23. PHYLOGENY OF THE CHRYSOPHYCEAE AND SYSTEMATICS OF *OCHROMONAS*. Stacy M. Edgar and Robert A. Andersen
24. FOOD UPTAKE IN THE MIXOTROPHIC *DINOPHYSIS ACUMINATA*. Emily W. Grason, Jan E. Rines and Lucie Maranda.
25. PHOTOPHYSIOLOGY OF DESERT GREEN ALGAE UNDER DESICCATION AND REHYDRATION. Dennis W. Gray, Zoe Cardon and Louise Lewis
26. BROWN ALGAL PHLOROTANNINS: A GENERAL STRESS RESPONSE? Carl W. Grobe and Dianne M. Ferris
27. DESMIDIACEAE AND MESOTAENIACEAE OF CHAMAECYPARIS SWAMPS, BARNSTABLE COUNTY, MASSACHUSETTS, USA. Aimlee D. Laderman, David Domozych and Gabrielle Sakolsky
28. A COMPARATIVE STUDY FOR *PFIESTERIA PISCICIDA* AND *CRYPTOPERINIDIOPSIS* SP. Senjie Lin, Margaret R. Mulholland, Huan Zhang and Edward J. Carpenter
29. AN INVENTORY OF SCALED CHRYSOPHYTES FROM THE ATLANTIC COASTAL PLAIN OF NORTH CAROLINA, USA, AND THEIR RELATIONSHIPS TO ENVIRONMENTAL VARIABLES. Anne M. Lott and Peter A. Siver

30. ORIGIN AND MORPHOLOGY OF DWARF MOSS-LIKE *FUCUS* FROM NORTHWEST ATLANTIC SALT MARSHES. Arthur C. Mathieson and Clinton J. Dawes
31. HOW DIFFERENT LIGHT REGIMES AND INTENSITIES AFFECT GROWTH RATES AND NUTRIENT UPTAKE IN THE ALGAL STRAIN *TETRASELMIS CHUI* (PLY 429). Shannon L. Meseck, Jennifer Alix, Gary Wikfors and Mark Dixon
32. *LACUNICULA SARDINIENSIS* LANGE-BERTALOT ET AL. (BACILLARIOPHYCEAE) AND ITS RELATIONSHIP WITH THE GENUS *CRATICULA* GRUNOW. Eduardo A. Morales and My Le
33. MARINE MICROFILAMENTOUS GREEN ALGAE: NEW LINEAGES IN THE ULOTRICHALES/ULVALES COMPLEX (ULVOPHYCEAE). Charles J. O'Kelly, Brian Wysor, Wendy K. Bellows and Jeffrey F. Brown
34. WHAT IS A SPECIES IN *CHLAMYDOMONAS*? Thomas Pröschold and Annette W. Coleman
35. GLUTAMINE SYNTHETASE GENE FAMILIES: AN EVOLUTIONARY PERSPECTIVE. Deborah L. Robertson, Sohini Ghoshroy and Molly R. Letsch
36. SEASONAL PRODUCTION OF CYANOBACTERIAL TOXINS IN ONEIDA LAKE, NEW YORK, USA. Mike Satchwell, Amber Hotto, Xingye Yang, Kristy Szprygada and Gregory Boyer
37. THE SILICA SECCHI DISK: AN INTERACTIVE PHYCOLOGICAL AND LIMNOLOGICAL TOOL. Peter A. Siver, Hannah A. Shayler and Anne-Marie Lott
38. NONLINEAR MULTIVARIATE POLYNOMIAL ANALYSIS OF PHYTOPLANKTON SPECIES IN THE LOWER HUDSON RIVER PATTERNS IN LOWER MANHATTAN SITES, 1996-2003. Zhao-Yan Wang, David A. Vaccari and M. Levandowsky

39. EVIDENCE FOR POLYPHYLY OF *ULOTHRIX* AND *MONOSTROMA*, AND OTHER NOVEL RELATIONSHIPS IN THE ULOTRICHALES (ULVOPHYCEAE). Brian Wysor, Charles J. O'Kelly, Wendy K. Bellows and Jeffrey F. Brown.
40. EFFECTS OF METAL CONCENTRATION AND pH ON GROWTH OF PHOTOSYNTHETIC PROTISTS ISOLATED FROM THE ACIDIC, HIGH-METAL RIO TINTO, SPAIN. Erik R. Zettler, Linda A. Amaral Zettler, Ricardo Amils, Ashley Meyer, and Mitchell L. Sogin

NOTES

ABSTRACTS

43rd Northeast Algal Symposium

University of Connecticut, Avery Point

April 23-25, 2004

(Alphabetical by First Author, Presenter Name is Underlined)

A FLOW-CYTOMETRIC METHOD FOR COUNTING MICROALGAL AND BACTERIAL CELLS IN THE SAME SAMPLE.

Jennifer H. Alix and Gary H. Wikfors.
NOAA, National Marine Fisheries Service, Northeast Fisheries Science Center, Milford, CT 06460.

Numeric counts of microorganisms in aquatic samples often are essential to research. Natural water samples contain many types of particles, including microalgae, bacteria, and other microorganisms, as well as non-living, suspended matter. Traditional methods of counting cells in the microscope or colonies on petri dishes are labor-intensive and subject to limitations in both accuracy and precision. Proxy measurements, such as optical density, chlorophyll fluorescence, or packed-cell volume, are subject to error from interference of one particle type with another or inability to distinguish relative contributions of different particle types. Thus, particle enumeration often limits the temporal or spatial resolution of data. We have addressed this limitation with a biomedical tool, the flow cytometer, which measures five optical properties in each particle passing a laser beam at a rate of several thousand particles per second.

The flow-cytometric (fcm) protocol we have been developing uses ratios of naturally-occurring particles with a known number of fluorescent, plastic microspheres added to the sample. Microalgal cells are differentiated from other particles by chlorophyll fluorescence, and living particles have been differentiated from non-living by staining with several DNA-binding fluorochromes. Microalgal counts in both pure and open-tank (bacterized) cultures by our fcm method agree very well with microscope counts (R^2>0.9999) over three orders of magnitude (10^4-10^7), and bacterial counts from pure cultures are similar to plate counts. In open-tank, microalgal cultures, aggregation has made interpretation of bacterial counts difficult, but we are addressing this with various anti-aggregating compounds. Petri-dish and fcm counts of bacteria in microalgal tank cultures are in the same order of magnitude. Processing time for each sample, including addition of reagents, fcm data acquisition, and data reduction, is approximately three minutes, estimated to be 1/3 the time for an algal microscope count alone. The labor saved is considerably greater if samples need to be settled and concentrated, or diluted, for valid microscope counts. The fcm method provides, in addition, some quantification of bacteria (subject to interpretation) and non-living particles with no further effort. We are applying this fcm, particle-counting method to studies of microbial and nutrient dynamics in open-tank, mass-algal cultures.

A MODULAR TRAINING PROGRAM FOR COMMERCIAL EUCHEUMA FARMING TECHNICIANS – AN EFFECTIVE AND EFFICIENT APPROACH.

Erick Invgald Ask
FMC BioPolymer; 1735 Market St.; Philadelphia, PA 19103; Erick_Ask@fmc.com

To assist FMC's suppliers to assure competency of their commercial eucheuma seaweed farming technicians, FMC BioPolymer's Raw Material Development group has developed a modular training program for: site selection, farm construction, farming protocol, post harvest handling, production problems, water safety, public speaking and other relevant topics. Each module has a testing section to assure students comprehend the module. Suppliers can use the modules to provide grading system/hierarchy in the technical support groups. Also, the modules are easy to modify for specific countries/cultures, environmental situations and needs of suppliers.

Though numerous handbooks, comic books, posters, brochures and videos have been produced over the last 30 years to assist farmers in improving production and quality, it is noted that the most powerful influence in successful areas is the field technician. Assuring that suppliers have competent and qualified field technicians is vital to their success.

EFFECTS OF TOXIC *ALEXANDRIUM FUNDYENSE* ON *ACARTIA HUDSONICA* INCLUDE ALTERED SEX RATIO.

David E. Avery, Lihua Chen and Hans G. Dam
University of Connecticut, Dept. of Marine Sciences, Groton, CT USA 06340

Geographically separated populations of the copepod *Acartia hudsonica* exhibit different responses to the toxins produced by the dinoflagellate *Alexandrium* spp. Populations that have been historically exposed to the toxins are resistant to their effects, whereas naïve populations are not. Furthermore, selection experiments have demonstrated that naïve populations can gain resistance in a few generations. In several laboratory experiments, the sex ratio (females:males) of cohorts exposed to *Alexandrium fundyense* were skewed toward females (>1). Moreover, the sex ratio appears to shift in a dose-dependent manner, and the shift is more pronounced in cohorts of the naïve population than in cohorts of the selected line (chronically exposed to *Alexandrium fundyense*). We are investigating the hypothesis that the shift toward female bias in sex ratio is due to differential mortality between the sexes, males being more susceptible to the toxins. Results thus far do not support the differential mortality hypothesis. Instead, they point toward environmentally induced sex change in response to *Alexandrium fundyense*.

ISLAND BIOGEOGRAPHY AT A MICROSCALE: SPECIES – AREA RELATIONSHIPS BETWEEN DIATOM TAXA IN PENNS CREEK, PENNSYLVANIA.

[1]Sidra Blake, [1]Thomas Leonard, [1]Sarah Kiemle, [1]Jack R. Holt and [2]Jeffrey Graham. [1]Biology Department. Susquehanna University. Selinsgrove, PA 17870. [2]Department of Mathematics and Computer Sciences. Susquehanna University. Selinsgrove, PA 17870.

Over the past two years we have studied the Species–Area relationships between diatom taxa and the surface areas of their substrates in Penns Creek, Snyder County, Pennsylvania. In one study we examined 64 undisturbed rocks and found a strong relationship between the diatom species (50 taxa) and rock surface area (R^2= 0.93). In a second study, we attempted to control for variations in rock shape, size, and composition by deploying 50 ceramic tiles as artificial substrates in four different sizes (4.1, 7.1, 10.62, and 14.92 cm^2). Also, we tested the occurrences of diatoms on tiles that share the same surface area but are different shapes and orientations in the creek. After three weeks we collected the diatoms from our substrates (both rocks and ceramic tiles) by scraping them. Then, we acid-cleaned the frustules for examination with light and scanning electron microscopy. By this method, the total number of diatom taxa observed in both studies was 50 and 65, respectively. We applied the Markov Chain Monte Carlo test to the occurrence data and found that substrates in the small and midrange sizes of rocks showed strong nonrandom distributions (> 9s.d. above the mean). However, the tiles had more diatom species, and they were more evenly distributed over the size ranges (1-2s.d. above the mean). The results suggest that after three weeks the diatom communities ere still in colonization mode and had not yet established an equilibrium between extinction and immigration.

DETERMINING THE AFFINITIES OF AN UNUSUAL FORM OF *FUCUS VESICULOSUS* L. USING MICROSATELLITE MARKERS

M. Blodgett, A.L. Wallace, A.S. Klein, and A.C. Mathieson

The high degree of morphological plasticity displayed by species of the brown algal genus *Fucus* L. is well documented, particularly in salt marsh habitats. The species *Fucus vesiculosus* form *gracillimus* (Collins) provides a good example of such variation. This form differs from *F. vesiculosus* L. in several ways, with evisiculate, narrow blades and slender fusiform receptacles. In addition, it possesses a fairly circumscribed distribution, being found only within tidal marshes in southern Massachusetts (U.S.A.) The goal of the current study is to use microsatellite markers to examine the population genetics of this form and to determine its affinities to *F. vesiculosus*. Total number of alleles, genotypes, and estimates of heterozygosity were determined for five microsatellite loci from fifteen individuals of *F. vesiculosus* form *gracillimus* from Barnstable Harbor (MA). These parameters will be compared to those found for populations of *F. vesiculosus* and *F. spiralis* L. from the same site. In addition, *F. vesiculosus* and *F. vesiculosus* form *gracillimus* from Barnstable Harbor will be compared to populations of *F. vesiculosus* and *F. vesiculosus* ecad *volubilis* (Hudson) Turner from four other salt marshes in Maine and Massachusetts to determine affinities within the species complex.

OCCURRENCE OF CYANOBACTERIAL TOXINS IN THE LAURENTIAN GREAT LAKES.

Gregory L. Boyer
State University of New York, College of Environmental Science and Forestry. Syracuse, New York, USA.

The North American Great Lakes located between the United States and Canada collectively provide drinking water for >22 million people. Toxic cyanobacterial blooms are well documented in the relatively shallow western basin of Lake Erie where concentrations of microcystin LR (MC-LR) have exceeded 20 μg L^{-1}. *Microcystis* blooms have also been reported for Lake Ontario, the lowest of the five lakes. Lake Erie drains into Lake Ontario, and the Lake Ontario shoreline is characterized by numerous embayments, many of which suffer from anthropogenic inputs of nitrogen and phosphorus. Over 400 samples were collected during the summers of 2001 and 2003 from both near-shore embayments (194) and offshore (223) sites around Lake Ontario. These samples were analyzed for microcystins, anatoxin-a and the PSP toxins. Microcystin levels, as measured by the protein phosphatase inhibition assay, were detected in trace amounts in 2001, with the maximum level of 0.15 μg MC-LR equivalents L^{-1}. Little if any toxin was observed in the near-shore embayments, despite the high levels of biomass. A similar situation was observed in the western basin in 2003. The near-shore embayments along NY had trace levels of microcystin-LR, whereas offshore locations reached levels as high as 0.25 μg MC-LR equivalents L^{-1}. In contrast, the western basin experienced a large September bloom of *Microcystis*, leading to near-shore microcystin concentrations exceeding the WHO advisory limit of 1 μg MC-LR L^{-1}. This bloom may have originated offshore and been transported shoreward by the prevailing winds and currents. However, one cannot discount the effects of anthropogenic inputs on the embayments. A second September cyanobacterial bloom in the northern Bay of Quinte also exceeded 1 μg MC-LR L^{-1}. These results suggest the occurrence of cyanobacterial toxins in large ocean-like lakes such as Lake Ontario is a complex interplay of physical and biological functions.

TADDAMPALI HAD AN INORDINATE FONDNESS FOR THE *SURIRELLAS*: THE ECOMORPHOLOGY OF AN UNLIKELY DIVERSITY.

Andrew J. Bramburger, Paul B. Hamilton, Peter E. Hehanussa, G. Douglas Haffner

Communities of biological organisms tend to exhibit levels of diversity in the tropics that are significantly greater than levels observed in higher latitudes. The diatom community of the ancient Malili Lakes (Sulawesi Island, Indonesia), however, clusters well below the latitude / species richness trendline, and exhibits levels of taxonomic diversity similar to those observed in diatom communities of the lakes in Arctic regions. The impoverished flora of the Malili Lakes is virtually devoid of planktonic forms, and has been strongly influenced by a paucity of benthic habitat, coupled with a suite of potent selective pressures associated with deep mixing. With its maximum species richness (46 taxa) reported in the Malili Lakes, the genus *Surirella* (Turpin) stands in contrast to this trend. A taxonomic review of the Malili Lakes *Surirella* taxa illustrates the morphological cohesiveness of the genus within the lakes and demonstrates the role of novel morphotypes in the development of this extraordinary level of diversity.

ACID-MINE AND SEWAGE EFFLUENT: INFLUENCE AND PERSISTENCE OF THE PLUME FROM SHAMOKIN CREEK INTO THE SUSQUEHANNA RIVER IN CENTRAL PENNSYLVANIA.

Meagan E. Brennan and Jack R. Holt.
Biology Department. Susquehanna University. Selinsgrove, PA 17870.

We examined the biological effects of both acid-mine and sewage effluent on the Susquehanna River from Shamokin Creek in Northumberland County, Pennsylvania throughout the Fall of 2003. We used the occurrences of diatom species on diatometers and scrapings from submerged rocks and wood to document the influence and persistence of the plume from Shamokin Creek into the Susquehanna River for 3 kilometers from the southern end of Sunbury, PA. In this reach, the Susquehanna River is bisected by a string of midstream islands that divide it into a west channel and an east channel. We sampled both sides of the east channel at 1 km intervals from the mouth of the creek for the 3 km reach. Also, we sampled above the confluence and in the mouth of the creek. In addition to the biotic samples, we took standard chemical and physical samples at 3 week intervals from the first of September to mid November. We identified diatoms to species using both light and SEM methods. Our results showed that the reduced lateral mixing in the river allowed for a chemically and biologically distinct plume, which behaved as a semi-isolated stream within the river, to persist through the 3 kilometer reach. Particular associations of diatoms differed on either side of the east channel. Species of *Cyclotella* and *Navicula* defined the associations outside of the Shamokin Creek plume, while species of *Nitzschia* defined the diatom associations within the influence of the creek.

RESOLVING THE PHYLOGETIC AFFINITIES OF CRUSTOSE GENERA OF THE RED ALGAL ORDER GIGARTINALES EMPHASIZING THE NORTH ATLANTIC.

Melissa Brooks and Gary W. Saunders.
Centre for Environmental and Molecular Algal Research, University of New Brunswick, Fredericton, New Brunswick, Canada

Red algal crusts of the order Gigartinales with isomorphic life histories have poorly resolved phylogenetic affinities. This is largely due to the difficulty in obtaining gametophytes for these species, which are required for familial and ordinal level classification. Due to this lack of reproductive structures, molecular analyses were used to determine the taxonomic placements of a number of crustose genera with an emphasis on the North Atlantic. Sequences from the large-subunit (LSU) rDNA were determined for the crustose genera *Cruoria, Haemascharia, Waernia, Plagiospora* and *Gainia*, along with 43 other gigartinalean species, and were subjected to phylogenetic analyses. The algal crusts were widely distributed throughout the Gigartinales. Under Bayesian analysis *Cruoria pellita* (Lyngbye) Fries allied with the Peyssonneliaceae, all members of which have a crustose morphology. *Haemescharia polygyna* Kjellman did not associate with any family or family cluster, and it lacked an affinity to *Cruoria* as had been previously suggested. The recently discovered *Waernia mirabilis* Wilce, Maggs et Sears grouped with *Constantinea simplex* Setchell within the Dumontiaceae with strong support in all analyses. *Plagiospora gracilis* Kuckuck, currently included in the Gloiosiphoniaceae, failed to join *Gloiosiphonia capillaris* (Hudson) Carmicheal in Berkeley, the type of the family, in any of the current analyses. However, it did associate at the base of the Endocladiaceae/Gloiosiphoniaceae/ Nizymeniaceae/ Phacelocarpaceae/Sphaerococcaceae family cluster, consistent with the morphological attributes of this genus. *Gainia mollis* Moe allied with *Dasyphloea insignis* Montagne with strong support in the Bayesian tree, but this association was only weakly supported in the distance tree, and was unsupported under parsimony. These results are discussed in light of the anatomical features know for each genus.

QUANTITATION OF CORE BIOCHEMICAL COMPLEXES IN FIELD SAMPLES AND DIVERSE PHYTOPLANKTON TAXA.USING GLOBAL ANTIBODIES

Christopher M. Brown[1], Douglas A. Campbell [1,2], Amanda M. Cockshutt[2]
[1]Department of Biology, University of New Brunswick, Fredericton, NB
[2]Department of Biology, Mount Allison University, Sackville, NB

Photoautotrophs share a set of key processes and pathways, including light capture, conversion of excitation energy to reducing power and ATP, carbon fixation and nitrogen assimilation. These functions are catalyzed by abundant protein complexes which dominate the proteomes of photoautotrophs. Levels and stoichiometries of key complexes such as PSI, cyt b6f, PSII, ATP Synthase, Rubisco, Nitrogenase and Glutamine synthetase determine the capacities of organisms for key metabolic transformations and indicate intracellular resource allocations and constraints on physiological performance. Under changing or suboptimal conditions, and across taxa, levels and stoichiometries of these complexes can vary widely. Allocation patterns may be characteristic for particular taxa or for physiological states. We are developing global antibodies and quantitation standards to measure these core complexes in populations and mixed communities. Within a given complex, certain peptide sequences of some subunits are well conserved over wide ranges of taxa. We use bioinformatics to design peptide sequence tags to elicit antibodies that recognize all members of the target protein family with equal efficiency, regardless of the species of origin. This broad taxonomic target range makes global antibodies useful for research into a) mixed communities of phytoplankton, containing large number of different or even unknown taxa and b) controlled studies of diverse organisms for which antibodies and quantitative tools are otherwise unavailable. We present protein determinations of key complexes for a wide range of photoautotrophs, including algae, cyanobacteria and higher plants.

