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## Marine Science Center newsletter: Fall 2004

Marine Science Center

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Marine Science Center



Northeastern  
UNIVERSITY

Nahant, Massachusetts

## The Ayers Lab

Dr. Joseph Ayers' research focuses on the control of adaptive behavior in underwater animals and robots. His approach combines neuroethology with biomimetics. Neuroethology attempts to explain the behavior of animals in terms of the properties and connectivity of networks of neurons and their interactions with sensory feedback. He has worked for over 35 years on the neurophysiology of locomotion, navigation and feeding in lobsters. He has also worked on the recovery of swimming behavior following spinal transection in the sea lamprey.

These studies have set the stage for his current work on biomimetics and neurotechnology. Biomimetics is the design and construction of robots that capture the performance advantages of animals in the natural environment. Lobsters have been successfully navigating the ocean bottom for millions of years, and the set of behaviors that they go through when searching for food is exactly what the Navy wants underwater robots to do to search for underwater mines. Similarly, the swimming movements of lamprey are highly efficient and leave no downstream wake signature making them stealthy in bioluminescent oceans.

Dr. Ayers and his colleagues have constructed two robotic platforms, the ambulatory lobster-based robot and the undulatory lamprey-based robot under the sponsorship of the Defense Advanced Research Projects Agency (DARPA) and the Office of Naval Research (ONR). The robots are capable of robust underwater locomotion, using artificial muscles, and achieve many of the performance advantages of the animal models. These robots have received extensive international press and TV coverage and have made MSC a leader in this field.

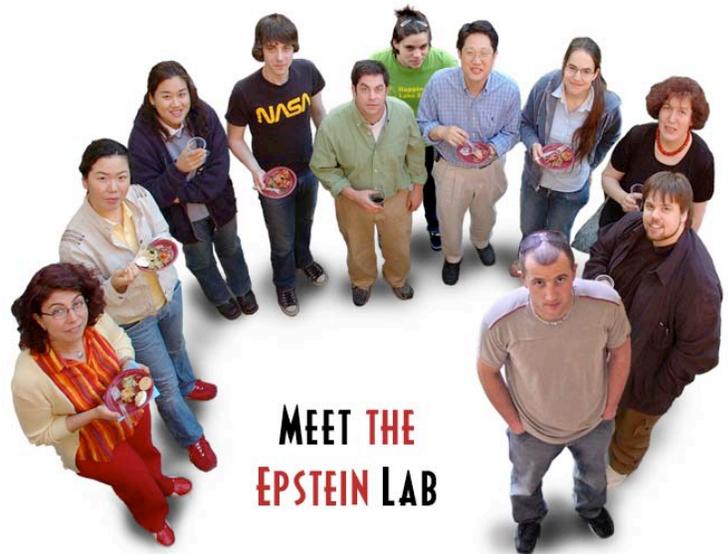
Dr. Ayers continues basic research on the neurophysiology of lobsters with two visiting German students, David Markert of the University of Bielefeld and Bjorn Katzur of the University of Hannover. David is studying the organization of walking command neurons while Bjorn is starting studies on the pharmacological modulation of lobster walking.

The laboratory is continuing integration of sensor based navigation in the lobster robot in collaboration with Walt Wilson of Merlin Technologies (San Carlos, CA) and Prof. Yong-Bin Kim of the Department of Electrical and Computer Engineering at Northeastern. Dr. Ayers' technician Chris Olcott, former postdoc Dr. Jan Witting (currently a Professor of Sea Education Associates), and an intern Colin Twomey continue to collaborate in the project. Over the past year Prof. Kim's students (Young Jun Lee, Jaeyoung Heo, Fengming Zhang and Jihyun Lee) have been upgrading the electronics and sensors of the robots. Prof. Kim is collaborating on the development of electronic neurons using analog VLSI.

Dr. Ayers also has new collaborations with Prof. Dinos Mavroidis of the Department of Mechanical Engineering on a worm-based burrowing robot and with Profs. Gilead Tadmor (nonlinear dynamics) and David Brady (sonar navigation systems) of Electrical and Computer Engineering.

Last year, Dr. Ayers spent a sabbatical at the Institute of Nonlinear Science at UCSD where he collaborated with Alan Selverston, Sasha Volkovski, Nikolai Rulkov, Henry Abarbanel and Misha Rabinovich in the development of a central pattern generator and elementary central nervous system for the robots using electronic and computational neurons based on nonlinear dynamical models of neurons.

