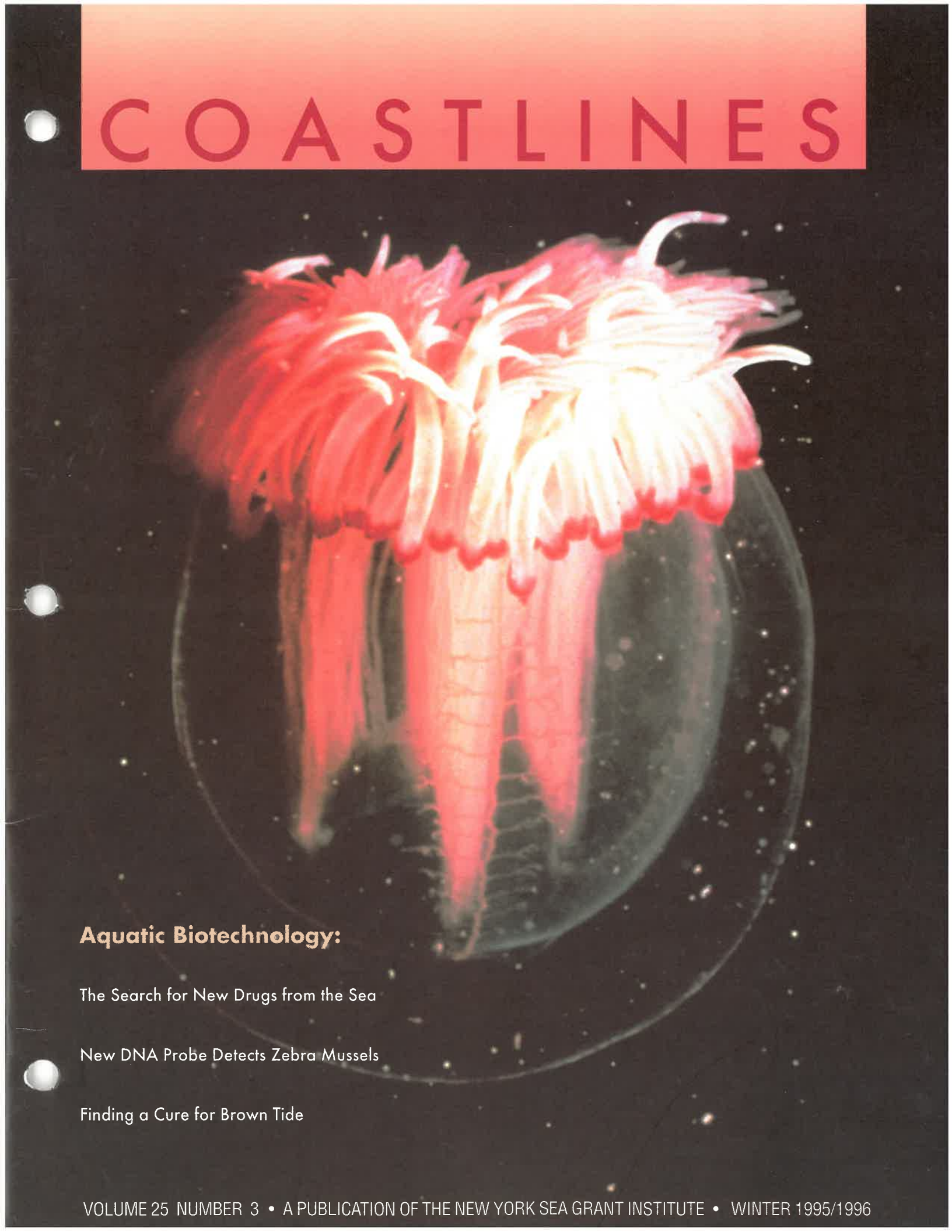
COASTLINES



Aquatic Biotechnology:

The Search for New Drugs from the Sea

New DNA Probe Detects Zebra Mussels

Finding a Cure for Brown Tide

VOLUME 25 NUMBER 3 • A PUBLICATION OF THE NEW YORK SEA GRANT INSTITUTE • WINTER 1995/1996

COASTLINES

A Publication of the New York Sea Grant Institute

Volume 25
Number 3
Winter 1995/1996

Director
Anne McElroy

Editor
Julie Zeidner

Assistant Editor
Judith Hogan

Layout
Patricia MacNeill

Production Assistants
Sharon O'Donovan
Susan Hamill

Contributors
Judith N. Hogan
Trent Schneider
Julie Zeidner

Cover Photo: **Jellyfish by Dr. William Fenical**

Note from the Director:

The biotechnological potential of the ocean and Great Lakes is the focus of the winter issue of COASTLINES. In an effort to understand and treat human illness, restore and protect marine ecosystems, and enhance the quality and quantity of seafood, scientists in partnership with industry are exploring the ocean's biological and geochemical processes to find solutions.

Towards this aim of broadening understanding and safely utilizing aquatic resources, New York Sea Grant has supported a wide range of biotechnology projects for more than a decade. During this time, a growing number of harmful algal blooms, drug-resistant viruses, and exotic pests have established a foothold in communities worldwide. The microscopic algae, *Aureococcus anophagefferens*, has plagued Long Island embayments since 1985, threatening the shellfish industry. For diseases like acquired immune deficiency syndrome (AIDS), there exists only a treatment of the symptoms, but no cure for the disease. The zebra mussel introduced from eastern Europe will soon cost the U.S. $500 million a year in clean-up costs and preventative measures.

New York Sea Grant, in cooperation with a national network of universities, is committed to helping find solutions to these problems. In this issue, COASTLINES editors explore some of the progress Sea Grant-funded researchers have made in the discovery and use of marine natural products in the fight against cancer, AIDS, and other diseases. They also discuss the application of genetic probes to detect zebra mussels and brown tide, as well as potential control methods for brown tide.

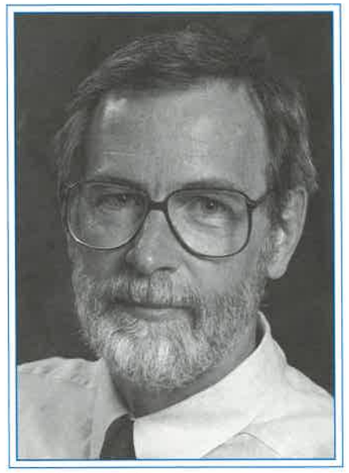
Projects funded by the National Sea Grant College Program on molecular genetics, pharmaceutical development, seafood safety, biofouling, environmental remediation, and aquaculture will enhance the health and welfare of residents of New York and the nation and lead to new jobs.

Best wishes from all of us at New York Sea Grant for the new year. We also encourage you to send in the response card attached to this issue to let us know what you think of our new magazine format.