MARINE AND ESTUARINE SEAWEEDS: GLOBAL BIOGEOGRAPHIC ASSUMPTIONS AND CRYPTOGENIC SPECIES

James T. Carlton
Maritime Studies Program, Williams College - Mystic Seaport, Mystic CT 06355
jcarlton@williams.edu

A standard default in classical ecology, biogeography, and evolutionary biology is that if the history of a given species in a community is not known, the species is considered native. Reviewed here is the global human-mediated transport of hundreds to thousands of species in the sea, including marine and estuarine algae, in the centuries prior to 1800, such that transoceanic and cosmopolitan distributions could be created long before biologists were common on the Earth. Dispersal vectors included or include ocean-going vessels, transporting species on their hulls or in ballast, and the widespread distribution of commercial oysters. The result is that there are (or should be) three biogeographic categories in all species lists: native, introduced, and “other” -- the latter being cryptogenic species, which cannot yet be clearly resolved as either native or introduced. Recognizing cryptogenic species is critical to understanding the evolution and assemblage of nearshore, shallow-water marine communities.

EFFECTS OF SALINITY AND MALE PRESENCE ON GROWTH AND REPRODUCTION OF GAMETOPHYTES OF THE BROWN ALGAE *MACROCYSTIS*, *PELAGOPHYCUS*, AND *PTERYGOPHORA*.

Molly K. Chambers, Melinda E. Coburn and Raymond J. Lewis.
Department of Biology, Wheaton College, Wheaton, IL 60187, USA

Kelps, members of the order Laminariales, are large marine brown algae that have microscopic gametophytes. Gametophytes can be grown vegetatively for years in media without iron, then induced to reproduce by the addition of iron. The objective of this research was to quantify the effects of salinity and male presence on Laminariales growth and reproduction. We conducted experiments using *Macrocystis pyrifera* and *Pterygophora californica* spores and vegetative gametophytes of *M. integrifolia* and *Pelagophycus porra*. *M. pyrifera* spores exhibited a trend towards greater oogenesis in 30 psu media and produced very well overall in one experiment, but in another failed to produce more than 3 eggs per 100 female gametophytes in any of the 6 salinities tested between 15 and 36 psu. Within that range, young *M. pyrifera* gametophytes survived at the highest rates at 19.5 psu and above. Young *P. californica* gametophytes survived at the highest rates at or above 23 psu (salinity range was 15-36 psu) and produced the most eggs and sporophytes at or above 31.5 psu. Within the salinity range of 16-34.5 psu, female vegetative *M. integrifolia* gametophytes exhibited maximum oogenesis at 23 psu in the presence of male gametophytes and very low levels of oogenesis in all salinities tested in the absence of males. *P. porra* gametophytes produced very few eggs when induced to reproduce, but male presence still had a statistically significant positive effect on oogenesis. The positive effect of males on oogenesis in female gametophytes is probably indicative of the activity of a pheromone released by males in Laminariales reproduction.

CULTIVATION OF THE EXTRACTIVE INORGANIC COMPONENT, *LAMINARIA SACCHARINA*, AND MONITORING OF THERAPEUTANTS IN AN INTEGRATED AQUACULTURE SYSTEM.

Thierry Chopin[1], Susan Bastarache[1], Manav Sawhney[1], Ellen Belyea[1], Julie MacDougall[2], Ian Stewart[3] and Patrick Fitzgerald[4]
[1]University of New Brunswick, Centre for Coastal Studies and Aquaculture and Centre for Environmental and Molecular Algal Research, P.O. Box 5050, Saint John, N.B., E2L 4L5, Canada, [2]Canadian Food Inspection Agency, CFIA Field Office, 61 Wallace Cove Road, Blacks Harbour, N.B., E5H 1G9, Canada, [3]Atlantic Silver Inc., 2 Salar Court, St. George, N.B., E5C 3N1, Canada, [4]Heritage Salmon Company Inc., 669 Main Street, Blacks Harbour, N.B., E5H 1K1, Canada

The development of sustainable integrated aquaculture systems requires combining fed aquaculture (fish or shrimp) with extractive inorganic aquaculture (seaweed) and extractive organic aquaculture (shellfish). This is based on an age-old, common sense, farming practice: the by-products (wastes) from one resource use become inputs into another. With the support of AquaNet, the Network of Centers of Excellence in Aquaculture in Canada, we are developing such a system at an industrial pilot scale by co-cultivating salmon (*Salmo salar*), kelp (*Laminaria saccharina*) and blue mussel (*Mytilus edulis*) at aquaculture sites in the Bay of Fundy, Canada.
The entire cycle of rearing *Laminaria saccharina* has been completed and improved (from 113 to 35 days), both in the laboratory and at the integrated sites: release in the laboratory of spores from mature macroscopic sporophytes, seeding of ropes, germination of microscopic gametophytes, sexual maturation of male and female gametophytes, development of zygotes into juvenile sporophytes, which are then transplanted to the sites for rapid grow-out. Photoperiod, nutrient enrichment, spore density, and timing of the production schedule are key parameters. The biomass production in proximity of salmon pens has been increased from 8.01 to 17.42 kg. m^{-1} of rope. At a reference site, 1250 m away from salmon pens, the biomass production reached 11.96 kg. m^{-1}. Chemical therapeutants used in the treatment of diseases in cultured salmon have not been detected since the beginning of our work (May 2001) in any of the periodically sampled kelps grown adjacent to the salmon pens. Increased kelp production in proximity to that of salmon and the absence of transfer of therapeutants validate the concept of integrated aquaculture. Adopting polytrophic practices will be key to the aquaculture industry to develop environmentally and economically balanced systems and increase its social acceptability.

THE RELATIONSHIP BETWEEN *ACROCHAETIUM SECUNDATUM* AND *A. VIRGATULUM*: RESOLVING DISTINCT MORPHOLOGIES IN LIGHT OF MOLECULAR IDENTITY.

Susan L. Clayden & Gary W. Saunders.
Centre for Molecular and Environmental Algal Research (CEMAR), Department of Biology, University of New Brunswick, Fredericton, N.B., E3B 6E1 CANADA.

A close relationship between the rhodophyte algae *Acrochaetium secundatum* and *A. virgatulum* has been posited by many phycologists. These are small (up to a few mm's in height) filamentous algae classified in Lineage 2 of the Florideophyceae, order Acrochaetiales. Morphologically the two *Acrochaetium* species have been separated based on differences in branching pattern and size, including cell dimensions and overall thallus size, with *A. virgatulum* being the larger plant. We collected *A. secundatum* and *A. virgatulum* growing on a variety of invertebrates and macroalgae from the east coast of Canada. Unialgal cultures were established and harvested for DNA analysis. We sequenced large subunit ribosomal DNA (LSU) to compare with a published sequence for *A. secundatum*, followed by analysis of the more variable ribosomal internal transcribed spacer (ITS). Morphometric measurements and chromosome counts were made using light microscopy. We determined that *Acrochaetium secundatum* and *A. virgatulum* have identical molecular sequences but are distinct morphologically. We accommodate these disparate results by discussing alternative scenarios. We also characterize a potentially conspecific alga, *A. densum*, from the west coast of Canada, a region where *A. secundatum* and *A. virgatulum* have not been recorded. *Acrochaetium densum* shares morphological attributes with these species, however, its molecular affinities are unknown.

THE EFFECTS OF HABITAT PATCHINESS ON DISPERSAL AND POPULATION GENETIC STRUCTURE OF *FUCUS DISTICHUS* L.

Melinda A. Coleman & Susan H. Brawley
School of Marine Sciences, 321 Hitchner Hall, University of Maine, Orono, ME, 04469 USA.

Patterns of genetic structure among spatially separated patches of habitat are important in understanding ecological processes such as dispersal and speciation. A useful model for such studies is *Fucus distichu*s, a seaweed predominantly localized to high intertidal rockpools. This monoecious alga reproduces through selfing and outcrossing. Earlier studies proposed that the occurrence of selfing and genetic structure of *F. distichus* would be high at the scale of rockpools. This is because gamete release occurs at low tide during neap tides when pools are isolated from bulk seawater. We used microsatellites to characterize population genetic structure of *F. distichus* from Schoodic Point and Chamberlain, Maine. We sampled *F. distichus* at three areas at Schoodic Point (separated by 0.75 to 2 km) and two areas at Chamberlain (separated by 50 m). At each site, *F. distichus* was collected from rockpools separated by between 1 and 30 meters. In addition, during spring 2003, recruits were found in some pools that previously had no *F. distichus*. These were sampled in order to estimate the spatial extent of *F. distichus* dispersal. Densities of *F. distichus* in rockpools varied greatly; at Schoodic there were up to 168 individuals per m^2 but at Chamberlain most pools averaged only 5 plants per m^2. Analyses using four polymorphic microsatellite loci found population differentiation between Schoodic Point and Chamberlain. Pairwise tests revealed differences among all sites except sites 1 and 2 from Schoodic. Surprisingly, Chamberlain sites (separated by only 50 m) were just as different from each other as from Schoodic sites. This is interesting since the density of *F. distichus* in rockpools at Chamberlain declined sharply in 2000 and most remaining individuals are juveniles. This suggests that recolonization following local extinction from some pools is in progress. This system offers a useful model for studies of dispersal and recolonization among patches of habitat.

IMMUNE RESPONSES IN THE EASTERN OYSTER, *CRASSOSTREA VIRGINICA,* EXPOSED TO BENTHIC DIATOMS CONTAMINATED WITH POLYAROMATIC HYDROCARBONS.

April Croxton[1, 2], Gary H.Wikfors[1], Richard D.Gragg III[2]. [1]NOAA Fisheries, Northeast Fisheries Science Center, 212 Rogers Avenue, Milford, CT 06460, USA, [2]Environmental Sciences Institute, Florida A&M University, Tallahassee, FL 32307, USA.

Globally, persistent organic pollutants (POPs) are the cause of great concern in the scientific community because of their ability to accumulate in food webs and pose health risks to humans and the environment. Polyaromatic hydrocarbons (PAHs) are among the numerous chemical pollutants that are impacting the aquatic and terrestrial biota. For decades, mollusks have been employed as sentinel species because their sessile nature allows the integration of cumulative effects from pollution in the aquatic ecosystem. Although accumulation of POPs in oysters has been used as a monitoring tool, little is known about the physiological effects of these toxins upon the bivalves themselves, including the presence of diseases and parasites in many ecosystems, which may limit oyster populations. POPs are associated with sediments, especially in subtropical areas, and oysters are thought to feed primarily on resuspended sediments, especially microphytobenthic diatoms, in these systems. POP exposure of oysters through feeding on contaminated benthic diatoms, and subsequent physiological effects, have been postulated, but not tested critically. The goal of this study is to examine immune responses of *Crassostrea virginica* exposed to cultured, benthic diatoms contaminated with an organic pollutant, naphthalene, to determine the role of food-borne contaminants in the defense system of the eastern oyster. This research will also involve a field component, which will compare immune defenses of the eastern oyster from a pristine site in Apalachicola Bay, and a PAH-contaminated site in Tampa Bay. Defense biomarkers to be examined will consist of hemocyte type, aggregation, viability, phagocytosis, and respiratory burst. Flow cytometric techniques will be used to quantify oyster immunological parameters. Although PAHs are well documented as organic pollutants, there is still a need for research to better understand their role in aquatic trophic linkages, and ultimately human health.

THE MBLWHOI LIBRARY DIGITAL HERBARIUM.

Joseph M. deVeer and Amy Stout.
MBLWHOI Library, Marine Biological Laboratory, Woods Hole, MA, 02543

The MBLWHOI Library Digital Herbarium [http://www.mbl.edu/herbarium] is a project to digitize the Library's herbarium collection of 8,000 vascular and non-vascular plant specimens. The non-vascular collection consists primarily of marine algae of Cape Cod and the Islands. Specimen images and related data are freely available on the Internet via a fully searchable database. Digitization of the marine algae collection is a joint project with NEAS. This paper discusses the evolution and value of the project, some technical background, and how the database is designed to contribute to the goal of understanding marine algal species diversity and distribution along the northeastern coast with emphasis on the Cape Cod region.

TRUE CONFESSIONS: LESSONS LEARNED AND NEW RESEARCH INITIATIVES IN THE MICROALGAL MASS CULTURE ROOM AT NOAA'S NATIONAL MARINE FISHERIES SERVICE MILFORD CONNECTICUT LABORATORY.

Mark S. Dixon and Gary H. Wikfors.
NOAA/NMFS/NEFSC, 212 Rogers Ave., Milford, CT 06460.

The Milford Mass Culture Room (MCR), houses a unique system for the cultivation of research-grade microalgae. The research of Dr. Ravenna Ukeles on techniques for the mass culture of microalgae led to the design and construction of the MCR. A 1973 publication describes the carboy system that currently is used. This system allows for production of large quantities of contaminant-free algal biomass. Semi-continuous culture management under consistent conditions of light, temperature, and media composition provides a product of repeatable and reliable quality. Large open tanks serve as models for commercial aquaculture applications and provide larger volumes of algae to Milford research initiatives.

Recent challenges, new research initiatives, and technological developments have taught us not to rest on past success. Research on bivalve and rotifer nutrition led to the replacement of some algal strains traditionally used in aquaculture with others. Open cultures mixed with bubbled air were susceptible to bacterial degradation and limited to short-term batch harvesting. Replacing bubbling with mechanical mixing significantly increased production and permitted long-term, semi-continuous production. Open cultures with higher surface area-to-volume ratios were more productive and sustainable. Ciliate contamination in open cultures became an issue in rotifer-feeding applications. This was addressed by using fresh water and artificial salt to eliminate the seawater source – effective, but expensive. More recently, we are using sub-micrometer, capillary tangential-flow filtration of seawater. The importance of supplemental carbon dioxide, as both carbon source and pH regulator, in bacteria-free carboy cultures was re-enforced through chance observations and subsequent adjustments. And most recently, we discovered that the pH buffer in our carboy and tank media degrades to ammonia (and much faster in bacterized cultures). This ammonia stresses grazers in closed systems, and degradation of the buffer reduces its effectiveness; the buffer problem is a top MCR priority. Current MCR work is a combination of refining existing procedures and applying them to new initiatives, including: studying harmful algal effects upon native and aquacultured grazers, using flow-cytometry to evaluate algal culture dynamics and grazer physiology, gaining a better understanding of the chemical processes within the algal media, and developing new, more effective methods of algal production.

THE CELL WALL OF THE DESMID, *PENIUM MARGARITACEUM* (CHLOROPHYTA).

David S. Domozych and Catherine E. Domozych
Department of Biology, Skidmore College, Saratoga Springs, NY 12866, USA.

Penium margaritaceum is a common resident of the biofilm communities of wetlands of the sountheastern Adirondacks. The alga produces prodigious amounts of a gel-like extracellular polymeric substance (EPS) that is secreted through pores of the cell wall (CW). In this study, an ultrastructural, biochemical and cytochemical analysis of the CW was undertaken. The CW consists of two distinct layers: an inner, fibrillar zone punctuated by a branched network of simple pores and an outer stratum consisting of a highly reticulated network of electron dense fibers. The outer layer was extracted by CDTA and consists of 68% GalA, 19% terminal GalA, 8% 6-linked GalA and 5% 4-linked GalA. X-ray microanalysis reveals that this outer layer is calcified. Immunocytochemical labeling with the monoclonal "anti-pectin" antibody, JIM 5, reveals that low esterified homogalacturonans are found in the outermost CW layer except in the cell center. Here, the CW labels in a thin band with the antibody, JIM 7, an antibody specific to esterified homogalacturonan. It is at this zone where rapid CW growth occurs during and after cytokinesis in the production of new daughter semi-cells. The CW pectin is produced in the Golgi Apparatus, specifically in peripheral zones of medial-to-trans face cisternae. The pectin is carried by secretory vesicles to the cell surface where it is secreted into the inner wall layer and through the CW pores.

PHYLOGENY OF THE CHRYSOPHYCEAE AND SYSTEMATICS OF *OCHROMONAS*.

Stacy M. Edgar and Robert A. Andersen.
Bigelow Laboratory for Ocean Sciences, West Boothbay Harbor, ME 04575, USA

Ochromonas sensu lato is the largest genus in the Chrysophyceae, containing over 100 names. *Ochromonas* species are biflagellate, naked, plastid-bearing single cells, distinguished from loricate, scaled, colonial and colorless genera. Most, if not all, species of *Ochromonas* are mixotrophic, i.e., they photosynthesize but they also engulf bacteria and other small prey. Preliminary evidence from *rbc*L and SSU rRNA sequence data, analyzed independently and combined, for 58 chrysophyte and synurophyte taxa (24 of which are *Ochromonas*) shows that *Ochromonas* is a polyphyletic genus. Also, the 18S rRNA sequence data and the 18S rRNA and rbcL data combined suggest the Synurophyceae is basal to the Chrysophyceae, lending support to the transfer of synurophytes out of the chrysophytes based on morphological evidence. The *rbc*L sequence data alone identify the synurophytes as a monophyletic clade, but they are placed well within the chrysophyte clade making the chrysophytes non-monophyletic. Each of the data sets examined independently, as well as combined, identify clades with similar taxon composition to one another. However, the basal relationships among the clades lack sufficient support for conclusive results. The goals of this research are 1) to establish a monophyletic *Ochromonas*, probably by assigning some species to other genera (existing or new), and 2) to test whether molecular data support the transfer of the synurophytes out of the Chrysophyceae. One major problem regarding our first goal is that the type species, *O. triangulata* Vysotskii, hasn't been observed in over 100 years, and it is unclear which of several clades of *Ochromonas* contains the type. Another challenge for both goals rests in supplying sufficient taxon sampling, as well as identifying and sequencing an additional conservative gene, to provide robust support of basal relationships needed to test our hypotheses. Results will be discussed.

WHY IS THE LAND GREEN AND THE OCEAN RED?

Paul G. Falkowski
Institute of Marine and Coastal Sciences and Department of Geology, Rutgers University, 71 Dudley Road, New Brunswick, NJ 08901 U.S.A.

This presentation will discuss the evolutionary history of chl b- and c-containing plastids, and the rise of the "red" line to ecological prominence in the contemporary ocean...(more details to be added).

ROCKWEED HARVESTING: EFFECTS ON THE ASSOCIATED ALGAL SPECIES.

Jill C. Fegley[1], Robert L. Vadas[2], and William A. Halteman[3].
[1]Corning School of Ocean Studies, Maine Maritime Academy, Castine, ME 04420, [2]Department of Biological Sciences, University of Maine, Orono, ME 04473, [3]Department of Mathematics and Statistics, University of Maine, Orono, ME 04473.

Harvesting of natural resources usually entails substantial removal of the target species. Where such species are dominant members of natural communities, their removal can have important consequences for their own regeneration as well as for the species assemblages associated with them. *Ascophyllum nodosum* (L.) Le Jolis is an ecologically and commercially important intertidal alga in the North Atlantic, and is increasingly being harvested in Maine. The effects of three harvest treatments (unharvested and harvested at 18 cm and 36 cm from the holdfast) on the associated understory algae at four separate sites in mid-coast Maine were followed for two years post-harvest. A three-factor, repeated-measures MANOVA was used to analyze effects of the harvesting treatment on the percent cover of understory algal species. *A. nodosum*, *Fucus vesiculosus*, *Hildenbrandia rubra* and *Phymatolithon lenormandii* were all significantly affected by the canopy removal. The mean percent cover of *A. nodosum* was reduced significantly following the experimental harvest but returned to baseline values within nine months. The cover of *Fucus* also decreased in cut plots. Also, there was a reduction in the mean percent cover of *Hildenbrandia* at three of the four experimental sites that was correlated with the intensity of harvest. At sites where *Phymatolithon* was abundant, removal of some of the canopy (36-cm cut) resulted in an increase in the percent cover, whereas an 18-cm cut resulted in death of plants suggesting that *Phymatolithon* may be light-limited under natural conditions. In conclusion, the response of understory algal species to harvesting was species- and site-specific.

FOOD UPTAKE IN THE MIXOTROPHIC *DINOPHYSIS ACUMINATA*.

Emily W. Grason, Jan E. Rines and Lucie Maranda.
Graduate School of Oceanography, University of Rhode Island, Narragansett, RI, 02882, USA

Evidence of food uptake in the photosynthetic genus *Dinophysis* comes solely from the presence of food vacuoles, as no photosynthetic cells have ever been observed in the act of feeding. We set out to examine the feeding ecology of *D. acuminata* in natural populations and under laboratory conditions. Using depth-integrated sampling of the water column, we determined the frequency of food vacuolated cells at two-hour intervals over a 24-h period in a shallow marine embayment. Food vacuoles in preserved cells were enumerated using Nomarski interference contrast microscopy; ultrastructural characters were recorded by transmission electron microscopy. A peak in feeding activity was observed toward dusk for an abundant June population, with 26% of cells with at least one food vacuole. Mechanisms of concurrent carbon acquisition are evident from the presence of chloroplasts with starch grains and food vacuoles within the same cell, but the vacuole content still cannot be identified. In a preliminary two-week long simulated grazing experiment, a mixture of two hypothesized preys, *Rhodomonas salina* and *Dunaliella tertiolecta*, was offered to *D. acuminata*; the *Dinophysis* populations decreased steadily and at the same rate, whether food was present or not.
The evaluation of the food vacuole frequency will be repeated in the coming season to verify the observed pattern, while grazing experiments will include a variety of prey items and incubation conditions. Our current inability to successfully culture any photosynthetic *Dinophysis* limits the entire approach, whether at the population or cellular level, to manipulation of field samples.

