TRANSECT

BIGELOW LABORATORY FOR OCEAN SCIENCES / SUMMER 2014 / VOLUME 6 / ISSUE 1

THE COVER IMAGE is an unidentified member of the algal class *Prymnesiophyceae*. This class of algae includes many species that thrive in nearly all ocean environments from the equator to the polar seas. This specific algae (CCMP2352) was isolated in 2003 from a sample collected off the coast of Corsica by the second Emeritus Director of NCMA, Dr. Robert A. Anderson. It is 5-10 millionths of a meter in diameter, or 5-10% the diameter of the average human hair.

It is with considerable pride, and a great deal of enjoyment, that I write this introduction to our first 2014 edition of *Transect*. This year marks our 40th anniversary of the founding of the Laboratory by Charlie and Clarice Yentsch. Their vision of how researchers might achieve significant new discoveries in marine science, and especially microbial and biogeochemical oceanography, endures to this day. Looking at our collective achievements I noted a simple fact: on average, one new paper has been published in peer-reviewed literature every 10 days for the 40 years of our history! Over those 40 years, however, we did not simply focus on new discoveries, we were also keen on stimulating the next generation in science and oceanography. For 25 years now, we have run the Keller BLOOM program for high school students in Maine. Jim McLoughlin's vision, matched by Maureen Keller and Clarice Yentsch's enthusiasm, has provided an enduring legacy for introducing the wonders of microbial life to more than 400 students.

These past 40 years have also wrought significant changes in the public funding of science in this nation, and in the priorities for marine science. In common with most other ocean institutes, we are grappling with these changes through planning and adaptation. Of course, one may take the view that such changes in funding and direction are cyclical, but there are endemic trends that impact the Laboratory significantly: our science is global and increasingly expensive in terms of infrastructure (ships, autonomous vehicles, bases, and supercomputers), other nations are investing heavily especially in operational and applied oceanography, and there is strong competition for available funding both public and private, not to mention among researchers. We have embarked on a strategic planning effort (2014-2020) that will go beyond simple mantras of diversification, public engagement, and industry collaboration. We will strive to adjust the way we operate as an institution, supporting our scientists, investing in our strengths, developing enduring and strategic partnerships with other organizations and nations, and searching out uniqueness, individuality, and quality in all aspects of our work and delivery of science.

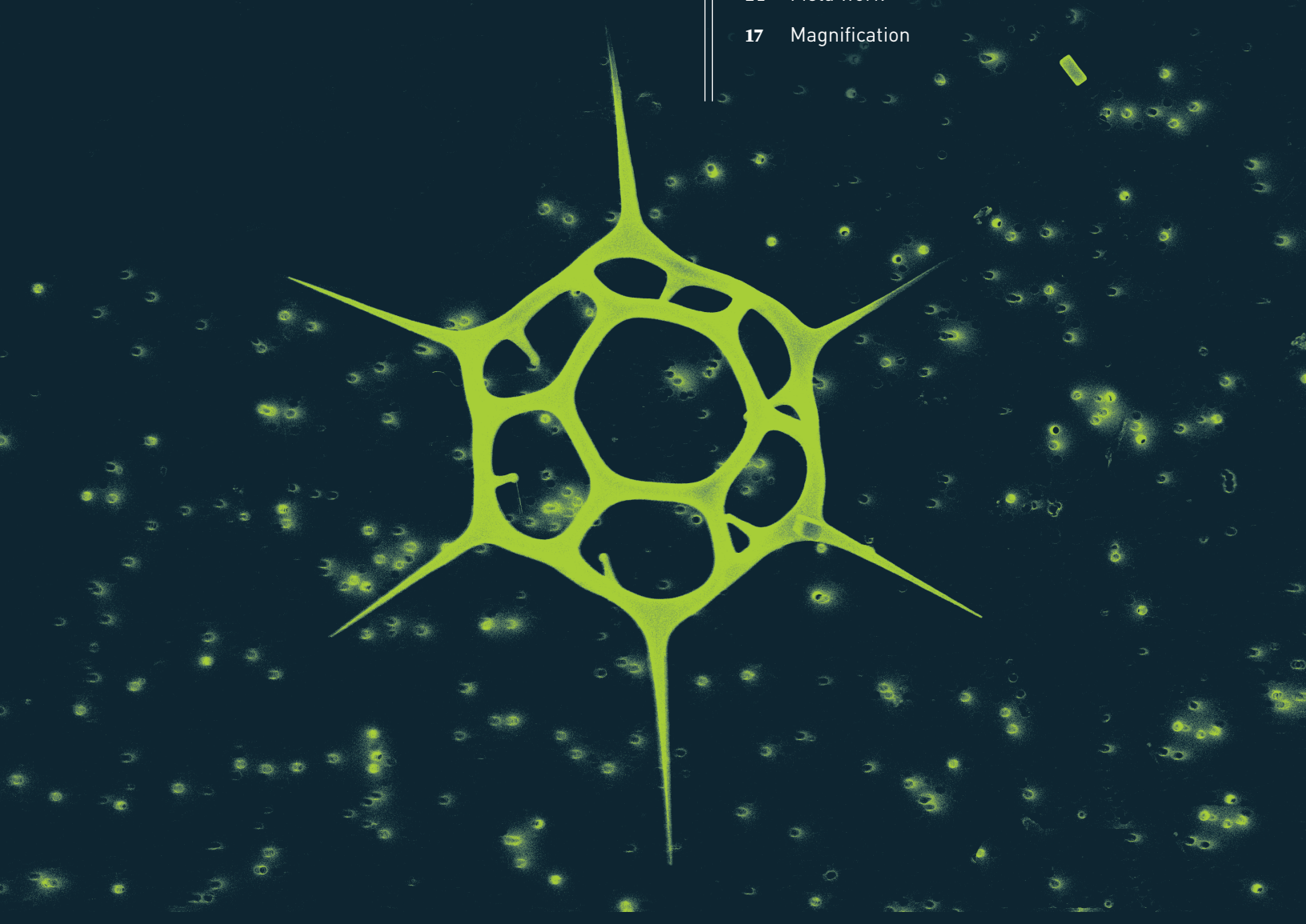
One example of how this is already happening is that our technologies are being put to good use helping to serve our state agency, the Maine Department of Marine Resources, in keeping your seafood safe! By introducing new analytical approaches to testing the level of toxins in shellfish, we are not only providing the DMR with more robust and detailed information on changing toxin levels in our seafood over a critical nine months of the year, but we are also demonstrating the huge value in research laboratories working with Maine regulatory authorities and seafood suppliers, where quality of the seafood and its export potential mean so much for employment and local economies.

I hope you will take a little time to read about some of our achievements and current science in this issue of *Transect*. I am sure you will see why my pride is well placed. This is a fabulous team of scientists, professional staff, administrators, and Trustees. Without them, and your individual and collective support, we could not have come this far—nor see such a bright and exciting future. Thank you one and all!

GRAHAM SHIMMIELD, PhD, FSB, FSRE

MANAGING EDITOR Darlene Trew Crist **DESIGN** Simmons Ardell

TABLE OF CONTENTS



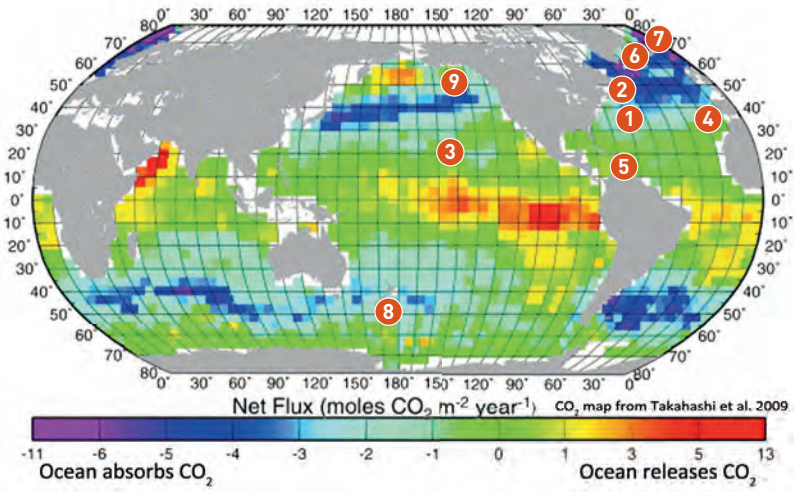
This year marks our 40th anniversary of the founding of the Laboratory by Charlie and Clarice Yentsch. Their vision of how researchers might achieve significant new discoveries in marine science, and especially microbial and biogeochemical oceanography, endures to this day.