Features

Coastwatch

Currents 16



Dr. Jon Clardy, page 2

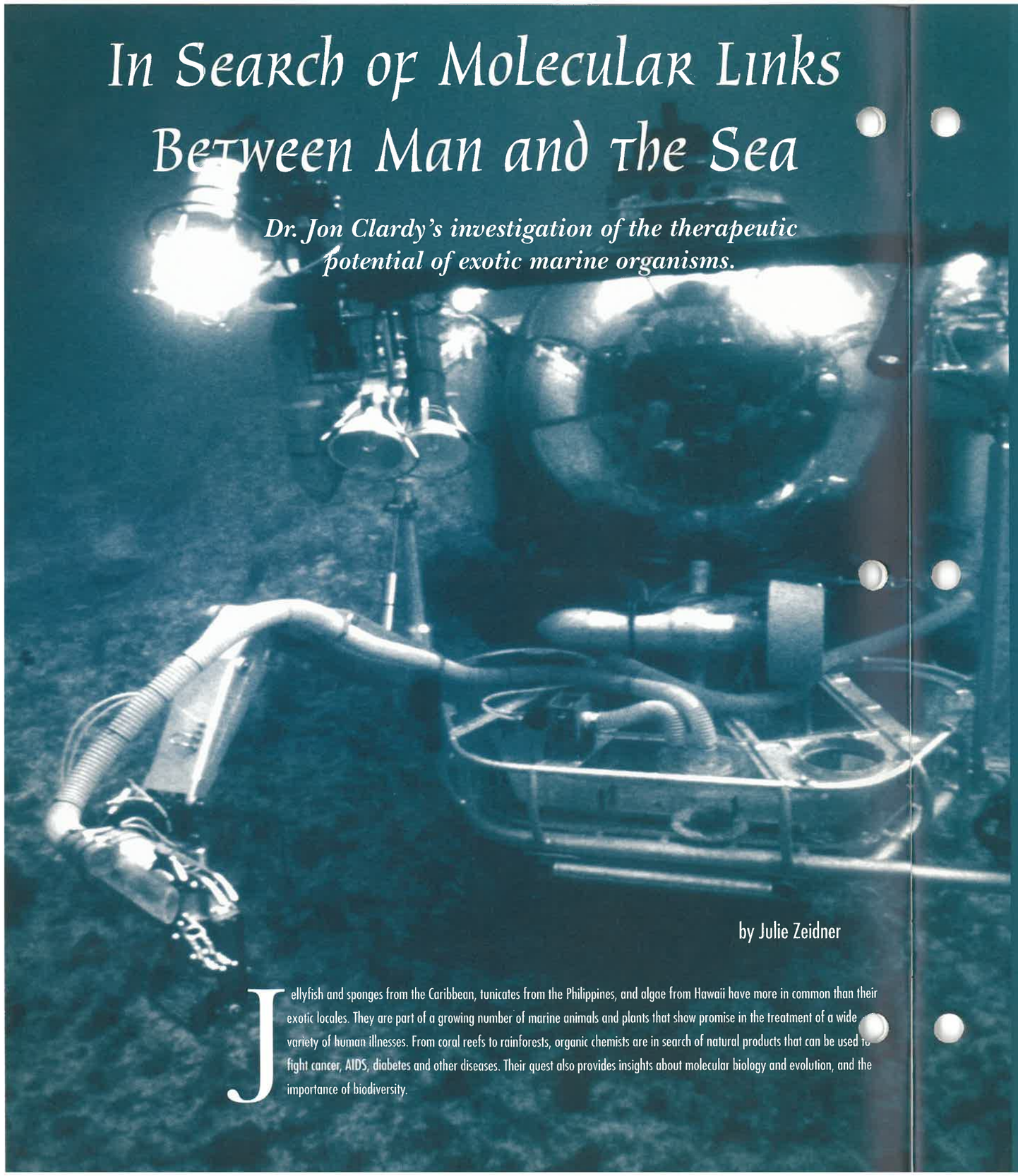
NYSG's administrative office is located at:

- SUNY Stony Brook: 516.632.6905

NYSG has extension offices located at:

- SUNY Stony Brook: 516.632.8730
- Cornell University, Ithaca: 607.255.2832
- Cornell University Horticultural Lab, Riverhead: 516.727.3910
- Cornell Cooperative Extension Center, Kingston: 914.338.3494
- State University College, Brockport: 716.395.2638
- SUNY Buffalo, Buffalo: 716.645.2088
- Cornell Cooperative Extension Center, East Aurora: 716.652.7874
- State University College, Oswego: 315.341.3042

In Search of Molecular Links Between Man and the Sea



Dr. Jon Clardy's investigation of the therapeutic potential of exotic marine organisms.

by Julie Zeidner

Jellyfish and sponges from the Caribbean, tunicates from the Philippines, and algae from Hawaii have more in common than their exotic locales. They are part of a growing number of marine animals and plants that show promise in the treatment of a wide variety of human illnesses. From coral reefs to rainforests, organic chemists are in search of natural products that can be used to fight cancer, AIDS, diabetes and other diseases. Their quest also provides insights about molecular biology and evolution, and the importance of biodiversity.

"The same way that poets look to nature to get ideas, scientists look to nature to get ideas," said Dr. Jon Clardy, the Horace White Professor of Chemistry at Cornell University. "The key is to look in places with high-species diversity, like tropical reefs, where there's all kinds of competition for space and nutrients." Because organisms from these environments have developed chemical defenses against predation and infection, they offer researchers natural substances on which to base new pharmaceuticals.

Since the discovery of penicillin in mold more than 60 years ago, scientists have looked for potential drugs in soil microbes, and more recently, drugs from marine microbes. But while novel chemicals from land-based plants and microbial fermentation are on the decline, scientists have barely scratched the surface of the sea's molecular potential. Technologies like the Johnson-Sea Link submersible developed by the Harbor Branch Oceanographic Institution are allowing scientists to reach greater depths in the ocean for long enough periods of time to begin to harvest new marine organisms.

Clardy's work serves as a model for the ground-breaking discoveries in bioorganic chemistry that have been made in the past two decades. His marine natural products research, supported in part by New York Sea Grant during the last 10 years, is helping pharmaceutical industry efforts to cure disease.

When scientists have questions about the molecular structure of compounds they have isolated they often consult Clardy. He is able to identify the atoms that make up molecules of such life essential agents as nucleic acids and proteins using X-rays and computer analysis. By understanding the formation, structure and activity of these molecules, and their role in cell replication and the transmission of genetic information, scientists can not only utilize these chemicals to their full potential, but actually improve upon them.

One marine microbe that recently proved to be a potent killer of cancer cells, as well as an active agent against tissue inflammation, was isolated from the surface of a jellyfish from the Florida Keys by Dr. William Fenical, a professor at the Scripps Institution of Oceanography. To get a better idea of how this biologically active compound named salinamide worked, Fenical sent samples for further study to Clardy's chemical laboratory in Ithaca, New York.

Photo courtesy of Harbor Branch Oceanographic Institution

Nature is the designer, and chemists are more like tailors, Clardy said.

"You get something off the rack that's pretty good," said Clardy, referring to organisms found in nature that are used to create pharmaceutical drugs. "Now what we're doing is customizing it. You've got to let out the waist, take a little off the legs."

Clardy illustrates the point with a computer drawing of the molecular structure of a protease inhibitor isolated from blue-green algae, that prevents thrombin from forming blood clots in the human body. The search for thrombin inhibitors that could be used to prevent strokes or heart attacks is a research thrust of all major pharmaceutical companies, and the subject of a major research project for Clardy.

"In nature you find things that you would have never thought of making yourself," Clardy said. "Marine natural products often suggest new molecular motifs."

A new molecular motif for inhibiting thrombin production was discovered in an extract of blue-green algae screened by Dr. Richard Moore, and his colleagues at the University of Hawaii at Manoa and the pharmaceutical company, Eli Lilly, in 1994. The compound was sent to Clardy's lab where both its structure and how it worked were determined.