PHOTOPHYSIOLOGY OF DESERT GREEN ALGAE UNDER DESICCATION AND REHYDRATION.

Dennis W. Gray, Zoe Cardon and Louise Lewis.
Department of Ecology and Evolutionary Biology, University of Connecticut, Storrs CT 06269-3043,USA

Green algae are a diverse group of photosynthetic organisms found a wide variety of habitats. These include both marine and freshwater environments, and even extend to terrestrial environments where algae form important symbioses with fungi to form lichens. However, perhaps one of the most severe environments inhabited by algae are desert locations where algae may form crusts on the soil surface. Life in a desert presents many challenges to these terrestrial algae that are not faced by their freshwater ancestors. These include the need to withstand long periods of desiccation, high temperatures and temperature fluctuations, and high light intensities. Despite the harsh conditions imposed by desert life, green algae appear to have repeatedly made the transition from aquatic to terrestrial habitats from freshwater ancestors. To better understand the physiological changes that allowed this shift in habitat we use chlorophyll fluorescence to compare the photosynthetic physiology of desert and phylogenetically related freshwater algae in response to desiccation and re-hydration.

BROWN ALGAL PHLOROTANNINS: A GENERAL STRESS RESPONSE?

Carl W. Grobe and Dianne M. Ferris.
Department of Biology, Westfield State College, Westfield, MA 01086

Phlorotannins are carbon-based secondary metabolites that are analogous to the tannins found in terrestrial plants. Members of the Phaeophyta are the only macroalgae to manufacture these polyphenols. Phlorotannins are often present at relatively high concentrations (up to 20% dry mass), yet their role has yet to be definitively determined. Classically, phlorotannins were assumed to be anti-herbivore compounds. Recent research suggests an ultraviolet-protective role for these compounds as well. We examined phlorotannin concentrations in populations of *Laminaria saccharina* growing *in situ* at three depths. We also assayed phlorotannin concentrations in *L. saccharina*, *Fucus vesiculosus,* and *Agarum clathratum* cultivated in experimental tanks covered by UV-opaque and -transparent Plexiglas. Phlorotannin concentrations in *L. saccharina* were not correlated with depth *in situ*, but were significantly higher in material exposed to UV in our experimental tanks. However, *L. saccharina* collected at the surface from a seasonal float contained undetectable concentrations of phlorotannins. The UV effect was not observed in either *F. vesiculosus* or *A. clathratum* cultivated in our experimental tanks. We propose that phlorotannin production serves as a general response to stress experienced by members of the Phaeophyta. Thus, grazing and UV exposure (and probably other stresses) trigger phlorotannin production. Long-term exposure to stresses trigger more effective, but slower, defensive systems that ultimately supersede the phlorotannin response.

TIME-DEPENDENT CHANGES IN HEMOCYTES OF EASTERN OYSTERS, CRASSOSTREA VIRGINICA, AND NORTHERN BAY SCALLOPS, ARGOPECTEN IRRADIANS IRRADIANS, EXPOSED TO A CULTURED STRAIN OF PROROCENTRUM MINIMUM.

Hélène Hégaret [1] and Gary H. Wikfors [2].
[1] Marine Sciences Department, University of Connecticut, Groton, CT, 06340, USA.
[2] NOAA, National Marine Fisheries Service, Northeast Fisheries Science Center, Milford, CT, 06460, USA.

There is a growing consensus that the extent and severity of HAB's are increasing worldwide. Disruptions in marine ecosystems by HAB's, especially involving phytoplankton grazers, are incompletely understood. To investigate possible immunological effects, juvenile oysters and scallops were exposed, under controlled laboratory conditions, to bloom concentrations of a cultured dinoflagellate, Prorocentrum minimum, with demonstrated lethal and sub-lethal, pathological effects upon these bivalves. Immune status of the mollusks was assessed periodically, using flow-cytometric hemocyte analyses for hematological characteristics and several hemocyte functions, during seven days of continuous exposure. For both oysters and scallops, P. minimum exposure had a significant effect upon immune profile, and this effect was dependent upon duration of exposure. The most pronounced effects of seven-day exposure of both oysters and scallops were increases in granulocyte percentage and dead hemocytes, following an initial (one-day) boost in hyalinocyte number. Changes in hemocyte function attendant with shifts in the hyalinocyte/granulocyte ratio were observed as well. This study demonstrated immunological effects of a harmful alga upon the immune systems of grazing mollusks. Moreover, the finding that immune-system effects of this representative HAB are dependent upon duration of exposure has likely ecological relevance.

MOLECULAR CHARACTERIZATION OF MICROCYSTIN PRODUCTION IN ONEIDA LAKE, NEW YORK, USA.

Amber Hotto, Michael Satchwell, and Gregory Boyer.
Faculty of Chemistry, SUNY College of Environmental Science and Forestry, Syracuse, NY.

Oneida Lake is a shallow eutrophic lake with a well-established toxic cyanobacterial population located northeast of Syracuse, NY, USA. Given its toxic history Oneida Lake can be used as a model system to study microcystin production. To investigate the relationship between actual and potential microcystin formation in this lake, samples were collected at 6 different stations throughout the summer of 2002 and analyzed for cyanobacterial toxin production. DNA was extracted from 1-L filtered samples and subjected to PCR using four different primer sets: CYA (cyanobacterial 16S ribosomal gene), Micro (*Microcystis* specific 16S rRNA), and *mcy B* and *mcy D* (part of the non-ribosomal microcystin synthetase complex). Microcystin production, as measured by the protein phosphatase inhibition assay (PPIA), started in early June and continued through early October, exceeding the WHO advisory level for drinking water (1 $\mu g\ L^{-1}$) in mid-August. PCR analysis indicated that the microcystin genes were present in the water column from mid-June through October, as 88% of the samples tested positive for *mcy B* and 79% of the samples tested positive for *mcy D*. Most of the samples (95%) tested positive by the Micro primer set, demonstrating that *Microcystis* spp. are present in the water column and could contribute to microcystin production. This information will be used to develop novel systems for real time analysis of microcystins in freshwater systems.

ANALYSIS OF DIFFERENTIALLY EXPRESSED PROTEINS IN *PFIESTERIA PISCICIDA* IN SEARCH OF GROWTH-RELATED PROTEINS.

Yubo Hou and Senjie Lin
Department of Marine Sciences, University of Connecticut, Groton, CT 06340, USA

In order to develop molecular markers for growth studies, we analyzed protein expression profiles of *Pfiesteria piscicida,* a heterotrophic dinoflagellate, under different growth conditions. *P. piscicida* cells were harvested under starved and well-fed conditions. Proteins were extracted, purified, and separated using modified two-dimensional electrophoresis (2-DE) protocol. Reproducible 2-DE protein patterns in both conditions were obtained and several differentially expressed proteins were detected.

IDENTIFICATION OF FLAGELLAR PROTEINS IN *CHLAMYDOMONAS REINHARDTII*.

Roshan Karki, S. Chettri, and K. Dragon.
Department of Biology, Eastern Connecticut State University, Willimantic, CT 06226, USA

Eukaryotic flagella are complex structures made up of more than 300 proteins arranged in a complex repeating pattern. These whip like structures project out of cell surface and are found in almost all plants and animals, including *Chlamydomonas reinhardtii*. Flagella can be isolated from the cell body with acid base treatment (pH shock) and readily obtained by differential centrifugation. Flagellar proteins of pre and post mating cells can be identified by labeling the cells with radioactive sulfur (S^{35}) and studied under autoradiogram. Results show that while there is little protein turnover in gametes, deflagellation triggers protein synthesis. The dikaryons (zygotes) of the wild type cells show new flagellar proteins distinct from their parents.

PHYTOPLANKTON PATTERNS IN THE LOWER HUDSON AND EAST RIVERS, N.Y., 1996-2003: THE INFORMATION CONTENT OF CATEGORICAL DATA.

Kim, E.-W.[1], Park, M.[2], Levandowsky, M.[1,2]. [1]Haskins Labs, Pace U., N.Y., NY 10038; [2]The River Project, N.Y., NY 10013

Canonical correspondence analysis (CCA) was used to analyze an 8 year series of weekly phytoplankton samples from surface water at 2 sites in Lower Manhattan during the period 1996-2003. The analysis used presence-absence data of 29 taxa readily identifiable with the light microscope from living material, and measurements of temperature, salinity, pH, Secchi depth and dissolved oxygen. The 2 sites were: The River Project (Pier 26 on the Hudson River); and the South Street Seaport (Piers 15-16 on the East River). The Hudson sample points formed distinct clusters with respect to salinity, temperature and season, whereas the East River samples, involving the same taxa, did not. The data suggest significant differences in organization of taxonomic contents of phytoplankton at these two sites: lower Hudson River phytoplankton is in some sense much more structured than that of the East River. Data analyzed here are the kind that could be readily obtained from inexpensive sampling programs, perhaps involving students or volunteers, using relatively simple gear and minimal laboratory facilities. The analysis indicates that meaningful statistical information can be obtained from such data.

EFFECTS OF TEMPERATURE AND AMMONIUM ON GROWTH, PIGMENT PRODUCTION AND NITROGEN UPTAKE IN FOUR SPECIES OF *PORPHYRA* NATIVE TO THE COAST OF NEW ENGLAND.

Jang K. Kim[1,4], George P. Kraemer[2], Chris D. Neefus[3], Ik Kyo Chung[4,5] and Charles Yarish[4]

[1]Department of Ecology & Evolutionary Biology, University of Connecticut, Groton, CT 06340, USA, [2]Division of Natural Science, Purchase College, State University of New York, Purchase, NY 10577, [3]Department of Plant Biology, University of New Hampshire, Durham, NH 03824, [4]Department of Ecology & Evolutionary Biology, University of Connecticut, CT 06901, USA, [5]Divisin of Earth Environmental System, Pusan National University, Busan 609-735, KOREA.

Porphyra is one of the world's most valued maricultured seaweeds. The effects of ammonium concentration and temperature on growth and tissue nitrogen content of *Porphyra* from coastal New England were studied in 50 liter tanks to produce critical information for the development of a land based aquaculture system. Four Northwest Atlantic *Porphyra* species: *P. leucosticta, P. amplissima, P. linearis* and *P. umbilicalis,* were cultivated for one and two weeks at saturating light intensities (100–150 $\mu Em^{-2}s^{-1}$) and six combinations of ammonium (25 and 250 μM) and temperature (10, 15 and 20 °C). The specific growth rate (SGR) was influenced by temperature and ammonium. The growth rate of *Porphyra leucosticta* was higher at 10 and 15 °C than at 20 °C. *Porphyra linearis* and *P. umbilicalis* showed significantly higher growth rate at 10 °C than at 15 and 20 °C. However, *P. amplissima* showed the highest growth rate at 20 °C. The growth rate of *P. linearis* and *P. umbilicalis* was significantly higher at 250 μM ammonium than that at 25 μM ammonium concentration. *Porphyra linearis* had the highest growth rate, increasing in biomass by about 16 %. The tissue nitrogen content of all species was on average 1.45 % higher in the DW at 250 μM than at 25 μM ammonium concentration. *Porphyra umbilicalis* had the highest tissue nitrogen contents (6.76 %) at 10 °C and 250 μM ammonium. Based from these results, *Porphyra linearis* and *P. umbilicalis* should be considered as potential candidates for bioremediation with fin- and shellfish mariculture.

BIOREMEDIATION OF EUTROPHIC AQUACULTURE EFFLUENTS BY *PORPHYRA*: DIURNAL PATTERNS AND INFLUENCE OF STOCKING DENSITY.

Kraemer, G. P.[1], Snellgrove, D.[2], Pereira, R.[3], and Yarish, C.[2]
[1]Department of Environmental Science, Purchase College (SUNY);
[2]Department of Ecology and Evolution, University of Connecticut, Stamford;
[3]Universidade de Porto, Portugal

Porphyra spp. are fast-growing and can accumulate nitrogen in tissues up to 7% of dry weight, making them candidates for use as the algal partners in integrated aquaculture. We have been investigating their performance under a variety of conditions to better define the operating parameters of an integrated aquaculture system. *Porphyra amplissima* and *P. dioica* were grown under a 12:12 L:D photoperiod at 15°C in culture medium containing 150 μM ammonium. Growth and media ammonium concentration were measured at 12 hour intervals over 96 hours. Growth rates during the dark phase were 32% (*dioica*) and 57% (*amplissima*) less than during the lighted phase, but still substantial. Ammonium uptake measurements are currently underway. *Porphyra amplissima* was also grown at stocking densities between 0.2-2.0 g FW L^{-1}. Over this density range, growth rates declined from 91-45% d^{-1}. Yield increased non-linearly towards an asymptote. At a stocking density of 2.0 g FW L^{-1}, yield had reached about 85% of the estimated maximum. We are currently examining ammonium removal, pigment concentration, and tissue nitrogen contents.

DESMIDIACEAE AND MESOTAENIACEAE OF CHAMAECYPARIS SWAMPS, BARNSTABLE COUNTY, MASSACHUSETTS, USA.

Aimlee D. Laderman[1], David Domozych[2], and Gabrielle Sakolsky[3].
[1]Marine Biological Laboratory, Woods Hole MA 02543, [2]Skidmore College, Saratoga Springs, NY 12866, [3]Cape Cod Mosquito Commission, Yarmouthport MA 02675.

Placoderm desmids (Desmidiaceae) and saccoderm desmids (Mesotaeniaceae) are richly represented in acid environments. The acid, low-nutrient, oxygen-deprived, dark waters of monotypic forests dominated by *Chamaecyparis thyoides* [(L.) BSP.] (Atlantic white cedar) support a unique phycological community with a high diversity of desmids. Atlantic white cedar, an obligate wetland conifer of freshwater peatlands, is a catastrophe-dependent, extremophilic evergreen native only to the East coast of the United States. It is found in isolated ecological-island stands from mid-Maine to mid-Florida and west to Mississippi, no more than 250 km from salt water. Its distinctive biotic assemblages grow under conditions too extreme for most temperate organisms. Of the 63 algal species identified to date in the cedar swamps of Barnstable County, Massachusetts, 22 are desmids. Saccoderms are represented by a single species (*Netrium*); the rest are placoderms. This survey of desmid algae is part of an all-taxon biotic census (in progress) of Atlantic white cedar wetlands rangewide. The survey is organized in a Filemaker Pro database and interactive website, linked to the global protistan database and website “micro*scope”.

CHARACTERIZATION OF TWO ACTIN GENES IN *PALMARIA PALMATA* (RHODOPHYTA).

Line LE GALL[1] and Cristophe LELONG[2]
[1]CEMAR, Dept of Biology, Mail Service # 45111, University of New Brunswick, Fredericton, NB, E3B 6E1, CANADA
[2]Laboratoire de Biologie et Biotechnologies Marines, Université de Caen, 14032 Caen Cedex, FRANCE

The cytoskeleton is a key effector of signal transduction. It controls and maintains the shape of cells, and plays an important role in algal morphogenesis. Nevertheless, there have been few investigations into the molecular biology of actin genes in red algae. In this context, a study was undertaken to characterize actin in the red alga *Palmaria pamata*.

Two partial actin gene sequences were isolated by PCR using actin primers designed from conserved regions in other organisms. Moreover, a southern blot analysis of genomic DNA confirmed the presence of only two actin genes. BLAST analyses have indicated that both genes were related to ß actin forms. One of these genes was characterised by an intron in the coding region and a greater identity with actin genes reported from other red algae.

This is the first report of two actin encoding genes in a member of the Florideophyceae. These results raise questions as to the origin and function of mutiple actin encoding genes in *P. palmata*. Thus far, an analysis of the expression of both genes in tetrasporophytic fronds using RT-PCR has been performed. But only further investigations will provide a clearer understanding of the actin gene family in red algae.

THE EFFECTS OF IRON CONCENTRATION, SALINITY AND MALE PRESENCE ON OOGENESIS IN *DICTYONEURUM CALIFORNICUM*.

Raymond J. Lewis and Megan E. Wood
Department of Biology, Wheaton College, Wheaton, IL, 60187, USA

The environmental conditions affecting gametogenesis in the kelps have been determined for a number of species of these brown algae. Two major requirements for gametogenesis in many species are adequate levels of blue light and iron. However, additional factors influence the reproduction of these brown algae, including salinity and the presence of male gametophytes. The objective of this study is to determine the optimal conditions for oogenesis in female gametophytes of *Dictyoneurum californicum*. Female gametophytes were cultured in increasing iron concentrations of 0, 3.3, 6.6, and 13.2 μM. Oogenesis increased most significantly between 0 and 3.3 μM, and the highest egg production was observed at 13.2 μM. This initial experiment was conducted at 30 psu salinity. Female gametophytes were cultured alone in seven seven different salinities, from 18 to 36 psu. The maximum number of eggs were produced at 21 psu, with a drop of oogenesis as salinity increased to 36 psu. Male gametophytes were also tested with the female gametophytes in the same salinity conditions. There was a significant increase in egg production with males present, with maximal egg production observed at 21 psu salinity. This indicates the presence of a pheromone produced by the male gametophytes that stimulates oogenesis by the females.

A COMPARATIVE STUDY FOR *PFIESTERIA PISCICIDA* AND *CRYPTOPERINIDIOPSIS* SP.

Senjie Lin[1*], Margaret R. Mulholland[2], Huan Zhang[1], Edward J. Carpenter[3]
[1] Department of Marine Sciences, University of Connecticut, Groton, CT 06340; [2] Department of Ocean, Earth & Atmospheric Sciences, Old Dominion University, 4600 Elkhorn Avenue, Norfolk, VA 23529-0276; [3]Romberg Tiburon Center, San Francisco State University, 3152 Paradise Dr., Tiburon, CA 94920.

We analyzed mitochondrial cytochrome *b* gene (*cob*) sequence and prey-predator dynamics for *Pfiesteria piscicida* (CCMP1831) and *Cryptoperidiniopsis* sp. (CCMP1828). Phylogenetic analysis with cob as well as rRNA SSU and LSU showed that *P. piscicida* and *Cryptoperidiniopsis* sp. were closely related. In batch cultures with Rhodomonas sp. as food, *P. piscicida* typically depleted *Rhodomonas* sp. rapidly, leading to extinction of both the prey and the predator populations (Lin et al. in revision), whereas *Cryptoperiniopsis* sp. exhibited a classical predator-prey oscillation, with an average time lag between the peak of the prey and that of the predator of 9.8 ± 1.6 days. Numerical analyses indicated that there were no or low threshold prey concentrations for *P. piscicida* to graze and grow. In contrast, *Cryptoperidiniopsis* sp. growth seemed to have a higher threshold prey/predator ratio (3.5 compared to 0.5 in *P. piscicida*). We conclude that albeit genetically similar, the two dinoflagellates have contrasting grazing and growth behavior. *P. piscicida* seems to be an "imprudent" and voracious predator, and *Cryptoperidiniopsis* sp. a "prudent" predator.

AN INVENTORY OF SCALED CHRYSOPHYTES FROM THE ATLANTIC COASTAL PLAIN OF NORTH CAROLINA, USA, AND THEIR RELATIONSHIPS TO ENVIRONMENTAL VARIABLES.

Anne M. Lott and Peter A. Siver.
Department of Botany, Connecticut College, New London, CT, 06320, USA.

The purpose of this study was to catalog the diversity of silica-scaled Chrysophyceae and Synurophyceae from a suite of lakes located within three primary regions along the Atlantic Coastal Plain of North Carolina, and to relate the distributions to environmental variables. Phytoplankton, periphyton, and surface sediments from each of the 28 sites were collected in May and June of 2001 and later analyzed extensively with both scanning electron microscopy (SEM) and light microscopy (LM) for scaled chrysophytes and diatoms. In addition, water samples were used to measure a suite of chemical characteristics, including specific conductivity, pH, alkalinity, total phosphorus, total nitrogen, chloride, sulfate and base cation concentrations. The Pocosin National Wildlife Refuge and the Croatan National Forest are located along the coast and are largely dominated with vegetation known as pocosins, which are wetland regions dominated by evergreen shrubs and scattered emergent trees. The Bladen Lakes region consists of vegetation associated with Carolina bays that is similar in composition to pocosin vegetation. Because the soils are comprised largely of woody peat and muck, the wetlands, ponds and waterways associated with pocosin and Carolina bay vegetation usually consist of acidic, poorly buffered and humic water. Although floras in North Carolina waterbodies are species-poor compared to other recent survey regions, they are unique and distinctive. We have identified thirty-five taxa of silica-scaled Chrysophyceae and Synurophyceae, including one newly described variety from this region, *Mallomonas multiunca* var. *pocosinensis*. This taxon was found in 30% of the sites and at greater than 45% relative abundance in over half of those waterbodies. Overall, the number of taxa found per lake ranged from 0 to 16, with *Synura sphagnicola*, *S. echinulata*, *S. petersenii*, and *M. wujekii* dominating the flora. The use of this flora in reconstructing paleolimnological environments will be discussed.

