TRANSECT

BIGELOW LABORATORY FOR OCEAN SCIENCES / SUMMER 2016 / VOLUME 8 / ISSUE 1

ON THE COVER

Shellfish and seaweed farmers are increasingly seeking the Laboratory's support in the provision of safe, healthy, sustainable food from our oceans.

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One of the best parts of my job is meeting new people who are genuinely interested in the work of the Laboratory and in supporting what we do. Usually, I spend the first ten minutes describing the excitement of working at the poles or tropical reefs, or to the deepest abyss—and nearly always on microbes or chemicals that nobody can see, let alone pronounce (say *Prochlorococcus* ten times fast). If I do this well, and their attention is still engaged, the next question is: "Graham, I understand what you do must be important, and that you have really excellent scientists and facilities, but why does all this *matter*? What does this *do for the economy?*" There is no doubt that connecting world-class science to the people and institutions that can make decisions, which improve our environment and society, is a major challenge for our collective research endeavor. I'm proud to say that we have launched two initiatives that are working to answer both of these important questions.

We have created two *Centers for Venture Research* that are solution-focused and clearly demonstrate why our work matters for both the natural environment and the economy. Unashamedly, we are using the "venture" term to convey the importance of early investment, potentially in higher-risk activity that has a strong outcome element upon which activities and decisions can be based. Our two CVR areas in seafood security and the opening Arctic have gained significant traction over the past seven months. This is a really exciting way of putting science to work that you can learn more about in this issue of *Transect*.

Bigelow Laboratory continues to invest in our infrastructure. Two major construction projects have begun this summer. The *Residence Project*, supported by the Harold Alfond Foundation and an anonymous donors will result in a $6.2 million, net-zero energy building providing high-quality accommodation for students, interns, and visiting scientists. To expand our algal culturing research into larger, semi-commercial quantities, we are constructing a dedicated *Research Greenhouse* with impact investment support from the Maine Community Foundation. Both projects bring much-needed infrastructure to support our research and outreach programs.

Of course, we wish the construction were already completed as we are in the midst of our largest ever summer intern program with 27 students from all over the country participating. Whilst this is going on, our first *phytoplankton taxonomic workshop* sponsored by NOAA, will bring professionals from far and wide. Next year, when the residence is complete in February 2017, we will be able to deliver a fantastic housing experience for all our visitors.

Finally, it is the individual and foundation support that makes our work possible and solidifies a platform upon which to launch scientific discovery and provide solutions for a better world for all of us. On behalf of everyone at Bigelow Laboratory, I want to thank each individual supporter and donor for making all this happen! Please enjoy reading about our progress in the pages that follow.

GRAHAM SHIMMIELD, PhD, FSB, FRSE

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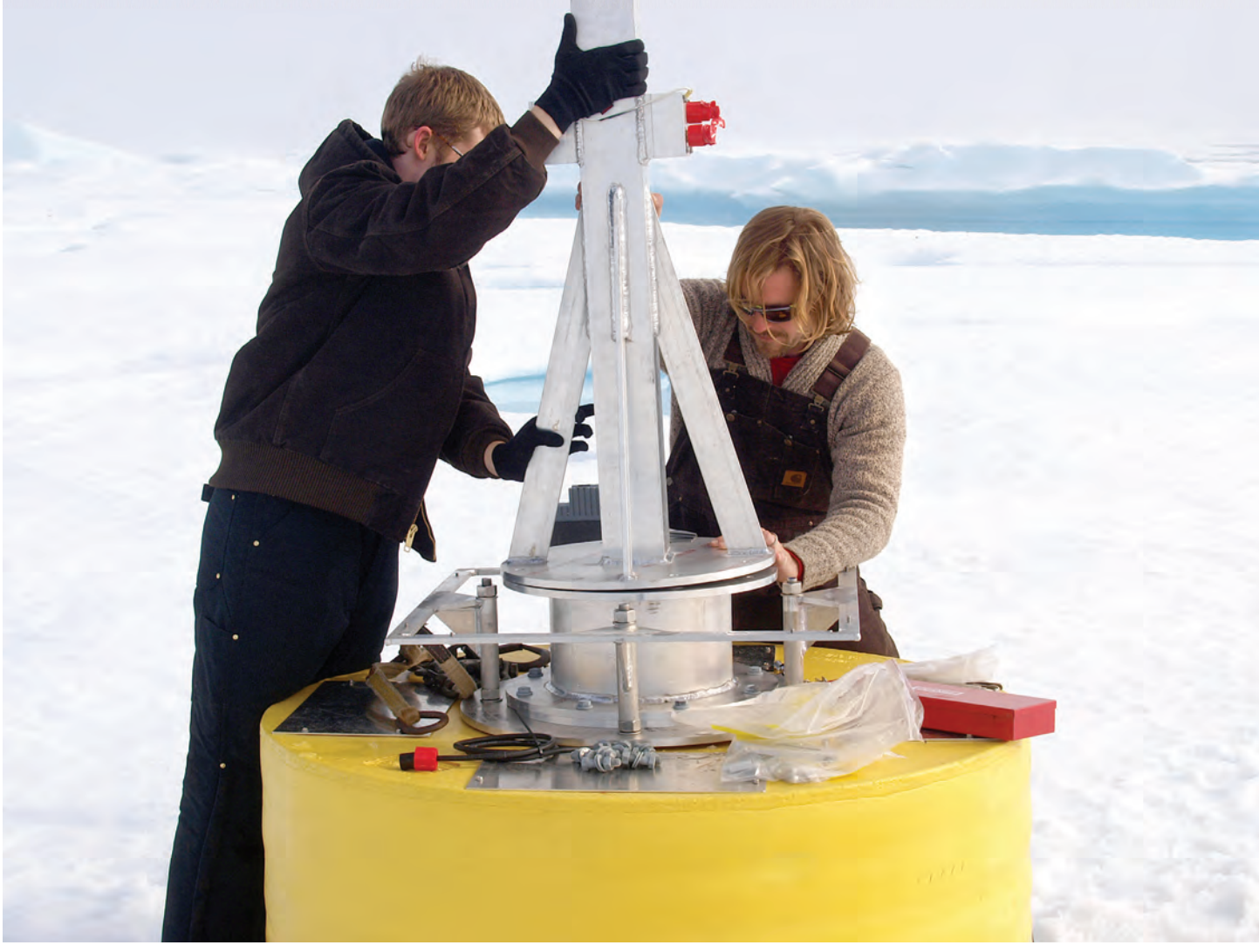
The past seven months have seen a profusion of new ideas and new facilities: residence hall and greenhouse under construction on site, and two new Centers for Venture Research launched. **LEARN MORE AT BIGELOW.ORG.**



Making research relevant

LEFT Bigelow staff preparing to deploy a monitoring buoy on Arctic ice. **RIGHT** Paul Dobbins, president of Ocean Approved, working with the CVR for Seafood Security to collect scientific equipment in Casco Bay, Maine.