**Left to Right: Barbara Schena, Sunok Jeon, Sun Hee Hong, Andrew Adams, Brett Hayward, Stacie Bush, Hoshin Paik, Dominica Nichols, Annette Bullmann, Alex Schering, and Ron Ortenberg**



Dr. Slava Epstein, and other researchers, were awarded \$1.5 million for a collaborative research grant, starting September 1, 2004. The title is, "Collaborative Research: Microbial Observatory in the Cariaco Basin - Dynamics of protistan diversity across time, space and chemical gradients" (S. Epstein, G. Taylor, S. Sievert, V. Edgcomb & D. Patterson, co-PIs), The collaboration is with Woods Hole, Marine Biological Laboratories, and Stony Brook.

The focus of Dr. Slava Epstein's research efforts is as follows:

**Biodiversity:** We apply state-of-the-art molecular tools to discover novel microorganisms in the ocean. Classic approaches are known to have missed major microbial classes that play key roles in the Earth's biogeochemistry. Molecular tools allowed us to discover new groups of marine microorganisms of the highest taxonomic ranks. We conduct in-depth research in local habitats and exploratory studies of extreme environments (high Arctic in Greenland; hydrothermal vents in Mexico; anoxic water masses in Venezuela).

**Environmental Microbiology:** The focus of a collaborative effort with Dr. Kim Lewis' lab is on presently uncultivated microorganisms, which represent >99% of all microbial species. Microbial uncultivability is one of the most important problems in microbiology, and gaining access to "uncultivables" will bring unprecedented advances in environmental sciences and biotechnology. We have developed a novel approach to microbial cultivation that appears to have largely solved the problem. We have gained access to the arguably world's largest pool of unexplored microorganisms and are in the process of their exploration.

Both areas hold high promise for future practical applications. In biodiversity research, we are discovering novel classes of organisms that are likely to serve as new sources of natural products for biotechnology.



Maggy Hunter, Geoff Trussell, Genevieve Bernatchez, and Liz Bryson

### The Trussell Lab

Research in the Trussell Lab continues to focus on three areas: 1) algal diversity and ecosystem functioning in rocky shore tidepools, (2) the influence on trait-mediated interactions between predatory crabs and snails and their effects on community diversity, intraspecific competition, and resource dynamics, and (3) the ecology and evolution of inducible defenses on rocky shores.

Our diversity-functioning research is in collaboration with UK scientist, Dr. Stuart Jenkins. Preliminary results indicate a positive relationship between diversity and productivity, and we are currently designing new experiments that will examine this relationship more explicitly. We also continue to document the powerful impact that trait-mediated effects can have on rocky shore communities. Recently, we published a paper documenting how such trait-mediated effects can cause a trophic cascade in tidepools. It turns out that risk cues released by predatory crabs cause herbivorous snails to emigrate from tide pools thus releasing resident algae from grazing. We are currently exploring how this behavior may cause changes in overall algal community diversity.

Research on inducible defenses continues and will receive a breath of fresh air with the arrival this fall of Jeremy Long. Jeremy is interested in the community-level implications of induced defenses in marine algae and will explore this issue from a number of perspectives. He conducted his PhD research under the guidance of Dr. Mark Hay (Georgia Tech), a leader in the field of chemical ecology.

A new project in collaboration with Dr. Paul Schmidt and graduate student Megan Phifer-Rixey (University of Pennsylvania), examines local and latitudinal variation in thermal stress and how it shapes the evolution of genotype frequencies at various allozyme loci and shell color polymorphism. We are particularly interested in how these two types of variation may interact to influence snail survivorship in thermally stressed and unstressed intertidal habitats.

Elizabeth Bryson (PhD Candidate) and Genevieve Bernatchez (PhD Candidate) continued their studies on multiple predator effects and the impact of an invasive crab on mudflat communities, respectively. Liz conducted a nice mesocosm experiment using food webs with different numbers of predators to examine how multiple predator effects may influence rates of resource consumption and growth. Genevieve conducted her research at the Wells Reserve in Wells, Maine and is currently processing data to address the impact two invasive crab species on the mudflat infaunal communities that border salt marsh habitat.

This fall, Tim Dwyer will arrive to pursue a MSC degree. Tim graduated from Bowdoin College and spent two summers working in Bob Steneck's lab at the University of Maine's Darling Marine Center. He is still contemplating a thesis topic, but I am sure it will result in five Ecology papers. We are also excited that Liz Kalies will be joining the lab as a technician. Liz is interested in trait-mediated interactions and recently completed her M.S. while working with Os Schmitz at Yale University. Liz will spend a year in the lab before pursuing more graduate school.