The molecular structure of compounds from other kinds of blue-green algae that might inhibit thrombin are also under study by Clardy and Dr. Masahiro Murakami at the University of Tokyo. Their goal is to find the best "binding motif" that can be modified and synthetically replicated to suit human needs.

"There is no reason why an organism that came from a tide pool in the western Pacific should make something perfect for inhibiting human thrombin," Clardy said. "What this means is all biochemical pathways are very similar. You can find something close but that might not be good enough. After a couple more experiments you can go to your computer and try to design something better."

The fundamental genetic code of all living organisms from bacteria to human beings is the same. That's why scientists can look almost anywhere for ideas. Proteases, which take apart proteins, are some of the best understood molecules. They are used by all organisms including insects and plants for digestion and sending signals in cells. When the AIDS virus slips its DNA into humans, for example, proteases have to chop the chain up before it can be made into a virus. Another long molecule, fibrinogen, is soluble in blood until modified by thrombin proteases, and a clot is formed.

While scientists know a lot about how protease molecules work and what inhibits them, they know much less about how the human body's immune system works and the chemical interactions that occur between the cell surface and its nucleus to trigger the body's defenses. To unlock the secrets of this chemical "black box," Clardy recently turned his attention to another marine compound called discodermilide. Researchers at the Harbor Branch Oceanographic Institute in Fort Pierce, Fla., isolated discodermilide from a sponge collected in the Caribbean that turned out to be very active in immunosuppressive assays. Immunosuppressive drugs make organ transplants possible, and prevent the body from attacking itself as it does with autoimmune diseases like diabetes, rheumatoid-arthritis and multiple sclerosis. Currently, there is no cure for such diseases, only treatment of the symptoms.

While discodermilide shows extraordinary promise as an immunosuppressive drug, nothing is known about how this agent interacts with cells in the human body. Clardy is investigating this issue with Dr. Stuart L. Schreiber, a chemistry professor at Harvard University, with funding from New York Sea Grant.

"You can find things that work to turn off your immune cells," Clardy said, "but you don't know how they work at a fundamental level."

The researchers are using discodermilide as bait to find out what molecules it interacts with and how it triggers the body's immune system. Since discodermilide doesn't operate in any known chemical pathways, the researchers hope to use it to find previously unknown proteins and cellular targets.

"It sounds funny," Clardy said, "but the only way to find out how these chemical chains work is to mess them up, because then you can find out where the signal gets stuck."

Researchers know that discodermilide is a small molecule that has to bind to a larger molecule, but they don't know what the larger molecule is, because it has never been isolated before. Using affinity columns, researchers pass immune cells over discodermilide in search of a protein that will bind to it.

"What we're doing is fishing for it, and the only thing we know about it is that it will bind to discodermilide," Clardy said.

If the researchers succeed in isolating the protein they will have gone far in unraveling some previously unknown cellular processes that could provide clues for treating cancer and other illnesses. Like taxol, the potent anticancer compound isolated from a Pacific yew tree, discodermilide appears to halt the reproduction of cancer cells.

Ultimately, molecular medicine can provide a foundation for understanding how all things work. Medical advances today are more frequently made by researchers like Clardy with expertise in both chemistry and biology, when the two disciplines are integrated. The discodermilide project is a collaborative effort that will expose graduate students working with Clardy and Schreiber to broader concepts of experimental design.

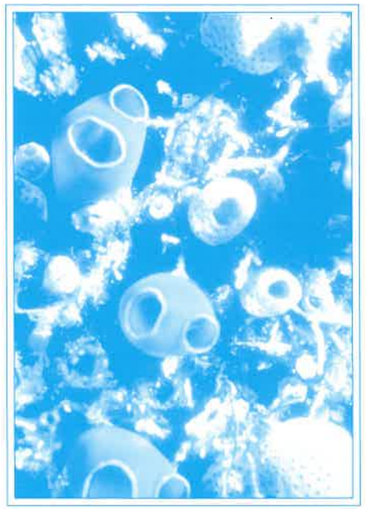
Clardy traces his own interest in the field to an incident early in his career. When a southern cornleaf blight wiped out Iowa's corn crop in 1969, Clardy's first year at Iowa State University, the professor began to analyze samples of other fungal toxins to learn more about their chemical interaction with host cells. He also began to investigate the therapeutic potential of exotic plants and animals from the ocean.

Clardy has been named on several patents for identifying the structure and role of marine natural products as pharmaceutical agents. In addition to identifying the chemical formula for salinimide, Clardy and Sea Grant scholar Linda Brinen, a Cornell University graduate student, identified the structure of neamphine, a crude extract of a sponge that is cytotoxic (it kills cancer cells). Salinimide had first been isolated from a

"You get something off the rack that's pretty good. Now what we're doing is customizing it. You've got to let out the waist, take a little off the legs."

compound found in a sponge from Papua New Guinea by Dr. Ray Andersen, a marine natural products researcher at the University of British Columbia. Clardy was also named on the patent for halomon, a red algae from the Pacific Ocean that shows selectivity for kidney cancer. The algae was collected by John Cardellina, director of the National Cancer Institute's drug discovery program.

The discovery of penicillin and other antibiotics has triggered enormous interest in natural product research. In pursuit of new compounds that yield new medicines, scientists have repeatedly turned to nature for solutions testing things like fungus from Norway, soil bacteria from Mt. Fuji, and sponge from Papua New Guineau. If scientists hadn't looked in such places, Clardy says, many pharmaceutical drugs that we have today would not have existed.



Scientists believe the loss of habitats with highly diverse plants and animals may be responsible for the emergence of new plagues. This argument, made by Laurie Garrett in her current best seller "The Coming Plague," is one Clardy supports.

As habitats, like the South American rainforest disappear, organisms that haven't had a chance to develop specific immunities are thrown together and begin to swap harmful parasites. As biological diversity diminishes, an increasing number of health problems are emerging, said Clardy, citing Stanford University Professor Paul Ehrlich's research on the interdependence of all living organisms.

"Species going extinct are like rivets popping off an airplane wing — rivets pop off all the time and it doesn't matter, but eventually enough rivets will go till the wing falls off, and then we crash," Clardy said. "I think that is what we're risking here."

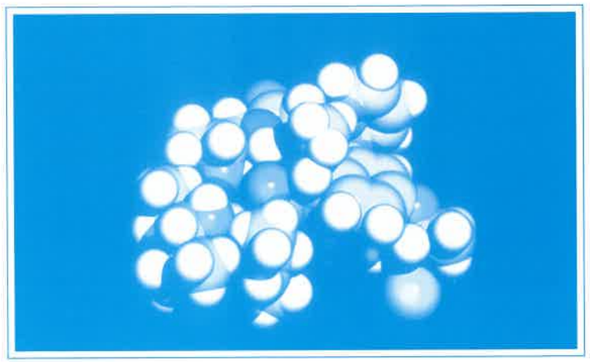
Despite the promise new medicines from natural products hold, taking a design for a new drug to the product stage is a long, difficult process, which rarely succeeds.

"Even for natural compounds with demonstrated utility," Clardy said, "the issue of supply can be vexing." The pharmaceutical industry bases its research on microorganisms that can be grown in test tubes in the laboratory to avoid the complication of limited natural supplies of exotic compounds like taxol from the Pacific yew and neamphine from the marine sponge. Such a task can be daunting given the difficulties of identifying the precise three-dimensional structure and function of molecules that have never been seen before, let alone understood.