Taking the long view yields better science

BY DR. JEREMY JACQUOT

When Charles David Keeling began to track atmospheric carbon dioxide (CO_2) concentrations at the Mauna Loa Observatory in 1958, he never could have imagined the lasting scientific and societal impacts that his observations would have. The decades-long record, which is still going strong but now maintained by David's son Ralph, showed for the first time that human activities were inextricably tied to rising CO_2 levels. The Keeling Curve, as it became known, even achieved mainstream popularity when it starred in *An Inconvenient Truth* alongside former Vice President Al Gore, who used it to alert the world to the threat of climate change.

PHOTO: SCRIPPS INSTITUTION OF OCEANOGRAPHY ARCHIVES, UC SAN DIEGO



1 Bermuda Atlantic Time-series Study (BATS)
2 Gulf of Maine North Atlantic Time Series (GNATS)
3 Hawaiian Ocean Time-series (HOT)
4 European Stations for Time series in the Ocean at the Canary Islands (ESTOC)
5 Carbon Retention in a Colored Ocean (CARIACO)
6 Irminger Sea
7 Iceland Sea
8 Munida
9 Line P/Ocean Station Pap

Movie fame aside, the reason for its enduring appeal and scientific merit is its longevity. Teasing the noise in the data due to natural variability from anthropogenically-linked trends can be tricky over periods of several years, or even decades, so researchers value these sustained time-series measurements. Michael Lomas, a senior research scientist at Bigelow Laboratory for Ocean Sciences, has devoted much of his career to studying how the oceans are changing in response to growing CO2 emissions and associated climate change. Lomas and his colleagues at the Bermuda Institute of Ocean Sciences run the Bermuda Atlantic Time-series Study (BATS), a sampling program in the North Atlantic Ocean, just southeast of Bermuda that has been dutifully monitoring temperature, pH, and a range of other biological and chemical properties on a biweekly to monthly basis since 1988.

Though seemingly modest in scope, the ramifications of the observations made at the BATS site have extended far beyond the shores of the small subtropical island. This research has yielded key insights into how phytoplankton diversity may respond to the gradual acidification of the ocean due to dissolution of atmospheric CO2, as well as how plankton diversity can absorb and store large amounts of CO2 in particle form. Already BATS' vast dataset, along with those of its sister site in Hawaii, the Hawaii Ocean Time-series (HOT), and seven other open ocean time-series programs, has been mined to write hundreds of peer-reviewed journal articles and to generate countless more ideas and hypotheses. And yet their greatest contributions may only come to fruition in later decades as the trends they are beginning to show become more definitive—as was the case for the Keeling Curve.

Lomas, who recently took part in a meeting about time-series organized by UNESCO's Intergovernmental Oceanographic Commission, will be leading an effort to assemble and document some of the many contributions made by these datasets and to describe how they have guided policymakers in their management decisions. "Part of it will be to highlight that just because the ocean is vast and deep doesn't mean that it's immune to the injustices of man," he says. "The changes that are happening are happening in a coordinated way; these aren't just a bunch of random, stochastic processes." Another goal will be to underscore the time-series' underutilized potential. Until now only a handful of studies have directly compared datasets, and Lomas believes that much could be gained from further comparisons, particularly when interpreted on a global scale.

JUST BECAUSE THE OCEAN IS VAST AND DEEP DOESN'T MEAN THAT IT'S IMMUNE TO THE INJUSTICES OF MAN.

When it comes to prescribing specific remedies for climate change mitigation, Lomas prefers to let the data do the talking. "I think that everyone understands the solution: the solution is we have to stop spewing CO2 with everything we do." And while his report will cite examples of successful policies that were informed by time-series findings, it will also highlight those that have failed or had unintended consequences. More often than not, in solving one problem, another was created. Ultimately, Lomas hopes to make one point clear: "We *do* have the ability and the power and the knowledge to effect solutions and change in the way we want."

First-in-nation for Bigelow Analytical Services

This spring, Bigelow Analytical Services received some very good news. After three days of intense scrutiny, the U.S. Food and Drug Administration gave Bigelow Analytical Services (BAS) the go-ahead to be the first lab in the nation to use a novel testing methodology to detect potentially deadly paralytic shellfish toxins in bivalve shellfish samples. The new method replaces the mouse bioassay testing method used for over 50 years, with an instrumental analysis that measures toxicity levels more precisely and efficiently.

"This is a huge step forward in improving the way shellfish are tested for toxins," said Carlton Rauschenberg, Bigelow Analytical Services Supervisor. "Paralytic shellfish toxin can be deadly. The quality and sensitivity of data produced by this method far exceeds what the national shellfish program has been able to achieve with the mouse bioassay."

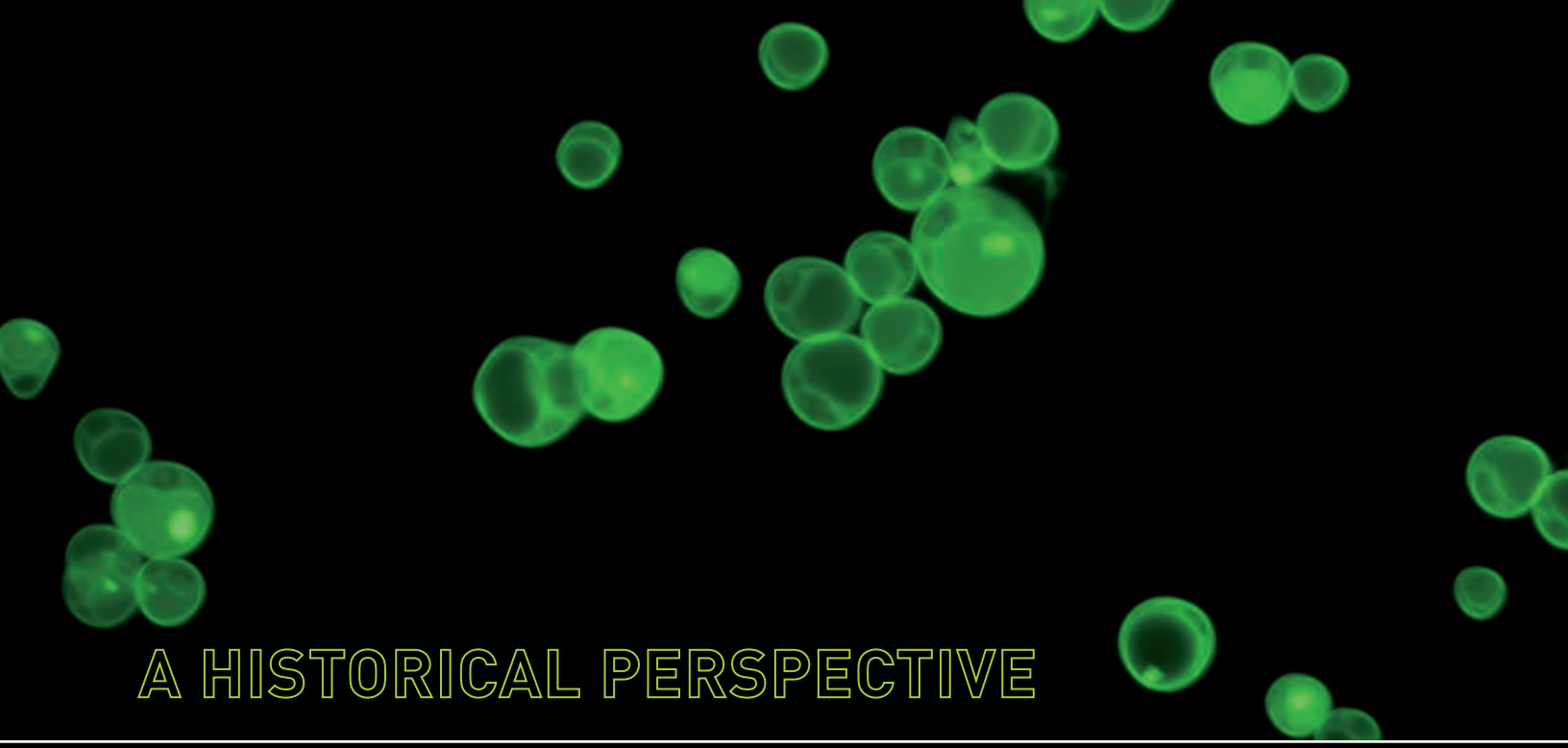
The testing methodology involves sample collection and extraction by Department of Marine Resources staff, with sample processing and analysis done by BAS. During the busy summer season, BAS expects to process up to 40 samples per day for the Department of Marine Resources (DMR). The new testing protocol makes it possible for DMR to conduct more frequent testing, with greater flexibility than with the mouse bioassay protocol. More frequent testing and expedient analysis will allow DMR to be more targeted and timely in their closures, allowing more areas to remain open to shellfish harvesting, while protecting public health.