Lastly, Dr. Patrick Ewanchuk, who was a post doc in the lab for the last two years, is heading to Providence College this fall to begin a tenure track appointment as an Assistant Professor in the Department of Biology. Pat was an outstanding colleague to have in the lab and will be missed greatly. Fortunately, our 6-year collaboration will not end with this move, and Pat and I will continue the various projects we currently have going.



Three Seas' Program Students Diving at East Point

### The Scientific Diving Program

Northeastern University has an active scientific diving program based at the MSC. Our program is an organizational member of the American Academy of Underwater Sciences (AAUS), the national organization that sets standards for scientific diving. On an annual basis, 50-60 NU certified scientific divers make 1200 - 1500 scientific dives. The MSC operates a year round scientific diving program with compressor facilities, dive locker and boats available for diving support. Scientific diver certification requires additional requirements beyond recreational scuba diver certification including; Diving medical; CPR, First Aid, and emergency oxygen administration training; 100 hours theoretical training and 12 training dives. The MSC has been formally training scientific divers for over 18 years. Many of our graduate students have conducted underwater research projects. Additionally, the Three Sea Program students all receive scientific diver training while in the program and use scientific diving in their courses and projects.

During September, the MSC will be hosting and conducting scientific diving monitoring projects for the HubLine pipeline project. Dr Rick Wahle from Bigelow Laboratory for Ocean Sciences in ME will be conducting glacial till early benthic phase lobster assessment and epifaunal benthic community surveys at stations along the pipeline. Ted Maney from MSC will lead a group conducting hard-bottom surveys by taking photographs and physical measurements of the substrate. For information on the NU scientific diving program, go to <http://www.marinescience.neu.edu/diving/index.html>.

FleetBoston Mysis Marine Science Summer Academy  
Massachusetts Young Scientists Investigation into the Sea



### Outreach Program

It has been an exciting year for the MSC Outreach Program! It was awarded three grants to support its mission. The MSC Outreach Program is dedicated to reaching children in the Boston and North Shore communities with fun, content-rich activities encompassing all of marine science. The goal is to enhance K-12 science learning.

New England BioLabs and General Electric each provided funding for 9<sup>th</sup> and 10<sup>th</sup> grade students in the North Shore Communities of Lynn, Gloucester and Salem. The students will participate in marine science cruises aboard the MSC's research vessel, the R/V Mysis, and tide pool excursions at the MSC site in Nahant.

FleetBoston awarded a grant providing funding for three years to run a marine science summer academy. The first year of the FleetBoston Mysis (Massachusetts Young Scientists Investigation into the Sea) Marine Science Summer Academy was a huge success. Approximately 30 incoming freshman from Boston Latin Academy, a public exam school, participated for 3 weeks in July at both NU main campus and the MSC site in Nahant. The topics spanned a wide spectrum of marine science, including biological, physical and chemical oceanography, GPS/ GIS, macro- and micro-algae, ecology, geology, scientific writing, scientific sampling and conservation. The grant provided funding for all costs, including salary for both NU and BLA faculty participation, all student costs including transportation, lunches, equipment, parent events, and even wading boots so the students were able to dive right in to the field work in which they participated.

The program will continue through the school year, with this summer's students forming a club that will be visited by MSC Outreach Staff numerous times to prepare for additional trips to Nahant, and guide the students in their creation of science fair projects. Next summer, the students will have the opportunity to participate in MYSIS as instructors-in-training.

This spring, the Outreach Program hired a new Outreach Program Assistant, Emily Blume. The addition of a dedicated staff member increased the capabilities of the program. At this time, the Outreach Program announces the creation of a position for an additional Outreach Program Assistant. The hiring process is currently underway.

The MSC Outreach Staff is very proud of its expanding the reach of its programs. We encourage groups of all sizes and ages to come for a visit, whether it is for a tide pooling trip, a nature/ history walk, or a marine science cruise aboard the Research vessel Mysis. Can't come to us? We'll gladly visit you! We are dedicated to aligning our program with the Massachusetts Science and Technology/ Engineering Curriculum Framework for all grade levels. For additional information or questions, please contact Emily Blume at (781) 581-7370 ext. 338 or e.blume@neu.edu.

### Three Seas Program

This unique educational program in marine biology enables up to 20 upper-level undergraduate and beginning graduate students to move beyond the confines of the traditional classroom into a year of field experience. They live and work in three distinct marine environments: the Atlantic Ocean, the South Pacific, and the US Coastal Pacific Ocean. As the Three Seas Program begins the 2004/5 academic year, we look to build upon our program changes in the prior year with even more exciting news.