ORIGIN AND MORPHOLOGY OF DWARF MOSS-LIKE *FUCUS* FROM NORTHWEST ATLANTIC SALT MARSHES.

Arthur C. Mathieson[a] and Clinton J. Dawes[a,b,]
[a]Department of Plant Biology and Jackson Estuarine Laboratory, University of New Hampshire, Durham, NH 03824.
[b]Department of Biology, University of South Florida, Tampa, Florida 33620.

Populations of a dwarf moss-like *Fucus* were found at 23 Northwestern Atlantic salt marshes extending from the Canadian border to Long Island, New York. The plants are restricted to the upper intertidal and occur within well drained sediments, primarily composed of medium to coarse sand; they lack holdfasts and are associated with other attached (i.e. parental) *Fucus* plants, detached fucoid ecads, and the halophytic marsh plants *Spartina alterniflora* and *S. patens*. The dichotomously branched, flattened fronds of these dwarf *Fucus* plants have a mean overall length and width of 19.4 $\pm$ 4.4 and 1.2 $\pm$ 0.5 mm, respectively; thus, they are larger than two populations that we collected from Galway Bay, Ireland near the type location of *F. vesiculosus* var. *muscoides* (9.3 $\pm$ 0.2 & 0.6 $\pm$ 0.0) and they overlap in size with several herbarium specimens from Alaska.

Common garden (i.e. transplant) studies of ecads and dwarf fucoid populations from three Gulf of Maine salt marshes confirmed that fragmented *Fucus spiralis* ecad *lutarius* and dwarf *Fucus* populations could become morphologically similar to native plants when transplanted to high and low elevations. It appears that extreme environmental conditions, including desiccation and variability of sediments (i.e. % clay, sand & water content), can modify fucoid morphology, resulting in a convergence of dwarf stature. The dwarf *Fucus* plants from the Northwest Atlantic may be derived from fragments of *F. spiralis* or *F. vesiculosus* and they should not be considered as distinct taxa. Dwarf *Fucus* populations may also be derived from hybridization between these two taxa, resulting in sterile plants. Although hybridization may be important, transplantation studies indicate that environmental extremes strongly influence fucoid morphology. Based upon observations of morphological continua between several *Fucus* ecads, we conclude that the "*mytili*" type fragments (i.e. *F. mytili* Nienburg) found attached to the byssal threads of *Mytilus edulis* are also part of a *F. vesiculosus* continuum.

A FIRST EVALUATION OF PHYLOGENETIC RELATIONSHIPS OF FRESHWATER BROWN ALGAE USING 18S rDNA AND *rbc*L SEQUENCES.

Linda A.R. McCauley[1] and John D. Wehr[2].
[1] Marine Biological Laboratory, 7 MBL Street, Woods Hole, MA 02543
[2] Louis Calder Center - Biological Station, Fordham University, Armonk, NY 10504

Freshwater brown algae are thought to be rare organisms compared to their many marine counterparts, and their phylogenetic relationships to better-known taxa are poorly known. All have filamentous or crustose morphologies, and their mode of sexual reproduction is known for only some of them. Six genera and seven freshwater species are currently recognized, and have been traditionally classified in one of two orders within the Phaeophyceae: Ectocarpales (five genera) or Sphacelariales (1 genus). Our study examined the probable phylogenetic relationships among some freshwater species (10 isolates of five freshwater species), in comparison with sequences of 27 marine species from 10 orders of brown algae, using 18S rDNA small subunit and RUBISCO large subunit (*rbc*L) sequences. Results of a BLAST search clearly supported placing all freshwater taxa within the Phaeophyceae. Both rDNA and *rbc*L data confirmed that a recently discovered freshwater population of *Ectocarpus* from Australia and the freshwater genus *Pleurocladia* are members of the Ectocarpales and should be placed in the family Ectocarpaceae. However, our data offer no support for the inclusion of *Heribaudiella fluviatilis* or *Bodanella lauterborni* in the Ectocarpales or with any recognized phaeophycean order. The *rbc*L data were sufficiently variable to show that these two genera were only distantly related to current members of the Ectocarpales. This clade exhibited relatively tight genetic similarities among its members, with *B. lauterborni* nested within populations of *H. fluviatilis* collected from British Columbia and Germany. More data may be needed to determine if this clade is a distinct order of brown algae, perhaps intermediate between the Sphacelariales and the Syringodermatales. Our data did not resolve the ordinal status of a freshwater isolate of *Porterinema fluviatile*, and provided no support for its inclusion within the Ectocarpales, as traditionally classified based on morphology.

DIGITAL IMAGE BANK AS A TEACHING RESOURCE.

Jennifer McInnis and Carl W. Grobe.
Department of Biology, Westfield State College, Westfield, MA 01086

We developed a set of digital images to serve as a teaching tool and student resource. The images range from photographs of entire specimens to micrographs of specific structures and tissues. Currently, we are using the image bank to facilitate laboratory exercises in which students observe the material fist-hand and then are able to review the material as a class using the projected images. The image bank is also made available to the students as a resource for reviewing the material. The digital images are much more versatile than similar images captured on film. For example, an image can be made available to students that illustrates specific features, tissues, or cell types. The same image can then be modified to include labels or descriptions, so that the appearance and location of the features is clearly indicated. As the size of our image bank expands, we anticipate that it could be used as a teaching resource for other courses in our department and as a resource for students looking for information on algae and related organisms. We plan to make the image bank available on the web, which will improve student access to the materials and will create a resource that is available to students beyond this particular class and beyond our campus.

EXPLORATION OF MORPHOLOGICAL AND GENETIC VARIATION WITHIN THE FAMILY HYDRODICTYACEAE (SPHAEROPLEALES, CHLOROPHYCEAE).

Hilary A. McManus and Louise A. Lewis.
Department of Ecology and Evolutionary Biology, University of Connecticut, Storrs, CT, 06250, USA.

A molecular phylogeny constructed from two nuclear gene regions of the freshwater green algal family Hydrodictyaceae, including multiple taxa from both culture collections and wild samples, sets the basis to explore morphological and genetic variation within the family. Hydrodictyaceae forms a monophyletic group within the Sphaeropleales, and the genera *Hydrodictyon* and *Sorastrum* are derived from *Pediastrum* forming individual monophyletic clades. Multiple isolates of *H. reticulatum* reveal little genetic variation between different geographic localities, while geographically separated strains of *Pediastrum* that share similar phenotypes are genetically distinct. Monographic works on the genus *Pediastrum* Meyen 1829 have described species, varieties and forms based on such characteristics as the size and shape of the marginal cells, pattern of cell wall sculpturing and extent of cell wall sculpturing. Depending on the author, the number of taxa assigned to the genus *Pediastrum* varies. Inclusion of additional isolates permits a more thorough exploration of the morphological variation and potential morphological convergence among species of *Pediastrum*. Using the phylogeny as a framework to explore the morphological variation within *Pediastrum*, it is apparent that some strains do not conform to the morphological classification scheme in use.

HOW DIFFERENT LIGHT REGIMES AND INTENSITIES AFFECT GROWTH RATES AND NUTRIENT UPTAKE IN THE ALGAL STRAIN *TETRASELMIS CHUI* (PLY 429).

Shannon L. Meseck[1], Jennifer Alix[1], Gary Wikfors[1], and Mark Dixon[1]
[1] NMFS 212 Rogers Ave Milford, CT 06460

Mass culturing phytoplankton in large volumes (i.e., 18,000-L tanks) is a practical way to produce live feeds for aquaculture. To reduce culturing costs, greenhouses can be used to minimize the amount of artificial light needed for algal growth. However, with natural sunlight there is much more variation in the light intensity and the day length than what would be found in a controlled laboratory environment. Light intensity, day length, and nutrient concentrations are important in regulating the growth of phytoplankton. This study investigated how different light intensities and day lengths affect the growth and nutrient uptake of *Tetraselmis chui* (PLY 429- an algal strain used widely as an aquaculture feed). *Tetraselmis chui* cultures were grown aseptically in E/4 media (similar macro-nutrient concentrations as f/2 media) at a temperature of 18°C. Four different light-dark cycles and three different irradiances were used, in a factorial experiment, to determine the relative importance of total light energy input and day length in controlling nutrient uptake and growth. Longer light-dark cycles and higher light intensities resulted in higher biomass production and complete utilization of nitrate and phosphate in less time, as compared with shorter days and lower intensities. Cultures exposed to 8 hours of light per day had minimal growth and nutrient uptake at all intensities. This finding that day length is important in determining growth and nutrient uptake in PLY429 suggests that, in New England during the winter months, artificial light will need to be added to algal cultures in a greenhouse.

PHYTOPLANKTON COMMUNITY STRUCTURE, ABUNDANCE AND DIVERSITY IN LONG ISLAND SOUND FROM 2002-2003.

Lilibeth Miranda[1], Huan Zhang[1], Paul Hargraves[2], and Senjie Lin[1]*
[1]Department of Marine Sciences, University of Connecticut, Groton, CT 06340
[2]Department of Biology, Graduate School of Oceanography, University of Rhode Island, Narragansett Bay, RI 02882

The Long Island Sound (LIS) is characterized by nutrient gradient along the western-eastern axis with eutrophication condition in the western Sound. To determine if there is trend in the phytoplankton community structure along the nutrient gradient,patterns in the spatial and temporal distribution and dominance of total phytoplankton were studied from 2002-2003, microscopically from 17 stations and molecularly at 4 of those stations. Microscopic analysis showed that diatoms dominated the phytoplankton community in all seasons with *Chaetoceros* spp., *Thalassiosira* spp. and *Skeletonema* spp. among the most abundant species. Dinoflagellates increased during summer time coinciding with the highest mean species diversity at this season. The total phytoplankton abundance increased from eastern to western LIS. The <10 μm fraction analyzed using SSU rDNA revealed overall dominance by small-sized diatoms represented by lineages varying along the western-eastern axis, exhibiting high genetic diversity, and detected otherwise undocumented dinoflagellate and pelagophycean taxa. The spatial variability of the stations was characterized by physico-chemical factors using cluster and principal component analyses, which was used to assess the distribution of certain organisms in the study area. Most of the phytoplankton species identified were abundant at high nutrient, low salinity waters of the western part of LIS.

LACUNICULA SARDINIENSIS LANGE-BERTALOT ET AL. (BACILLARIOPHYCEAE) AND ITS RELATIONSHIP WITH THE GENUS *CRATICULA* GRUNOW.

Eduardo A. Morales and My Le
Patrick Center for Environmental Research, The Academy of Natural Sciences of Philadelphia, PA 19103-1195.

Recently, a new diatom species, *Lacunicula sardiniensis*, was discovered by Lange-Bertalot et al. The same authors placed this species in a new genus (*Lacunicula*) based on a channel system found near the raphe. We present here a detailed analysis of a North American population of the same species from Zollner Creek, Oregon. It is proposed that the mentioned species should be placed in the known genus *Craticula* instead.
Lacunicula sardiniensis shares many characteristics with species in the genus *Craticula*; among them are: 1) the presence of a channel system on both sides of the raphe, 2) the similarity of areolar patterns in both external and internal views of the valves, 3) the similarity in the characteristics of the helictoglossa, 4) the presence of longitudinal ridges (extra depositions of silica) on the valve mantle and valve face, and 4) the presence of a canopeum along the axial area of the valves. There are many other raphid diatom genera that are broadly defined to include species with a wide variability of features. For example, the genus *Pinnularia* contains spiny and spineless species and the genus *Sellaphora* contains species with and without a channel system and canopeum. These broadly defined genera are accepted by Lange-Bertalot and collaborators. Thus, there does not appear to be a reason not to apply the same broad concept in the case of *Craticula*. Therefore, the transfer of *L. sardiniensis* to *Craticula* as *C. sardiniensis* is proposed.

POPULATION GENETIC STRUCTURE OF *FUCUS VESICULOSUS* L. WITH RESPECT TO HYDRODYNAMIC REGIMES.

Jessica F. Muhlin and Susan H. Brawley.
School of Marine Sciences, University of Maine, Orono, ME 04469, USA.

Water motion (i.e. calm versus rough conditions) influences the release of eggs and sperm, fertilization, dispersal, and settlement of newly formed individuals of the brown alga *Fucus vesiculosus*. Release of gametes is controlled and confined to periods of calm water conditions. Hydrodynamic regimes may therefore indirectly influence population genetic structure of *F. vesiculosus*, that is, how genetically similar individuals are in space. Levels of water motion on either side of a coastal point can vary greatly during the period when *F. vesiculosus* is able to release eggs and sperm. As a consequence, there may be asynchrony of reproduction on opposite sides and spatial or temporal isolation of individuals that can reproduce with each other. This isolation may result in genetic differentiation. We are testing whether populations of *F. vesiculosus* on opposite sides of a coastal point are genetically distinct from each other. Three polymorphic microsatellite loci were used to define genetic structure of *F. vesiculosus* at a large spatial scale by comparing two Maine coastal promontories that are 80 km apart and on a smaller scale by comparing sites on either side of each promontory (separated by 100s of meters). Preliminary results indicate significant genetic differentiation between the two coastal points. Pairwise tests reveal differences among some sites at Schoodic Point but do not reveal any differences among sites at Pemaquid Point. Populations of *F. vesiculosus* on opposite sides of coastal points do not appear to be genetically distinct from each other. (Supported by NSF OCE-99043)

CELLULOSE SYNTHASE (*CESA*) GENES FROM *VALONIA VENTRICOSA* AND *COLEOCHAETE SCUTATA*.

Alissa A. Neill and Alison W. Roberts. Department of Biological Sciences, University of Rhode Island, Kingston, RI 02881, USA.

Cellulose is an important component of plant and many algal cell walls and exists as a crystalline microfibril composed of parallel β-1,4-glucan chains. Terminal complexes (TCs) are the structures that house the cellulose-synthesizing complex, within the plasma membrane. The structure of TCs ranges from 6-subunit rosettes (plant-like) to large linear (bacterium-like), and is a determinant of microfibril size. The catalytic subunits of cellulose synthase, encoded by *CesA* genes, have common conserved regions, and regions that vary between plants and bacteria. Although the relationship between TC structure and microfibril size has been characterized, the relationship between CesA protein structure and TC structure has not been determined. Understanding the role of CesA proteins in TC assembly may allow manipulation of microfibril structure and assembly. Sequence analysis of *CesA* genes from algal species with different types of TCs, may shed light on the relationship between CesA structure and TC assembly. *Valonia ventricosa* is a green alga that produces some of the largest microfibrils known. This coenocytic alga has large linear TCs that produce the large cellulose microfibrils. *Coleochaete scutata*, another green alga, possesses an 8-subunit rosette TC. We hypothesized that the *CesA* sequences from *V. ventricosa* or *C. scutata* would differ from those of organisms such as *Mesotaenium caldariorum* or land plants that possess 6-subunit rosette TCs. With the use of degenerate primers, partial genomic sequences of *V. ventricosa* and *C. scutata* putative *CesA* genes were cloned and analyzed. Using the BLASTX program to search the NCBI database, the genomic sequences were compared to *CesA* sequences from other algae and plants in order to identify sequence similarities. The search revealed high similarity to plant *CesA* genes. The small amount of algal sequences we have so far do not show substantial differences from plant *CesA* sequences, but with the use of other methods, such as inverse PCR, RAGE, and RACE, we will be able to completely sequence and characterize the *CesA* genes in *V. ventricosa* and *C. scutata*. This work was funded by the U.S. Department of Agriculture NRI-GCP and the University of Rhode Island Foundation.

MARINE MICROFILAMENTOUS GREEN ALGAE: NEW LINEAGES IN THE ULOTRICHALES/ULVALES COMPLEX (ULVOPHYCEAE). Charles J. O'Kelly, Brian Wysor, Wendy K. Bellows and Jeffrey F. Brown. Bigelow Laboratory for Ocean Sciences, West Boothbay Harbor, Maine, 04575, USA.

Microfilamentous green algae, once known as the "marine Chaetophoraceae", are common in marine habitats worldwide, but their taxonomic diversity and phylogenetic relationships have been poorly understood. Two species in particular have come to human attention, one (described under the name *Entocladia endozoica* Goldberg et al., 1984) as a pathogen of sea fans in the Caribbean, and another (*Ulvella lens* Crouan & Crouan, 1859) as the principal component of settling plates for larvae of abalone and sea urchins in mariculture.

Phylogenetic analyses of nuclear- and chloroplast-encoded gene sequences, coupled with investigations at the light and electron microscope levels of algae in culture and from field-collected samples, indicate that all of the ca. 35 species examined to date are members of Ulvophyceae. These algae are distributed among six distinct lineages in the Ulotrichales/Ulvales complex: the Gomontiaceae (Ulotrichales) and the Kornmanniaceae, Ulvellaceae, *Bolbocoleon* lineage, *Phaeophila* lineage, *Ctenocladus / Acroblaste* lineage, and *Ochlochaete / Ruthnielsenia* lineage (Ulvales). The *Ctenocladus / Acroblaste* and *Ochlochaete / Ruthnielsenia* lineages are newly discovered, and the circumscriptions of Gomontiaceae, Kornmanniaceae, and Ulvellaceae significantly revised. The *Ochlochaete / Ruthnielsenia* lineage is the proximate outgroup for the Ulvaceae (sea lettuces).

This complex of microfilamentous green algae contains the only species known in the Ulvophyceae, apart from the Trentepohliales, to have plugged perforate septa or plasmodesmata. Phylogenetic analyses indicate that such septa have evolved three times. *Smithsoniella* (perforate septa) and *Sporocladopsis* (plasmodesmata) are phylogenetically-separated genera of Ulvellaceae, while *Ctenocladus* and *Acroblaste* (perforate septa, distinct from those of *Smithsoniella*) constitute a separate lineage.

Phylogenetic distances among most microfilamentous green algae are relatively small for the markers used. Exceptions are found among the species of Kornmanniaceae and in the *Phaeophila* lineage. These cases may represent instances of accelerated molecular evolution.

The sharp distinction in ultrastructural, reproductive, and life history characters between species assigned to Ulotrichales and to Ulvales is not reflected in the molecular phylogenies, many of which tend to place Ulvales within Ulotrichales, with coccoidal Ulotrichales as stem taxa. Taxon sampling, and unequal rates of sequence evolution, may be contributing to this discordant result. Supported by NSF.

WHAT'S IN THE BOX? THE SEARCH FOR A PHLOROTANNIN MOLECULAR MARKER IN THE BROWN ALGA *FUCUS VESICULOSUS*.

Karen N. Pelletreau and Nancy M. Targett.
Graduate College of Marine Studies, University of Delaware, Lewes, DE, 19958 USA.

Phlorotannins are a major group of brown algal metabolites of putative polyketide origin that are involved in cell wall structure, UV protection, and defense. Their concentrations in algae can be quite variable and numerous studies have attempted to establish a relationship between these concentrations and external factors such as nutrients, light and herbivory. These relationships are correlative at best and, to date, understanding the impact of environmental factors can be assessed only by measuring phlorotannin concentrations in the algae. Despite the considerable amount of research describing the ecological roles of phlorotannins, knowledge of the biosynthesis of phlorotannins remains a "black box". This lack of information has hampered a mechanistic understanding of the factors that affect phlorotannin biosynthesis in brown algae. The development of a molecular marker for a putative "on/off" switch of phlorotannin production would provide crucial information needed for the interpretation and development of ecological models explaining environmental regulation of phlorotannin synthesis. Polyketides are a wide range of compounds generated by polyketide synthases (PKS). Recent advances in understanding PKS from other organisms provide tools to search for an analogous system in the model brown alga *Fucus vesiculosus*. Results of our investigation of PKS genes in genomic and cDNA from *F. vesiculosus* will be presented and compared to information on PKS genes from fungi, bacteria and dinoflagellates.

WHAT IS A SPECIES IN *CHLAMYDOMONAS*?