Issues of efficacy and safety make finding new drugs even more difficult. In research labs like the National Cancer Institute, a whole battery of cell lines derived from human cancer are treated with natural compounds to determine which ones are effective at killing cancer cells. Still, compounds selective in cancer assays may be ineffective in treating tumors in mice, but might have be very effective against treating other illnesses. Other potential drugs like those selective in inhibiting human thrombin may turn out to be dangerous, because they inhibit other biological functions.

"Our understanding of molecular biology is not as sophisticated as we think, and our ability to predict how a drug works is not as sophisticated as we think," Clardy said.

This makes finding a new drug an expensive prospect.



"It takes about $300 million and 15 years to develop a product," Clardy said. "That's why most things fail. It's a big pyramid with a few very expensive molecules at the top, and a lot of things that need to be weeded out. That's one way to temper your expectations."

If they are approved by the Food and Drug Administration, protease inhibitors will be the first new family of synthetic drugs to fight AIDS since AZT was approved eight years ago.

The thrombin-inhibitor Clardy identified from blue-green algae could become a drug, but the process could take another decade. Clardy would be 61 by then.

"It's a long process to come up with a drug and I would say we're at the stage where we have a good idea, and we have to see if we can make it better," Clardy said. "We already know that this molecule is an orally available thrombin inhibitor. It's not a drug, but it could become one."

While some noted marine natural chemists like Fenical, Dr. John Faulkner, a professor at the Scripps Institution of Oceanography, and Chris Ireland, a professor at the University of Utah, continue to collect new and unusual specimens, Clardy has moved away from searching out new compounds and is primarily working on molecular biology.

Figuring out how discodermilide shuts down the immune system may be Clardy's biggest challenge.

"It's a new pathway, a new protein, a new target, that will tell us about some biology we never knew," Clardy said. "If someone hadn't extracted a sponge, and run an assay on it, we wouldn't have the ability to do that." ◆

Species going extinct are like rivets popping off an airplane wing — rivets pop off all the time and it doesn't matter, but eventually the wing falls off and then we crash."

Discovering Zebra Mussels Before They Inflict Damage

Dr. Sandra Nierzwicki-Bauer, left, Sea Grant Scholar Jane Wyllie, right.
Photo by Thomas Griffin, courtesy of Rennselaer Polytechnic Institute

By Judith N. Hogan

Since the discovery of zebra mussels (*Dreissena polymorpha*) in Lake Erie seven years ago, the small striped mollusk has wreaked havoc in New York's Great Lakes region by clogging electric generation facility and public water facility industrial plant pipes and boat intakes, disrupting natural ecosystems and littering beaches with its sharp shells and rotting meat. The cost of cleanup and preventative measures for the area will soon reach nearly $500 million a year, according to estimates from the U.S. Fish and Wildlife Service.

But New York Sea Grant researchers hope that a new DNA probe, which would identify zebra mussel larvae quickly and efficiently, might minimize impacts in facility intakes. The probe would also reduce the amount of infestation if the mussels enter pristine waterbodies such as Lake George, a popular tourist spot currently of concern due to its proximity to Lake Champlain and the Hudson River, both which harbor large populations of zebra mussels.

The Invasion and Its Effects

Native to the region of the Black and Caspian Seas, zebra mussels are believed to have been transported to North America as hitchhikers in the ballast water tanks of ships from European freshwater ports. When ballast water was discharged into the Great Lakes so too were the mussels.

Their name stems from the elongated shell which is marked by alternating light and dark bands, much like the stripes of a zebra. Though the freshwater bivalve mollusk is usually less than three inches long at maturity, its small size is not indicative of its ability to multiply and colonize. A female mussel can produce one million eggs per season, creating reef-like colonies of more than 100,000 per square meter on lake bottoms, and up to 750,000 million in intake conduits.

The fertilized eggs hatch into tiny larvae known as veligers. The zebra mussel is unique from other freshwater bivalves in that veligers stay in the water column longer, up to five weeks before settling on the bottom and other hard surfaces. The potential for transport is great as the movement of these planktonic forms is influenced by winds and currents. In the larval and juvenile form, mussels can be carried by engine intakes, wells, bait buckets or bilges filled with zebra mussel infested water.

Using dense elastic-like threads (called byssal fibers) and an epoxy-like adhesive, zebra mussels can build huge colonies several layers thick. Since they prefer moving water, a favorite landing spot for the mussels is intake pipes from power plants and industrial facilities. Zebra mussel colonization can eventually block the flow of water, interfering with the production of electricity, clean water and a number of manufacturing operations.

Once colonized, adult mussels are hard to remove due to the byssal fibers and adhesive which cements them to hard surfaces. Their life span can range from three to five years.

Since New York's first mussel sighting, the mollusks have infested many upstate waterbodies including Oneida Lake, Lake Champlain and the Finger Lakes and have found their way into the Hudson River. The immediate threat for downstate New York is the effect the mussels could have on the New York City public water supply system which serves 10 million residents. While no New York power plants or other facilities have been shut down due to infestation, many now require constant monitoring and additional maintenance.

Preventive maintenance options include filters, flooding with hot water, use of oxidizing biocides and molluscicides, or using antifouling paints on pipes and boat intakes. But environmental regulations often dictate what can and can't be done, and the cost of prevention is often very prohibitive for smaller industrial companies.

In the ecosystem, high zebra mussel populations impact existing food webs since the mussels compete for the same type of food as fish larvae and other larger zooplankton. The mussels are filter-feeders, drawing water in through a tube called a siphon and removing what they can use for food. Desirable food includes tiny floating plants and animals called phytoplankton and zooplankton. In the Hudson River, researchers are discovering that zebra mussels are dramatically impacting both phytoplankton and zooplankton populations, dropping them to less than 20 percent of their normal concentrations.

Targeting The Veligers

In an effort to stop zebra mussel colonization before it starts, a research team at the Rensselaer Polytechnic Institute (RPI) is investigating the use of DNA genetic probes to test for the presence of zebra mussel veligers.

Professor Sandra Nierzwicki-Bauer, chairman of biology at RPI and director of RPI's Darrin Fresh Water Institute, and postdoctoral research associate Marc Frischer believe early detection could be a key to stopping the damage zebra mussels inflict, and that genetic data about the veliger could provide vital information about the biology and ecology of the mollusk. New York Sea Grant Scholar Jane Wyllie is assisting on the project, which will be the foundation of her master thesis.

Initiated in September 1994 with a $112,000 grant from New York Sea Grant, the DNA probe project has three goals: to develop a zebra mussel specific oligonucleotide 18S rRNA targeted DNA probe for use in rapid and sensitive detection of veligers; monitoring Lake George for the transport of mussels into the lake, and using the newly created probes to obtain a better understanding of zebra mussel recruitment and its ecology.

Though there is no current technology to eliminate veligers, several researchers across the country are investigating different possibilities since the zebra mussel is most susceptible to chemical treatment at its larval stage. But it's a tough challenge, said Frischer, explaining, "it's hard to attack the veligers selectively without killing everything else in the ecosystem."

But reliable and efficient detection at the mussel's earliest stage would signal the need for preventative action and could help avoid the massive colonizations which have taken place in some water intakes, said the researchers. Prevention measures could include warning boat owners to wash boat bottoms with hot water to kill veligers before launching the boat in mussel-free waters, and alerting municipalities and industrial plants to install control systems before colonization began blocking intake pipes.