This year Bigelow Laboratory launched two new Venture Research Centers to bring an innovative approach to its science. The Centers are an exciting expansion of how our science will be used and how it will be funded. They are designed to respond to societal needs by translating our research so that it can inform problem solving, policy, and public awareness. The two new centers focus on areas of extreme importance—seafood security and the opening Arctic Ocean.

CVRS MATCH THE EXPERTISE OF OUR SCIENTISTS AND TECHNOLOGY TO SPECIFIC SOCIETAL NEEDS

We asked CVR directors Nichole Price and Christoph Aeppli to respond to a few questions about the new centers:

WHY HAVE WE LAUNCHED THE CVRS?

Price: We launched the Centers for Venture Research to turn knowledge into action—and to do so quickly, efficiently, and with the best available scientific information. The CVRs are designed to help translate what we know as scientists so that this knowledge can be used to craft policy, to inform the public, and to develop science-based solutions, whenever and wherever possible. Consider the difference this can make: the latest science and technology being put to work in real ways to affect positive change.

HOW DO THE CVRS ACTUALLY WORK?

Aeppli: A simple way to think about the CVRs is as a matchmaker: the Centers match the expertise of our scientists and access to our advanced technology to specific needs identified by policymakers, the private sector, philanthropists, foundations, and the interested public. These needs run the gamut from the simple—providing a white paper so that policymakers can understand the implications of a changing ocean condition and use this information to craft policies based on science—to the exceedingly complex—such as developing multiple ways to improve the nutritional value and flavor of aquaculture products.

Our basic science research is typically funded by federal grants won through a competitive process. Rather than using federal funds, the work of the CVRs will be financed by a broader group of supporters, whose composition will depend upon the project, the need, and the desired outcome. Through the CVRs, we are offering ways, for example, for philanthropists to support increased understanding about the implications of ocean acidification in the Gulf of Maine or for those from the private sector to obtain information about the best methods to clean up oil spills in a marine environment. The work we take on is flexible, varied, and driven by what information or technology is required to address a specific issue.

WHY NOW?

Price: The ocean is under threat and changing in ways that are difficult to see and even more difficult to measure. New, important ocean stressors are invisible—chemistry, heat, sound, and toxic contaminants—making it hard for people to comprehend that the ocean is at risk, and even harder to implement policies or design solutions to avoid further consequences. We chose to launch the CVRs to allow for a quicker match between the available scientific understanding and technologies and development of potential policies and solutions to help address these ongoing changes in the best possible way.

WHY ARE THEY NAMED CENTERS FOR VENTURE RESEARCH?

Aeppli: We chose the name "Centers for Venture Research" because we are applying the same techniques used by venture investors to the translation of basic ocean-related research for problem-solving and improving input to policy and public awareness. We are applying science using some of the best available business practices such as detailed and comprehensive knowledge of the

existing market, niche differentiation, clarity of objective defined through project milestones, and excellent, timely project and communication management to achieve desired goals.

The term "venture" also often infers risk with the potential for huge gains. In our CVRs, the financial risk is spread among many investors, with the potential gain being an improved environment, or scientifically-based solutions, or better, more informed policies.

WHAT ARE THE BENEFITS OF SUCH AN APPROACH?

Price: This approach moves the science past focusing solely on problems, toward identifying beneficial outcomes. It's a more pragmatic approach than traditionally-funded scientific research, with the opportunity to achieve quicker results and understanding that can be applied to pressing problems or questions.

We are also creating a new paradigm for the federal requirement to address the "broader impacts of research." Both CVRs are uniquely well suited to translate and apply the best available science and technology so that solutions are based on solid scientific data, policy crafted with knowledge of environmental risks and benefits, and the public is fully informed about issues relating to human and ocean health as changes in the marine environment continue.

WHY DID WE CHOOSE THESE TWO TOPICS?

Aeppli: We chose two key areas, seafood security and the new ocean in the Arctic, because they present pressing needs for science-based policy and solutions. We have been involved in seafood security for over 40 years and have been conducting research in the Arctic for two decades. We have the expertise and understanding to help fill the knowledge gap in these areas for the greater good and benefit of all.

CVRS MOVE THE FOCUS PAST PROBLEMS TO FINDING SCIENCE-BASED AND TECHNOLOGY-RESOLVED SOLUTIONS.

How a $5,000 idea blossomed into a $300,000 greenhouse

It all started with a good idea, willing partners, and a $5,000 corporate-sponsored research project. The idea germinated, blossomed, and grew into a $300,000 greenhouse and the formation of a marine algae research facility. The Maine Algal Research and Innovation Accelerator, MARIA, will be constructed on the Bigelow Laboratory for Ocean Sciences campus in East Boothbay this summer. The Maine Community Foundation is providing funds for the construction project and scaling up of activity.

The path from a seeded idea to a full-scale greenhouse and business accelerator was a circuitous one and makes for a story worth telling.

Mike Lomas, Director of the National Center for Marine Algae and Microbiota (NCMA) at Bigelow Laboratory, had established a successful relationship with Field Energy LLC, a private company looking to develop a process to improve the quality of fatty acid products. Fatty acids are essential for healthy brain development in children, reduce cardiovascular diseases, lower blood pressure, and prevent development of hypertension. There is a huge potential market for better products. NCMA and Field Energy LLC developed a research plan. The research is now ongoing at the Laboratory, with additional support from Maine Technology Institute (MTI) and the U.S. Department of Agriculture, with key analyses being done by Bigelow Analytical Services, another core facility of Bigelow Laboratory.

Since the partnership was well established and working smoothly, the seed money provided by MTI gave Lomas the opportunity to explore other options and expand upon the idea of "what if?" What if there was a place that could provide one-stop shopping, so to speak, for algal research and development? What if the money could be found to build a pilot-scale facility that could grow enough algae to explore new, commercial, algal-based products for society's benefit as well as that of Maine aquaculture? What if such a facility could be built on-site at Bigelow Laboratory's campus so it could take advantage of the collective expertise of its scientists?

