



THE PROMISE
of **MARINE**
BIOTECHNOLOGY
in FLORIDA

Florida Marine Biotechnology: Finding and Protecting the Ocean's Treasures

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BIOTECHNOLOGY. Though the 21st Century has only just begun, it is safe to say this word is one that will characterize and shape it. The media reports daily on developments in the field ranging from innovative medical applications that we now take for granted to the sometimes controversial practice of genetically modifying crops.

But within that broad heading of biotechnology lies a lesser-known subfield whose potential is as vast as the sea itself, but like the sea its benefits have barely been tapped. The field is marine biotechnology. In simplest terms, marine biotechnology is the use of marine organisms, their genetic make-up, or their natural products or processes for the benefit of humankind, and it offers the potential to fight countless diseases and reverse environmental dilemmas. Florida, with its vast ocean resources, is a natural location for development in the field—a fact that has not gone unnoticed by researchers, legislators and others.

However, it takes more than natural resources to grow an industry, and Florida also possesses an impressive and growing store of technological and human potential. Already, institutions across the state have established themselves as leaders in everything from deep-sea exploration for cancer and other disease cures to the development of vital new environmental monitoring techniques and tools.

The pages that follow draw on research at least partially funded by Florida Sea Grant to reveal a sampling of the excitement inherent to marine biotechnology, and highlight some of the many key researchers and institutions in the field. Our goal is to provide to a broad array of readers information they can use. Economic development interests and potential investors will see emerging products; legislators, reporters and the public will find help for grasping some of the wonders and benefits of this vibrant new field of science; and scientists and those who sponsor research will see opportunities for collaboration.



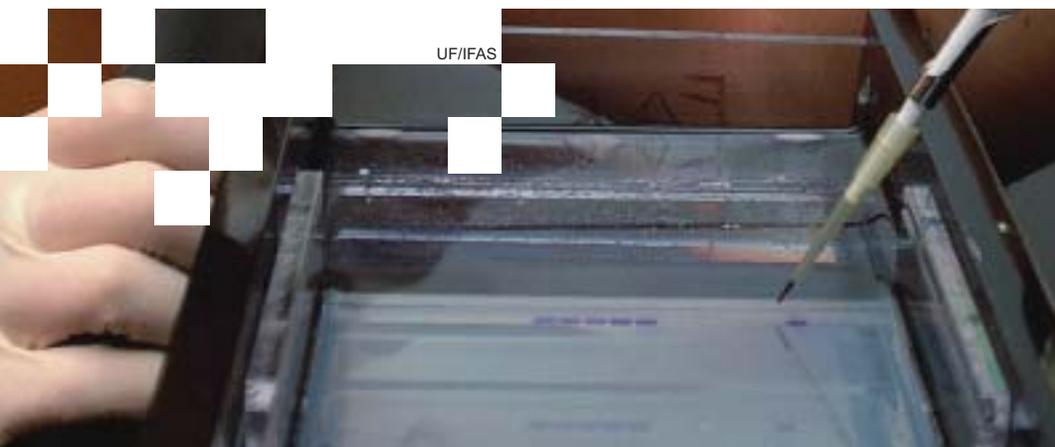
A Climate as Inviting as the Weather

Signs that Florida is dedicated to further establishing itself as a marine biotechnology leader are plentiful. Florida Sea Grant, having long since identified advancing marine biotechnology in the state as a priority, allocates more funds to projects in the field than any other state. BIOFlorida, the statewide trade association for the biotechnology and biosciences industry, now includes several marine-focused partners and state agencies such as Enterprise Florida that are actively promoting expansion of the state's biotechnology industry, including marine sectors.

Through a new 2003 economic development program, the Florida

legislature awarded \$10 million in funding to create a Florida Atlantic University-based Center of Excellence in Biomedical and Marine Biotechnology. The same year Governor Jeb Bush announced that the state had leveraged hundreds of millions of dollars in tax and other incentives to convince the world-renowned Scripps Research Institute, based in California, to establish a new facility in Palm Beach County. Expansion by Scripps into the ocean realm is widely expected through collaboration with Florida marine biotech leaders. Another encouraging development came from the 2004 state legislative session, which approved \$600,000 in funding to support Harbor Branch Oceanographic's drug discovery program.

As this young field develops, the benefits to the state and its residents will be substantial and far-reaching. New high-paying jobs and opportunities to entice students trained in the state will be created, new companies will be attracted, the state's economy will be further diversified beyond the bounds of tourism, and Florida's own coastal and ocean resources will be better protected. Realizing such benefits and maximizing the state's potential will take long-term commitment to research, education, faculty and student training, and development from legislators and industry in partnership with academic institutions. But, if the current climate is any indicator, that is precisely what should be expected.



Above: Shark tissue is analyzed at Nova Southeastern University. At right: Pharmaceutical applications of the ocean's resources may be on the horizon.

Mysterious Killer

Discovery of potentially life-saving sponge triggers search for unknown cancer-fighting mechanism



Forcepia, the elusive reddish sponge that could save lives.

In 1987, scientists from Harbor Branch Oceanographic were using one of the institution's submersibles in the Bahamas to collect sponge samples for biomedical research when they gathered a small, nondescript reddish sponge. Chemical and biological analysis of the sponge revealed nothing unusual, so it was logged into the institution's collection of some 30,000+ samples, stored in an ultra-cold freezer in a hurricane-proof bunker, and all but forgotten.

Using the material available, analysis of the sponge--which had been identified as a species of *Forcepia*--continued. A group of compounds it produced called lasonolides continued to show great promise, and the team was able to decipher their chemical structure, confirm their novelty, and receive patents, but they desperately needed still more material to continue.