Fingerprinting Benefits

The current technique for identifying zebra mussel veligers is a difficult and time consuming task since under the microscope the veligers often look similar to other organisms, said Frischer. Though the new DNA probe will still involve using a microscope, the identification process will be much quicker, allow more water samples to be tested and will not require a highly trained scientist for analyzing the samples, he added.

The first step in creating the DNA probe requires identifying a portion of the mussel's genetic makeup. After identifying several regions which may be suitable to target, a probe will be created which will only link to the RNA of the zebra mussel. The probe is a combination of a piece of DNA synthesized to match the sequence of the zebra mussel and a "reporter" molecule. Veligers will appear colored when the probe attaches to them.

"This will allow us to get very sensitive detections, higher than what can be done right now microscopically. It also has the potential of being automated eventually," said Frischer, adding that the genetic approach is also providing information about the zebra mussel's evolutionary history which "improves our basic understanding of this animal."

Scientists are discovering that differences in water chemistry and temperature could be contributing factors in why mussels seem to grow faster in North American waters compared to European waters. Calcium levels appear to be a determining factor in survival, said Frischer, which may explain why there are no zebra mussels in Lake George, a softwater lake. Furthermore the more acidic the water, the less likely zebra mussels can live, he added.

"Zebra mussels have some very unusual features, compared to other freshwater bivalves, and I think that has a lot to do with how we can control them and what they are going to do to ecosystems. Knowing where they came from and who they are related to can help us to understand this organism," Frischer said.

The zebra mussel project is an extension of ongoing research at RPI in which Dr. Nierzwicki-Bauer's laboratory has been developing probes for direct in-situ hybridization of bacteria in deep subsurface sediments, to gain a better understanding of microbial communities use for development of bioremediation approaches.

"Given that zebra mussel infestation of Lake George is a major concern to the area, and with mussels already in Lake Champlain and the Hudson, work in this area seemed a logical extension of my group's activities," she said.

Although the new probe is specific for the zebra mussel, there are several related areas of study it could be used for application, said Nierzwicki-Bauer, explaining that the general technology and detection methodologies may be directly applicable to other non-indigenous marine and aquatic species.

"We hope to develop some future partnership with industry in terms of developing the prove metho dology to make it much more accessible. In addition to being able to map where the mussels are coming in, and monitor bodies of water, we also think it could be useful for testing the effectiveness of treatment projects at power plants," said Frischer.

The probe technology could also be used in the arena of waterborn pathogens, investigation of whether zebra mussels selectively filter microbes and possibly serve as a sink for human pathogens, as well as further study of the ecology of the zebra mussel itself.

"Our next step using the probe will be to study the larval ecology of the veligers, as well as mortality factors, aspects we don't really understand at this point," added Nierzwicki=Bauer.

As of this past Fall, the research team had completed nearly 95 percent of the project and hope to have the problem completely developed by August of 1996. ◆

New York Sea Grant Publications

NYSG now charges a handling fee for all publications. Please send requests with a self-addressed mailing label including checks payable to:

New York
Sea Grant Institute
115 Nassau Hall
SUNY at Stony Brook
Stony Brook, NY
11794-5001 or
call 516.632.9124

Guidelines to Increase Survival of Released Sport Fish

Mark H. Malchoff and David B. MacNeill

Guides the angler through the management rationale behind release of sport-caught fish. Discusses the causes of angling mortality in fish, and presents both general recommendations on releasing fish and more specific suggestions for increasing survival of marine offshore and bottom fish species, warm-water freshwater species, and trout and salmon taken at greater depths. $2.

Long Island Sound Conference Proceedings Available

Proceedings from the 1994 Long Island Sound Research Conference where marine scientists and resource managers gathered to discuss the role of research in assessing the status of the Sound are now available from New York Sea Grant.
The one-day forum was held at the State University of New York at Stony Brook. The theme of the conference was the role of scientific research in determining whether the Sound's condition is improving or not, and how research efforts can gauge this. 103 pages. $7.

Brown Tide Summit On Video

A video of the two-day Brown Tide Summit sponsored by New York Sea Grant, the Marine Sciences Research Center of the State University of New York at Stony Brook and the Peconic Estuary Program, is now available from Sea Grant.
Experts from across the country gathered at the summit to discuss current brown tide research and to create a research agenda that will determine the next steps in dealing with the issue.
Brown tide has plagued Long Island's East end bays for almost a decade, and recent outbreaks this summer had a devastating effect on the scallop harvest. Nearly 70 nationally recognized scientists from universities and research centers participated in workshops. $50.

Marine Science Careers

Today's marine scientists pursue a great variety of wide-ranging careers, using the latest in technology to address the problems and issues that face our marine resources. This guidebook, compiled by Sea Grant, contains question and answer profiles and photos of 38 marine scientists and other professionals from around the country.
The guide focuses on several major career areas: marine biology, oceanography, ocean engineering and closely related fields. It is intended for high school students, but it will also be of interest to college undergraduates, middle school students, parents, teachers, and guidance counselors. It also includes information on the outlook for marine science careers in general and a list of additional resources.
Copies are available for $5 from either: Sea Grant Communications, Kingman Farm, Univ. of New Hampshire, Durham, N.H. 03824-3512 (checks payable to UNH), or WHOI Sea Grant Communications, 193 Oyster Pond Road, CRL 209, Woods Hole, Mass. 02543-1525 (checks payable to WHOI).

Journal Reprints

For up to three journal reprints NYSG charges a $1 handling fee. For each additional reprint add $.25. For bulk orders contact NYSG.

Dietary n - 3 Polyunsaturated Fatty Acids Modify Syrian Hamster Platelet and Macrophage Phospholipid Fatty Acyl Composition and Eicosanoid Synthesis: A Controlled Study

M.E. Surette, J. Whelan, G. Lui, I. Hardard'ottir, and J.E. Kinsella.

1995 Biochimica et Biophysica Acta.1255:185-191.

Concentration of Selected Priority Organic Contaminants in Fish Maintained on Formulated Diets in Lake Ontario Waters

J. K. Buttner, J. C. Makarewicz, and T. W. Lewis.

1995. The Progressive Fish-Culturist. 57:141-146.

Identification of Marine Invertebrate Larvae by Means of PCR-RAPD Species-Specific Markers

M. A. Coffroth and J. M. Mulawka III.

1995. Limnology and Oceanography. 40(1):181-189.

Use of Angler Diaries to Examine Biases Associated with 12-Month Recall on Mail Questionnaires

N. A. Connelly and T. L. Brown.

1995. Transactions of American Fisheries Society. 124:413-422.

Phenotypic Similarity and the Evolutionary Significance of Countergradient Variation

D. O. Conover and E. T. Schultz.

1995. Elsevier Trends Journal 10(6):248-252.

Winter Field Trials of Enrofloxacin for the Control of *Aeromonas salmonicida* Infection in Salmonids

H.-M. Hsu and P. R. Bowser.