THIS ADVANCE KEEPS MAINE AT THE FOREFRONT OF SHELLFISH MONITORING PROGRAMS.

This initiative is the result of collaboration between DMR and BAS that started some 21 months ago, when the state, looking for more efficient testing capabilities, turned to BAS. DMR provided the testing equipment, which the Laboratory personnel operate and use to provide the analyses to the state.

"I am extremely proud of the work done both by DMR and BAS in successfully developing this public/private partnership and for leading the nation in transitioning to an accurate and cost effective method for biotoxin analysis," said Kohl Kanwit, director of the DMR Bureau of Public Health.

Graham Shimmield, executive director of Bigelow Laboratory, echoed Kanwit's view but added, "This advance keeps Maine at the forefront of shellfish monitoring programs. We have already been contacted to run samples for other research institutions and for industries seeking to export shellfish overseas."



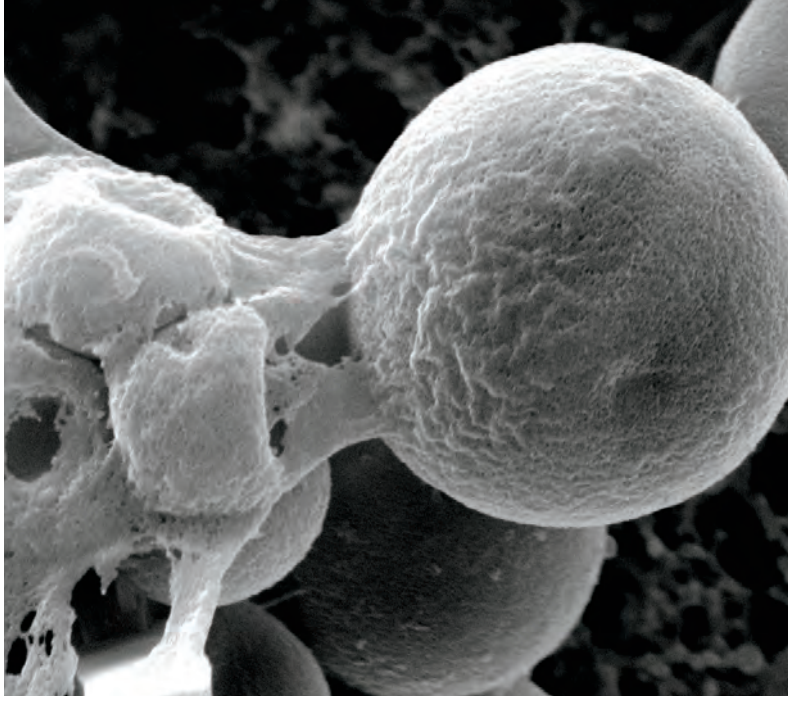
A HISTORICAL PERSPECTIVE

This new collaborative effort between the state of Maine and Bigelow Laboratory is not the first time the two entities have come together to sort through a scientific puzzle. In September 1972, coffee-colored water off the coast of Gloucester, Massachusetts forged a bond between DMR researchers John Hurst and Laboratory co-founders Charlie and Clarice Yentsch that lasted for decades. The coffee-colored water was the first time an abundance of an organism carrying a paralytic shellfish toxin was found in waters south of Maine. DMR's John Hurst had a well-established monitoring program in Maine coastal waters. DMR Commissioner Spencer Apollonio provided seed money to the Yentsches to "see what you can do to advance knowledge of this organism." The collaboration was launched!

The formal launch of Bigelow Laboratory for Ocean Sciences in West Boothbay Harbor in 1974, on a site adjoining DMR headquarters, allowed a decade-long collaboration between DMR's Hurst and Clarice Yentsch to flourish. The team published a seminal report on paralytic shellfish poisoning in 1974. With funding provided by the U.S. Food and Drug Administration and the National Institute of Environmental Health Sciences, Hurst and Yentsch continued to expand what was known about paralytic shellfish poisoning for the next decade. Clarice Yentsch said that one of the highlights was taking students to Monhegan Island for sampling and monitoring trips, where they would work and stay in the Red House, with no electricity and a small generator that gave them power for about an hour each day. This fieldwork and setting inspired many. Current Senior Research Scientist Barney Balch was one of many students who worked in the annex, and carries on his scientific curiosity at Bigelow Laboratory today. Artist Jamie Wyeth memorialized the house that served as a haven for scientific query in a painting entitled *The Red House*.

Clarice Yentsch went on to become one of the innovators to adapt flow cytometry, which had been used to identify cancer cells, to oceanographic research. This tool has become part of the standard tool kit of marine research labs worldwide. John Hurst carried on the investigation of paralytic shellfish toxins. When he retired in 2011, he not only left a substantial body of knowledge into the cause and effects of paralytic shellfish toxins, but also helped to advance monitoring and prediction needed to help keep Maine seafood safe for public consumption.

PERKINSUS MARINUS is a marine protozoan parasite responsible for "Dermo" disease in oysters, which has caused extensive damage to the shellfish industry and estuarine environment. Bigelow Laboratory Senior Research Scientist José Antonio Fernández-Robledo is investigating the possibility of using this parasite to develop an oral vaccine against malaria.



Big thinking with huge potential

PARASITES. OYSTERS. MALARIA. VACCINES. A slew of ingredients for a good spy novel are everyday realities in the laboratory of marine microbiologist José Antonio Fernández-Robledo (*pictured above*). Fernández-Robledo is working in collaboration with researchers from the U.S. Military Marine Vaccine Program, the Naval Medical Research Center, and Walter Reed Army Institute of Medical Research to explore how oyster parasites might play a role in the development of a vaccine for malaria. Military researchers have been seeking such a vaccine for decades.

RESEARCHERS ARE ONE STEP CLOSER TOWARD POSSIBLY CREATING AN ORAL VACCINE FOR MALARIA.