Of the *Forcepia* pieces already collected, the largest had come from trawl work off southwest Florida. So, the team used



Nearly five years later, a group from Harbor Branch was collecting samples in the British Virgin Islands when they came upon another reddish sponge. By this time they had begun using a new test of pharmaceutical potential, and to the team's excitement, chemicals from the sponge showed an outstanding ability to kill lung, breast, and other cancer cells. But if work on the promising compounds was to continue, the group simply had to have more of the sponge to study.

So, the team began digging through records and samples in the bunker in search of more of the red sponge, no simple task considering that an estimated 10,000 species of sponge exist and many have overlapping physical characteristics. But in time, they realized that beginning with the 1987 Bahamas collection, a few other pieces of the sponge, mostly small ones, had been collected.

trawls again to work the area on various trips during the 1990s, but to little avail. They could find only a few bits of the sponge, and not enough to support their research goals. Finally, the group was forced to give up in frustration, unsure whether their work with the lasonolides could continue.

But by 1999, the potential importance of the lasonolides was clear enough that the Harbor Branch team returned to explore the Gulf site by submersible. They had low expectations for the day's dives in the relatively barren area, but they knew of no other way to continue the *Forcepia* quest. Ultimately, their fears of unproductive dives proved unfounded and they extended their stay from one to five days, because they discovered an almost unimaginable wealth of *Forcepia*, so much in fact that to this day they refer to the region fondly as *Forcepia* Land.

As it turns out, the species of *Forcepia* in question is especially prone to break up in trawl nets, but working with the submersible on the seafloor they were there intact for the plucking. Because the team found so much of the sponge they suspect they “seeded” the area by breaking sponges up while trawling with each fragment growing into a new sponge colony.

On the Killer’s Trail

With sufficient material in hand, the group, currently led by **Amy Wright**, was able to perform more advanced experiments with the lasonolides, most notably working in cooperation with the National Cancer Institute to run the compounds through a series of tests to identify specific known cancer-killing mechanisms. To everyone’s astonishment, all the tests came out negative, suggesting the lasonolides use a mechanism never before seen.

The result was as intriguing as it was troublesome. A new mechanism for killing cancer cells could mean a new level of efficacy against dreaded forms of cancer or perhaps an ability to attack cancers resistant to existing treatments. But understanding the actual mechanism a drug uses to kill cancer cells is a critical step in the development process required to predict a potential treatment’s effects on humans.

To understand the lasonolides’ activity, the Harbor Branch

group has explored, and continues to explore, a number of possible routes. For one approach, the team has Florida Sea Grant funding to apply a technique called affinity chromatography to the problem. Affinity chromatography involves attaching molecules of the lasonolides to small beads, adding mixtures of protein extracts from broken up cancer cells. Then researchers can determine which of the proteins in cancer cells attach to the lasonolides, indicating which proteins are affected by the compounds. Identifying such proteins could help lead the group to the cancer cell mechanisms targeted by the lasonolides.

The team is also using DNA microarrays (see p. 9, “To Raise a Sponge”) to compare cancer cells treated with lasonolides to untreated cancer cells to determine differences in gene expression between them to zero in on the critical mechanisms.

Finally, though the lasonolides have not yet been licensed, the Harbor Branch group is collaborating with a commercial partner to apply additional modern genomics techniques to solving the lasonolide activity mystery.

Although Harbor Branch has made substantial progress toward the goal of understanding how lasonolides work, the story of the lasonolides is far from over as the group and its collaborators work toward the goal of getting the drugs into clinical trials and hopefully on to market.

The lasonolides are an excellent example of Florida’s potential in marine biotechnology, both as the source of novel compounds with the potential to profoundly impact human lives, and as the source of the expertise and resources needed to develop them.

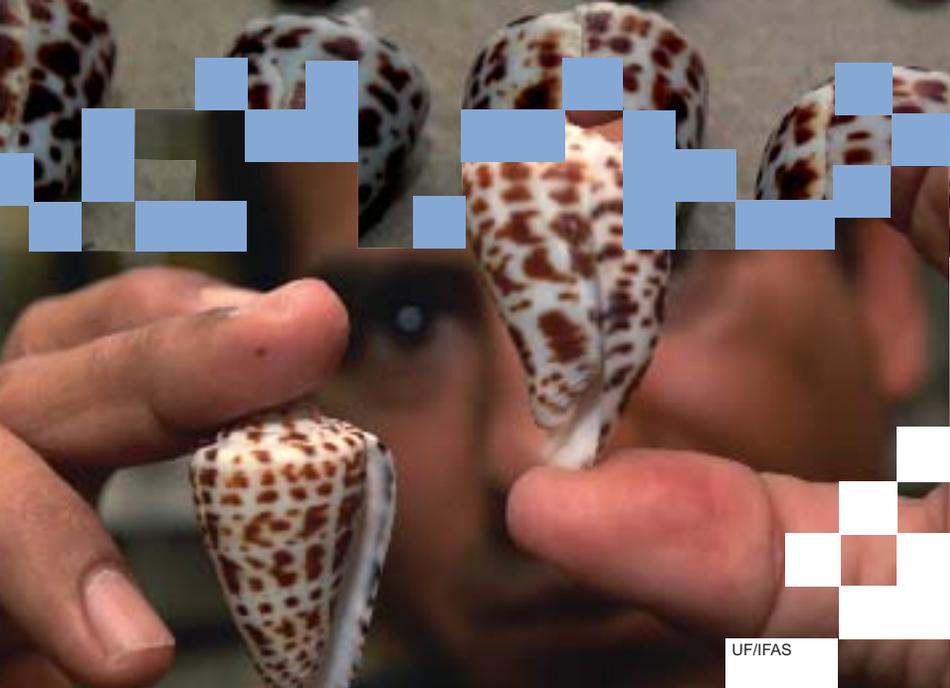


Amy Wright (top) and colleagues process fresh samples collected off the Florida coast using the *Johnson-Sea-Link I* submersible.

A Timeline of Florida Marine Biotechnology Milestones

1996

Survey of Florida universities and marine research institutions identifies faculty interested and capable of pursuing marine biotechnology research, who advise Florida Sea Grant on setting long-term priorities for development of the field in the state.