1995. Journal of the World Aquaculture Society. 26(3).

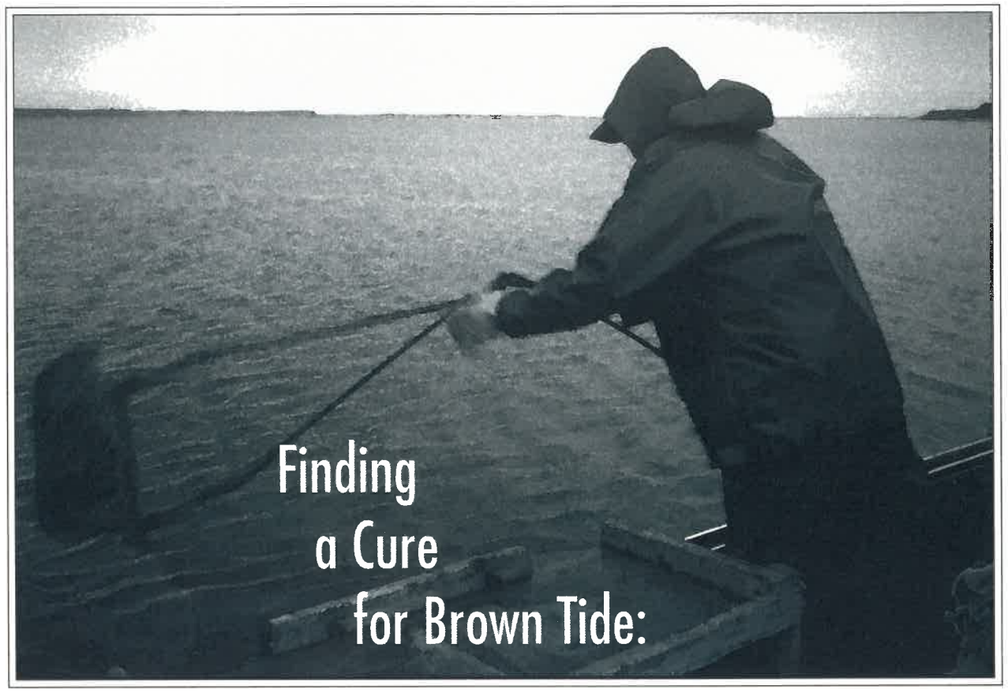
Effects of Temperature, Salinity, and Fish Size on Growth and Consumption of Juvenile Bluefish

J. A. Buckel, N. D. Steinberg and D. O. Conover.

1995. Journal of Fish Biology. 47:696-706.

Other Newsletters available from Sea Grant:

- Charterlines
- Coastal Educators News
- Commercial Passenger Fishing Vessel News
- *Dreissena!*
- Great Lakes Research Review
- Marine Archaeology
- Marine Facilities Notes
- Marine Network News
- New York Great Lakes Water Level Update
- Perspectives: Great Lakes Program
- Tourism News



Finding a Cure for Brown Tide:

Photo courtesy of Chris Smith of Cornell Cooperative Extension

Marine and Political Scientists Brainstorm at Summit to Help Solve Problem. By Julie Zeidner

Just before the official opening of the bay scallop season on Long Island in October 1995, political pressure was mounting to thwart further economic hardship for scallop harvesters. The potential loss of other fishery resources and impacts on the tourism industry — all important aspects of Long Island's community tradition — were also at stake. Scientists from across the United States, government officials, and local members of the public met for a Brown Tide Summit in Islip, N.Y. to review the current status of information about brown tide and to develop a plan to address the problem that would encompass local, regional, and national efforts.

For scientists brown tide represents part of a growing number of harmful algal blooms increasing in incidence and variety around the world that will require their expertise to solve. The public is frustrated that the cause of brown tide, and solutions for this problem, remain a mystery.

The microscopic algae (*Aureococcus anophagefferens*) named brown tide for the muddy color it turns the water, first appeared in Peconic Bay in 1985. It wiped out the scallop crop, and left baymen nearly empty-handed. For much of the past decade prior to brown tide, one of Long Island's most valued and anticipated products, Peconic Bay scallops, had a dockside value of $2 million. Brown tide blooms have reduced the annual fall scallop harvest yields to only a few thousand dollars.

Brown tide, which commonly reaches a peak in summer, can kill shellfish outright, and block sunlight to eelgrass and other underwater plants, destroying the habitat scallops and other marine resources depend on for shelter. Brown tide's first mysterious appearances were in both Rhode Island's Narragansett Bay and Long Island's Peconic and Great South Bays. While it disappeared from Narragansett Bay, it has continued to occur periodically in Long Island embayments, as well as in New Jersey's Barnegat Bay throughout the decade. A close relative of brown tide has also been persistent year round in some Texas bays since 1990.

"Brown tide reared its ugly head this year, after we all basked in the glory of a wonderful crop the previous year," said U.S. Representative Michael Forbes (R-NY), who spoke at the Brown Tide Summit sponsored by New York Sea Grant, the Marine Sciences Research Center at the State University of New York at Stony Brook, and the Peconic Estuary Program. Funding was provided by the National Oceanic and Atmospheric Administration (NOAA). "It is clear to all of us that this is something vital to the future of Long Island's economy. If we lose a grip on shellfishing and the fishing industry in general, it gets to the heart and soul of this area that we love."

New sources of research funding to help solve the problem were also announced at the conference. Dr. Donald Scavia, director of the NOAA's Coastal Ocean Program, said that pending availability of funds, his agency would direct $1.5 million for brown tide research during the next three years. Suffolk County Executive Robert Gaffney also announced that the county would set aside $100,000 to support brown tide research at the Brockhaven National Laboratory this year.

Researchers have made progress in understanding brown tide since the organism was discovered a decade ago. New York Sea Grant and the Suffolk County Department of Health Services have devoted funds to address this problem throughout this period. An antibody probe to detect brown tide developed by Dr. Donald Anderson, a biologist at the Woods Hole Oceanographic Institution, has enabled scientists to easily distinguish brown tide from other microscopic algae. Researchers including Dr. Elizabeth Cosper of SUNY's Marine Sciences Research Center (MSRC) have been able to single out factors that stimulate the growth of brown tide like iron, and isolate naturally-present viruses in seawater that can rapidly lead to its demise. But scientists concede that they are still far from having found a cure for brown tide since the organism is not fully understood yet.

During the two-day summit, scientists reported the results of studies that characterize factors in the environment that might cause the brown tide to grow including warmer weather, and increased salinity and reduced water circulation due to lack of rainfall. Based on results to date, it is not clear what impacts human and industrial waste products that run off the land into waterways have on the brown tide organism. Nitrogen, found in sewage effluent, appears to have little or no direct effect on the growth of the algae, scientists said. Recent studies have shown that increased water usage is pumping more iron into the bays, which might stimulate the growth of brown tide. Iron bound to compounds like citric acid used in new laundry detergents might also contribute to bloom formations.

Other studies have demonstrated the negative ecological impacts of the brown tide organism on aquatic biota. Brown tide not only blocks sunlight to underwater plants, but the work of Dr. V. Monica Bricelj at MSRC and Dr. Gregg Tracey at Science Applications International, Corp. has also shown the severe toxic effect brown tide has on bivalves inhibiting their ability to eat, grow, and reproduce successfully. In addition to wiping out the scallop population and diminishing the size and quality of hard clams, research by Drs. Darcy Lonsdale and Gordon Taylor of MSRC illustrates the negative impact brown tide has on other small plants and animals that form the basis of the food chain for larger fish.