As it turns out, the oyster parasite, *Perkinsus marinus (photo right)*, about which Fernández-Robledo is an expert, is a cousin to *Plasmodium falciparum*, which causes malaria in humans. Because these two parasites share a close phylogenetic relationship, (they evolved in independent branches but both as parasites), they share many of the same traits to infect, survive, and proliferate inside the host. The research team decided to test the oyster parasite to see if it would cause an immune reaction in the malaria mouse model, as a first step to test the potential as a delivery vaccine against *Plasmodium*.

The results of these experiments are very encouraging and have put researchers one step closer toward possibly creating an oral vaccine for malaria. The experiments proved that the *Perkinsus* could be given orally, which is much easier to administer with fewer risks than via injection. Moreover, the oyster parasite ingestion caused no negative pathologies in the mice, but did deduce a strong immune response. As hoped, the mice recognized the oyster parasite as a foreign body and created antibodies to eliminate it—the exact response desired by a vaccine.

Fernández-Robledo explained that the benefit of using the oyster parasite, *Perkinsus marinus*, for an experiment such as this is that *Perkinsus* can be cultured in the laboratory in the absence of the oyster host, making it readily available and transportable, and being produced in large amounts. Together with his collaborators at Walter Reed Army Medical Center, Fernández-Robledo is now actively working on expressing genes from *Plasmodium* in *Perkinsus* with the hope that the combination of antigens of both organisms would protect against malaria. This test would be carried out again in the mouse model of malaria before moving to other mammals.

Malaria is a global health issue that in 2012 affected 207 million people in 99 countries, and caused an estimated 219 million cases and 660,000 deaths. About 80 percent of cases and 90 percent of deaths occur in Africa. Hence, if this approach to malaria works, it would not only have all the makings of a good novel, but would have a positive effect on global health, as well.

Keller BLOOM celebrates 25 years

BY THOMAS E. KELLER *(excerpted from* Maine Voices*)*

On May 22, 2014, more than 400 Maine high school students experienced, for many, a life-altering and unique annual event at Bigelow Laboratory for Ocean Sciences campus in East Boothbay, Maine. Every summer for the past 25 years, the Keller BLOOM (Bigelow Laboratory Orders of Magnitude) program has brought together 16 juniors to engage in ocean science at the world-renowned laboratory.

program originally was simply BLOOM but it was renamed to honor Maureen Keller who died in 1999.

PROGRAM ACTIVITIES

On the first full day of the program, BLOOM participants learn sampling and data collection methods, and put these into practice using standard oceanographic equipment on a research cruise of the local Sheepscot River estuary.

I LEARNED SO MUCH ABOUT THE OCEAN, BEING A SCIENTIST, PLANKTON, AND MYSELF DURING THE BLOOM PROGRAM.

This program began in 1989 when two visionary young scientists (Maureen Keller and Clarice Yentsch) and a Board member (Jim McLoughlin) decided Bigelow Laboratory would make a fine place to bring a group of regular students to help them understand the ocean that is so central to life in Maine. The three imagined a program that would give the students a chance to work side by side with some of the nation's top scientists, hauling nets, puzzling through microscopes, making sense of the ocean's many mysteries. To make it equally available to all, they decided to always select one student from each of Maine's counties to participate, and to cover all the costs, even food and accommodation. The name of the

The next two days are spent working with scientists on four different activities in the lab, using state-of-the-art techniques and instrumentation to explore phytoplankton, zooplankton, pigments, nutrients, bacteria and marine viruses.

On the final day of the program students give a presentation on their research and experience to their friends and families. During the program students also engage in formal and informal discussions with scientists on everything from public policy to scientific ethics. After the week of activity, students leave with a better understanding of ocean science and are equipped with the skills and knowledge necessary to pursue further studies in science.

PHOTO: DAVID FIELDS

Maine waters are warming fast

BY DR. NICK RECORD

When I think back on this memorably brutal winter, I think of shivering in my coat, paying high heating bills, something about a polar vortex, and a spring that seemed to never arrive. I also think of my father telling me it's not that bad. "You call this winter?" the old-timer harrumphed. "Why, when I was a young boy, the snow banks used to come up over my head!" Back then it was "20 below for weeks at a time, and the lakes stayed frozen over until May." I can find similar anecdotes in family logs going back generations. Ice skating every November. Snow storms in June. Surviving on mammoth during the last glaciation. And so on.

Was it really that much colder a generation ago? Or can I shrug off these claims and keep complaining about the bitter cold? There's only one good tool for confronting this sort of hyperbole: data. Luckily I'm a nerd, and I have lots and lots of data. A little digging did in fact confirm some of my father's claims. For example, ice-out on the lakes is two or three weeks earlier now than a generation ago.

In my data mining, however, and working with Andy Pershing and Kathy Mills of the Gulf of Maine Research Institute, I came across a more interesting discovery. I'm an oceanographer by trade, so I turned my attention to temperature data from the Gulf of Maine. Satellites have been passing over our oceans for a few decades now, measuring water temperatures from orbit. I was aware of the average warming trend of maybe a thirtieth of a degree Celsius each year. What I didn't realize was that this rate has increased ten-fold over the past decade in the Gulf of Maine. That equates to a nearly 3-degree (or 5 degree Fahrenheit) increase over that time. There are a lot of climate stories out there, so I'll put that in perspective. Over the past ten years, the Gulf of Maine has been warming faster than 99.9% of the ocean. In some parts of the gulf (for example Jordan Basin), it's faster than 99.99%.

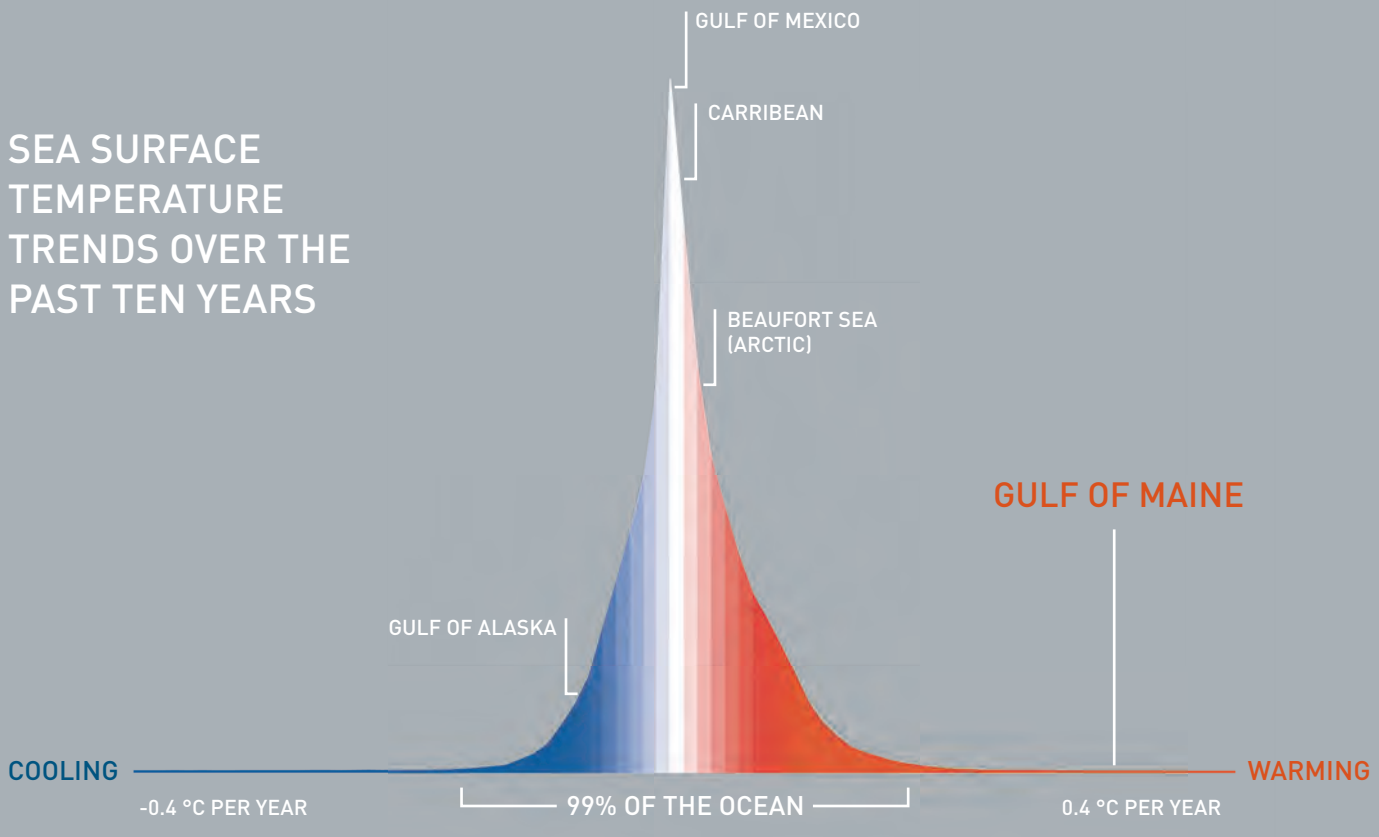
THESE LAST FEW YEARS HAVE BEEN LIKE A SNEAK PREVIEW OF WHAT CLIMATE SCIENTISTS ARE PREDICTING FOR THE END OF THE CENTURY.