Thomas Pröschold[1,2] and Annette W. Coleman[2]
[1]Present address: Univ. of Cologne, Bot. Inst., Gyrhofstr. 15, D-50931 Köln, Germany;
[2]Brown Univ., Dept. BioMed., Providence RI 02912, USA

The genus *Chlamydomonas* (including *Chloromonas*) is one of the largest green algal genera comprising more than 600 species. The species within these genera are traditionally described by using only morphological characters of vegetative cells. To initiate a comprehensive analysis of the phylogeny and systematics of both genera, we determined nuclear-encoded SSU and ITS rDNA sequences of more than 100 strains of *Chlamydomonas* and *Chloromonas* and incorporated these into global molecular phylogenetic analyses of Chlorophyceae. In addition, we studied the morphology and reproduction of the strains by light microscopy. We recognize and designate 25 monophyletic lineages (clades) within the Chlorophyceae, 14 of which are confined to the CW (basal bodies displaced clockwise) subgroup. Strains assigned to *Chlamydomonas* and *Chloromonas* were found in 7 different clades confirming the polyphyly of the two genera as presently conceived. To initiate the taxonomic revision of *Chlamydomonas*, *C. reinhardtii* is proposed as conserved type species of the genus. In consequence, species in clades other than the clade containing *C. reinhardtii* must be transferred to other genera, a process initiated in this contribution. The oogamous species of *Chlamydomonas* studied represent a monophyletic lineage, which is described as *Oogamochlamys*. The sister clade to *Oogamochlamys* consists of isogamous strains characterized by chloroplasts with incisions and was described as *Lobochlamys*. Based on secondary structures of SSU and ITS rDNA sequences and results of crossing experiments, a new generic and species concept within the Volvocales can be demonstrated here by *Oogamochlamys* and relatives.

GLUTAMINE SYNTHETASE GENE FAMILIES: AN EVOLUTIONARY PERSPECTIVE.

Deborah L. Robertson, Sohini Ghoshroy[1] and Molly R. Letsch[1]
Department of Biology, Clark University, 950 Main Street Worcester, MA 01610
[1]These authors contributed equally to the research project.

Glutamine synthetase (GS) is found in all organisms and plays an essential role in nitrogen metabolism. Members of three gene families (GSI, GSII, GSIII) are found in both prokaryotes and eukaryotes, and phylogenetic examination of the gene families will contribute to our understanding of the evolution of nitrogen metabolism. We are particularly interested in photosynthetic eukaryotes, which express multiple GS isoenzymes. In diatoms, a nuclear-encoded GSII enzyme is targeted to the chloroplast while GSIII functions in the cytosol. Phylogenetic analyses provided strong support for the monophyly of diatom and *Porphyra yezeoensis* GSII genes and moderate to weak support for an oomycetes-diatom-*Porphyra* clade. This suggests the diatom/stramenopile GSII gene evolved via lateral gene transfer with the subsequent loss/replacement of the host GSII gene. In contrast, the phylogeny indicated vascular plant isoenzymes evolved via gene duplication following the divergence of green algae and vascular plants. Thus, while multiple isoenzymes exist in photosynthetic eukaryotes, they arose via different and independent evolutionary processes.

GSIII sequences are known from prokaryotes, *Dictyostelium*, diatoms, and based on our analyses, from heterkonts isolated from environmental samples. The presence of GSIII in *Dictyostelium* and heterkonts is consistent with the hypothesis that GSIII was present in the nuclear genome of early eukaryotes and lost in several lineages. Phylogenetic analyses of GSIII did not provide support for lateral gene transfer from prokaryotes to eukaryotes however, GSIII sequence data are sparse and phylogenetic resolution will require broader taxon sampling.

Eukaryotic GSI sequences form a monophyletic group suggesting GSI was also present in the nucleus of the earliest eukaryotes. However, the presence of gene fusions, mutations in active site residues, and genetic studies suggest that GSI plays a regulatory rather than enzymatic role in eukaryotes. Further examination of GSI may provide information regarding the evolution of novel gene functions.

EFFECTS OF A PUTATIVE MALE PHEROMONE ON OOGENESIS IN THE BROWN ALGA *MACROCYSTIS INTEGRIFOLIA*.

David Sakoda, Katherine Wells, and Raymond J. Lewis
Department of Biology, Wheaton College, Wheaton, IL, 60187, USA

The giant kelp, *Macrocystis integrifolia* Bory, occurs in dense forest formations near the shore of the Pacific coastal region of North America and along land masses in the subantarctic Southern hemisphere. The reproductive cycle of *M. integrifolia*, which involves alternation of generations between diploid sporophytes and haploid gametophytes, is directed in part by pheromones. Female gametophytes produce pheromones which signal the release and attraction of sperm to eggs. However, little is known about possible male pheromones which have been observed to enhance oogenesis in female gametophytes. We examined the nature and effects of a putative male pheromone through experiments involving cell-free male medium and varying ratios of male/female gametophytes. In the first experiment, female gametophyte cultures were exposed to 1 of 4 different treatments: one dose of cell-free male medium on day 1; five doses of cell-free male medium administered on days, 1, 3, 6, 8, and 10; constant exposure to male gametophytes; and no exposure to male gametophytes or cell-free male medium. Females receiving doses of cell-free male medium on days 1, 3, 6, 8, and 10 produced a significantly larger number of eggs than cultures receiving a single dose of male medium on day 1 or no male medium at all. However, the amount of oogenesis in cultures containing both male and female gametophytes was far greater than that seen in any of the other three treatments. This suggests that the male secreted pheromone is either volatile or decomposes quickly. In the second experiment, female and male gametophytes were cultured in varying ratios. Oogenesis occurred in all cultures from 0-90% male, with very little oogenesis in 0% male. Egg production increased significantly as the proportion of males was increased. This is consistent with the males providing a dose of pheromones that is increased with the number of males present. Further research is being conducted to more specifically characterize the male secreted pheromone and its effects across species lines.

SEASONAL PRODUCTION OF CYANOBACTERIAL TOXINS IN ONEIDA LAKE, NEW YORK, USA.

Mike Satchwell, Amber Hotto, Xingye Yang, Kristy Szprygada, and Gregory Boyer.
Faculty of Chemistry, State University of New York, College of Environmental Science and Forestry, Syracuse, NY, USA.

Oneida Lake is a 33.6 km long shallow, wind-mixed lake located in central New York, USA. It is valued for its sport fishing, boating and recreational swimming. During the summers of 2002-2003, samples were collected weekly from 6 stations and analyzed for microcystins, anatoxin-a and the PSP toxins (2002: 78 samples, 2003: 95 samples). Additionally, samples were collected for nutrient analysis, chlorophyll-a, taxonomy, DNA analysis, and basic water quality parameters such as DO, temperature, pH and Secchi depth. Primary productivity, as determined by decreasing Secchi depth, reached a maximum in late August at all 6 stations, which coincided with peaks in chlorophyll-a, phycocyanin and microcystin levels. In both years, the onset of microcystin production was detected as early as mid June, as measured by the protein phosphatase inhibition assay, and reached a maximum of 2.9 $\mu g\ L^{-1}$ in 2002 and 3.4 $\mu g\ L^{-1}$ in 2003. Beginning in mid- to late August of both years, there was a consecutive period of 10 (2002) or 18 (2003) days in which all 6 stations had microcystin levels in excess of the WHO advisory level of 1.0 $\mu g\ L^{-1}$. The percent of samples that had microcystin levels greater than 1.0 $\mu g\ L^{-1}$ was 9% in 2002 and 24% in 2003. Anatoxin-a was detected in trace amounts in both years (2002, 4 samples, highest concentration 0.008 $\mu g\ L^{-1}$; 2003, 6 samples, highest concentration 0.020 $\mu g\ L^{-1}$). The PSP toxins were not detected in any sample from either year. Oneida Lake offers an excellent model system to develop techniques that can be used to rapidly detect and respond to harmful algal blooms due to the seasonal production of cyanobacterial toxins.

A NEW SPECIES OF *CHONDRACANTHUS* FROM BERMUDA—EXTINCTION BEFORE DESCRIPTION?

Craig W. Schneider[1] and Christopher E. Lane[2].
[1]Department of Biology, Trinity College, Hartford, CT 06106-3100, USA
[2]Department of Biology, University of New Brunswick, Fredericton, NB E3B 6E1, Canada

A species that we have collected over several years in Walsingham Pond in Bermuda is shown to be a unique new entity in *Chondracanthus* (Gigartinaceae) based upon morphological evidence and analysis of *rbc*L sequences from plastid DNA. Walsingham, connected to the ocean by submerged caverns, is the type locality of four other taxa of macroalgae, thus an important biological site in the islands. The new species is firmly embedded in a phylogenetic clade with other known *Chondracanthus* species, including two known from the Atlantic, *C. acicularis* and *C. teedei*. The new Bermuda species is morphologically intermediate between those two. When Hurricane Fabian struck Bermuda with all her fury in Sept. 2003, surface waters of the landlocked salt pond were reconnected with the Atlantic Ocean for the first time in recorded history. Events of the hurricane caused the pond to turn anoxic, leading to the death of most of the intertidal and subtidal biota in this once thriving, protected pond—a virtual classroom for Bermuda's macroalgal biodiversity. A dive in Walsingham one month post-Fabian showed the type locality of the new species (a vertical wall) to be a mass of bacterial decomposition. Since that time, we have discovered that *Phycotheca Boreali-Americana* exsiccata no. 1884 (Collins, Setchell & Holden 1912, as *Gigartina acicularis),* and other historical specimens from Bermuda identified as *G. acicularis* are also the new species.

THE VALUE OF A MARINE PROTECTED AREA FOR A UNIQUE POPULATION OF *CHONDRUS CRISPUS*. IRISH MOSS,PRINCE EDWARD ISLAND, CANADA.

Glyn Sharp[1], Robert Semple[1]
Fisheries and Oceans Canada, Bedford Institute of Oceanography, Dartmouth, Nova Scotia, Canada, B3Z 2A4

The marine lagoon Basin Head contains a unique gametophyte generation of unattached "giant" *Chondrus crispus*. Under the Canadian Fisheries Act cannot be harvested, but protection of its habitat was possible when the Oceans Act was promulgated in 1996. This act allows the development of a management plan for the lagoon that will consider all issues impacting on the preservation of the *Chondrus crispus* population.
Potential negative impacts on the population include, physical disturbance, water quality, changes in lagoon structure and eutrophication. Eutrophication of the lagoon is the most pressing threat to this small ecosystem. Nutrient inputs from intensive agriculture elevate Nitrate and Phosphate values in the summer to levels above 1000 ug l^{-1} and 200 ug l^{-1} respectively. Macrophyte blooms, primarily *Ulva lactuca* increase plant biomass in the Basin at the rate of 10% to 30% per day in optimal conditions. In areas of poor water circulation the breakdown of plant material produces anoxic conditions. The accumulated Ulva lactuca biomass declines in the fall through microbial degradation, herbivory and natural flushing of the lagoon. A management plan for the lagoon must extend beyond the marine boundaries and address issues of land use and development. Designation of the Basin Head lagoon as an MPA has brought a focus on both the unique *Chondrus crispus* population and the general ecological health of the lagoon.

KEY TO FRESHWATER ALGAE: A WEB-BASED TOOL TO ENHANCE UNDERSTANDING OF MICROSCOPIC BIODIVERSITY.

Hannah A. Shayler and Peter A. Siver.
Department of Botany, Connecticut College, New London, CT 06320, U.S.A.

The Freshwater Ecology Laboratory at Connecticut College is developing an interactive, web-based, computerized identification key for freshwater algal genera using Lucid Professional software. Users may answer questions in any order to quickly and efficiently narrow down the list of taxa to only those that match the characteristics they have chosen. All characters and terms are clearly explained for ease of use by those unfamiliar with the algae. This non-hierarchical, user-friendly key will be linked to web pages containing a wealth of resources, including images, movies, and information about the morphology, ecology, and reproduction of each organism. Cultures from the Carolina Biological Supply Company representing nearly 70 freshwater genera from a variety of algal groups were observed and photographed using high resolution digital imaging to fully document morphology and structure. High quality video footage of each taxon was outputted as QuickTime movies, on DVD, and on VHS cassettes. The movies incorporate titles, diagrams, and structural terminology to further familarize students with the morphology and taxonomy of the algal groups and genera. Our key and its supplemental materials will provide a unique and innovative alternative to traditional dichotomous keys that is particularly appropriate for introducing students to the algal groups and genera.

THE SILICA SECCHI DISK: AN INTERACTIVE PHYCOLOGICAL AND LIMNOLOGICAL TOOL.

Peter A. Siver, Hannah A. Shayler and Anne-Marie Lott.
Department of Botany, Connecticut College, New London, CT 06320, U.S.A.

The Freshwater Ecology Laboratory at Connecticut College has developed an extensive interactive website, http://silicasecchidisk.conncoll.edu. The SilicaSecchiDisk provides research tools for diatoms and scaled chrysophytes, an extensive limnological database, and educational aids for the study of freshwater algae. Visitors to the site may search our full database to access organismal and lake ecological data generated by a National Science Foundation sponsored Biotic Survey and Inventory of "*Scaled Chrysophytes and Diatoms in Seepage Lakes Along the East Coast of the United States*," as well as the results of other projects. Users may search by geographic location, lake name, or any chemical or physical parameter to access the limnological database of chemical, physical, and morphological data on lakes and ponds from our research in northern New England (Maine, Vermont, New Hampshire), the Adirondacks (New York), Cape Cod (Massachusetts), Connecticut, North Carolina, and Florida. Our extensive organismal database of scaled chrysophyte and diatom taxa common to North America includes an image library (with SEM and light micrographs) and a searchable database of ecological information, biogeographic records, and taxonomic data, as well as interactive taxonomic keys for some chrysophyte taxa. A complementary section highlights images and references for new chrysophyte and diatom taxa resulting from the research efforts of the Freshwater Ecology Laboratory. Finally, the Algal-Ed section of the SilicaSecchiDisk provides students, educators, and researchers with an interactive identification key for freshwater algae that is linked to images, movies, and organismal information. Together the various components of the SilicaSecchiDisk allow access to all information generated by the Freshwater Ecology Laboratory and provide unique and interactive educational tools.

TROPHIC CASCADING EFFECTS OF MESOZOOPLANKTON ON PRIMARY PRODUCTION ACROSS GEOGRAPHICAL GRADIENTS IN NUTRIENT AVAILABILITY.

Amy Nicole Smith[1] and Hans G. Dam[1].
[1]Department of Marine Sciences, University of Connecticut, Groton, Connecticut, 06340, USA.

Primary production is controlled by both bottom-up forcing (nutrient availability) that sets upper limits for productivity and top-down forcing (grazing pressure) that inhibits productivity from reaching maximum levels. The existence of trophic cascades in marine planktonic communities has received scant attention. Previous studies, mostly from freshwater systems, have suggested that the importance of top-down effects depends on size and nutritional quality of available prey. Because nutrient availability affects both the size and the nutritional quality of the primary producers, we conducted a series of 'cascade' experiments along a north-south transect in the North Atlantic (Woods Hole, MA to Scarborough, Tobago). Effectively, we assessed the importance of top-down forcing on marine primary production across a large-scale, natural gradient in bottom-up forcing. Although no clear direct or indirect effects were observed in New England shelf or slope waters, we observed strong indirect effects of mesozooplankton on chlorophyll *a* concentrations and net growth rates at four offshore stations in the Sargasso Sea (less than 20 micron phytoplankton size fraction). An unexpected indirect effect, although weaker, was also observed in the highly productive Amazon/Orinoco waters on the South American shelf. These results demonstrate that top-down forcing by mesozooplankton is indeed an important control of primary production across diverse marine ecosystems.

LARGE-VOLUME MICROALGAL CULTURE IN A GREENHOUSE ENVIRONMENT.

Barry C. Smith, and Gary H. Wikfors.
DOC, NOAA, NMFS, Northeast Fisheries Science Center, Milford Laboratory, Milford, CT, 06460 USA

The Greenhouse for Research on Algal Mass Production System (GRAMPS) was constructed as a facility for research on growing large volumes of dense algal cultures to produce biomass for aquaculture and other applications. Targeted production density is $1x10^6$ cells/ml in two 20,000-liter tanks and nine 500-liter cylindrical tanks.

Although the targeted cell density has been achieved, and exceeded several times, typical densities have been about $0.75x10^6$ cells/ml with operating volumes ranging from 12,000 to 19,000 liters. The marine algae cultured were *Tetraselmis chui* (PLY429) and *Tetraselmis striata* (PLAT-P). Other algae grown in 500-liter cultures have included *Isochrysis* spp. (ISO, T-ISO, and C-ISO) as well as *Rhodomonas* sp. (RHODO). Semi-continuous production cultures have lasted between 45 and 195 days.

The main obstacles to a truly reliable (stable) semi-continuous culture have been unwanted, living contaminants. A *Euplotes* sp. ciliate and two types of cyanobacteria have presented the greatest challenges. The ciliate was eliminated with improvements in sanitizing the culture vessel and associated tools. At this time, cyanobacteria may have been successfully excluded with a combination of sanitizing the culture vessels and ultra filtration of supply water. Currently, five 500-liter cultures have remained uncontaminated for over 150 days.

A computer monitoring and control system is being implemented to collect and log data, and to control culture pH throughout GRAMPS. With this automation operational, cultures can be held within an optimum range for maximal nutrient availability, which will enhance overall culture stability. Automated monitoring also will facilitate investigations for optimization of economic returns for nutrient and energy inputs.

COPEPODOLOGY FOR THE PHYCOLOGIST WITH APOLOGIES TO G. E. HUTCHENSON

Patricia A. Tester. National Oceanic Atmospheric Administration Beaufort Laboratory, 101 Pivers Island Rd., Beaufort, North Carolina 28516-9722 Phone: 252-728-8792, Fax: 252-728-8784, Email: Pat.Tester@noaa.gov

Heterocapsa triquetra is one of the most common bloom forming dinoflagellates found in estuaries and near shore regions around the world. In order to bloom, *H. triquetra* optimizes a suite of factors including low grazing pressure, increased nutrient inputs, alternative nutrient sources, and favorable salinity and hydrodynamic conditions, as well as the negative factors of temperature-limited growth, short day lengths, and periods of transient light limitation. The prevailing environmental conditions associated its wintertime blooms are largely the result of atmospheric forcing. Low-pressure systems moved through coastal area at frequent intervals and are accompanied by low air temperatures and rainfall. Runoff following the rainfall events supplies nutrients critical for bloom initiation and development. *Heterocapsa triquetra* blooms can reach chl *a* levels >100 µg L^{-1} and cell densities between 1 to 6 x 10^6 L^{-1}. As the blooms develop, nutrient inputs from the river became insufficient to meet growth demand and *H. triquetra* feeds mixotrophically, reducing competition from co-occurring phytoplankton. Cloud cover associated with the low-pressure systems light limit *H. triquetra* growth as do low temperatures. More importantly though, low temperatures limit micro and macrozooplankton populations to such an extent that grazing losses are minimal.

IMPACT OF THE INVASIVE ALGA *GRATELOUPIA TURUTURU* (HALYMENIACEAE, RHODOPHYTA) ON THE NATIVE ALGA *CHONDRUS CRISPUS* (GIGARTINACEAE, RHODOPHYTA)

James Torbett, Tony Fuda, Francis Piercey, Martine Villalard-Bohnsack and Marcie Marston
Department of Biology, Roger Williams University, Bristol, Rhode Island

Since its introduction, the invasive red alga *Grateloupia turuturu* has spread throughout Narragansett Bay, along the Rhode Island coastline, and to both Block Island and Long Island. At these locations, *G. turuturu* has established primarily in *Chondrus crispus* beds. This study examines *G. turuturu*'s impact on the native alga *C. crispus*. For the past 6 years, the percent cover of *G. turuturu* and *C. crispus* has been monitored at several locations in Narragansett Bay. The average percent cover of *G. turuturu* in our quadrats has remained at over 60%, while *C. crispus* coverage has decreased to less than 15%. Our field studies also include placing sand-coated plates inoculated with *G. turuturu* spores in *C. crispus* beds. Preliminary results suggest that *G. turuturu* thalli adversely affect *C. crispus*. In addition, we have initiated studies to examine the potential impact of *G. turuturu* on the genetic structure of the Rhode Island *C. crispus* population. Several different regions of the *C. crispus* genome are being sequenced from specimens collected throughout Narragansett Bay. The genetic diversity of these sequences is lower than we expected based on previous reports in the literature. For example, sequences of the mitochondrial *cox2-cox3* intergenic spacer region are identical for all Rhode Island *C. crispus* individuals tested thus far. We are now testing more specimens and using additional molecular markers to look for regions of greater diversity. Although our preliminary field data suggest that *G. turuturu* can negatively impact *C. crispus*, the extent of this impact is not yet known.

MORTALITY OF THE BROWN SEAWEED *ASCOPHYLLUM NODOSUM* (*LE JOLY*) PRODUCED BY CUTTER RAKE HARVESTS IN SOUTHERN NEW BRUNSWICK.