BIOMEDICAL FOCUS

Double-edged Sting

Snail venom can save lives and kill pain

Though collectors prize cone snails for their exquisite shells, certain species are deadly. But it's not their beauty that attracts biomedical researchers to cone snails, it's that sometimes deadly side that interests them.

Of the roughly 1,000 species of cone snails known in the world, only a handful have deadly potential, but each of them does, of course, move at... a snail's pace. That means they need an edge to survive in the competitive marine environment. So, each species produces a fabulously complex--and potent--venom to paralyze and kill fish, worms, and other cone snails for food. Biomedical scientists took an interest in the cone snails decades ago when they learned that humans killed by cone snails felt no pain as they slipped away.

We now know that cone snail venoms, whether deadly to humans or not,

contain components that affect the human nervous system--sometimes profoundly. In simple terms, some of the components change the way electrical signals such as those responsible for pain are conducted through the brain and the rest of the neurological system.

Those changes also have the potential to alter both the way humans perceive pain and the effects or progression of strokes and nervous system diseases such as Parkinson's and Alzheimer's. In fact, a drug derived from cone snail venom called Prialt has already been classified as approvable by the FDA as a painkiller, and it's 10,000 times more potent than morphine as well as non-addictive. Other potential cone snail-derived treatments are under development.

Such developments are encouraging, but perhaps more encouraging is the fact that each variety of cone snail venom

has an average of 100 components. Multiply that by the number of species and you get a rough estimate of 100,000 components out there with possible benefits, of which only a fraction have been tested for medical potential.

Probing a Vast Library

One of the leaders in the quest for new cone snail treatments is Frank Mari, a biochemist at Florida Atlantic University in Boca Raton. With funding from Florida Sea Grant and other sources, he is studying the venom of several different cone snail species that he and colleagues have collected around the world. They collect the nocturnal animals either during night dives using scuba, or using trawl nets. Mari also recently became the first person to ever collect cone snails using a research submersible. Collection work has taken him from a lagoon just a few

1997



BIOFlorida, the state trade association for the biotechnology industry, is formed with Florida Sea Grant represented on board of directors.

Special issue of Sea Grant's *Fathom* magazine dedicated to marine biotechnology.

Two Florida faculty invited to participate in 12-person national press briefing on marine biotechnology in Washington, D.C.

15-person faculty-industry roundtable is convened as the initial Florida marine biotechnology summit.



At left: Frank Mari, in his laboratory at Florida Atlantic, examines cone snails collected in the Florida Keys. Above left: Each snail stinger holds a unique, biochemically complex venom. Above right: Mari (far right) and two graduate students during a night dive to collect samples.

miles from his laboratories to the waters of the Indo-Pacific.

To explore the benefits of cone snail venom, Mari and his team, including numerous graduate students training for careers in marine biotechnology, begin by separating out individual chemical components of the venom mixture using various chromatography techniques. Each of the components, known as conopeptides, can then be analyzed for potential benefits.

First, researchers inject an isolated component into the fish and worms the animals normally eat to learn which are responsible for their paralysis and death. Next, the scientists explore a component's effects on mammal neurological cells. This is a tricky task as humans and other mammals have hundreds of different kinds of pathways for conducting the electrical signals that make our nervous systems work.

The team impregnates cells with a venom component then determines its effects through such techniques as measuring electrical currents in the cells, or adding a fluorescent compound to the component

so that its movement can be tracked. Once an effect on cells is identified, researchers can then gauge potential benefits.

To deal with pain, for instance, the goal is to find components that block the electric pathways that transmit feelings of pain to and within the brain. For a disease such as Alzheimer's, the goal instead might be to find components that enhance or reopen certain pathways whose closure prevents proper memory function.

The team's ability to quickly and effectively separate the venom components and discover their effects in cells and their chemical structure has now been greatly enhanced by new equipment purchases made possible by funding through the Center of Excellence in Biomedical and Marine Biotechnology.

Remarkable Discoveries

Though Mari continues probing cone snail venom for its pharmaceutical benefits, he and his team have already had substantial success. Within the venom of one cone snail, they have found six new classes of neurologically active compounds. Mari's group has also discovered a never-

before-seen variation of an amino acid in the venom of one cone snail. Amino acids are the building blocks of the proteins that make life itself possible, so the team is working diligently to discover what beneficial effects this new component will have. The work is made all the more promising by the fact that the chemical components on which the group is currently focused have relatively small and simple chemical structures, meaning that they should be fairly easy to produce if pursued as new pharmaceuticals.

Mari has already begun filing patents on compounds discovered that are showing the most promise and is negotiating possible licensing agreements with pharmaceutical companies as well as considering establishing a company to commercialize the results of this work.

"Basically every day I walk into my lab there is something new, and that makes it very exciting," says Mari, "We're exploring nature's kitchen, and the more we find, the better our chances of discovering new and better drugs."



Florida faculty compete for and receive disproportionate share of competitive funds distributed by special National Sea Grant marine biotechnology program.

1998



UF/IFAS

Committee to Advance Florida Marine Biotechnology Research & Education meets for first time and recommends funding priorities such as permanent research and graduate student training funds. (extends through to 2000)

Expanding the Marine Microbial Library

Harbor Branch Oceanographic Institution

Many microorganisms harbored within marine sponges are known to produce or are suspected of producing chemicals with outstanding potential to fight disease. Unfortunately, standard methods have traditionally enabled researchers to culture only a tiny fraction of the microorganisms in a given sponge, though such culturing can be a critical option for producing cells for study, or for producing compounds with potential therapeutic uses.

Sea Grant funded a group of scientists at Harbor Branch led by **Julie Olson**, now at the University of Alabama, to develop new techniques to better tap this vast pool of potential disease treatments. The team was

in fact able to substantially increase the number of microbe species from sponge samples that could be grown for study by testing various additives to determine which enhanced growth. They also conducted similar experiments to find ways to increase the volume of chemical products microorganisms produce when grown in culture.