Many of the story lines in the news over the past few years—disappearing shrimp, a new longfin squid fishery popping up, unusual lobster migrations and the havoc they wreak on the industry—have a strong connection to the changing oceanography in our region. I don't know if many people realize how extreme these changes have been. In some ways, these last few years in the Gulf of Maine have been like a sneak preview of what climate scientists are predicting for the end of the century.

One note about these changing conditions. The warming has come about through a combination of "normal" climate oscillations, some unusual atmospheric events, and the underlying global warming trend. That is to say, it's likely that the trend will change over the next decade. So if your plan is to take advantage of the warming by going for a dip, you might want to hold off for a few more years.

PHOTO: RICK KRISHFIELD

SEA SURFACE TEMPERATURE TRENDS OVER THE PAST TEN YEARS



DEGREE OF WARMING OVER PAST DECADE

Yellows and reds indicate warming across ocean regions; various shades of blue indicate cooling, with dark blue indicating the greatest cooling. The Gulf of Maine stands out as the fastest warming region.

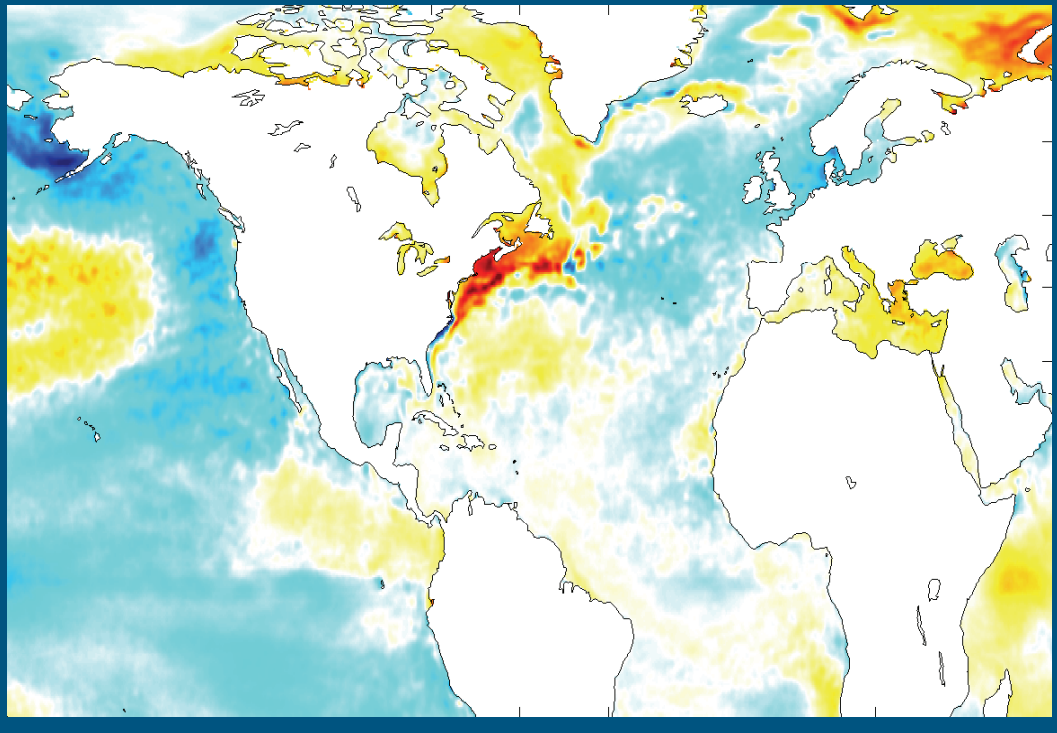


PHOTO: AMY ROOT-DONLE

PROFILE Neil Rolde

Neil Rolde was a young child when he caught the "ocean bug." His summer days were filled with snorkeling, fishing, and sailing the coast of Maine. To this day, he would much prefer being in the water than nearly anywhere else.

His passion for the water, combined with an unyielding curiosity for how things work—and a tenacity for fixing them when they don't—were driving forces behind his long affiliation with Bigelow Laboratory for Ocean Sciences. Rolde first became intrigued with the idea of a marine lab in Maine as Special Assistant to then Governor Ken Curtis. During that time, the U.S. Department of Defense had transferred title to McKown Point in West Boothbay Harbor to Maine's Department of Marine Resources. DMR subsequently leased a portion to Bigelow Laboratory for Ocean Sciences co-founders Charles and Clarice Yentsch, who established an ocean research lab there with a vision of collaborative inquiry and grand things to come.

After leaving the Curtis Administration, Rolde went on to establish his own political career and served in Maine's House of Representatives from 1974 to 1990. In 1990, Rolde jokingly explains that he found a "spectacular way to retire, when I ran for U.S. Senate against the widely popular Senator Bill Cohen."

Never deterred in his curiosity and interest, and at the time looking for something to do, Rolde was approached by his good friend Jim McLoughlin. McLoughlin was doing some communications outreach for Bigelow Laboratory, which in the early 90s was experiencing some growing pains. Rolde was enticed to join the Board of Trustees in 1991, then chaired by Admiral Jack Hayes.