The "what ifs" resulted in the creation of MARIA, a facility that could not only grow algae, but serve as a center for developing universal algal standards, and exploring new and varied ways that algae could be incorporated into products.

"The seed funding was critical. It truly gave us the opportunity to germinate the idea to see if it might bear fruit," explained Lomas. "We used the funds to flesh out the concept, figure out what projects might be feasible

with a greenhouse on-site, and how many might be required to make the project financially stable. Then we went on to the bigger questions of how large the greenhouse would have to be, how we would finance it, how many people would be needed to support it, and a whole slew of other questions that come along with starting up a new venture of this sort."

IMPACT INVESTMENT FUNDS FOR A BIG IDEA

The MTI funds were soon supplemented by a sizable, roughly $100,000, federal grant and ultimately culminated in the award of $300,000 by the Maine Community Foundation's Impact Investment Fund. This support will provide for the construction of a roughly 4,000-square-foot, pilot-scale production greenhouse on Bigelow Laboratory's ocean science campus on the Damariscotta River.

NCMA has already constructed a mini-scale production facility in the Seawater Suite at Bigelow Laboratory to test growth processes for scaling up once the larger facility is operational.

"My hope is that the greenhouse will serve as a flywheel that drives innovation. It will accelerate the process of taking ideas for natural products created using micro- and macro algae and turning them into concepts," added Lomas. "The greenhouse will allow us to help other entrepreneurs regardless of where they might be in the process – from those with an idea and money but no experience, to those who know exactly what they want to do but need a place to do it. Wherever they are on that continuum, they can come in, consult with our experts, and we will be able to grow the product and provide the services they need."

Lomas sees MARIA and the greenhouse as providing both product and consulting services as well as being flexible to respond to customers' and partners' needs. "For example, someone might come in and want to grow organism X," explains Lomas. "We may not know how to grow organism X, but we have the infrastructure and culturing experience to help them figure out the best way to grow the organism. Conversely, someone may come in and want to grow an organism on a larger scale to test commercial and financial viability. We can help them achieve that here. We can fill the gap of whatever our customers need to help them achieve new and viable products."

MARIA WILL SERVE AS A FLYWHEEL THAT DRIVES INNOVATION AND OPENS OPPORTUNITIES

Botryococcus, pictured here, creates beneficial lipids that can be used in algal biofuels. It illustrates the microalgae that can be grown by the MARIA project.

Because of the quantity of algae it will be able to produce, MARIA also will be developing algal standards by providing a consistent source of material. These standards could range from mock-community genome standards, to algal toxin standards, to algal pigment standards, that could be implemented by NASA-based ocean color investigators, to other metabolite standards. Such standards are critical for research and product development, so there is a basis upon which to measure quality, composition, and other features.

Ground will be broken for the greenhouse in July 2016, and it is expected to be operational in October 2016. According to Lomas, MARIA is but one of many positive examples of the successful implementation of Bigelow Laboratory's strategy to apply its state-of-the-art knowledge and expertise to providing real world solutions. "We are exceedingly grateful to MTI, the U.S. federal government, and the Maine Community Foundation for helping us realize this vision. Ultimately, it will benefit the people of Maine and perhaps contribute to improved health in the nation, maybe the world."

New residence in the works

Ground was broken in early April on a 32-bed student and visiting scientist residence with four visitor's apartments on Bigelow Laboratory's campus. Made possible by a $3.1 million grant from the Harold Alfond Foundation, which was matched by an anonymous donor, the residence is expected to be ready for occupancy by spring 2017.

A separate endowment has been established to cover maintenance and operating costs of the new net-zero facility for 50 years.

"We are both honored and delighted that the Harold Alfond Foundation has recognized the value of the Laboratory's education programs by offering its generous support, making it possible for us to house students and visitors safely and comfortably on-site while participating in our many educational and collaborative research programs," said Graham Shimmield, executive director of Bigelow Laboratory. "It will allow us to expand our educational programs so more students and professionals have access to our world-class scientists."

Bigelow Laboratory serves high school students from every county in Maine, undergraduate students from across the U.S., professional short course attendees, and visiting scientists from around the globe.

The new 15,000 square-foot dormitory residence will overlook the Damariscotta River on the Laboratory's East Boothbay campus and will be a short walk from the main Laboratory building and its shore facility. The design embodies efficiency, ease of maintenance, and respect for the surrounding environment.

The net-zero energy building was designed by Scott Simons Architects of Portland, Maine. The Portland office of Consigli Construction Company, Inc. is providing construction management services.

GIVING Supporting growth and innovation

WAYS TO GIVE

Would you like to contribute to our Annual Fund? We offer several easy ways to make your fully tax-deductible donation:

BY PHONE

Call Bigelow Laboratory's Advancement Team to make a credit card gift over the phone at: (207) 315-2567 ext. 106.

ONLINE

Donate to Bigelow Laboratory's Annual Fund via credit card using our secure online form at www.bigelow.org/support.

BY MAIL

Send checks to:

Bigelow Laboratory
for Ocean Sciences
PO Box 380
East Boothbay, ME 04544

We also welcome gifts of securities, donor advised fund grants, and planned gifts. Please call (207) 315-2567 ext. 106 for details.

A cornerstone of Bigelow Laboratory's ability to grow and innovate was laid this past winter by a visionary donor who saw the great potential of our world-renowned scientists to share their knowledge with industry.

Through the creation of *The Sash A. and Mary M. Spencer Entrepreneurial Fund*, the donor established a formal method for awarding seed money to Bigelow Laboratory researchers in support of commercialization activities. The Fund supports entrepreneurial projects leading to the commercial development of promising discoveries, including paying for patent applications.

Understanding that private companies often help to bring state-of-the-art technologies to market, the purpose of the Fund is to generate new data and products that will entice industry collaborators to engage in sponsored research projects with Bigelow Laboratory scientists.

Executive Director Graham Shimmield praised the generous donor's support stating, "This investment is the kind of strategic philanthropy that inspires innovation among our researchers. We are honored by this imaginative and generous gift."

Bigelow Laboratory research staff may apply to the Fund and applications are evaluated by an internal peer-review committee. Those requests that have the potential to lead to industrial collaborations while staying true to institutional objectives will be awarded. Additional donations to *The Sash A. and Mary M. Spencer Entrepreneurial Fund* are welcome.