Raul A. Ugarte, Bruce Moore, Jacqueline Bettle and Joshua Sharp
Acadian Seaplants Limited. 30 Brown AV. Dartmouth, N.S. Canada. B3B 1X8

Mortality of *A. nodosum* (rockweed) plants has been monitored from the commercial landings since 1995 by both the harvesting company and the province of New Brunswick. The current regulation restricts the incidence of plants with holdfasts in the harvest to 10% of the harvested biomass. Although this measure is part of several precautionary measurements to protect the resource and the habitat, it was not clear whether this percentage was adequate as we lacked field data to establish a good correlation with the rate of natural mortality. Mortality in most commercial brown seaweeds species is relatively easy to determine if a single shoot emerges from the holdfast and no regeneration occurs from the residual tissue after harvest. However the rockweed plant is a complex structure of shoots (clump) generated from a single holdfast and regeneration occurs even after intense harvests.

This study evaluated the impact of the harvest on rockweed clumps, by analyzing the size structure of harvested and non-harvest clumps from a harvesting area with a consistently high incidence of plants with holdfasts during the past nine years. These clumps were also compared with naturally detached (storm-cast) rockweed clumps from the same area.

The average length of non-harvested clumps (71.8 cm ± 0.79 SE) was not significantly different from the harvested and naturally detached clumps. However, they were significantly different ($P < 0.05$) in weight (124.5 g ± 8.2 SE Vs 78.7 g ± 2.7 SE and 67.8 g ± 5.2 SE), number of shoots (41.6 ± 1.27 SE Vs 8.2 ± 0.24 SE and 6.4 ± 0.57 SE) and holdfast area (124.0 mm^2 ± 4.0 SE Vs 21.6 mm^2 ± 0.60 SE and 14.9 ± 1.2 SE). The overall impact of the harvest on rockweed mortality is discussed in relation to the characteristics of the harvesting method and the rockweed population structure for southern New Brunswick.

NONLINEAR MULTIVARIATE POLYNOMIAL ANALYSIS OF PHYTOPLANKTON SPECIES IN THE LOWER HUDSON RIVERPATTERNS IN LOWER MANHATTAN SITES, 1996-2003.

Zhao-Yan Wang[1], David A. Vaccari[1], M. Levandowsky [2].
[1]Stevens Institute of Technology, Hoboken, NJ. 07030, [2]Haskins Labs, Pace U., NY 10038 USA

An 8-year series of weekly phytoplankton samples from the lower Hudson River was analyzed by nonlinear multivariate polynomial regression (MPR). Models were developed to predict the presence or absence of 3 phytoplankton taxa: *Actinoptychus undulatus*, *Rhizosolenia setigera*, and *Scenedesmus quadricauda*, using measurements of temperature, salinity, pH, Secchi depth and dissolved oxygen. The MPR model had a significantly better ability to predict the presence of the 3 taxa studied compared to multilinear regression models and other linear approaches such as discriminant analysis, and could describe more complex relationships. For example, the model showed that *R. setigera* had an envelope of conditions for high probability of occurrence that encompassed high salinity conditions, with the threshold of salinity being lowest at about 5 degrees Celsius, increasing at higher and lower temperatures.

COMBINING RIBOSOMAL RNA GENES TO RESOLVE PHYLOGENETIC RELATIONSHIPS AMONG THE LINEAGE-4 ORDERS OF FLORIDEOPHYCEAE (RHODOPHYTA): DOES A MULTI-GENE APPROACH PROVIDE NEW INSIGHT?

Rodney D. Withall and Gary W. Saunders. Centre for Environmental and Molecular Algal Research, Dept. of Biology, University of New Brunswick, Fredericton, N.B. Canada

Phylogenies based on the nuclear small-subunit (SSU) ribosomal DNA have resolved four distinct monophyletic lineages in the class Florideophyceae. Unfortunately, a number of key phylogenetic issues within these four lineages remain equivocal using this same gene system, particularly at the ordinal level in Lineage 4. Of the nine orders currently recognized in this lineage, SSU analyses only resolve an association between the Halymeniales and Rhodymeniales. The large-subunit (LSU) was hypothesized to provide resolution were the SSU failed, however, combined analyses utilizing both genes revealed conflicting ordinal associations. Our current phylogenetic analyses with increased taxon sampling and more comprehensive representation within Lineage 4 reveal that a contradictory association between the Halymeniales and the Gracilariales is an artifact stemming from a combination of long-branch attraction and low taxon sampling. Our current lack of understanding of ordinal relationships in this lineage is further confounded by a number of independent lines of the Gigartinales *sensu lato*. Two remaining disparate families of this order, the Acrosymphytaceae and Calosiphoniaceae, consistently fail to associate with other representative families. A new order, Acrosymphytales *nom. prov*., is proposed to include the Acrosymphytaceae and Calosiphoniaceae.

EVIDENCE FOR POLYPHYLY OF *ULOTHRIX* AND *MONOSTROMA*, AND OTHER NOVEL RELATIONSHIPS IN THE ULOTRICHALES (ULVOPHYCEAE).

Brian Wysor, Charles J. O'Kelly, Wendy K. Bellows and Jeffrey F. Brown. Bigelow Laboratory for Ocean Sciences, West Boothbay Harbor, Maine, 04575, USA.

Among the classic discoveries of the "comparative ultrastructure" phase of green algal systematic biology research was that species with an unbranched uniseriate filamentous morphology (genus *Ulothrix* sensu lato) form a complex assemblage with representatives of three of the five classes then recognized (*Ulothrix*, Ulvophyceae; *Uronema*, Chlorophyceae; *Klebsormidium*, "Charophyceae", now Klebsormidiophyceae). Species assigned to *Ulothrix* (Ulvophyceae) are known to be ultrastructurally heterogeneous, but the assignment to a single genus has not been questioned.

Molecular phylogenetic investigations, however, indicate that *Ulothrix* (Ulvophyceae) remains polyphyletic within algae now placed in the order Ulotrichales, and that ultrastructural features, especially pyrenoid ultrastructure, are at least partially correlated with the molecular signature. To date, it is known that marine species of *Ulothrix* characterized by an "entire" pyrenoid matrix (not traversed by thylakoid membranes or cytoplasmic channels) are closely related to species of *Urospora* and *Acrosiphonia*, while the predominantly freshwater species *U. zonata*, characterized by pyrenoids traversed by thylakoids, is most closely related to microfilamentous species now placed in the genera *Chamaetrichon*, *Pseudendoclonium* and *Trichosarcina*. Observations on the marine *Ulothrix* species include both ultrastructural and molecular characterization of holotype specimens.

A similar situation exists for the genus *Monostroma*. *Monostroma undulatum* (or *Protomonostroma undulatum*), with "entire" pyrenoids, is closely related to *Ulothrix* species with "entire" pyrenoids, and with them belongs in the "*Acrosiphonia*" clade of Ulotrichales. *Monostroma grevillei*, with pyrenoids traversed by thylakoids, is most closely related to species now placed in the genera *Collinsiella*, *Gomontia* and *Eugomontia*, none of which have *Monostroma*-like gametophyte morphology. The only non-molecular clue to the existence of a clade containing *Collinsiella*, *Gomontia*, *Eugomontia* and *M. grevillei* is that all produce sporophytes that penetrate into calcified shells e.g. those of mollusks. Neither *M. grevillei* nor *P. undulatum* appears to be closely related to *M. oxyspermum* (*Gayralia oxysperma*) or to species of *Capsosiphon*, sometimes included within *Monostroma*. Supported by NSF.

THE DEMISE OF THE CHAETOSIPHONACEAE (CLADOPHORALES, CHLOROPHYTA): MORPHOLOGY AND MOLECULAR PHYLOGENY OF *CHAETOSIPHON MONILIFORMIS*, *BLASTOPHYSA* SPP. AND *WITTROCKIELLA* SPP.

Brian Wysor, Charles J. O'Kelly, Wendy K. Bellows and Jeffrey F. Brown. Bigelow Laboratory for Ocean Sciences, West Boothbay Harbor, Maine, 04575, USA.

The French botanist Jacob Huber, in 1892, created the family Chaetosiphonaceae for two endophytic, "hair"-bearing multinucleate-celled green algae, *Chaetosiphon moniliformis* Huber and *Blastophysa rhizopus* Reinke. *Chaetosiphon moniliformis*, the type and only species of its genus and the type species of the family, is known only from the Mediterranean Sea and was known only from the type locality until additional records were made in the last decade of the 20th century. Consequently, the relationships of this alga with *Blastophysa rhizopus* and with another group of "hair"-bearing cladophoralean algae, the genus *Wittrockiella*, have not been assessed with modern methods. Huber suggested that the Chaetosiphonaceae is a "stem taxon" for the Cladophorales, and an early molecular phylogeny study including *Blastophysa rhizopus* seemed to support this suggestion.

Phylogenetic reconstructions from gene sequences demonstrate that *Chaetosiphon moniliformis*, *Blastophysa* spp. and *Wittrockiella* spp. are unrelated to each other. The "basal" position for *Blastophysa* is confirmed, while *Wittrockiella* belongs to the "*Aegagropila*"-clade of Cladophorales. *Chaetosiphon* is closely related to e.g. *Anadyomene* and *Ernodesmis* in the principal clade of Cladophorales. The molecular differences have correlates among morphological and cytological characters. For instance, the "hairs" (setae) of *Blastophysa* species lack included organelles, while the hairs of *Wittrockiella* and *Chaetosiphon* contain organelles, especially nuclei. Also, nuclear divisions are fully synchronized within cells of *Blastophysa* and *Wittrockiella*, while those of *Chaetosiphon* are not.

Morphological and molecular characters separating *Chaetosiphon moniliformis* from its neighbors in the molecular phylogeny do not support retaining the Chaetosiphonaceae as a distinct family of Cladophorales. The "stem taxon" position proposed for *Blastophysa* is supported in the molecular phylogeny. The discordance between the non-cladophoralean molecular signature and the distinctly cladophoralean ultrastructural signature of *Blastophysa* has yet to be reconciled, and may influence views on the evolutionary history and classification ("Cladophorophyceae") of the lineage. Differences in primary gene sequence between strains suggest that *Blastophysa* is not a monotypic genus as is commonly thought. Fully synchronized mitoses within cells may be a diagnostic feature for *Blastophysa* and the "*Aegagropila*"-clade of Cladophorales. Supported by NSF.

THE EFFECT OF PH ON THE STABILITY OF THE CYANOBACTERIAL NEUROTOXIN, ANATOXIN-A.

Xingye Yang, M.F. Satchwell, and G. L. Boyer (Advisor). Faculty of Chemistry, State University of New York, College of Environmental Science and Forestry, Syracuse, NY 13210, (Xyang02@syr.edu)

Cyanobacterial blooms and their toxins have caused environmental and human health problems worldwide. Recently, the neurotoxic cyanobacterial toxin, anatoxin-a, has caused the deaths of several dogs near Lake Champlain, as well as the death of a Wisconsin teenager. This is the first reported human fatality due to anatoxin-a intoxication in the United States. Anatoxin-a is produced by a number of cyanobacteria species, but is rarely found at significant concentrations in natural waters. One possible explanation is the toxin is rapidly degraded to products such as anatoxin-a epoxide and dihydroanatoxin-a under natural conditions of light and alkalinity. Understanding this degradation process is important to assess the potential health risks associated with these toxic cyanobacterial blooms. The stability of anatoxin-a was investigated in laboratory studies. Under neutral conditions, anatoxin-a was stable for up to 30 days. In contrast, anatoxin-a was readily degraded with increasing pH. At pH 9.5, approximately 80% of anatoxin-a degraded within 10 days to form epxoyanatoxin-a and other unidentified degradation products. Further studies on the photochemical degradation of anatoxin-a are in progress to elucidate the effect of light on this degradation process.

EFFECTS OF METAL CONCENTRATION AND pH ON GROWTH OF PHOTOSYNTHETIC PROTISTS ISOLATED FROM THE ACIDIC, HIGH-METAL RIO TINTO, SPAIN.

Erik R. Zettler[1,2], Linda A. Amaral Zettler[3], Ricardo Amils[2,4], Ashley Meyer[5], and Mitchell L. Sogin[3].

[1]Sea Education Association, P.O. Box 6, Woods Hole, MA 02543

[2]Centro de Biología Molecular, UAM-CSIC, Cantoblanco, Madrid 28049, Spain

[3]Josephine Bay Paul Center for Comparative Molecular Biology and Evolution, Marine Biological Laboratory, Woods Hole, Massachusetts 02543, USA

[4]Centro de Astrobiología, INTA-CSIC,Torrejón de Ardoz 28850, Spain

[5]Falmouth Academy, 7 Highfield Drive, Falmouth MA 02540

The Rio Tinto is an acidic river that flows over 90 km through the Iberian pyritic belt in southwestern Spain. Despite the acid conditions (pH 1.7-2.5) and very high heavy metal concentrations (e.g. up to 20g/L Fe and 100 μg/L Cu), there are abundant biofilms containing conspicuous eukaryotes. Three clonal cultures of photosynthetic representatives from these biofilms, *Euglena* cf. *mutabilis*, *Chlamydomonas* sp., and *Chlorella* sp. were isolated from the river. In order to determine their preferred hydrogen ion and metal concentrations, they were grown in Modified Acid Medium at a range of pH values between 2 and 8, ferrous iron concentrations from trace to 20g/L, and copper concentrations from trace to 100 μg/L. All cultures grew at iron concentrations of up to 20g/L, but the responses varied between species. *Euglena* growth rates were similar at all concentrations but relative biomass (measured as in-vivo fluorescence) decreased sharply above 3g/L Fe. *Chlorella* growth rates and biomass were highest from 1-5 g/L Fe decreasing at trace and high concentrations, while *Chlamydomonas* growth rates and biomass were highest below 5g/L Fe. The Rio Tinto cultures grew faster and achieved higher biomass at a higher copper concentration than a control *Chlamydomonas reinhardtii* culture, but did not grow above concentrations of 5 μg/L. Preliminary results indicate that the organisms isolated from the Rio Tinto grow better at low pH.

SPATIAL AND SEASONAL VARIATION IN DINOFLAGELLATE DIVERSITY IN LONG ISLAND SOUND ANALYZED WITH MITOCHONDRIAL CYTOCHROME *B*.

Huan Zhang, Yubo Hou, Lilibeth Miranda and Senjie Lin
Department of Marine Sciences, University of Connecticut, Groton, CT 06340

Mitochondrial cytochrome *b*, a gene widely used for phylogenetic studies for various organisms, was isolated for dinoflagellates, and dinoflagellate-specific *cob* primers were designed. Water samples were collected from the western (WLIS; A4) and the eastern Long Island Sound (ELIS; K2 and Avery Point) in the four seasons, and DNA extracted was used in PCR with the *cob* primers. The amplicon was cloned, and over 20 clones from each water sample were sequenced. Phylogenetic analysis revealed clear spatial and temporal variation in dinoflagellate community. The highest total abundance and diversity index (H') was observed in the summer (July). Prorocentrale taxa were distributed mainly in WLIS, and exclusively in July. Gymnodiniale group was the dominant dinoflagellates through out the year, accounting for a larger fraction of dinoflagellates in WLIS in 2002 and being dominant at Avery Point (ELIS) in 2003. *Akashiwo* sp. was the dominant Gymnodiniale in the summer (August and September). *Pfiesteria*-like dinoflagellates occurred in ELIS, more in the spring-summer season. A Gonyaulacales/*Pfiesteria* complex was detected in all seasons in both ELIS and WLIS, and it dominated the dinoflagellate community in ELIS during summer-autumn of 2002 and January of 2003. Strong interannual variation was observed in abundance of Gonyaucales, in which *Alexandrium*-like species occurred in all seasons in 2002 and was more abundant in ELIS in the winter of 2003. Suessiale taxa (zooxanthallae) appeared in spring at WLIS, summer at ELIS in 2002, and both spring and summer at ELIS (Avery Point) in 2003. In addition, some apparently unknown and ancestral taxa were detected.

DISTINGUISHED SPEAKER: Patricia Ann Tester

Research Fishery Biologist 252 728-8792
National Ocean Service, NOAA Fax 728-8784
101 Pivers Island Road
Beaufort, NC 28516 Pat.Tester@NOAA.gov

EXPERIENCE

National Ocean Service, NOAA (2004-presen)
Branch Chief (acting) Coastal Ecosystems Research
National Ocean Service, NOAA (1999-2004)
Team Leader, Plankton Ecology/Physiology
National Marine Fisheries Service, NOAA (1981 -1998)
Research Fishery Biologist, Program in Lower Trophic Food Web 1990-1998
Research Associate, Duke University Marine Laboratory, Beaufort, NC (1977-1980)
Graduate Res. Assistant, Oregon State Univ., School of Oceanography, Corvallis, OR (1973-1976)
Supervisor Central Quality Control Laboratory, United Vintners, Asti, CA (1971-1972)
Adjunct Professor, Old Dominion University, Norfolk, VA (1990 - present)

1987 Provide Testimony to House Small Business Administration Committee on Red Tides
1988 Unit Citation Award NOAA
1990 Special Achievement Award, NOAA, Red Tide Response
1991 Citation North Carolina Marine Science Board, Governor Martin
1993 Food Chain-Web Control of Harmful Algae, Swedish Royal Academy joint research team,
1994 MARE (Microalgae of the Adriatic Region) Project, EEC joint research team, Fano Italy
1994-Present Member of ICES-IOC Working Group on Harmful Algal Bloom Dynamics
1995-Present Interagency Network on Climate and Human Health (WHO-WMO-UNEP)
1996 Fish and Wildlife Federation National Panel on Mitigation & Control of HABs
1996 NATO Advanced Study Institute: Physiological Ecology of Harmful Algal Blooms
1997 State of Maryland Technical Advisory Committee, Pocomoke River Fish Health
1998 NRC, Ocean Studies Board, Committee on The Ocean=s Role in Human Health
1999 Nancy Pace Groseclose Lecturer, Emory & Henry College
2000 Senior Forum Lecturer Davidson College
2000 Provide Informational Briefing to House of Representatives & Senate on HABs
2000 National Organizing Committee Harmful Algal Blooms 2002
2000 HABSOS (Coastal GOOS demonstration for HABs in the Gulf of Mexico) Steering Com.
2000 Symposium on Harmful Marine Algae in the US, Steering Committee (Int. Meeting 2002)
2001-02 Working Group on Tropical HABs Smithsonian Field Station Belize
2002 Plenary Speaker 1st Red Tide Forum, Mexico City
2003 Provasoli Award, Phycological Society of America, 2003 PSA Presidential Speaker

EDUCATION

Oregon State University, Ph.D., Oceanography, Corvallis, OR 1983
Oregon State University, M.S., Oceanography, Corvallis, OR 1976
California State University, Sonoma B.A. with honors Life Sciences, Chemistry, 1971

RESEARCH INTERESTS

Dr. Tester's interests include the effect of climatology, circulation and water column conditions that are necessary for the initiation, growth and transport of phytoplankton blooms, especially toxic phytoplankton. She is a collaborator in a regional southeast and Gulf of Mexico SeaWiFS project as well as the Gulf of Mexico Ecology and Oceanography of Harmful Algal Blooms. Her research involves the use of remote sensing to serve as an early warning of conditions that are conducive to harmful algal bloom transport or develop. She also studies the transfer of toxins through lower trophic level marine food webs and the consequences of zooplankton grazing on pelagic community structure.

SPECIAL ASSIGNMENTS/ACTIVITIES

1992 - Present National Research Council Advisor (Guo 1992-94; Cervetto1995-96; Dyble 2004- present; Ornolfsdottir 2004- present)

1996 Train scientists at the Plankton Sorting & ID Center, Sea Fisheries Inst., Gdynia, Poland

1998 Train scientists at the Fisheries Technology Laboratory - Tema, Ghana

2000 Brief US Senate & House on Harmful Algal Blooms and Marine Mortalities

PUBLICATIONS SINCE 1995

Tester, P.A., S. Varnam. D.L. Eslinger, M. Culver, R. Swift, J. Yungel and R. Wayne. Litaker. 2004. Airborne detection of ecosystem responses to an extreme event: Biomass displacement after hurricane induced flooding in Pamlico Sound and Albemarle Sound, NC. Estuaries. 26:1353-1364.

Örnólfsdóttir, E. B., J.L. Pinckney and P.A. Tester. Quantification of the relative abundance of the toxic dinoflagellate, *Karenia brevis*, using photopigment biomarkers. J. Phycol. (in press)

Stumpf, R.P., M.E. Culver, P.A. Tester, M. Tomlinson, G.J. Kirkpatrick, B.A. Paderson, E. Truby, V. Ransibrahmanakul, M. Saracco. 2003. Monitoring *Karenia brevis* blooms in the Gulf of Mexico using satellite ocean color imagery and other data. Harmful Algae. 2:147-160.

Litaker, W, R. Sundseth, M. Wojciechowski, C. Bonaventura, R. Henkens, and P. Tester. 2001. Electrochemical detection of DNA or RNA from harmful algal blooms species. In: G.M.Hallegraeff, S.I.Blackburn, C.J. Bolch & R.J.Lewis (eds). "Harmful Algal Blooms 2000". Proc.9th Int. Conf. Harmful Algal Blooms, IOC-UNESCO, Paris 2001.