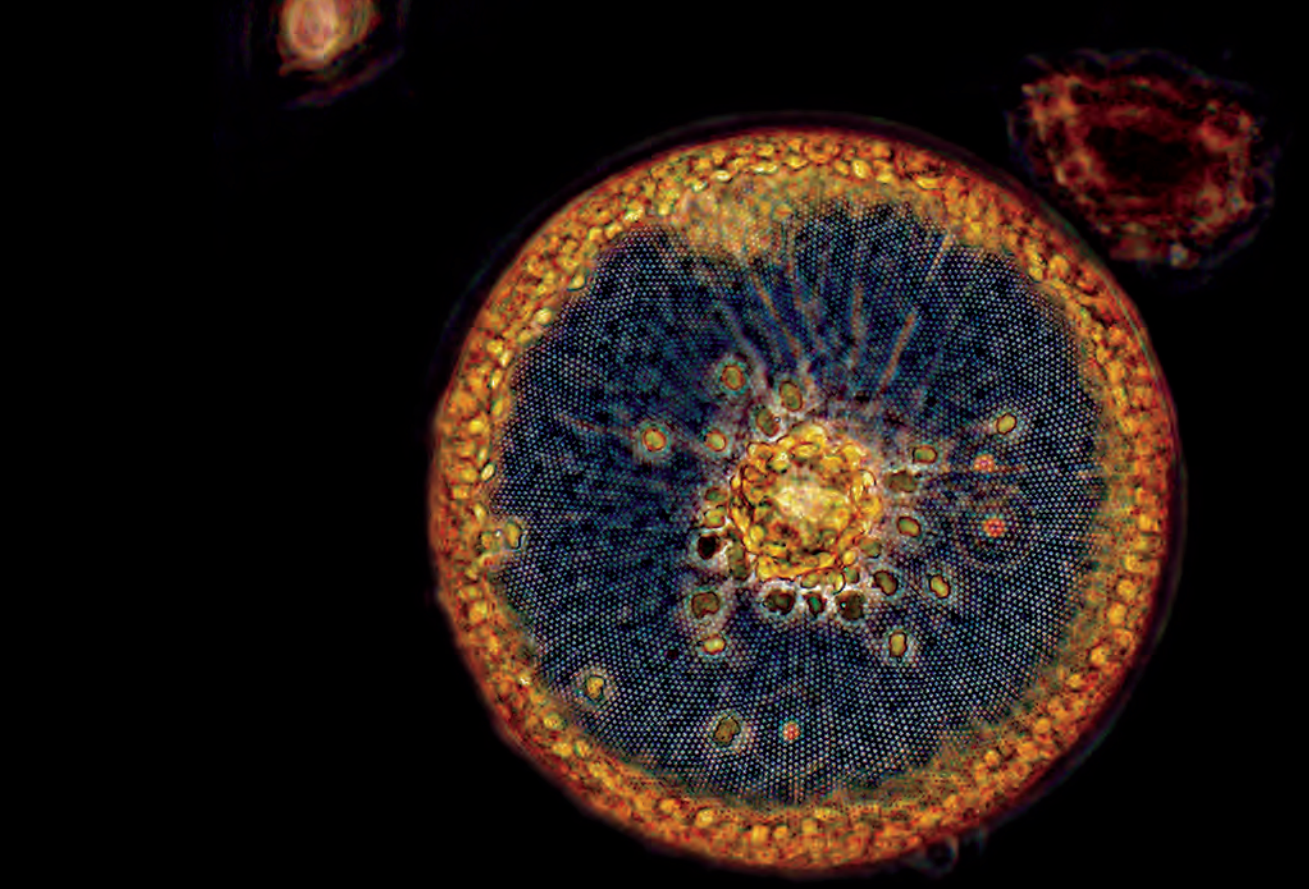
Until 1996, the Laboratory had been operating without an executive director. Hayes assigned Rolde the job of securing professional management help. Rolde went off to inquire about hiring Dr. Louis "Sandy" Sage, who had experience running a freshwater lab in Pennsylvania. At lunch in Boston, Rolde recounts, "I was never very good at poker. After talking with Sandy for about 20 minutes, I looked at him and said, 'We want you.'" It was the beginning of a period of positive change and growth for the Laboratory. In large part the turnaround was achieved due to the enthusiastic efforts of Neil Rolde and his commitment to seeing the Lab succeed.

By 2000, Rolde had become Chairman of the Board of Trustees and led the board to adopt his vision for a new and expanded laboratory facility. He teamed with fellow Board member Dick Morrell, who had served with Rolde in the legislature, and Sandy Sage to launch a capital campaign to build a new laboratory in Southport. That proposal was defeated in a town-wide vote, which Rolde describes as "the best thing that ever happened to us," for it resulted in a land swap that provided space for the award-winning facility that was ultimately built in East Boothbay in 2012.

I SEE BIGELOW LABORATORY AS AN INTEGRAL PART OF THE NEW MAINE ECONOMY.

With the institution of term limits, Rolde moved from Bigelow's Board of Trustees to its Advisory Board in 2011, where he has continued his unwavering commitment to the Laboratory. He wants the Laboratory to realize its potential as an economic driver for Maine's economy. "I see Bigelow Laboratory as an integral part of the new Maine economy."

Bigelow Laboratory is not the only concern in Maine that has benefited from Rolde's interest, guidance, and largesse. He helped launch the University of New England in Biddeford, Maine and was instrumental in the expansion of York Hospital, where three of his four daughters and two grandchildren were born. Today, Rolde is actively working with the Frances Perkins Center in Damariscotta, Maine to ensure that the first woman appointed to a U.S. Cabinet position (Secretary of Labor appointed by President Franklin Delano Roosevelt) receives her just due. The Nonprofit Leadership Institute named Rolde 2012 Maine Philanthropist of the Year. He certainly has added much to Bigelow Laboratory for Ocean Sciences, helping to keep it on a successful trajectory.



MIGHTY MICROBES

Marine microbes are tiny organisms that live in marine environments and can only be seen under a microscope and other highly sophisticated instrumentation. They include cellular life forms: bacteria, fungi, algae, plankton, and viruses that freeload on the cellular life forms. Marine microbes are everywhere in the global ocean, and are the most diverse and abundant life forms in the ocean.

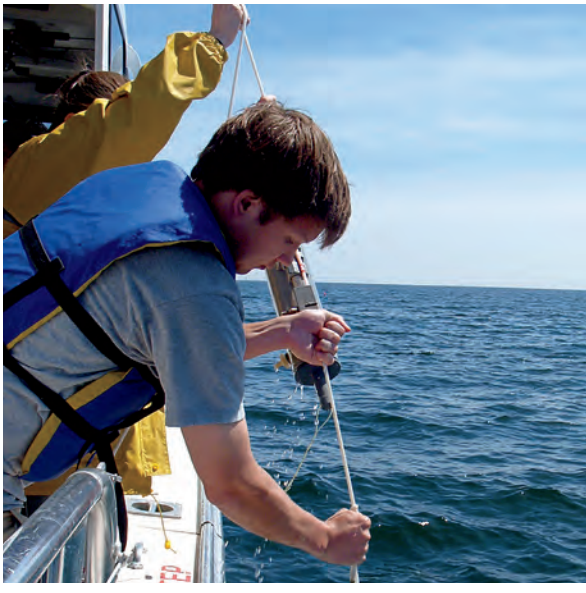
Bigelow Laboratory for Ocean Sciences is the only independent research laboratory in the world that primarily focuses on understanding life in the microbial ocean.

Here are some reasons why the work done here is so important:

- Microbes comprise 98 percent of the total biomass of the global ocean.
- They supply more than half the world's oxygen. (Another way to look at this is they are responsible for every second breath we take!)
- They are the major processors of the world's greenhouse gases and have the potential to mitigate the effects of climate change.
- They serve as the basis of the entire marine food web.
- Bigelow Laboratory researchers investigate the microbial ocean ecosystem and how it affects, and is affected by, life on Earth. What is learned through this research will be essential to our conservation and responsible use of the ocean and the many valuable services it provides.

PHOTO: PETER COUNTWAY

GIVING The Paris Challenge



More than 180 donors increased previous donations or made new ones between July 1, 2013 and June 30, 2014 to help advance Bigelow Laboratory's 2014 Annual Fund. These gifts have helped us meet—and exceed—the Paris Family's generous $50,000 matching gift challenge.

Our deepest thanks go to Herb and Harriet Paris for their vote of confidence in Bigelow Laboratory—and to YOU for fostering the pursuit of quality education and scientific discoveries upon which our society, our ocean, and our planet depend.

Your generosity to Bigelow Laboratory for Ocean Sciences' Annual Fund helps:

- Enable flexibility and innovation among our scientists and staff.
- Fuel the Laboratory's growth.
- Inspire budding young scientists to pursue careers with the potential to solve societal problems, promote the health of our planet, and boost the economy.
- Maintain our momentum as we settle in to our new campus.
- Spark enthusiasm for ocean science in students of all ages.