Such improvements could well lead to the discovery of new drugs, or to the development of a production technique that will allow production of promising new compounds in quantities sufficient for commercial marketing.



Microbial cultures on agar plates.

HBOI

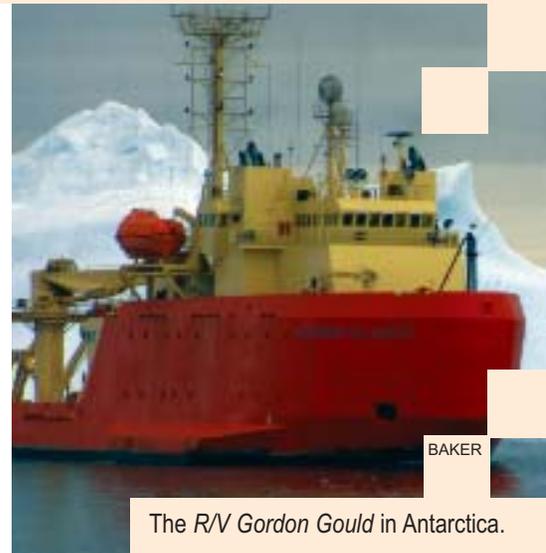
From Florida to Antarctica

University of South Florida and Florida Institute of Technology

Though microorganisms are ubiquitous throughout the world's oceans and are known to produce important compounds with pharmaceutical potential, they remain an underused source for new drugs. With funding from Florida Sea Grant and other sources, **Bill Baker** of the University of South Florida, with **Julia Grimwade** and **Alan Leonard** at Florida Institute of Technology have been working diligently to tap that resource by searching around the world from Florida to Antarctica for new microorganisms. One of their many findings was that microorganisms from temperate Florida waters are more likely to produce bioactive

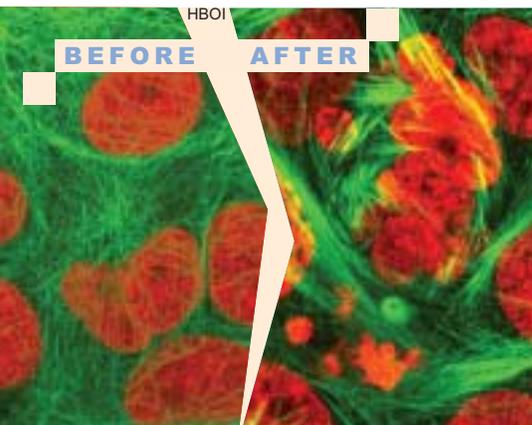
compounds than those from more exotic locations such as Antarctica.

The team has isolated thousands of different microorganisms from invertebrates such as sponges they have collected and has found a number that show promising anti-microbial effects. These are now undergoing further study. The researchers are also working to genetically manipulate certain bacteria collected so that they will produce compounds of interest normally produced by other organisms, and in larger quantities than what is produced by source organisms.



The R/V Gordon Gould in Antarctica.

BAKER



Cancer cells before and after treatment with discodermolide.

HBOI

Seeking the Source of a Cancer Killer

Harbor Branch Oceanographic Institution

The deep-sea sponge *Discodermia* produces, among other promising products, a chemical called discodermolide that has proven extremely potent at treating various forms of cancer and is currently in human clinical trials. However, developing a sustainable method for producing discodermolide has remained challenging. Because there were indications that discodermolide is actually produced by a microorganism in *Discodermia* rather than by the sponge itself, Sea Grant funded early research to discover the

microorganism, which could then be cultured to produce the drug in quantity. Harbor Branch scientists, led by **Susan Sennett**, explored various possibilities individually testing the more than 100 microbes they were able to culture from the sponge to see if any produced products with effects similar to discodermolide, but without success. A synthetic method for producing discodermolide has now been developed. However, it is costly and time-consuming, so researchers are still seeking the elusive microorganism.

2000

First-ever marine session held at national Biotechnology Industry Organization (BIO) conference, assisted by Florida Sea Grant.

Florida House and Senate committees approve legislation to create the Florida Marine Biotechnology Research, Development and Training Program, which remains under consideration.



Working Toward Sustainable Production

Florida Atlantic University and Harbor Branch Oceanographic Institution

When marine organisms produce chemical compounds with commercial potential, one of the greatest hurdles is finding a sustainable means of producing the compounds in sufficient quantities. Collection of organisms from the wild may be possible at some limited scale, but this option is generally not sustainable because it is both ecologically harmful and prohibitively expensive. Florida Atlantic University researcher **Russ Kerr**, along with colleagues at Harbor Branch Oceanographic, is exploring a number of potential solutions to the sustainable production problem for various compounds including anti-inflammatories and a potential cancer treatment. These solutions include work toward the genetic engineering of bacteria to insert genes that will allow them to produce compounds of interest discovered from other organisms. The team is also working to isolate and then raise under laboratory conditions the micro-organisms that are often responsible for the production of important compounds first discovered in larger host animals. The research team has already experienced substantial successes with both these lines of investigation.



FAU

Above: Russ Kerr gathers samples in the Bahamas. Below: Shirley Pomponi, surrounded by reef on a collection dive.

To Raise a Sponge

Harbor Branch Oceanographic Institution

For the longest running Florida Sea Grant-funded biotechnology project, Harbor Branch researchers led by **Shirley Pomponi** applied a number of novel techniques to the overall goal of raising healthy cultures of sponge and other marine invertebrate cells that produce important bioproducts. The overarching goal was again the development of sustainable means for producing important products.

The first phases of the project focused on identifying chemical additions to cell cultures that would promote cell growth or increase an organism's production of target compounds. In later work, the team began applying cutting-edge genomics technologies to the task of improving production levels. The researchers used human DNA microarrays, which allow the identification of genes in a sample organism, in this case sponges, whose roles are unknown that match human genes attached to the microarray whose functions are known.