Scientists tempered expectations of baymen in the audience by cautioning that there would be no quick-fix solution for brown tide. They said one of the impediments preventing them from getting a better picture of how brown tide operates has been limited funding for the problem, which has tended to fluctuate with the sporadic appearance of brown tide. Also, since brown tide blooms are not always present, it is difficult to conduct research for a long enough time to yield definitive results. Until the basic biology of brown tide is understood, there is little hope of managing the problem.

"No one can sustain an effective research program without sustained money," said Anderson. "Everyone's looking for control (of brown tide), but you have to look at ecology and oceanography first."

On the final day of the summit, scientists described to the public a plan for what brown tide research still needs to be done to effectively deal with the problem. The research questions on brown tide that still need to be addressed will focus on understanding what causes brown tide to grow and out compete other organisms, and then disappear. It will involve a quantitative evaluation of how chemical, physical, and biological factors effect brown tide. Finally, further studies are needed to more precisely determine what impacts brown tide has on commercially important shellfish.

"The important thing is not in these questions themselves but in the details that we're adding to try to answer them." said Dr. Kirk Cochran, MSRC's dean and director. "Secondly, there needs to be development of a centralized information center that can handle the new information, along with networking and sharing this information with the public."

"I'm impressed by the wealth of information on brown tide, but there's clearly a lot that still needs to be done to solve this issue," said Dr. Anne McElroy, director of New York Sea Grant. "We are hopeful that the coordinated research plan proposed will provide the information needed to effectively deal with this devastating biological problem."

Scanning electron micrograph of brown tide species at x 30,000 magnification. Photo courtesy of Dr. Elizabeth Cosper.

"Everyone's looking for control, but you have to look at ecology and oceanography first"

Harmful algal blooms are an emerging focus for international and national marine programs. Internationally, the Intergovernment Oceanographic Commission has developed an International Harmful Bloom Program to coordinate training programs, and encourage countries to start research, education and outreach programs on the issue. A U.S. interagency task force with representatives from the National Science Foundation, NOAA, the National Marine Fisheries Service, the Department of Defense and other groups has developed a research plan on harmful algal blooms, and a spinoff report entitled "ECOHAB: A National Research Agenda" has been issued. ECOHAB calls for researchers from multiple regional programs to work together on harmful algal bloom research. Federal programs like the National Sea Grant College Program have committed funding for brown tide research in every state where it has occurred since its discovery. In addition, largely in response to the Brown Tide Comprehensive Management and Assessment Program, the U.S. Environmental Protection Agency established the Peconic Estuary Program, which is working on a Comprehensive Conservation and Management Plan to protect Peconic Bay's shellfish, vegetation, and rare or endangered species.

Baymen in the audience said finding a solution to save the scallop fishery demands immediate attention.

"Right now as bay people, we cannot wait," said Florence Sharkey, a member of the Brookhaven Baymen's Association. "We need something to get us through the bad part, and with the scientists figuring out the rest, we can wait a long time."

Scallop aquaculture programs may provide short-term relief for brown tide, said Chris Smith, a Cornell Cooperative Extension Specialist, who serves as a technical advisor to the Long Island Green Seal Program, a bay scallop seeding effort run by a committee of baymen.

"By planting a small number of scallops through seeding programs, you can create a significant economic harvest," said Smith, noting that 25 percent of the 1989 scallop crop were from scallops planted by Green Seal's seeding program in 1988.


Aerial photograph of brown tide afflicting Peconic Bay on south side of shore and the clear Atlantic Ocean on the north side of shore. Photo by R. G. Rowland.

"Right now as bay people, we cannot wait"

New York State Assemblyman Fred Thiele reminded researchers at the summit that the people of Long Island were able to get $15 million from the state legislature to preserve the Pine Barrens. If the public rallies behind brown tide research they might succeed in getting the money necessary to find a solution, he said.

"There's marine science and political science, and this project is going to be a little bit of both," said Thiele, directing his advice to scientists in the audience. "You have to articulate in a clear, concise way what the benefits are to brown tide research, how much it is going to cost, how much it is going to take, and get the public behind it."

SEAFOOD CORNER

Clams can be prepared in a variety of fun and interesting ways. Try steaming or grilling them with lobster, corn and potatoes for a traditional clambake, or serve them with or without your favorite sauce on the half shell. Clams are featured in dishes from around the world. Favorite recipes include paella, chowders, bouillabaisse, pasta dishes and a variety of baked clam appetizers.

The first coastal inhabitants of New York called Long Island the "Island of Shells" in recognition of the vast numbers of clam, oyster and other shells one sees on its shore. The dockside value of clams landed in New York State is greater than any seafood product.

A rich source of protein, vitamins and minerals, clams are a low calorie food that is also low in fat, saturated fat and cholesterol. Clams are also a good source of Vitamin B_{12}, iron, iodine and other trace minerals.

For copies of a free New York Seafood Council clam brochure, contact New York Sea Grant.

Nutritional Information

(for 3 ounces of steamed clam meat or 12 small steamed clams)*

Calories:	126
Protein:	22 grams
Total Fat:	1.7 grams
Saturated Fat:	0.2 grams
Omega-3s:	0.2 grams
Sodium:	95 milligrams
Cholesterol:	57 milligrams

*Source: Seafood Savvy, Ken Gall, Cornell Cooperative Extension Information Bulletin, 1992.

Linguini & Clams

A recipe by Chef Chris Neary - East Point Inn, East Rockaway, NY

12 little neck clams

1/2 teaspoon fresh garlic

3 tablespoons olive oil

Rinse clams, drain and set aside. In a sauté pan, heat the oil. Add the garlic and lightly toss until golden brown.

2 tablespoons butter or margarine

1/4 teaspoon chopped basil

1/2 teaspoon chopped parsley

Add the little neck clams, cover and steam until the clams open. Add the remaining ingredients and simmer

1/8 teaspoon oregano

1/4 teaspoon fresh lemon juice

salt and pepper to taste

3–4 minutes. Serve over medium size cooked linguini, cooked al dente.

Serves 2.

New York Sea Grant

115 Nassau Hall
SUNY Stony Brook
Stony Brook New York
11794–5001

Address Correction Requested

NON-PROFIT ORG.

U.S. POSTAGE PAID

STONY BROOK NY

PERMIT NUMBER: 65

International Conference Focuses On Land-Based Marine Pollution

Threats to the global marine environment and the health and economic well-being of the 3.5 billion residents who live in the world's coastal areas was the focus of a conference hosted by the United States this fall.

Photo by Ian Stupakoff

This two-week event was the culmination of a comprehensive and sequential approach begun in 1993 under the auspices of the United Nations Environment Programme (UNEP) to deal with the nearly 80 percent of marine pollution and other types of marine degradation which is caused by land-based activities. The action program addresses activities including discharges from industry, agriculture, forestry, transport and urban development, in particular sewage discharges.

The marine environment, both in coastal zones and in open seas, has been under increasing threat. Population densities, industrial growth, tourism development and the siting of transportation and trade centers have had adverse effects on a variety of coastal ecosystems. Incidences of red algae blooms, coral bleaching, health epidemics and the decline in the quality and quantity of marine food resources are also vivid examples of the deterioration of this fragile environment and critical habitats.

Dealing with effects of land-based activities involves addressing concerns that cut across all sections of society. The draft Global Programme of Action for the Protection of the Marine Environment from Land-based Activities identifies concrete actions needed at various levels of society, including innovative financing mechanisms to prevent, control and reduce the degradation of – as well as speed the recovery of – the marine environment.