We wish to thank the individual who established the Fund, and all of our supporters for their belief in our mission. Combining the power of our scientific expertise with philanthropy, Bigelow Laboratory can serve as a trusted partner with industry—from large corporations to early tech start-ups—providing ocean-based solutions to today's complex problems.

PROFILE Bobbie Brown

Chairman, Board of Trustees,
The Louise H. and David S. Ingalls Foundation

Dr. Barbara "Bobbie" Brown, president of The Louise H. and David S. Ingalls Foundation, has been carrying on the tradition of using the family's good fortune to make a difference in the world. Established by her grandparents, pictured at right, and incorporated in 1953 in Cleveland, Ohio, the Foundation was founded with the broad purpose of improving the physical, educational, mental, and moral conditions of humanity throughout the world. No small objective, but over the last 63 years, the Foundation has really made a difference. Its genesis is a novel approach of providing funds for projects that individual family members put forward.

While many families might gather for barbecues or vacations, the extended "Ingalls" clan comes together twice annually to discuss ways of making the world a better place. Each spring and fall, nearly 30 family members gather in Ohio and Florida, and along with reconnecting with siblings and cousins, they discuss the Foundation's giving choices. This tradition of family involvement was started at the beginning and has been carried on by subsequent generations. Explains Brown, "As kids, we were brought to board meetings and we had a vague idea of what was going on, so now it's part of all of our genes."

THE INGALLS FOUNDATION IS DRIVEN BY FAMILY VALUES AND INTERESTS OF FAMILY MEMBERS

Each of the five children of Louise and David Ingalls are represented on the board, and the members work together to discuss and negotiate philanthropic gifts that draw on the visions of Louise and David as well as on their own causes that they would like to support. Brown, the youngest of third daughter Louise Ingalls Brown's four children, runs the Foundation on a daily basis, providing astute direction and involvement in the Cleveland, Ohio community, where the Foundation is based. Brown also finds time to serve as Secretary of the board of the American University in Cairo. She has been involved in paleontological fieldwork in Ethiopia, Kenya, and Pakistan for over two decades. She brings this global view to the work of the Foundation and to managing the interests of her family members.

Bigelow Laboratory has been a beneficiary of the Foundation's support of family members' passions. Brown's cousin, Chip Davison, has been on or near the ocean virtually all of his life, having sailed it, fished it, farmed it, and simply enjoyed its beauty. He directed this passion to encourage the Foundation to invest in both the Laboratory's education programs and in an initiative to measure biotoxins in shellfish for Maine's Department of Marine Resources.

Davison explains, "Bigelow Laboratory is right there with me on my enthusiasm for the ocean. They encourage Maine students to look outward and to understand the importance of the ocean not only in their daily lives, but as it relates to the health of the planet. Their scientists pique students' curiosity about the ocean and how it works, which is a valuable experience."

The family is spread throughout the country, but has remained committed to carrying out the work of the Foundation together. Their giving ranges from programs that advance education, the arts, and the environment, to human health, history, science, and more. Brown describes, "We are a very close-knit family. We're big—getting bigger with the fifth generation coming along... For us, it's the family, and supporting the family. We support what our parents and grandparents were interested in as well as what we're interested in."

It is a remarkable family endeavor, in which Bigelow Laboratory is fortunate to be included.

A new tool is providing important insights into how cells function

Dr. José Antonio Fernández Robledo is using genetic engineering to unwrap the mysteries of parasites that infect oysters by investigating the unique properties of their individual genes. This is no small task for it requires sorting through an estimated 20,000 genes that make up just one cell of the oyster parasite *Perkinsus marinus,* pictured on the facing page. Scientists have only begun to crack this genetic code and half of these genes remain to be identified and described.

"The genetic makeup of *Perkinsus* is about as complex as human cells, but we now have techniques that allow us not only to see genes, but to manipulate them to better understand what a specific gene does and how it does it. By being able to single out individual genes, we are significantly adding to what is known about cell function."

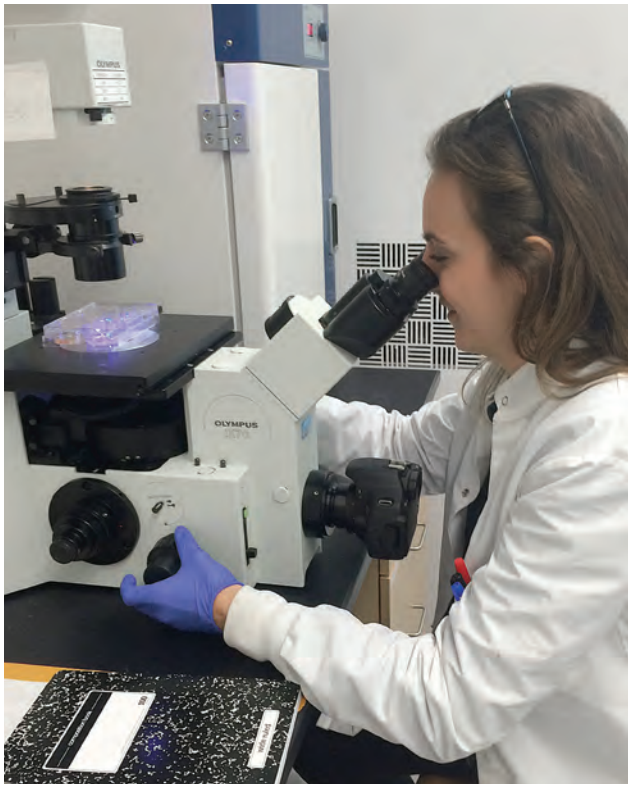
USING GENETIC ENGINEERING TO UNWRAP THE MYSTERIES OF PARASITES THAT INFECT OYSTERS