Using this technique, which had never before been applied to marine invertebrates, the team was able to identify sponge genes responsible for prolonging the life of cells and others that regulate the production of important products. The team is now exploring ways to promote expression of such genes.

The project's final phase focused on applying the same microarray techniques to the task of identifying genes in tumor cells affected by the lasonolides (see p. 4) with substantial success.

Overall, this work has led to marked improvements in the ability to maintain healthy cell cultures with high production rates for target compounds, while also revealing new and important information that will aid in the development of marine-derived pharmaceuticals.



HBOI

First statewide directory of research and education faculty published with 75 researchers identified.

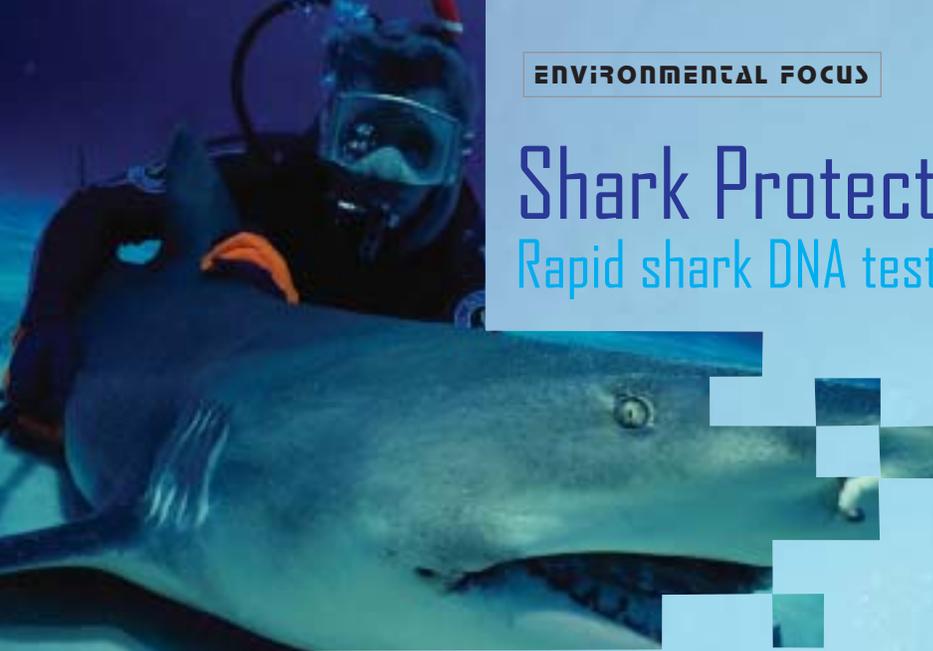
FSG organizes invited marine biotechnology sessions at annual BIOFlorida meeting.



Florida Sea Grant leaders deliver invited presentation to National Academy of Sciences workshop on marine bioproducts.

Shark Protection

Rapid shark DNA test puts the bite on crime



Here's a riddle: How do you properly manage populations of animals that play vital roles in ocean ecosystems but are heavily fished, if you cannot even determine how many of the animals are being caught?

The answer is you can't. But one Florida researcher is diligently applying new and innovative marine biotechnology techniques to correcting the situation.

The animals in question are sharks, and while images of them may strike fear in some, warranted or unwarranted, in reality sharks should be far more wary of the humans who have fished many species' populations into serious danger, even the brink of extinction. Because sharks play critical roles in ocean ecosystems as top predators, such declines pose a serious ecological threat. The situation is especially dire considering that sharks take on average 12 to 15 years to reach sexual maturity, meaning that depleted populations can take

decades to recover even if good management practices are put in place.

A key barrier to proper management of shark populations is that managers and scientists worldwide have not been able to accurately gauge just how much damage is being done to the populations of specific species and by whom. Shark parts, especially the fins prized in Asian markets for use in soups, tend to arrive at docks and markets already removed, so that identifying the species they came from is all but impossible visually. And, no scientific method has been available to determine species quickly enough to make monitoring feasible. This has rendered prosecution of illegal shark part dealers difficult, but that is now set to change.

Shark Signatures

When Mahmood Shivji and his colleagues at Nova Southeastern University's Guy Harvey Research Institute in Ft. Lauderdale set out to solve this important but perplexing problem, they knew they would need to develop an identification process that was rapid, accurate, and economical.

First the group zeroed in on a region of DNA common to all sharks. Next, for each targeted shark species they identified sequence segments within the region that were the same for all sharks of the same species, regardless of where on the globe they lived, but that were different for other species. Once these segments were identified, the team could then use the Polymerase



UF/IFAS

Mahmood Shivji's work has been featured worldwide.

"Virtual" statewide department of faculty connected via Internet listserv.



Florida Marine Biotechnology Summit II convenes with 45 attendees.

Chain Reaction (PCR) technique, which detects the presence of specific DNA sequences in a sample.

To prevent overlap, each of the sequences targeted for use identifying a species was carefully chosen so that it was from a distinct spot that does not overlap with the identifying segment for another species. This has made it possible to test a sample for the presence of nine different identifying sequences at once, allowing discrimination between nine shark species with just a single PCR reaction.

Shivji's team has now established genetic signatures for dozens of common species such as bull (*Carcharhinus leucas*), and great white (*Carcharodon carcharias*) sharks.

Already the shark identification technique has been used to study the global trade in shark parts in places such as China. There researchers have used the technique to identify the shark parts sold in markets, where approximately 100 different trade names exist, but no information has been available about what species corresponded to what name.