Tester, P.A., Y. Pan and G.J. Doucette. 2001.Accumulation of domoic acid activity in copepods. 9th International Conference on Harmful Algal Blooms. In: G.M.Hallegraeff, S.I.Blackburn, C.J. Bolch & R.J.Lewis (eds). "Harmful Algal Blooms 2000". Proc.9th Int. Conf.

Litaker, W., V.E. Warner, C. Rhyne, C.S. Duke, B.E. Kenney, P.A. Tester and J. Ramus. 2002. The effect of diel and interday light variations on the cell division pattern and growth of the bloom-forming dinoflagellate *Heterocapsa triquetra* in the field. Mar. Ecol. Prog. Ser. 232:63-74.

Litaker, R. W., M. W. Vandersea, S. R. Kibler, E. J. Noga, and P. A. Tester. 2002. Reply to comment on the life cycle and toxicity of *Pfiesteria piscicida* revisited. J. Phycol. 38:1268-1272.

Litaker, R.W., M.W. Vandersea, S.R. Kibler, V.J. Madden, E.J. Noga and P.A. Tester. 2002. Life cycle of the heterotrophic dinoflagellate *Pfiesteria piscicida* (Dinophyceae). J. Phycol. 38:442-463.

Swinker, M., P. A. Tester, D.K. Attix, D. Schmechel. 2002. Human health effects of exposure to *Pfiesteria piscicida*: a review. Microbes and Infection. 4:751-762.

Burke, W.A. and P.A. Tester. 2002 Skin problems related to noninfectious coastal microorganisms.Dermatologic Therapy 15:10-17.

Litaker, R.W. and P.A.Tester. 2002. Molecular methods for detecting and characterizing harmful phytoplankton. pp. 342-353. In: Manual of Environmental Microbiology, 2nd Ed. America Society of Microbiology, Washington, DC.

Steidinger, K., J. Landsberg, R.W. Richardson, E. Truby, B. Blakesley, P. Scott, P. Tester, T. Tengs, P. Mason, S. Morton, D. Seaborn, W. Litaker, K. Reece, D. Oldach, L. Haas and G. Vasta. 2001. Classification and identification of *Pfiesteria* and *Pfiesteria*-like species. Environmental Health Perspectives 109:661-665.

Pinckney, J.L., H.W. Paerl, P. Tester, T.L. Richrdson. 2001. The role of nutrient loading and eutrophication in estuarine ecology. Environmental Health Perspectives. 109:699-706.

Pinckney, J.L., H.W. Paerl, E.Haugen and P.A. Tester. 2000. Responses of phytoplankton and *Pfiesteria*-like dinoflagellate zoospores to nutrient enrichment in the Neuse River Estuary, NC (USA). Mar. Ecol. Prog. Ser. 192:65-87.

Tester, P.A., J.T. Turner and D. Shea. 2000. Vectorial transport of toxins from the dinoflagellate *Gymnodinium breve* through copepods to fish. J. Plankton Res. 22:47-61.

Stumpf, R.P. Arnone, R.A. R.W. Gould, P. Martinolich, V. Ransiabrahmanakul, P.A. Tester, R.G. Steward, A. Subramaniam, M. Culver, J.R. Pennock. 2000. SeaWiFS ocean color data for US Southeast coastal waters. pp. 25-27. In: Sixth International Conference on Remote Sensing for Marine and Coastal Environments. Charleston SC. Veridian ERIM Intl. Ann Arbor MI, USA,

Pinckney, J.L., H.W. Paerl. E.Haugen and P.A. Tester. 2000. Responses of phytoplankton and *Pfiesteria*-like dinoflagellate zoospores to nutrient enrichment in the Neuse River Estuary, NC (USA). Mar. Ecol. Prog. Ser. 192:65-78.

Millie, D.F., C.P. Dionigi, O. Schofield and P.A. Tester. 1999. The importance of understanding the molecular, cellular, and ecophysiological bases of harmful algal blooms. J. Phycol. 35:1353-1355.

Litaker, R.W., P.A. Tester, E.M. Haugen, Colorni, M.G. Levy and E.J. Noga. 1999. The phylogenetic relationship of *Pfiesteria piscicida, Cryptoperidiniopsoid sp., Amyloodinium ocellatum* and a *Pfiesteria*-like dinoflagellate to other dinoflagellates and apicomplexans. J. Phycol. 35:1379-1389.

Graneli, E., P. Carlsson, J.T. Turner, P.A. Tester, C. Bechemin, R. Dawson and E. Funari. 1999. Effects of N:P:Si-ratios and zooplankton grazing on phytoplankton communities in the northern Adriatic Sea. I. Nutrients, phytoplankton, biomass, and polysaccharide production. Aquat. Microb. Ecol.

Millie, D.F., C.P. Dionigi, O. Schofield and P.A. Tester. 1999. The importance of understanding the molecular, cellular, and ecophysiological bases of harmful algal blooms. J. Phycol. 1353-1355.

Litaker, R.W., P.A. Tester, E.M. Haugen, Colorni, M.G. Levy and E.J. Noga. 1999. The phylogenetic relationship of *Pfiesteria piscicid, Cryptoperidiniopsoid sp., Amyloodinium ocellatum* and a *Pfiesteria*-like dinoflagellate to other dinoflagellates and apicomplexans. J. Phycol. 35:1379-1389.

Graneli, E., P. Carlsson, J.T. Turner, P.A. Tester, C. Bechemin, R. Dawson and E. Funari. 1999. Effects of N:P:Si-ratios and zooplankton grazing on phytoplankton communities in the northern Adriatic Sea. I. Nutrients, phytoplankton, biomass, and polysacchride production. Aquat. Microb. Ecol. 18:37-54.

Turner, J.T., P.A. Tester, J.A. Lincoln, P. Carlsson, and E. Graneli. 1999. Effects of N:P:Si-ratios and zooplankton grazing on phytoplankton communities in the northern Adriatic Sea. III. Zooplankton populations and grazing. Aquat. Microb. Ecol. 18:67-75.

National Research Council. 1999. From Monsoons to Microbes: Understanding the Ocean's Role in Human Health. National Academy Press, Washington, DC. pp. 132.

Tester, P.A. and R.P. Stumpf. 1998. Phytoplankton blooms and remote sensing: What isthe potential for early warning. J. Shellfish Res. 17:1469-1471.

Warlen, S. M., P.A. Tester and D.R. Colby.1998. Recruitment of larval fishes into a North Carolina estuary during a *Gymnodinium breve* red tide bloom. Bull. Mar. Sci. 63:83-95.

Turner, J.T., R.R. Hopcroft, J.A. Lincoln, C.S. Huestis, P.A. Tester and J. C.Roff. 1998. Zooplankton feeding ecology: Grazing by marine copepods and cladocerans upon phytoplankton and cyanobacteria from Kingston Harbour, Jamaica. P.S.Z.N.I. Mar. Ecol. 19:195-208.

Tester. P.A., J. Braun, A.J. Chester, F. A Cross, S.P. Epperly, J.V. Merriner and R.P. Stumpf. 1998. Application of remote sensing to real-time management of marine resources: today and tomorrow. pp. 175-179 In: Proceedings of the Ocean Community Conference'98. Marine Technology Society, Baltimore, MD.

Steidinger, K.A., G.A. Vargo, P.A. Tester and C.R. Tomas. 1998. Bloom dynamics and Physiology of *Gymnodinium breve*. pp. 133-153. In: Physiological Ecology of Harmful Algal Blooms (eds.) D.M. Anderson, A.D. Cembella and M. Hallegraeff. Springer-Verlag.

Turner, J.T., P.A. Tester and P.J. Hansen. 1998. Interactions between toxic marine phytoplankton and metazoan and portistan grazers: What are the Questions? pp. 453-474. In: Physiological Ecology of Harmful Algal Blooms (eds.) D.M. Anderson, A.D. Cembella and M. Hallegraeff. Springer-Verlag.

Tester, P.A., R.P. Stumpf and K. Steidinger.1998. Ocean color imagery: What is the minimum detection level for *Gymnodinium breve* blooms? 1998. pp. 149-151. In: Harmful Algae (eds.) B. Reguera, J. Blanco, M. Fernandez and T. Wyatt. Xunta de Galicia and IOC of UNESCO Publishers.

Stumpf, R.P., V. Ransibrahmanakul, K.A. Steidinger and P.A. Tester. 1998. Observations of sea srface temperature and winds associated with Florida, USA, red tides (*Gymnodinium breve* blooms). pp. 149-151 . In: Harmful Algae. (eds.) B. Reguera, J. Blanco, M. Fernandez and T. Wyatt. Xunta de Galicia and IOC of UNESCO Publishers.

Tester, P.A. and K.A. Steidinger. 1997. *Gymnodinium breve* red tide blooms: Initiation, transport and consequences of surface circulation. Limnol. Oceanogr.42:1039-1051.

Turner, J.T. and P.A. Tester. 1997. Toxic marine phytoplankton, zooplankton grazing and pelagic food webs: A review. Limnol. Oceanogr. 42:1203-1214.

Millie, D.F., O.M. Schofield, G.J. Kirkpatrick, G. Johnsen, P.A. Tester and B.T. Vinyard. 1997. Phytoplankton pigments and absorption spectra as potential 'biomarkers' for harmful algal blooms: A case study of the Florida red-tide dinoflagellate, *Gymnodinium breve*. Limnol. Oceanogr. 42:1240-1251.

Boesch, D.F., D.M. Anderson, R.A. Horner, S.E. Shumway, P.A. Tester and T.E. Whitledge. 1997. Harmful algal blooms in coastal waters: Options for prevention, control and mitigation. An assessment conducted for the National Fish and Wildlife Foundation and NOAA Coastal Ocean Program (Decision Analysis Series No. 10). Chesapeake Research Consortium, Edgewater, MD. 49 pp.

Tester, P.A. 1996. Climate change and marine phytoplankton. Ecosystem Health 2:192-197.

Tester, P.A., M.E. Geesey, C. Guo, Hans W. Paerl and D. F. Millie. 1995. Evaluating phytoplankton dynamics in the Newport River Estuary (North Carolina, U.S.A.) by HPLC-derived pigment profiles. Mar. Ecol. Prog. Ser. 124:237-245.

Epperly, S.P., J. Barun, A.J. Chester, F.A. Cross, J.V. Merriner, P.A. Tester and J.H. Chruchill. 1996. Beach strandings as an indicator of at-sea mortality of sea turtles. Bull. Mar. Sci. 59:289-297.

Carlsson, P., E. Graneli, P. Tester and L. Boni. 1995. Humic substances and copepod grazing as structuring forces in an autumn plankton community. Mar. Ecol. Prog. Ser. 127:213-221.

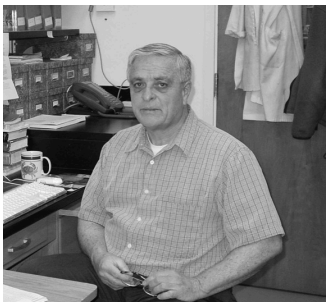
Tester, P.A. and B. Mahoney. 1995. Implication of the diatom, *Chaetoceros convolutus*, in the death of red king crabs, *Paralithodes camtschatica*, Captains Bay, Unalaska, Alaska. pp. 95-100. In: Harmful Marine Algal Bloom. (eds.) P. Lassus, G. Arzul, E. Erard, P. Gentien, C. Marcaillou-Le Bout. Levoisier, Intercept Ltd. Paris.

Ortner, P.B., T.N. Lee, P.J. Milne, R.G. Zika, M.E. Clarke, G.P. Podesta, P.K. Swart, P.A. Tester, L.P. Atknison and W.R. Johnson. 1995. Mississippi river flood waters that reached the Gulf Stream. Journal of Geophysical Research 100(C7):13,595-13,601.

Epperly, S.P., J. Braun, A.J. Chester, F.A. Cross, J.V. Merriner and P.A. Tester. 1995. The winter distribution of sea turtles in the vicinity of Cape Hatteras and their interactions with the summer flounder trawl fishery. Bull. Mar. Sci. 56:547-568.

HONORARY CHAIRPERSON

ARTHUR C. MATHIESON



Department of Plant Biology and the Jackson Estuarine Laboratory
University of New Hampshire 03824.
Office phone (Jackson Estuarine Laboratory):
603-862-2175 or 603-862-5133

Education:

B.S. 1960 Botany, University of California, Los Angeles
M.S. 1961 Botany, University of California, Los Angeles
Ph.D. 1965 Botany-Oceanography, University of British Columbia, Vancouver, Canada

Academic Background:

1982 - present: Professor of Botany and Faculty in Residence
Jackson Estuarine Laboratory
1974 - present: Professor of Botany, UNH
1972 - 1982: Director, Jackson Estuarine Laboratory, UNH
1969 - 1974: Associate Professor of Botany, UNH
1965- 1969: Assistant Professor of Botany, University of New Hampshire (UNH)
1961 - 1965: Teaching and Research Assistant, University of British Columbia
1960 - 1961: Teaching and Research Assistant, University of California, Los Angeles

Selected Experiences:

Field work: Oceanographic cruises from Vancouver Island to central coastal Alaska, 1961, 1963 and 1965

Economic algal survey for Marine Colloids, Inc. in Newfoundland (1967), Puget Sound (1969), and the Gulf of Maine (1969)

Aquanaut-Scientist, Tektite II program, summer, 1970, FLARE submersible program, spring, 1971

Extensive field experience in the Pacific coast of North America (Mexico to Alaska), Japan, Hawaii, Guam, Philippines, the Mediterranean, Western Europe, the Caribbean and the eastern coast of North America (Florida to Newfoundland)

Receipt of one of the first UNH Faculty Scholars Award.

Vice President Great Bay Conservation Trust and
Committee for the Great Bay Estuarine Sanctuary (1984-86)

Membership in Professional Societies:

Phi Sigma, Sigma Xi, Phycological Society of America, International Phycological Society, A.I.B.S., Great Bay Estuarine Conservation Trust

Major Qualifications: Ecology, systematics and mariculture of benthic marine algae, including studies on eutrophication, primary productivity, nutrient relationships, autecology, physiological ecology, floristic-biosystematic evaluations, and invasive species

I am a certified SCUBA diver (NAUI) with over 35 years of experience, including saturation diving in Tektite II (1970) and FLARE (1971)

Selected publications of >160 referred journal articles:

Aquaculture, economic significance and uses of seaweeds:

Mathieson, A.C. 1967. Seaweed - A Growing Industry. Industrial Research Inc. and Oceanology International. (Nov. - Dec.) Pacific Search. Vol. 3, No. 69, p. 12.

Mathieson, A.C. 1975. Seaweed Aquaculture. Mar. Fish. Rev. 37: 2-14.

Cheney, D., A.C. Mathieson and D. Schubert. 1981. The application of genetic improvement techniques to seaweed cultivation: I. Strain selection in the carrageenophyte *Chondrus crispus*. In: Levring, T. (ed.), Proceedings of Xth Int. Seaweed Symp., Goteborg, Sweden, Aug. 11-15, 1980, Walter de Gruyter, Berlin, pp. 559-567.

Tveter-Gallagher, E., D. Cheney and A.C. Mathieson. 1981. Uptake and incorporation of ^{35}S into carrageenan among different strains of *Chondrus crispus*. In: Levring, T. (ed.), Proceedings of Xth International Seaweed Symposium, Goteborg, Sweden, Aug. 11-15, 1980, Walter de Gruyter, Berlin, pp. 521-530.

Mathieson, A.C. 1982. Seaweed Cultivation: A review. In: C.J. Sindermann (ed.), Proceedings of the Sixth U.S.-Japan Meeting on aquaculture, Santa Barbara, California, August 27-28, 1977, pp. 25-66. U.S. Dept. Commer., Rep. NMFS Circ. 442, pp. 25-66.

Tveter-Gallagher, E., T.N. Wight and A.C. Mathieson. 1982. Effects of various types of carrageenans on human fibroblasts in vitro. In: Hoppe and T. Levring (eds.), Marine Algae in Pharmaceutical Science, Vol. 2. Walter de Gruyter, Berlin, pp. 51-64.

Mathieson, A.C. and W.J. North. 1982. Algal aquaculture: Introduction and bibliography on algal aquaculture. In: Parker, B. and J. Rosowski (eds.), Selected Papers in Phycology II. Phycological Society of America, Lawrence, Kansas, pp. 773-787.

Mathieson, A.C. 1986. A comparison of seaweed mariculture programs-activities. In: Bilio, M., H. Rosenthal, and C.J. Sindermann (eds.), Realism in Aquaculture: Achievements, Constraints and Perspective. European Aquaculture Society, Bredene, Belgium, pp. 107-140.

Tveter-Gallagher, E. and A.C. Mathieson. 1986. Biological properties of carrageenans. In: Colwell, R.R., E.R. Pariser and A.J. Sinskey (eds.), Biotechnology of Marine Polysaccharides. Hemisphere Publishing Corp., Washington, pp. 413-428.

Yarish, C., R. Wilkes, T. Chopin, X. G. Fei, A. C. Mathieson, A. S. Klein, D. Friel, C. D. Neefus, G. G. Mitman, and I. Levine. 1998. Domesticating indigenous *Porphyra* (nori) species for commercial cultivation in Northeast America. World Aquaculture 29: 26-29, 55.

Yarish, C., R., T. Chopin, R. Wilkes, A. C. Mathieson, X. G. Fei, and S. Lu. 1999. Domestication of nori for northeast America: the Asian experience. Bull. Aquaculture Association of Canada 99: 11-17.

Autecological investigations:

Burns, R. and A.C. Mathieson. 1972. Ecological studies of economic red algae. II. Culture studies of *Chondrus crispus* Stackhouse and *Gigartina stellata* (Stackhouse) Batters. J. exp. mar. Biol. Ecol. 8:1-6.

Burns, R. and A.C. Mathieson. 1972. Ecological studies of economic red algae. III. Growth and reproduction of natural and harvested populations of *Gigartina stellata* (Stackhouse) Batters. in New Hampshire. J. exp. mar. Biol. Ecol. 9:77- 95.

Fralick, R.A. and A.C. Mathieson. 1972. Winter fragmentation of *Codium fragile* (Suringar) Hariot ssp. *tomentosoides* (van Goor) Silva (Chlorophyceae, Siphonales) in New England. Phycologia 11:67-70.

Fralick, R.A. and A.C. Mathieson. 1973. Ecological studies of *Codium fragile* in New England, U.S.A. Mar. Biol. 19:127-132.

Dawes, C.J., A.C. Mathieson and D.P. Cheney. 1974. Ecological studies of Floridian *Eucheuma* (Rhodophyta, Gigartinales). I. Seasonal growth and reproduction. Bull. Mar. Sci. 24:235-273.

Fralick, R.A., K.W. Turgeon and A.C. Mathieson. 1974. Destruction of kelp populations by *Lacuna vincta* (Montagu). Nautilus 88:112-114.

Mathieson, A.C. and R.L. Burns. 1975. Ecological studies of economic red algae. V. Growth and reproduction of natural and harvested populations of *Chondrus crispus* Stackhouse in New Hampshire. J. exp. mar. Biol. Ecol. 17:137-156.

Mathieson, A.C., J.W. Shipman, J.R. O'Shea and R.C. Hasevlat. 1976. Seasonal growth and reproduction of estuarine fucoid algae in New England. J. exp. mar. Biol. Ecol. 25:273-284.

Chock, J.S. and A.C. Mathieson. 1976. Ecological studies of the salt marsh ecad *scorpioides* (Hornemann) Hauck of *Ascophyllum nodosum* (L.) Le Jolis. J. exp. mar. Biol. Ecol. 23:171-190.

Niemeck, R.A. and A.C. Mathieson. 1976. An ecological study of *Fucus spiralis* L. J. exp. mar. Biol. Ecol. 24:33-48.

Mathieson, A.C., E. Tveter, M. Daly and J. Howard. 1977. Marine algal ecology in a New Hampshire tidal rapid. Bot. Mar. 20:277-290.

Daly, M.A. and A.C. Mathieson. 1977. The effects of sand movement on intertidal seaweeds and selected invertebrates at Bound Rock, New Hampshire, U.S.A. Mar. Biol. 43: 45-55.

Josselyn, M.N. and A.C. Mathieson. 1978. Contribution of receptacles from the fucoid *Ascophyllum nodosum* to the detrital pool of a north temperate estuary. Estuaries 1: 258-261.

Kilar, J.A. and A.C. Mathieson. 1978. Ecological studies of the annual red alga *Dumontia incrassata* (O.F. Muller) Lamouroux. Bot. Mar. 21:423-437.

Josselyn, M.N. and A.C. Mathieson. 1980. Seasonal influx and decomposition of autochthonous macrophyte litter in a north temperate estuary. Hydrobiol. 71:197-208.

Mathieson, A.C. 1982. Field Ecology of the brown alga *Phaeostrophion irregulare* Setchell *et* Gardner. Bot. Mar. XXV:67-85.