Beginning last year, the program starts with a fall semester at the MSC in Nahant. This proved to be a tremendous success as students had the opportunity to experience three New England seasons, with a taste of summer in September, all of autumn, and 18 inches of New England winter (i.e. snow) in December!

Also new last year was a 10 week spring session spent at the University of Southern California's Wrigley Marine Science Center on Santa Catalina Island, which is located 20 miles offshore from Los Angeles, California. The relatively mild air and water temperatures (when compared to Nahant in April) was very well-received by our students. Along with this new location we included two new courses, as part of a continuing effort to offer our students an education and experience in marine science that is both broad and deep: Physiological and Molecular Marine Ecology, co-instructed by Dr. Gretchen Hofmann (UCSB) and Dr. Amy Moran (UNC-Chapel Hill), and Marine Conservation Biology, co-instructed by Dr. Kathy Ann Miller (USC) and Dr. Mar Wonham (Univ. of Alberta).

We are pleased to announce that the winter portion of our program will be moving across the Pacific Ocean to French Polynesia, on the island of Moorea, at UC Berkeley's Gump Marine Station. Located 9 miles from Tahiti, this location provides an incredibly diverse and pristine coral reef ecosystem. For a quick study of the beauty of Moorea, see the 1983 remake of "The Bounty." Adding to the excitement is the news that Dr. Peter Edmunds, our Biology of Corals faculty member, along with 3 other colleagues, were awarded a Long Term Ecological Research grant by the National Science Foundation to study the reefs of Moorea. With several other Three Seas Program faculty members participating as associate investigators in this study, we could not have hoped for a better tropical research/academic context for our program.

If you'd like to help promote the Three Seas Program, our new recruiting poster is now available, with a new 32 page color brochure in the final stages of production. Contact the Three Seas Program by visiting our new website at [www.eastwest.neu.edu](http://www.eastwest.neu.edu).



Students from the Three Seas Program, along with faculty and TAs from the Physiology and Molecular Marine Ecology course at the Wrigley Marine Science Center, on Catalina Island, CA in May 2004

## Fall 2004 Newsletter

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We have had another successful year in our research, teaching and outreach missions. I wish to thank all who have supported these efforts.

Ed Jarroll, Director



Left to Right: Doc Riser and Don Levitan

### Riser Lecture

The MSC hosted the 18th annual Riser Lecture on April 9, 2004. The guest speaker was Dr. Don Levitan from Florida State University. The title of the lecture was, "Love and jealousy in sea urchins; density dependent sexual selection and the evolution of sexual dimorphism."

The MSC will be hosting the 19th annual Riser Lecture in April of 2005. The guest speaker will be Dr. John W. Grahame from University of Leeds. The title of the talk is, "Snails on the seashore: shells, geography, genes and speciation." If you would like to attend please call Liza Genovese at 781-581-7370 ext 319. The lecture and reception are free. Following the reception is a sit down dinner, which is held at the Nahant Country Club that is attended by the speaker, MSC faculty, graduate students, staff, and visiting researchers. All are welcome to attend the dinner at a nominal fee.

### Doc's Corner

Big argument last year about fox's den. Lots of burrows in the banks of the various bunkers; all about the same diameter; few very deep. Problem was we now have a fairly large number of woodchucks on the property, so the question was if any of the burrows was the fox's den. While nicotinizing on the dirt road behind the lab one afternoon in early spring, I noted two openings, one above the other and about four feet apart, in the bank along the side of the bunker. There were a couple of gull carcasses and a couple of ducks, all well desiccated. I called this the "larder" and began to monitor it hoping to see the fox stick its head out of one of the holes. Mirabile dictu, one morning while correlating the changes in the larder, I saw a movement in the lower hole, and staying motionless, witnessed a head. 'twas a baby fox. Now we could be sure we had guessed right and our fox was a vixen. Anyhow we all started keeping a watch and eventually counted four kits. After several weeks, we noticed the kits on the bank behind the lab in full view in an open space near the top. Apparently the vixen took them out to play there each morning. They ceased to show up about the time that the shrubs and weeds greened up, and we went months without seeing any of the family. In mid August, I saw a fox coming from the dirt road and heading into the brush where the old mansion had been. Scruffy looking beast and I do not know if it was the vixen or one of the kits. We still have loads of woodchucks, and the cock pheasants still crackle. Can only assume that the rodent population (other than woodchucks) is supporting the population. Re the larder. I guessed wrong. It was for the kits to play with. At least my theory that it was food storage was scientific. It was the latter and proved to be fallible.