By analyzing samples from markets in Hong Kong, the group created a concordance linking species to trade name. With that information, Shivji and his research collaborator Shelley Clarke of the Imperial College, UK, were able to analyze Hong Kong market records to determine the quantity of various species being caught to support the fin trade, giving a good measure of its impact on various populations. Further identification

work of this type in other countries will yield vital information about global shark catches to aid resource managers and others in establishing better practices for shark conservation.

On the Docks

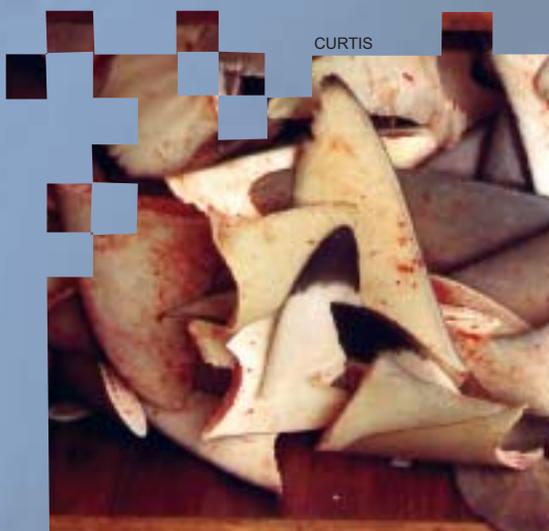
Florida Sea Grant has funded some of the work to develop the species identification techniques, but the importance of Shivji's work has also been widely recognized in the form of funding awards from the Wildlife Conservation Society, the David and Lucille Packard Foundation, and the Pew Institute for Ocean Science. The research has also led to significant press coverage by The New York Times, New Scientist, Science, Nature, NationalGeographic.com and others.

Through that exposure, the Shivji group caught the eye of the National Oceanic and Atmospheric Administration's Office of Law Enforcement, which called to enlist their help in identifying illegally harvested shark fins confiscated from U.S. fishing vessels. The Shivji team now works regularly with officials in various regions to identify the species for seized shark parts. Typically, fins from prohibited shark species are found during these investigations, illustrating the work's importance, although the technique also leads to the exoneration of innocent traders.

Because the same basic methods developed for sharks can also be applied to any type of wildlife, including both fish and land animals, researchers are

already developing genetic signatures for billfish and tuna species at the request of law enforcement officials. With billfish, officials have to deal with the sticky problem of bans on selling Atlantic billfish while the same species can be legally imported from the Pacific and sold. So the Shivji team is working to identify sequences that will allow not only identification of species, but also separation of Atlantic and Pacific populations.

With the necessary techniques now in hand, compliments of Florida marine biotechnology, our understanding of human impacts on populations of vital fish and other animal species, and our ability to manage them wisely, is now on a path toward dramatic improvement.



Shark fins used to be unidentifiable without time-consuming analysis. A rapid test by the Shivji group can identify those harvested illegally.



Florida team secures national award for marinebiotech.org web site development.

Industry needs assessment survey by Florida Sea Grant identifies five Florida companies already involved in marine/aquatic biotechnology and several others interested in becoming involved.

Making Oysters Safer

University of Florida



Human infection from certain bacteria found in oysters is fatal in about 50% of the roughly 50 cases reported each year, so bringing it under control has been a high priority for the Food and Drug Administration. One innovative possibility for achieving this goal is to identify a phage, or bacterial virus, that can kill the harmful bacteria. With Sea Grant funding, University of Florida researchers **Donna Duckworth** and **Paul Gulig** have already isolated more than a dozen candidate phages for accomplishing the task. Ultimately the technique could be used to ensure the safety of mass quantities of oysters if held in water tanks containing an effective phage that would infect and eliminate the bacteria before the oysters were sold. Other possible applications for the technique include the treatment of fish infected by harmful bacteria at aquaculture facilities.

Florida Sea Grant has also funded research by University of Florida scientist **Anita Wright** and colleagues that led to the development of a genetic method for detecting potentially deadly bacteria in oysters using the Real-time Polymerase Chain Reaction technique. The key advantage of the new method is that it takes only a few hours, unlike conventional processes taking days or weeks to complete. With further development, which is being funded by the U.S. Department of Agriculture, Wright's method could make safety spot checks of oysters feasible for the first time, preventing contaminated oysters from making it to market. This would remain important even if techniques such as Duckworth's were ultimately put in place, because it would allow confirmation of proper functioning of the systems involved.

Innovative Seawater Monitors

University of South Florida

Potential health threats from effluent and seepage containing carcinogens could be limited through rapid, accurate, detection, but conventional assays for those carcinogens that pose the greatest risks to humans do not work with seawater. However, with funding from Florida Sea Grant and the National Oceanic and Atmospheric Administration, a research team led by **John Paul** at the University of South Florida has now developed and field-tested a saltwater detection technique. It exploits the fact that, when in the presence of carcinogens, bacterial cells normally found in water will reproduce viruses (phages) in such quantity that their cells burst. This releases virus particles that can then be detected as an indicator of carcinogen presence.

Enteroviruses are another human health concern because they can occur in levels dangerous to humans at beaches and other areas impacted by pollution. The Paul group has also developed the first method for detecting the quantity of enteroviruses in water samples. Previous tests could determine only whether or not enteroviruses were present, meaning that a beach could be closed even if enteroviruses were not abundant enough to pose a threat. To develop the method the group identified genes unique to enteroviruses for detection using standard laboratory techniques. With National Science Foundation funding, the group is now working to get their laboratory test ready for use in the field.



UF/IFAS

Killing Bottom Paint's Environmental Threat

University of Florida



SWAIN

The world market for marine paints that prevent the damaging growth of barnacles and other organisms on boat and ship hulls is worth billions of dollars. Unfortunately, all paints currently available pose significant threats to ecosystems by harming or killing organisms that are not causing problems along with those that settle on hulls. To complicate the problem, some of these paints are now being regulated off the market though suitable alternatives are not yet available.