Mathieson, A.C., C.A. Penniman, P.K. Busse and E. Tveter-Gallagher. 1982. Effects of ice on

Ascophyllum nodosum within the Great Bay Estuary of New Hampshire-Maine. J. Phycol. 18: 331-336.

Chock, J.S. and A.C. Mathieson. 1983. Variations of New England estuarine seaweed biomass. Botanica Marina XXVI:87-97.

Hardwick-Witman, M.N. and A.C. Mathieson. 1983. Intertidal macro-algae and macroinvertebrates: seasonal and spatial abundance patterns along an estuarine gradient. Est. and Coast. Shelf Sci. 16:113-129.

Mathieson, A.C., C. Neefus and C. Emerich Penniman. 1983. Benthic ecology in an estuarine tidal rapid. Bot. Mar. 26:213-230.

Sideman, E.J. and A.C. Mathieson. 1983. The growth, reproductive phenology and longevity of non-tide pool *Fucus distichus* (L.) Powell in New England. J. exp. mar. Biol. Ecol. 68: 111-127.

Zechman, F.W. and A.C. Mathieson. 1985. The distribution of seaweed propagules in estuarine, coastal and offshore waters of New Hampshire, U.S.A. Bot. Mar. XXVIII: 283-294.

Penniman, C.A., A.C. Mathieson and C. Emerich Penniman. 1986. Reproductive phenology and growth of *Gracilaria tikvahiae* McLachlan (Gigartinales, Rhodophyta) in the Great Bay Estuary, New Hampshire. Bot. Mar. 29:147-154.

Short, F.T., A.C. Mathieson, and J.I. Nelson. 1986. Recurrence of the eelgrass wasting disease at the border of New Hampshire and Maine, USA. Mar. Ecol. Prog. Ser. 29:89-92.

Shannon, R.K., G.E. Crow and A.C. Mathieson. 1988. Seasonal abundance and recruitment patterns of *Petalonia fascia* (O.F. Muller) Kuntze and *Scytosiphon lomentaria* (Lyngbye) Link var. *Lomentaria* in New Hampshire, U.S.A. Bot. Mar. 31:207-214

Mathieson, A.C. 1989. Phenological patterns of northern New England seaweeds. Bot. Mar. 32:419-438.

Levin, P. and A.C. Mathieson. 1991. Variations in a host-epiphyte relationship along a wave exposure gradient. Marine Ecology Progress Series 77:271-278.

Mathieson, A.C. and Guo, Z. 1992. Patterns of fucoid reproductive biomass allocation. British phycol. J. 27: 271-292.

Mathieson, A.C. and C.J. Dawes. 2001. A muscoides-like *Fucus* from a Maine salt marsh: its origin, ecology and taxonomic implications. Rhodora 103:172-201.

Harris, L.G. and A.C. Mathieson. 2000. Patterns of range expansion, niche shift and predator acquisition in *Codium fragile* ssp. *tomentosoides* and *Membranipora membranacea* in the Gulf of Maine. Pederson, J. (editor), Marine Bioinvasions, Proceedings of the First National Conference, January 24-27, 1999, MIT Sea Grant College Program, Cambridge, MA, pp 46-56.

Mathieson, A. C., C. J. Dawes, L. G. Harris, and E. J. Hehre. 2003. Expansion of the Asiatic green alga *Codium fragile* subsp. *tomentosoides* in the Gulf of Maine. Rhodora 105: 1-53.

Floristic studies:

Mathieson, A.C., C.J. Dawes and H.J. Humm. 1969. Contributions to the marine algae of Newfoundland. Rhodora 71:110-159.

Mathieson, A.C. and S.W. Fuller. 1969. A preliminary investigation of the benthonic marine algae of the Chesapeake Bay Region. Rhodora 71:524-534.

Gruendling, G.K. and A.C. Mathieson. 1969a. The phytoplankton flora of Newfound and Winnisquam Lakes, New Hampshire. Rhodora 71:444-477.

Hehre, E. and A.C. Mathieson. 1970. Investigations of New England marine algae III. Composition, seasonal occurrence and reproduction periodicity of the marine Rhodophyceae of New Hampshire. Rhodora 72:194-239.

Mathieson, A.C., R.A. Fralick, R. Burns and W. Flahive. 1971. Comparative studies of subtidal vegetation in the Virgin Islands and the New England coastlines. In: J.W. Miller, J.G. Van Derwalker and R.A. Waller (ed.). Scientists in the Sea, Dept. Interior, pp. 106-131.

Mathieson, A.C. and R. Fralick. 1972. Investigations of New England marine algae V. The algal vegetation of the Hampton-Seabrook Estuary and the open coast near Hampton, New Hampshire. Rhodora 74:406-435.

Coleman, D.C. and A.C. Mathieson. 1974. Investigations of New England Marine Algae VI: Distribution of marine algae near Cape Cod, Mass. Rhodora 76:537-563.

Mathieson, A.C. and C.J. Dawes. 1975. Seasonal studies of Florida sublittoral marine algae. Bull. of Mar. Sci. 25:46-65.

Mathieson, A.C., R.A. Fralick, R. Burns and W. Flahive. 1975. Results of the Tektite Program. Phycological studies during Tektite II at St. John, U.S. V.I. Bull. Nat. Hist. Mus. of Los Angeles County Bulletin 20:76-103.

Coleman, D.C. and A.C. Mathieson. 1975. Investigations of New England marine algae VII: Seasonal occurrence and reproduction of marine algae near Cape Cod, Massachusetts. Rhodora 77:76-104.

Reynolds, N.B. and A.C. Mathieson. 1975. Seasonal occurrence and ecology of marine algae in a New Hampshire tidal rapid. Rhodora 77:512-533.

Mathieson, A.C. 1979. Vertical distribution and longevity of subtidal seaweeds in northern New England, U.S.A. Bot. Mar. 30:511-520.

Femino, R.J. and A.C. Mathieson. 1980. Investigations of New England marine algae IV: The ecology and seasonal succession of tide pool algae at Bald Head Cliff, York, Maine, U.S.A. Bot. Mar. XXIII:319-332.

Mathieson, A.C., E.J. Hehre and N.B. Reynolds. 1981. Investigations of New England marine algae I: A floristic and descriptive ecological study of the marine algae at Jaffrey Point, New Hampshire, U.S.A. Bot. Mar. 24:521-532.

Mathieson, A.C., N.B. Reynolds and E.J. Hehre. 1981. Investigations of New England marine algae II: The species composition, distribution, and zonation of seaweeds in the Great Bay Estuary System and the adjacent open coast of New Hampshire. Bot. Mar. XXIV: 533-545.

Menez, E. and A.C. Mathieson. 1981. The marine algae of Tunisia. Smithsonian Contrib. to Mar. Sci., No. 10, 59 pp.

Mathieson, A.C. and E.J. Hehre. 1982. The composition, seasonal occurrence and reproductive periodicity of the Phaeophyceae (brown algae) in New Hampshire. Rhodora 84:411-437.

Mathieson, A.C. and E. Hehre. 1983. The composition and seasonal periodicity of the marine Chlorophyceae in New Hampshire. Rhodora 85:275-299.

Fralick, R.A., E.J. Hehre and A.C. Mathieson. 1985. Observations on the marine algal flora of the Azores I: Notes on the epizoic algae occurring on the marine molluscs *Patella* ssp. Universidade dos Acores, Ponta Delgada, Ciencias Biologicas, pp. 39-43.

Mathieson, A.C. and E.J. Hehre. 1986. A synopsis of New Hampshire seaweeds. Rhodora 88: 1-139.

Mathieson, A.C. and C.A. Penniman. 1986. Species composition and seasonality of New England seaweeds along an open coastal-estuarine gradient. Bot. Mar. 29:161-176.

Mathieson, A.C. anc C.A. Penniman. 1986. A phytogeographic interpretation of the marine flora from the Isles of Shoals, U.S.A. Bot. Mar. 29:413-434.

Mathieson, A.C. and C.A. Penniman. 1991. Floristic patterns and numerical classification of New England estuarine and open coastal seaweed populations. Nova Hedwigia 52:453-485.

Mathieson, A.C. 1992. Transport of seaweeds by tagged migratory fish populations. Bot. Mar. 35: 419-422.

Hehre, E.J. and A.C. Mathieson. 1993. *Porphyra amplissima* (Kjellman) Setchell et Hus: New records of an "Arctic" seaweed in southern Maine, New Hampshire and northern Massachusetts. Rhodora, 95:184-187.

Mathieson, A.C., E.J. Hehre and M. Costa. 1993. Algal vegetation of the York River Estuary and the adjacent open coast of southern Maine. Rhodora, 95:285-324.

Mathieson, A.C. and E.J. Hehre. 1994. A comparison of the marine algae from the Goleta Slough and adjacent open coast of Goleta/Santa Barbara, California with those in the southern Gulf of Maine. Rhodora 96:207-258.

Mathieson, A.C., E.J. Hehre, J. Hambrook and J. Gerweck. 1996. A comparison of insular seaweed floras from Penobscot Bay, Maine, and other Northwest Atlantic Islands. Rhodora 98:369-418.

Mathieson, A.C. and E.J. Hehre. 1996. Marine algae. In: J. Taylor, T.D. Lee and L.F. McCarthy (editors), New Hampshire's Living Legacy. The Biodiversity of the Granite State, New Hampshire Fish and Game Department, Nongame and Endangered Wildlife Program, Concord, NH, pp. 70-73.

Mathieson, A.C., C.J. Dawes and E.J. Hehre. 1998. Floristic and zonational studies of seaweeds from Mount Desert Island, Maine: an historical comparison. Rhodora 100:333-379.

Mathieson, A.C., E.J. Hehre and C.J. Dawes. 2000. Aegagropilous *Desmarestia aculeata* from New Hampshire. Rhodora 102:202-207.

Mathieson, A.C., C.J. Dawes, M.L. Anderson and E.J. Hehre. 2001. Seaweeds of the Brave Boat Harbor salt marsh and adjacent open coast of southern Maine. Rhodora 103:1-46.

Mathieson, A.C. and C.J. Dawes. 2002. *Chaetomorpha* balls foul New Hampshire, USA beaches. Algae 17:283 292.

Genetic/morphometric studies:

Cheney, D. and A.C. Mathieson. 1978. Population differentiation in the seaweed *Chondrus crispus*: preliminary results. Isozyme Bull. 12:57.

Blair, S., A.C. Mathieson and D. Cheney. 1982. Morphological and electrophoretic investigations of selected species of *Chaetomorpha* (Chlorophyta: Cladophorales). Phycologia 21:164-172.

Sideman, E.J. and A.C. Mathieson. 1983. Ecological and genecological distinctions of a high intertidal dwarf form of *Fucus distichus* (L.) Powell in New England. J. exp. mar. Biol. Ecol. 72:171-188.

Sideman, E.J. and A.C. Mathieson. 1985. Morphological variation within and between natural populations of non-tide pool *Fucus distichus* (Phaeophyta) in New England. J. Phycol. 21:250-257.

Neefus, C.D. B.P. Allen, H.P. Baldwin, A.C. Mathieson, R.T. Eckert, C. Yarish and M. Miller. 1993. An examination of the population genetics of *Laminaria* and other brown algae in the Laminariales using starch gel electrophoresis. In: Chapman, A.R.O., M.T. Brown and M. Lahaye (eds.), Fourteenth International Seaweed Symposium, Brest, France. Hydrobiologia, Kluwer Academic Publ. 260/261: 67-79.

Kuebler, J.E., S.C. Minocha and A.C. Mathieson. 1994. Transient expression of the GUS reporter gene in protoplasts of *Porphyra miniata* (Rhodophyte). J. Mar. Biotechnol., 1:165-169.

Huang, X., J.C. Weber, T.K. Hinson, A.C. Mathieson and S.C. Minocha. 1996. Transcient expression of the GUS reporter gene in the protoplasts and partially digested cells of *Ulva lactuca* L. (chlorophyta). Botanica Marina 39:467-474.

Klein, A .S., A. C. Mathieson, D. F. Cain, H. A. Taylor, A. L. West, C. D. Neefus, C. Yarish, J. Brodie, B.W. Teasdale, and A. L. Wallace. 2003. Identification of Northwestern Atlantic *Porphyra* (Bangiaceae, Bangiales) based on sequence variation in nuclear SSU and plastid rbcL genes. Phycologia 42: 109-122.

Monographic studies:

Mathieson, A.C. and J.S. Prince. 1973. Ecology of *Chondrus crispus* Stackhouse. Proc. Nova Scotia Inst. Sci. 27:53-79 (supplement).

Pringle, J.D. and A.C. Mathieson. 1987. *Chondrus crispus* Stackhouse. In: Tseng, C.K. & M. Doty (eds.), Case Studies of Seven Economic Seaweeds. Food and Agriculture Organization of the United Nations, Rome, pp. 49-121.

Mathieson, A.C. and P. Nienhuis (eds.). 1991. Intertidal and Littoral Ecosystems, Vol. 24: Ecosystems of the World, Elsevier Sci. Publ., Amsterdam, 564 pp.

Morphological and reproductive studies:

Mathieson, A.C. 1966. Morphological studies of the marine brown alga *Taonia lennebackerae* Farlow *ex*. J. Agardh I. Sporophytes, abnormal gametophytes and vegetative reproduction. Nova Hedwigia 12:65-79.

Mathieson, A.C. 1967. Morphology and life history of *Phaeostrophion irregulare* S. *et* G. Nova Hedwigia 13:293-318.

Tveter, E. and A.C. Mathieson. 1976. Sporeling coalescence in *Chondrus crispus* (Rhodophyceae). J. Phycol. 12:110-118.

Tveter-Gallagher, E. and A.C. Mathieson. 1980. An electron microscopic study of sporeling coalescence in the red alga *Chondrus crispus*. Scanning Electron Microscopy III: 571-580.

Tveter-Gallagher, E., A.C. Mathieson and D.P. Cheney. 1980. Ecology and developmental morphology of male plants of *Chondrus crispus* (Gigartinales, Rhodophyta). J. Phycol. 16:257-264.

Kilar, J.A. and A.C. Mathieson. 1981. The reproductive morphology of *Dumontia incrassata* (O.F. Muller) Lamouroux. Hydrobiol. 77:17-23.

Norall, T.L., A.C. Mathieson and J. Kilar. 1981. Reproductive ecology of four subtidal red algae. J. exp. mar. Biol. Ecol. 54:119-136.

Mathieson, A.C. 1982. Reproductive phenology and sporeling ecology of *Chondrus crispus* Stackhouse. In: Tsuda, R.T. and Y.-M. Chiang (eds.), Proceedings of the Republic of China-U.S.A. Cooperative Science Seminar on Cultivation and Utilization of Economic Algae. June 5-7, 1978, U. of Guam Marine Laboratory, Mangilao, Guam, pp. 33-40.

Shannon, R.K., G.E. Crow and A.C. Mathieson. 1988. Evidence for sexual reproduction in *Petalonia fascia* (O.F. Mueller) Kuntze. Bot. Mar. 31:511-513.

Physiological studies:

Mathieson, A.C. and R.L. Burns. 1971. Ecological studies of economic red algae I. Photosynthesis and respiration of *Chondrus crispus* Stackhouse and *Gigartina stellata* (Stackhouse) Batters. J. exp. mar. Biol. Ecol. 7:197-206.

Fuller, S.W. and A.C. Mathieson. 1972. Ecological studies of economic red algae. IV. Variations of carrageenan concentration and properties in *Chondrus crispus* Stackhouse. J. exp. mar. Biol. Ecol. 10:49-58.

Mathieson, A.C. and C.J. Dawes. 1974. Ecological studies of Floridian *Eucheuma* (Rhodophyta, Gigartinales). II. Photosynthesis and respiration. Bull. Mar. Sci. 24:274-285.

Dawes, C.J., J.M. Lawrence, D.P. Cheney and A.C. Mathieson. 1974. Ecological studies of Florida *Eucheuma* (Rhodophyta, Gigartinales). III. Seasonal variation of carrageenan, total carbohydrate, protein and lipid. Bull. Mar. Sci. 24:286-299.

Mathieson, A.C. and T. Norall. 1975. Photosynthetic studies of *Chondrus crispus*. Mar. Biol. 33:207-213.

Mathieson, A.C. and T. Norall. 1975. Physiological studies of subtidal red algae. J. exp. mar. Biol. Ecol. 20:237-247.

Mathieson, A.C. and E. Tveter. 1975. Carrageenan ecology of *Chondrus crispus* Stackhouse. Aquat. Bot. 1: 25-43.

Fralick, R.A. and A.C. Mathieson. 1975. Physiological ecology of *Polysiphonia* species (Rhodophyta, Ceramiales). Mar. Biol. 29:29-36.

Mathieson, A.C. and E. Tveter. 1976. Carrageenan ecology of *Gigartina stellata* (Stackhouse) Batters. Aquat. Bot. 2:353- 361.

Mathieson, A.C. 1982. Physiological ecology of the brown alga *Phaeostrophion irregulare* Setchell *et* Gardner: I. Juvenile plants. Bot. Mar. XXV:87-91.

Mathieson, A.C. 1982. Physiological ecology of the brown alga *Phaeostrophion irregulare* Setchell *et* Gardner: II. Macroscopic plants. Bot. Mar. XXV: 93-99.

Chock, J.S. and A.C. Mathieson. 1979. Physiological ecology of *Ascophyllum nodosum* (L.) Le Jolis and its detached ecad *scorpioides* (Hornemann) Hauck (Fucales, Phaeophyta). Bot. Mar. 22:21-26.

Niemeck, R.A. and A.C. Mathieson. 1978. Physiological studies of intertidal fucoid algae. Bot. Mar. 21: 221-227.

Mathieson, A.C., C. Emerich Penniman and E. Tveter-Gallagher. 1984. Phycocolloid ecology of underutilized economic red algae. Hydrobiologia 116/117:542-546.

Tveter-Gallagher, E., J.N. Cogburn, A.C. Mathieson and J.A. Schiff. 1984. Location of carrageenan and incorporation of $^{35}SO_4^{2-}$ into sulfur amino acids in the red alga *Chondrus crispus*. Hydrobiologia 116/117:488-492.

Penniman, C.A. and A.C. Mathieson. 1985. Photosynthesis of *Gracilaria tikvahiae* McLachlan (Gigartiales, Rhodophyta) from the Great Bay Estuary, New Hampshire. Bot. Mar. 28:427-435.

Hardwick-Witman, M. and A.C. Mathieson. 1986. Tissue nitrogen and carbon variations in New England estuarine *Ascophyllum nodosum* (L.) Le Jolis populations. Estuaries 9:43-48.

Mathieson, A.C. and C.J. Dawes. 1986. Photosynthetic responses of Florida seaweeds to light and temperature: a physiological survey. Bull. Mar. Sci. 38:512-524.

Penniman, C.A. and A.C. Mathieson. 1987. Variation in chemical composition of *Gracilaria tikvahiae* McLachlan (Gigartinales, Rhodophyta) in the Great Bay Estuary, New Hampshire. Bot. Mar. 30:525-534.

Guo, Z.-Y. and A.C. Mathieson. 1992. Physiological ecology of four ulvoid green algae. Bot. Mar., 35:523-533.

Taxonomic studies:

Dawes, C.J. and A.C. Mathieson. 1972. A new species of *Pseudocodium* (Chlorophyta, Siphonales) from the west coast of Florida. Phycologia 11:273-277.

Neefus, C.D., A.C. Mathieson, A.S. Klein, B. Teasdale, T. Bray and C. Yarish. 2002. *Porphyra birdiae sp. nov*. (Bangiales, Rhodophyta): a new species from the northwest Atlantic. Algae 17:203-216.

Review papers:

Mathieson, A.C., T.A. Norton and M. Neushul. 1981. The taxonomic implications of genetic and environmentally induced variations in seaweed morphology. Bot. Rev. 47:313-347.

Norton, T., A.C. Mathieson and M. Neushul. 1981. Morphology and Environment. In: Lobban, C.S. and M.J. Wynne (eds.), The Biology of Seaweeds. Bot. Monog. Vol. 17, Blackwell Scientific Publications, pp. 421-451.

Norton, T., A.C. Mathieson and M. Neushul. 1982. A review of some aspects of form and function in seaweeds. Bot. Mar. XXV: 501-510.

Norton, T. and A.C. Mathieson. 1983. The biology of unattached seaweeds. In: Round, F. and D. Chapman (eds.), Progress in Phycological Research, Vol. 2. Elsevier Sci. Publ., Amsterdam, 2:333-386.

Mathieson, A.C. 1991. Northwest Atlantic rocky shore ecology. In: A.C. Mathieson and P. Nienhuis (eds.), Intertidal and Littoral Ecosystems, Vol. 24: Ecosystems of the World, Elsevier Sci. Publ., Amsterdam, pp. 109-191.

NOTES