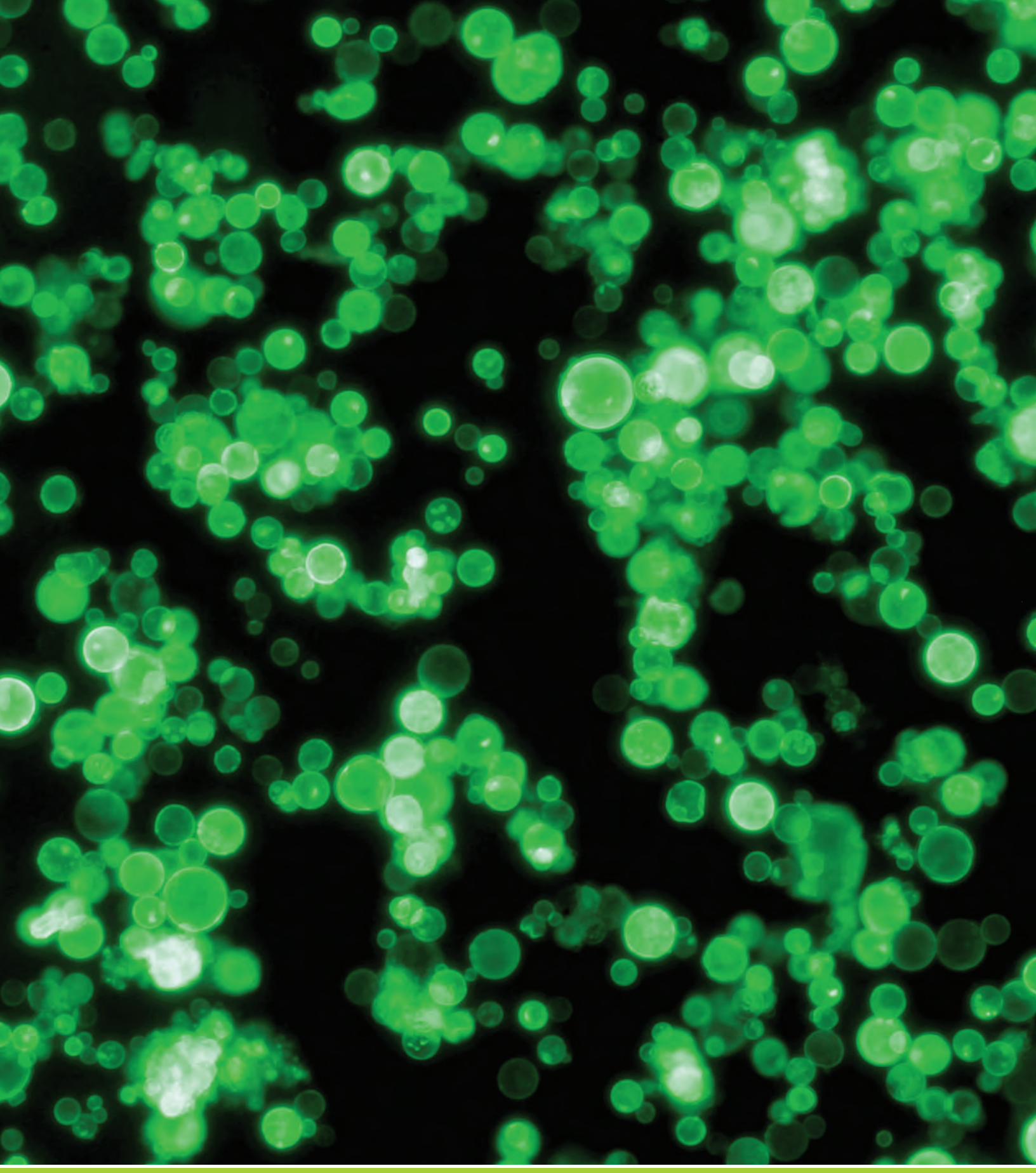
Fernández Robledo begins his investigation by tagging genes with fluorescent proteins, allowing him to follow genes inside the cell in real time under a microscope. The location of the gene within the cells provides clues as to its function. Next, he uses a gene editing technique, called CRISPR/Cas9 to clip out a gene or part of a gene to see if, and how, the engineered gene alters the parasite's biology. (CRISPR stands for "clustered regularly interspaced short palindromic repeats," which describes the genetic basis of the method. Cas9 is a protein that cuts DNA.)

This CRISPR gene editing technique makes it possible to discern if a gene is essential for the parasite's survival within its host or if the gene is involved in the parasite's virulence. Knowing such functions in genes will lead to innovative solutions that can help ameliorate the negative effects of this parasite in oyster aquaculture.

There has been growing recognition for the value of research that aims to understand how organisms function at the genetic level. The National Science Foundation has established a new funding program—Enabling Discovery through Genomic Tools, or EDGE—to advance the development of genetic tools and subsequent insights into the genetics of organisms. *Perkinsus* may also prove to be a valuable model system for diseases of mollusks. So far, it is the only protozoan parasite of mollusks where some genetic engineering methodologies have already been developed and used.

"The beauty of this work is that organisms can be cultured in the laboratory. We can test hypotheses on the bench, in the safety of secure laboratory space with procedures that ensure there is no release into the environment. The process allows us to ask more complex questions and find answers—and hopefully solutions—to pressing problems sooner," added Fernández Robledo.