Scientists at the University of Florida are working diligently to fill the void. The team, led by **William Kem**, studies marine worms that produce poisonous compounds. Certain compounds they have isolated from these poisons

show great promise in preventing barnacles from settling on hulls, but they may also harm innocent crustaceans. To solve this problem the team has synthesized a variety of compounds with structures similar to but altered from the most promising nemertine worm poison compound. The result was a group of compounds, on which patents have been filed, that continue to block settlement but with dramatically reduced lethality for crustaceans. Field tests are now ongoing to determine if the chemicals will make suitable bottom paint additives. The Kem group is also exploring the worm compounds' potential as pesticides, an application for which they have also shown promise.

Top: Raw, on the half shell: can it be safer? Middle: Lauren McDaniel, from John Paul's laboratory, collects a water sample at Rookey Bay. Bottom: The *USS John Paul Jones* -- a lot to keep clean.

UF/IFAS

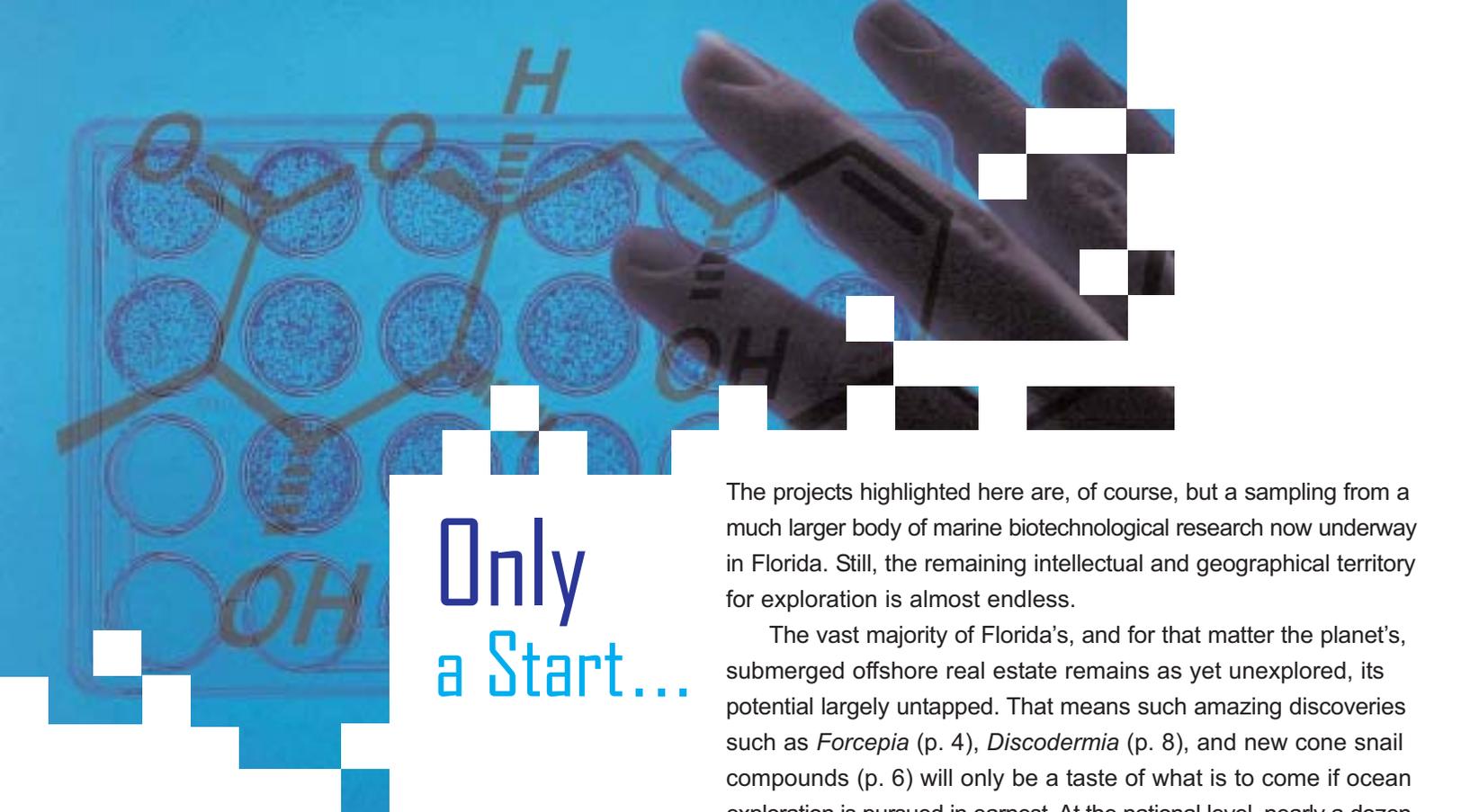


Legislature creates Florida Center of Excellence in Biomedical and Marine Biotechnology at Florida Atlantic University.



2003

Florida Marine Biotechnology Summit III convenes with 74 attendees.



Only a Start...

The projects highlighted here are, of course, but a sampling from a much larger body of marine biotechnological research now underway in Florida. Still, the remaining intellectual and geographical territory for exploration is almost endless.

The vast majority of Florida's, and for that matter the planet's, submerged offshore real estate remains as yet unexplored, its potential largely untapped. That means such amazing discoveries such as *Forcepia* (p. 4), *Discodermia* (p. 8), and new cone snail compounds (p. 6) will only be a taste of what is to come if ocean exploration is pursued in earnest. At the national level, nearly a dozen potentially life-saving compounds derived from marine creatures are already in human clinical trials with the potential for approval from the Food and Drug Administration in the next few years.

But the field is too complex and costly for one investigator, laboratory, or organization to "go it alone." Indeed, one of the hallmarks of the development of the field in Florida has been a spirit of collaboration and cooperation, illustrated by the network of organizations and resources on the following pages. The list is not complete, and if Florida is to continue its emergence as a marine biotechnology leader, further and expanded collaborations will be essential. If you, your company, or your institution is interested in becoming a part of this exciting endeavor, there are numerous opportunities for a joining of forces.