More than 1,000 families, businesses, and charitable foundations have provided financial support to Bigelow Laboratory's Annual Fund since 1974. **We sincerely thank all of our Annual Fund donors** for their steadfast support of our work over the past 40 years.

WAYS TO GIVE

Would you like to contribute to our 2015 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

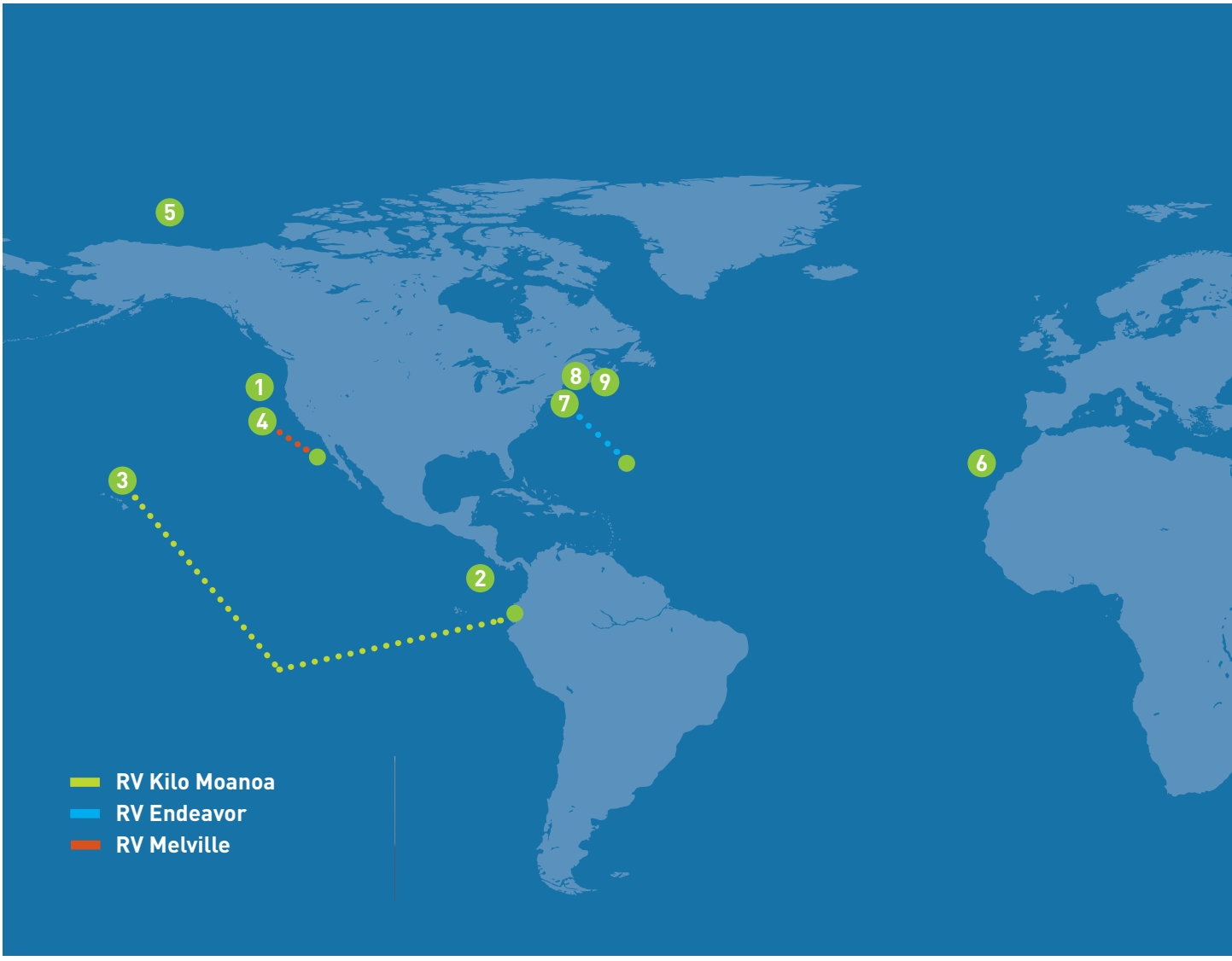
Send checks to:

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

PHOTO: LEFT, ROBERT HEALING; RIGHT, BIGELOW LABORATORY ARCHIVES

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 are some upcoming expeditions.



1 Juan de Fuca Ridge Flank subseafloor observatories cruise

Senior Research Scientist **Beth Orcutt** will be aboard the RV *Atlantis* with the human submersible *Alvin* from the Woods Hole Oceanographic Institution in the Pacific Ocean off the coast of Seattle from August 8-25 to visit long-term subseafloor observatories embedded deep below the seafloor. Orcutt will be using *Alvin* to collect samples, to recover and deploy custom experiments, and to collect data to examine microbial life in this extreme environment.

2 Return to Dorado Outcrop cruise

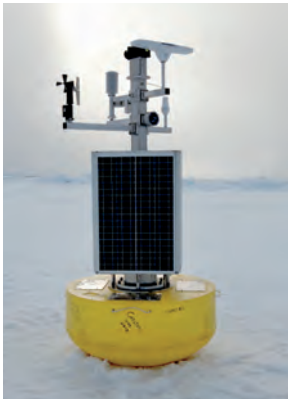
Dr. Orcutt will again be aboard the RV *Atlantis* and a passenger on *Alvin* from November 28-December 10. This time, the research team will be exploring the seafloor off the Pacific coast of Costa Rica. They will revisit a newly discovered site of low-temperature hydrothermal venting to collect sediment, rocks, and fluids.

3 Hawaii to the Equator cruise

Senior Research Scientist **Mike Lomas** will leave Honolulu, Hawaii on September 19 aboard the RV *Kilo Moana*. He and a scientific team of 15 will head toward the Equator and back again to gain a better understanding of the complex relationships between ocean chemistry and phytoplankton biology. They will be measuring phytoplankton to determine the ratios of carbon, nitrogen, and phosphorous they contain. While at sea for three weeks, the researchers will also be conducting a range of experiments to gain a better understanding of how phytoplankton control the cycling of carbon, nitrogen, and phosphorous in the ocean.

4 Iron Biogeochemistry off the California Coast

The currents, various rivers, and mixture of wide and narrow continental shelves produce a mosaic of iron conditions along the California coast. Senior Research Scientist **Ben Twining**, post-doctoral researchers **Jeremy Jacquot** and **Dan Ohnemus**, and **Jade Enright**, a rising senior at Colby College will be aboard the RV *Melville* from July 3-27 studying the role of iron uptake and storage by diatoms growing in the waters from Big Sur to the Gulf of Farralones. They think that certain diatoms that contain the iron storage molecule ferritin have an ecological advantage in this system. The Bigelow Laboratory researchers are part of a 36-member scientific team studying iron chemistry in this dynamic region of the Pacific.



5 O-Buoys in the Beaufort Sea

As part of the Bigelow-led O-Buoy Chemical Network, Purdue graduate student **Wes Halfacre** is headed to the Beaufort Sea to continue this multi-year work in the Arctic Ocean, where researchers have designed and deployed the first long-term automated, autonomous on ice sampling of atmospheric chemistry. Halfacre will be aboard the Canadian Coast Guard Vessel *Louis St. Laurent* from September 9 through October 15. He will be deploying the 11th and 12th in the series of "O-Buoys," which measure atmospheric carbon dioxide, bromine oxide, ozone, and meteorological parameters. These buoys also will be taking pictures every 20 minutes of the Arctic pack ice. OB-12 is specially outfitted for the first time with an under sea ice seawater-module that will measure seawater temperature, salinity, oxygen, nitrate, pH, fluorescence, and backscatter.