A key topic of discussion at the conference included the reauthorization of the Magnuson Fishery Conservation and Management Act, the principle law governing the management of U.S. fisheries. According to the United Nations' Food and Agriculture Organization, 70 percent of all fish stocks are fully exploited, overexploited or rebuilding from past overfishing. During a floor debate, the U.S. House of Representatives adopted 12 pages of amendments before voting. As of late November the Senate was preparing a substitute bill.

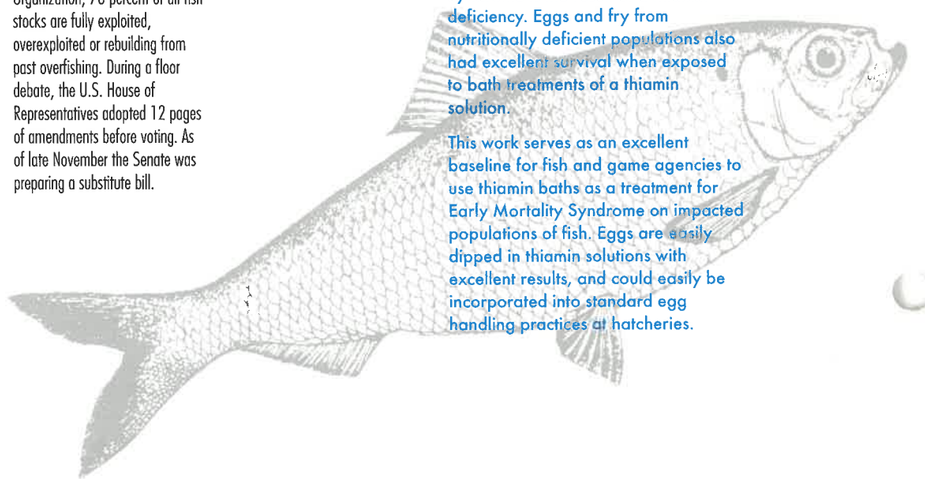
Reproductive Failure in Salmon Linked to Alewife Forage Base

Researchers at Cornell University have obtained information that confirms the link between Early Mortality Syndrome (also called "Cayuga syndrome") in landlocked Atlantic Salmon and the presence of an alewife forage base.

Both alewife and smelt are known to contain high concentrations of the enzyme thiaminase, which is thought to destroy thiamin in the adult fish. Adult fish from Otsego Lake, Cayuga Lake and Green Pond, which have either an alewife or smelt forage base do not reproduce successfully or reproduce with limited success. Little Clear Pond, on the other hand, does not have an alewife forage base, but does have adult Atlantic salmon that are capable of reproduction. Eggs taken from Little Clear Pond fish, which successfully reproduce, contained thiamin at much higher concentrations than eggs from sources experiencing reproductive failure.

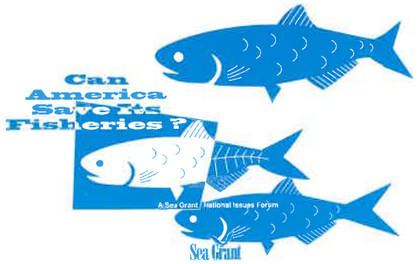
The results are consistent with the hypothesis that Early Mortality Syndrome is the result of a thiamin deficiency. Eggs and fry from nutritionally deficient populations also had excellent survival when exposed to bath treatments of a thiamin solution.

This work serves as an excellent baseline for fish and game agencies to use thiamin baths as a treatment for Early Mortality Syndrome on impacted populations of fish. Eggs are easily dipped in thiamin solutions with excellent results, and could easily be incorporated into standard egg handling practices at hatcheries.



National Forum Focuses on Fisheries Issues

Two dozen of America's leading experts on fisheries issues—representing the views of government managers, industry leaders, university scientists, conservationists and Native Americans - addressed critical questions relating to the use and management of America's fisheries resources at a national forum held in Washington D.C. this past fall.



The goal of the Sea Grant National Issues Forum, *Can America Save It's Fisheries*, was to create greater awareness among the nation's media, policy makers and industry leaders about the status of the nation's fisheries, its current status, and what can be done to save the fisheries.

"We felt it was especially timely to conduct this national forum," said James Cato, President of the Sea Grant Association, adding that the pending congressional reauthorization of the Magnuson Fishery Conservation and Management Act of 1976 "provides a unique opportunity to make changes that will improve our management capabilities."

Citing United Nations Food and Agriculture Organization statistics, Cato said that 70 percent of the world's fish stocks are fully exploited, over exploited or rebuilding from past over-fishing. Nine of the world's 17 major fisheries are in serious decline, and four others are classified as "commercially depleted."

"As a university-based research and outreach program, Sea Grant's fundamental mission is to provide the nation with information that can be used to solve problems. The issue here is the science-based use and management of American's fisheries issues," Cato said.

A summary report on the forum is available from the National Sea Grant Media Relations Office, National Sea Grant College Program, 0112 Skinner Hall, University of Maryland, College Park, MD 20742-7640 or by calling 301.405.6381.

Follow The Signs To New Pumpout Facilities

Through a cooperative effort between federal and state agencies, new pumpout facilities are being constructed at public and private marine facilities in New York under a federal grant program established under the Clean Vessel Act.

The new grant program, administered by the U.S. Fish and Wildlife Service through the New York Department of Environmental Conservation, is providing matching grants for the construction of new pumpout facilities. So far, over $660,000 in new construction has started, with 51 marine facilities receiving funding. As part of each grant the marine facilities have also committed at least 25 percent of the funds necessary for construction.

Also participating in the program are the New York Department of State Coastal Management Program, New York Environmental Facilities Corporation and New York Sea Grant Extension which designed new signs and posters to alert boaters to the new facilities.

"Not only does this new program benefit boaters but also the general public. The discharge of untreated waste into our waters can introduce disease-carrying microorganisms that contaminate aquatic environments and impair their value," said David White, New York Sea Grant Great Lakes Program Coordinator. The decaying wastes can also reduce oxygen levels in water, making it difficult for fish and other marine species to breathe.

The program's funding is from the Sport Fish Restoration Account of the Aquatic Resources Trust Fund, commonly referred to as the Wallop-Breaux Fund. This fund is the result of excise taxes on fishing equipment, motors, fuel, and import duties on fishing tackle and pleasure boats.

New York Sea Grant Appoints New Associate Director

New York Sea Grant has announced the appointment of Dale R. Baker as the new Associate Director of Extension and Program Leader. Mr. Baker comes to New York following 21 years of service with the Minnesota Sea Grant College Program, where he served as associate director for the past 15 years.

Though the job is new, Mr. Baker is extremely familiar with his new surroundings, and NYSG. Born and raised in the Ithaca area, he attended Syracuse University where he received his Bachelors of Science in Wood Products Engineering. He then headed to nearby Cornell University to earn his Masters in Sanitary and Agricultural Engineering. His first professional position following college, and a two-year stint with the Peace Corps, was with the New York Sea Grant Program when he was named as the first regional extension specialist for the Oswego office. He served two years before heading to Minnesota Sea Grant to serve as leader of the extension program.

"New York Sea Grant is extremely fortunate to have attracted someone with Dale Baker's extensive experience and commitment to the Sea Grant concept to join our management team," said New York Sea Grant Director Anne McElroy.