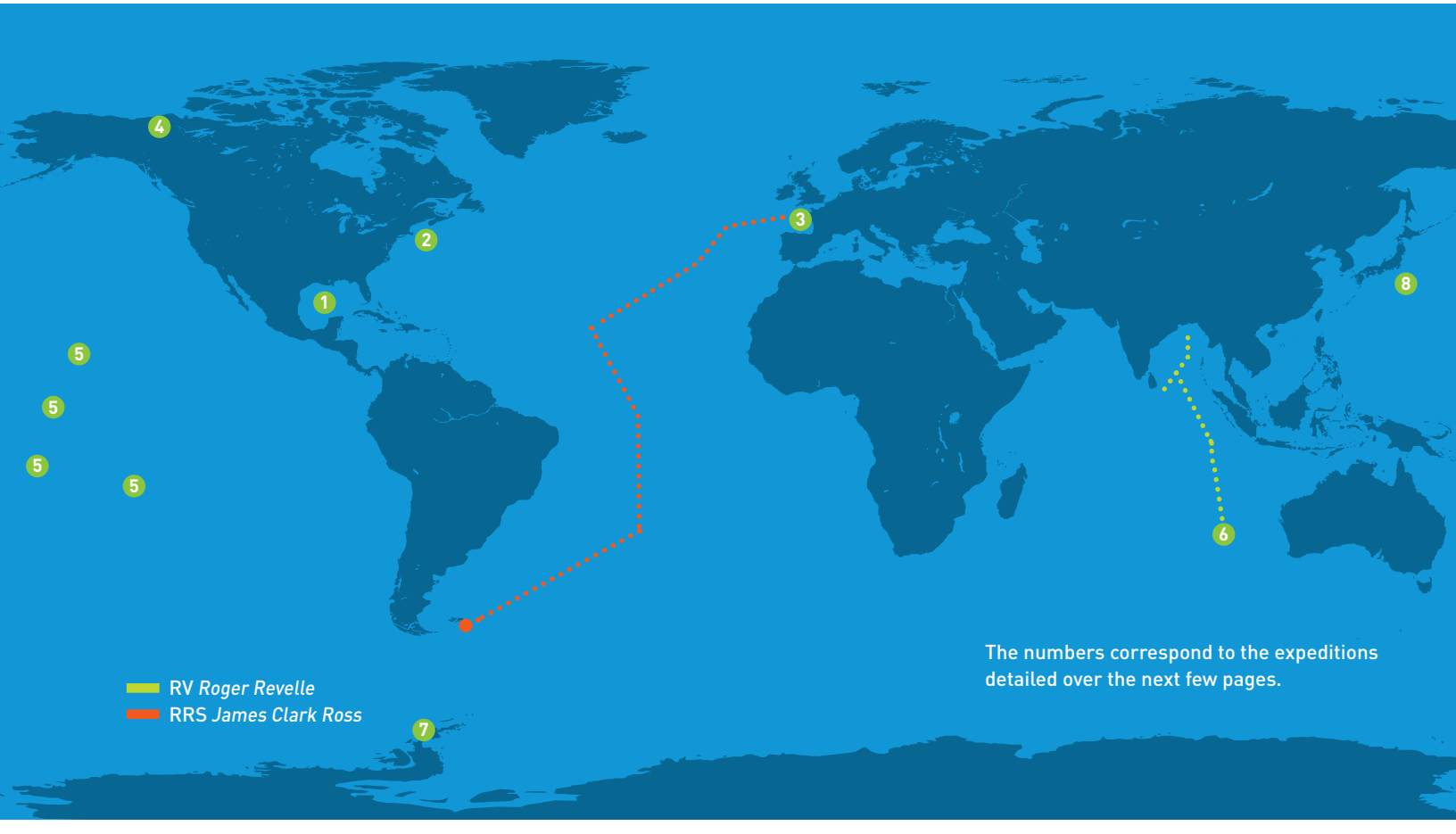




EDITOR'S NOTE As genetic engineering moves forward, Bigelow Laboratory has instituted precise guidelines governing its use that go above and beyond federal guidelines to ensure that all procedures are contained within secure laboratory space. These guidelines are publicly available and posted on our website.

FIELD WORK

This summer and beyond, Bigelow Laboratory for Ocean Sciences researchers will be in many parts of the global ocean, collecting samples and making measurements for their ongoing research. Here's a sampling of our current expeditions:



GULF OF MEXICO

1 In April, **Dr. Christoph Aeppli** traveled to several sites on the Gulf of Mexico coast to collect oil samples from the 2010 *Deepwater Horizon* disaster. He will travel again during the summer with intern **Amanda Herzog**. Aeppli is collecting on-shore samples from 2010-2018 to better understand how the various components of oil break down and change over time, as well as to determine the potential toxicity of the samples.

1 In September, members of **Dr. Beth Orcutt**'s lab will spend a week in the Gulf of Mexico to continue their long-term study of the impacts and fate of oil and gas released in offshore waters of the Gulf during the *Deepwater Horizon* oil spill. Their experiments are designed to track the rate at which crude oil degrades on the seafloor and to identify the microbial controls on this process.

GULF OF MAINE/ ATLANTIC OCEAN

2 **Dr. Barney Balch** will continue his time series (now in its 18th year) of coastal phytoplankton productivity this summer between Portland, Maine and Yarmouth, Nova Scotia. By coupling the data from this long-running time series with data collected by Henry Bigelow in 1912, Balch and his collaborators have recently noted a reduction in productivity as well as color changes in the Gulf of Maine over the past 80 years, which they associate with increased amounts of dissolved organic matter leaching from soils into rivers and running to the Gulf. Continued sampling will further elucidate this relationship, while providing important scientific data used by NASA for satellite ground-truthing.

2 **Dr. Nick Record** is studying the copepod, *Calanus finmarchicus*, in the Gulf of Maine this summer. He and colleagues from the University of Maine are conducting monthly cruises aboard the RV *Gulf Challenger* looking for deep layers of hibernating copepods to assess temperature conditions.

Record is also continuing his citizen scientist Gulf of Maine jellyfish reporting initiative this summer and is partnering with colleagues in Halifax to extend the initiative to the Halifax coast. Send your jellyfish sightings to jellyfish@bigelow.org.

2 **Dr. Nichole Price** continues to deploy instruments in Casco Bay in collaboration with the kelp farm Ocean Approved and the Island Institute. She is measuring carbon dioxide levels and acidity inside and outside of the kelp farm lines. Price is analyzing data to see if her sugar kelp can temporarily sequester carbon dioxide in localized offshore regions.

2 **Dr. Pete Countway** and Research Scientist **Dr. Nicole Poulton** will continue collecting samples from the McKown Point dock in West Boothbay Harbor.

This is part of a long-running data set, providing an important baseline for understanding changes in coastal Maine.

3 **Dr. Jason Hopkins**, a postdoctoral researcher in the Balch Lab, will take part in Atlantic Meridional Transect cruise #26 this fall aboard the RRS *James Clark Ross*. This work is a continuation of the team's tuning and validating NASA satellite ocean color data. Hopkins will cover more than 8,000 miles of the Atlantic Ocean, departing the United Kingdom in September and arriving in the Falkland Islands in November.

ARCTIC LAKES

4 **Dr. Beth Orcutt** spent a week in early spring at the Mackenzie River Delta, Northwest Territories, Canada researching how methane—a potent greenhouse gas—builds up in ice-covered lakes in this Arctic region. Orcutt is examining the role of microbes in making and consuming the methane. She will return in mid-August to work on the lakes when they are ice-free.

PACIFIC OCEAN

5 This summer, **Dr. Nichole Price** is continuing her work in the Pacific Ocean with the assistance of Postdoctoral Researcher **Dr. Ben**

FIELD WORK, *CONTINUED*

Neal, and Research Technician **Brittney Honisch**. Price plans to continue collecting data across 45 degrees latitude in the Pacific to explore how highly sensitive coralline algae respond to variations in pH concentrations over time and space.