The marine biotechnology field is maturing rapidly. Substantial resources, both natural and technological, coupled with the continued strong support from state and federal governments, make it clear that Florida is poised to lead the way.

HBOI



Discodermolide, potent anti-cancer drug discovered by Florida researchers in deep-sea sponge, enters human clinical trials.

NOAA



US federal fisheries managers begin using Florida researcher's genetic shark identification technique to crack down on illegal harvest of shark fins from protected species.

Florida's Marine Biotechnology Network

--- Gaining Strength

Coordination



Florida Sea Grant

Coordinates a strategic approach to marine biotechnology research, development and education across a statewide network of institutions and scientists. Funds limited research projects; building an outreach capability to transfer the scientific information base that its research has created.

www.flseagrant.org

BioFlorida

Trade association that provides support and development for the state's biotechnology and related life science community and sponsors an annual conference.

www.bioflorida.com

Research and Training



Florida Atlantic University, Boca Raton

Home base for the state-funded Center of Excellence in Biomedical and Marine Biotechnology as well as ongoing studies of sustainable marine compound production methods and pharmaceutical benefits of bioactive materials from marine organisms.

www.floridabiotech.org



Florida Gulf Coast University, Fort Myers

Growing biotechnology program includes research ranging from harmful algal bloom studies to biosecurity work.

www.fgcu.edu



Florida Institute of Technology, Melbourne

Department of Marine and Environmental Systems faculty are expert in marine microbes and their potential role in providing antibiotics.

www.fit.edu/AcadRes/dmes



Florida International University, Miami

Bio-informatics & Biotechnology Research Group currently exploring marine topics such as toxins from microscopic organisms.

www.fiu.edu



Harbor Branch Oceanographic Institution, Fort Pierce

Biomedical Marine Research Division has well-established drug discovery program with collection of over 25,000 marine organisms. Discovered discodermolide. Institution's research submersibles allow regular deep-sea access.

www.hboi.edu



Mote Marine Laboratory, Sarasota

A leader in the study of harmful algal blooms and the development of molecular methods for their detection.

www.mote.org



Nova Southeastern University, Fort Lauderdale

Guy Harvey Research Institute conducts basic and applied research aimed at effective conservation, restoration and understanding of the world's fishes.

www.nova.edu/ocean/



University of Florida, Gainesville

Various marine biotechnology programs at the main campus (e.g., seafood and coastal water pathogens) as well as the Whitney Marine Laboratory all loosely coordinated through the Interdisciplinary Center for Biotechnology Research.

www.biotech.ufl.edu/



University of Miami's Rosenstiel School of Marine & Atmospheric Science, Miami

Marine and Freshwater Biomedical Science Center explores dietary risks associated with marine toxins and marine model systems of human disease.

www.rsmas.miami.edu



2004



Florida grants The Scripps Research Institute \$310 million toward construction of research facility in Palm Beach County.

Florida Marine Biotechnology Summit IV for the first time held concurrently with annual BioFlorida conference.



University of South Florida,
Tampa and St. Petersburg
Relevant work includes the development of innovative methods and tools for detection of marine contaminants and Antarctic and Florida drug discovery work.
www.marine.usf.edu



University of West Florida,
Pensacola
Center for Environmental Diagnostics and Bioremediation engages in research on assessment and improvement of environmental health; also offers service and education programs.
www.uwf.edu/CEDB



The Scripps Research Institute
World renowned biomedical research facility establishing new base in Palm Beach County.
www.scripps.edu

Funding Sources

National Oceanic and Atmospheric Administration
www.noaa.gov
Food and Drug Administration
www.fda.gov

National Science Foundation
www.nsf.gov

National Sea Grant
www.nsgo.seagrant.org

National Institutes of Health
www.nih.gov

Small Business Innovation Research Program
Provides highly specialized early-stage research and development funding for small firms, including some with academic partners. Solicitations periodically released from any of 10 participating federal agencies on topics that the agency is interested in funding.
www.zyn.com/sbir/funding.htm

Additional Resources

Florida Marine Biotechnology Summit
Biennial conference held in Florida for researchers, students, resource managers, and business interests in the field of marine biotechnology. Coordinated by Florida Sea Grant.

Florida Marine Biotechnology Statewide Faculty E-mail List
Features periodic announcements of funding opportunities and conferences specifically related to marine biotechnology. To subscribe, send request to:
jhw@flseagrant.org

National Marine Biotechnology Web Site
Includes articles and interviews that cover individual research programs, promising discoveries, and basic elements of the field as well as resources for professionals such as a calendar of upcoming events. Initial development phase running through 2005.
www.marinebiotech.org

Florida Marine Biotechnology: Research, Development and Training Capabilities to Advance Science and Commerce
Census of Florida faculty involved in marine biotechnology research, technology and education. Includes contact information. TP 110. Full text available at www.flseagrant.org or by calling 352-392-5870

Marine Biotechnology Research in Florida Sea Grant 1996-2003
Summarizes 24 Florida Sea Grant-funded projects in non-technical language suitable for general readers. TP 134. Full text available at www.flseagrant.org or by calling 352-392-5870

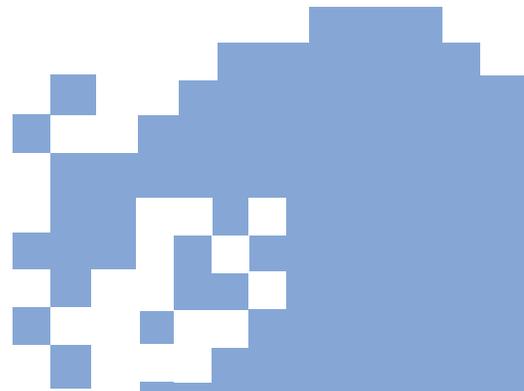


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