INDIAN OCEAN

6 **Sara Rauschenberg**, a research technician in the Twining lab, spent

six weeks at sea in the central Indian Ocean aboard the RV *Roger Revelle* as part of the Global Ocean Ship-based Hydrographic Investigations Program (GO-SHIP). Rauschenberg analyzed samples for trace metal content. She and postdoctoral researcher **Dr. Steven Baer** collaborated on nutrient limitation experiments, working to understand whether the lack of nitrogen, phosphorus, iron, or some combination inhibits phytoplankton growth. Read more about Baer's expedition on the facing page.

ANTARCTIC

7 **Dr. Paty Matrai** and **Dr. Pete Countway**, Research Associate **Carlton Rauschenberg**, and Bigelow-Colby College *Changing Oceans* semester program alumna **Kathryn Moore** will be spending six weeks at Palmer Station, Antarctica starting in December 2016. The team will study how DMSP gas affects the diversity and composition of microbes in the Southern Ocean.



EDITOR'S NOTE Rather than simply reading about some of our research expeditions, we thought it would be interesting for readers to hear directly from scientists on research vessels about their experiences. We hope you enjoy their accounts as much as we did.

DR. STEPHANIE CARR

8 Aboard the DV *Chikyu*

Greetings from the *Chikyu*! The *Chikyu* is a Japanese drilling vessel for the International Ocean Discovery Program and my home during this 30-day research expedition. We are currently southeast of Japan, hovering over the Nankai Trough subduction zone, an area where the Philippine Sea tectonic plate is diving (subducting) beneath southwest Japan. As the expedition's microbiologist, my job is to collect a microbial colonization chamber that was installed 400 meters below the seafloor, across a fault in this subduction zone, almost 6 years ago. This chamber is 18 centimeters long and four centimeters in diameter. Filled with rocks, it continuously samples water that exists below the crust, between rock fractures in this zone. Our objective is to trap and grow microorganisms living within this subsurface water source. Everything is working perfectly. The chamber was brought onboard and, using an onboard microscope, I have successfully identified microorganisms growing in the samples.

In my spare time I have been reading *The Martian* by Andy Weir, a science fiction story about Mark Watney, an astronaut who has been accidently abandoned on the planet Mars. I find the book amusingly relatable. Like Mark, I am very concerned with oxygen concentrations because the microorganisms that I have collected grow in the absence of oxygen. I work in a nitrogen-filled glove bag with gas monitors and an air lock. Working in the glove bag is like working in a bulky, clumsy space suit. Like an astronaut, I also ration my favorite food supplies. Don't get me wrong, the food on the *Chikyu* has been

I LEFT THE COMFORTS OF HOME TO EXPLORE A REMOTE AND DRASTICALLY UNDERSTUDIED ENVIRONMENT.

outstanding. We had fresh sushi in the beginning and are now enjoying scallops, steak, and ramen. But to keep me going over the 30 days, I brought along some personal favorites—Earl Grey tea, Cadbury's mini chocolate Easter eggs and a bag of Lifesavers—that I treat myself to as the journey progresses.

The biggest similarity I have with Mark is in our expedition roles. Like Mark, I am the biologist on a ship of engineers and geologists. I left the comforts of home to explore a remote and drastically understudied environment. The ocean covers 70 percent of our planet, and yet we have better maps of Mars than we do of our own seafloor. We also know very little about how life works at or beneath the seafloor's surface.

I am thrilled to have the opportunity to collect these unique samples. And I can't wait to get these samples back to the Lab where I will extract cellular DNA and use this genetic code to explore how the cells are growing, what they feed on, and their impact on their environment. I haven't finished Mark's story yet, but at least I know that my story has been successful and productive, and I can't wait for the next chapter.

DR. STEVEN BAER

6 From the Indian Ocean aboard the RV *Roger Revelle*

When I tell people that I am an oceanographer, the first question I am invariably asked is whether I do a lot of scuba diving. As the answer is negative, the follow-up question is whether I work on a submarine, exploring the depths of the unknown dark ocean. The questioning usually ends when I tell them that I use a fancy bucket to scoop water on deck and then filter it.

The reality is: shipboard work is difficult. My six weeks on this research vessel require daily, heavy labor on a moving steel platform that radiates the equatorial sun and smells of diesel fuel and paint fumes. There is the added pressure of justifying the expense to operate the vessel, along with the limited opportunity to collect samples from a specific place and time. So every moment is taken advantage of; the science operates 24 hours a day. We work extremely hard to collect samples and perform experiments and then move to the next location to do it again.

But even given all of the above, I love it. In some ways, it is like summer camp for grownups. Working in a challenging environment, constantly searching for new science opportunities and answers, and living, eating, and sleeping in close quarters with all of your coworkers fosters strong relationships. The uninterrupted 360-degree view of the horizon provides amazing vistas every day, and an incredible display of stars every night.

Currently, I am in the middle of the Indian Ocean, thousands of miles from land, in pursuit of the microbial life that sustains the ocean food web. We are here because this area of the world's ocean is wildly understudied. With the work we are doing here, we will provide an unprecedented description of phytoplankton biodiversity and physiology in the central Indian Ocean. We will then be able to understand how phytoplankton respond to low concentrations of nitrogen, phosphorus, and iron (critical elements for life), something that is currently poorly understood.

Even though it presents challenges like being away from family, working in rough seas, and coping with the elements, there is no place I'd rather be than here in the present, filtering water to understand how life and chemistry sustain each other in the ocean.

EVENTS Summer 2016

Unless otherwise indicated, all events take place at Bigelow Laboratory for Ocean Sciences, 60 Bigelow Drive, East Boothbay, Maine.

JUNE 20–JULY 20
TINY GIANTS: MARINE MICROBES REVEALED ON A GRAND SCALE
Portsmouth Public Library, Portsmouth, NH

JUNE 30
PRESENTATION ON TINY GIANTS
5:30–7:00 pm
Portsmouth Public Library, Portsmouth, NH

JULY 1
PUBLIC TOUR
3:00–4:30 pm
Please reserve space at (207) 315-2567 ext.104 or rsvp@bigelow.org

JULY 15
OPEN HOUSE
Featuring science-inspired artwork created by artist-in-residence Carter Shappy
10:00 am–3:00 pm

JULY 21
THE COUNCIL'S ANNUAL SUMMER OUTING
9:30 am–1:30 pm
By invitation only
Damariscotta River aquaculture tour for Council giving society members

AUGUST 12
PUBLIC TOUR
3:00–4:30 pm
Please reserve space at (207) 315-2567 ext.104 or rsvp@bigelow.org

AUGUST 5–SEPTEMBER 9
TINY GIANTS: MARINE MICROBES REVEALED ON A GRAND SCALE
Waterfall Arts, Belfast, ME

AUGUST 18
DR. NICK RECORD ON TINY GIANTS
7:00–8:00 pm
Waterfall Arts, Belfast, ME

CAFÉ SCI 2016
CHANGING CLIMATE/ CHANGING OCEAN

JULY 5–AUGUST 23
6:00–7:00 pm
Beginning July 5, all Café Sci sessions will be held in The Commons of Bigelow Laboratory, 60 Bigelow Drive, East Boothbay. There's free parking, refreshments, and a new and improved sound system. We hope you will join us this summer on Tuesday evenings.

JULY 5
DR. BETH ORCUTT
If a frozen lake burps methane into the atmosphere and no one is around to see it, did it happen?

JULY 12
DR. CINDY HEIL
Do toxic algal blooms affect you?

JULY 19
DR. MIKE LOMAS
How do temperature fluctuations ripple through the Arctic food web?

JULY 26
DR. BEN TWINING
What does melting Arctic ice mean for phytoplankton?

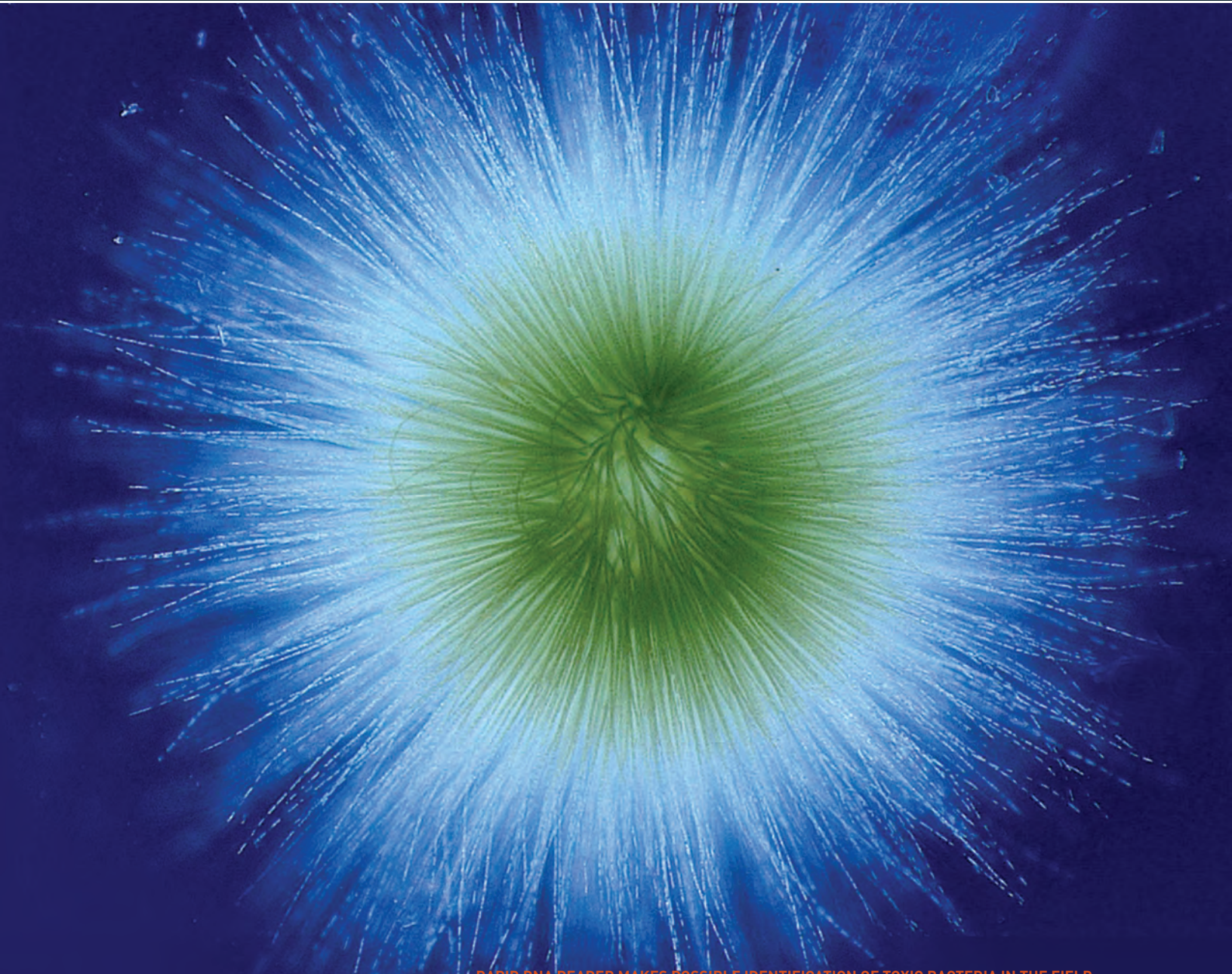
AUGUST 2
DR. PATY MATRAI
Just how much micro and nano plastics are we ingesting when we eat seafood?

AUGUST 9
DR. JOAQUÍN MARTÍNEZ MARTÍNEZ
How many viruses are in a teaspoon of seawater? What difference does it make?

AUGUST 16
DR. NICHOLE PRICE
Is seafood secure?

AUGUST 23
DR. CHRISTOPH AEPPLI
What happens if there is an oil spill in the Arctic?

MAGNIFICATION



RAPID DNA READER MAKES POSSIBLE IDENTIFICATION OF TOXIC BACTERIA IN THE FIELD

Although scientists at Bigelow Laboratory primarily conduct marine-based research, Dr. Pete Countway has been working with colleagues from Colby College on a project funded by the United States Geological Survey in the Belgrade Lakes region of Maine. The scientists are investigating the distribution and timing of blooms of *Gloeotrichia*, pictured above, a toxic cyanobacterium (blue green algae capable of photosynthesis) found in lakes throughout the region. Through this project, they have developed a rapid DNA-based detection assay to test for this organism in water samples and have also generated the first DNA sequences for the *Gloeotrichia* found in Maine. This new technology holds great promise for widespread use and identification of this toxin in Maine's many lakes.

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Bigelow Laboratory for Ocean Sciences is materially advancing what is known about marine microorganisms and how they affect global ocean processes. What we are learning is essential to the future of the ocean and the many valuable resources it provides.

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