6 Offshore of Gran Canaria

From mid-September to late November, Senior Research Scientist **Steve Archer** and post doctoral researcher **Kerstin Suffrian** will be working from the Oceanic Platform of the Canary Islands (PLOCAN), a non-profit consortium dedicated to science and technology located in Gran Canaria. Senior Research

PHOTOS OF SCIENTISTS: ROBERT MITCHELL

Scientists **Paty Matrai** and **Pete Countway** will be working up data from Maine. The research team will be helping to deploy KOSMOS 2.0, less than one mile offshore. KOSMOS 2.0 consists of nine large (20 m deep x 3 m diameter, the equivalent of 60 cubic meters) floating mesocosms, experimental water enclosures. The mesocosms will be adjusted to varying levels of acidity to try to simulate ocean acidification over the next 100 years. The research team will monitor what happens to plankton and the gas exchange over the 10-week experiment. Of note, KOSMOS 1.0 was lost in a severe freak storm early this year.

8 Boothbay Maine sampling

This summer, Senior Research Scientist **Pete Countway** will continue a weekly sampling program at the McKown Point dock in West Boothbay Harbor as part of a project to characterize plankton community dynamics and the effect of protistan grazers on blooms of some of the smallest marine phytoplankton.

These small phytoplankton (← 2-3 um) are the first link in many marine food webs, yet very little is known about the identity of the grazers that may control the timing and magnitude of phytoplankton bloom formation. Sampling from the dock in West Boothbay Harbor has been ongoing for the past 12 years and forms an increasingly important baseline data set given the predicted changes to environmental conditions in the Gulf of Maine.

Countway also will be conducting experiments in the 2,500-liter ocean mesocosms located on Bigelow Laboratory's East Boothbay campus to investigate the effects of ocean acidification (OA) on bacterial gene expression and the structure and diversity of marine plankton communities. The OA project is a collaboration with Senior Research Scientists **Steve Archer** and **Paty Matrai** and the grazing project is a collaboration with **Nicole Poulton** of Bigelow Laboratory and **Brian Palenik** of Scripps Institute of Oceanography.

9 NASA/*Nova Star* sampling across Gulf of Maine

The longest running time series of coastal phytoplankton productivity in the nation (36 years) will continue this summer under the direction of Senior Research Scientist **Barney Balch** with the support of his Bigelow Laboratory team aboard the *Nova Star* ferry. Once each month from late spring to early fall, Balch and his team take water samples while aboard the *Nova Star* during its crossing from Portland, Maine to Yarmouth, Nova Scotia. The research team provides groundtruthing for NASA satellites, while collecting data that is providing valuable insights about the long-term changes in the productivity of the Gulf of Maine (on which all marine life in the Gulf depends). This long-term sampling transect will be done aboard the RV Connecticut for the months from late fall to early spring. The team also deploys the autonomous glider, *Henry*, along the same transect to help sample over the entire water column.

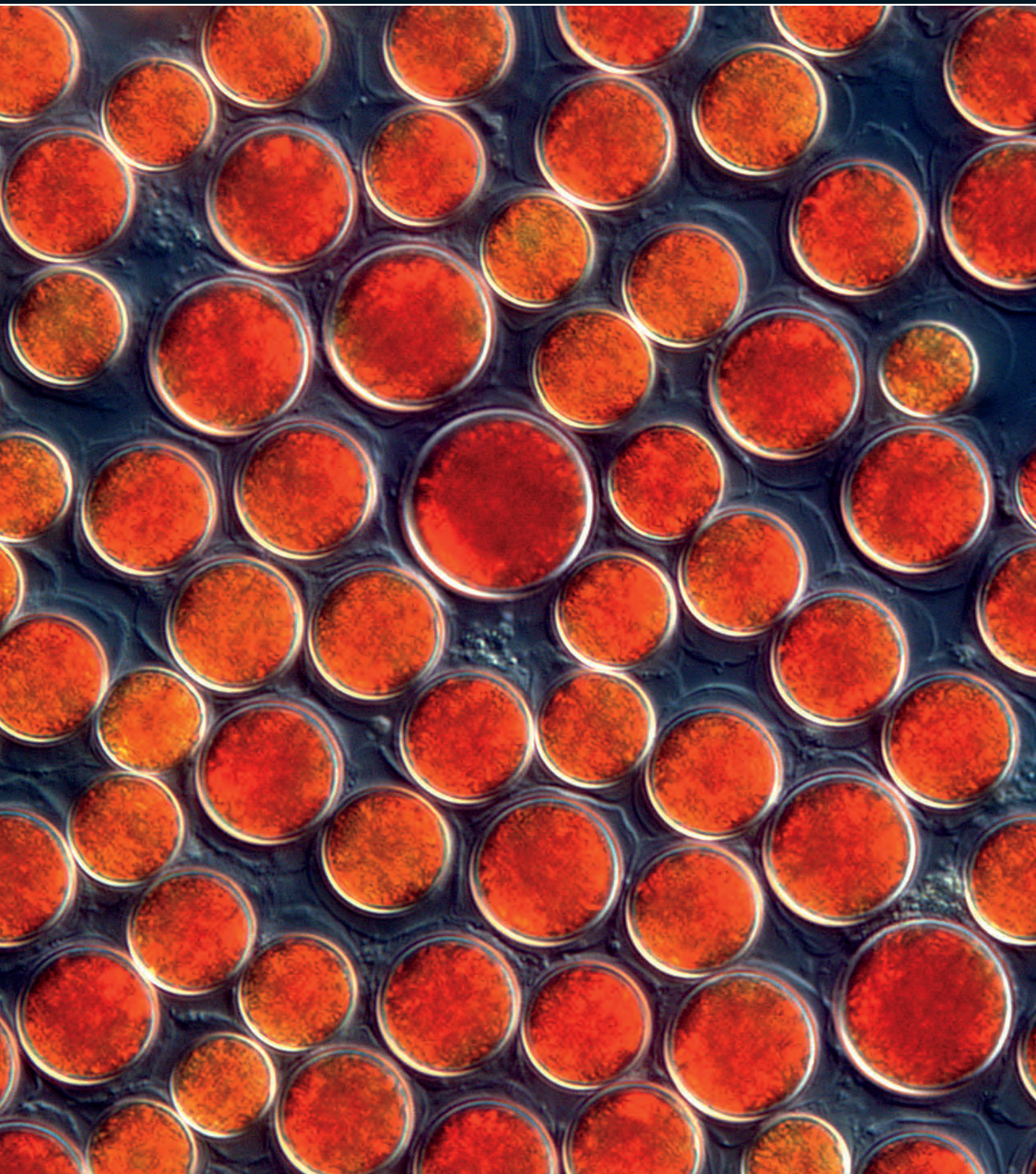
BIGELOW LABORATORY RESEARCHERS WILL EXPLORE FOUR OUT OF FIVE OCEANS THIS FIELD SEASON

7 SABOR cruise from Gulf of Maine to Bermuda

Research scientist **Nicole Poulton** boarded the RV *Endeavor* in Narragansett, Rhode Island on July 17 to begin a three-week NASA-sponsored cruise to investigate polarization of light in the ocean. The scientific team is taking samples and comparing findings from complex coastal waters like the Gulf of Maine to the blue open waters of the North Atlantic. Poulton is doing onboard analysis of carbon in phytoplankton using flow cytometry, a tool originally used to count cancer cells, which Bigelow Laboratory pioneered for use in ocean research.

Haematococcus is a flagellated unicellular green alga. It is grown commercially for its astaxanthin, which is used in both the aquaculture and nutraceutical industries. (Sample collected in East Boothbay, Maine by Dr. Peter Countway.)

MAGNIFICATION



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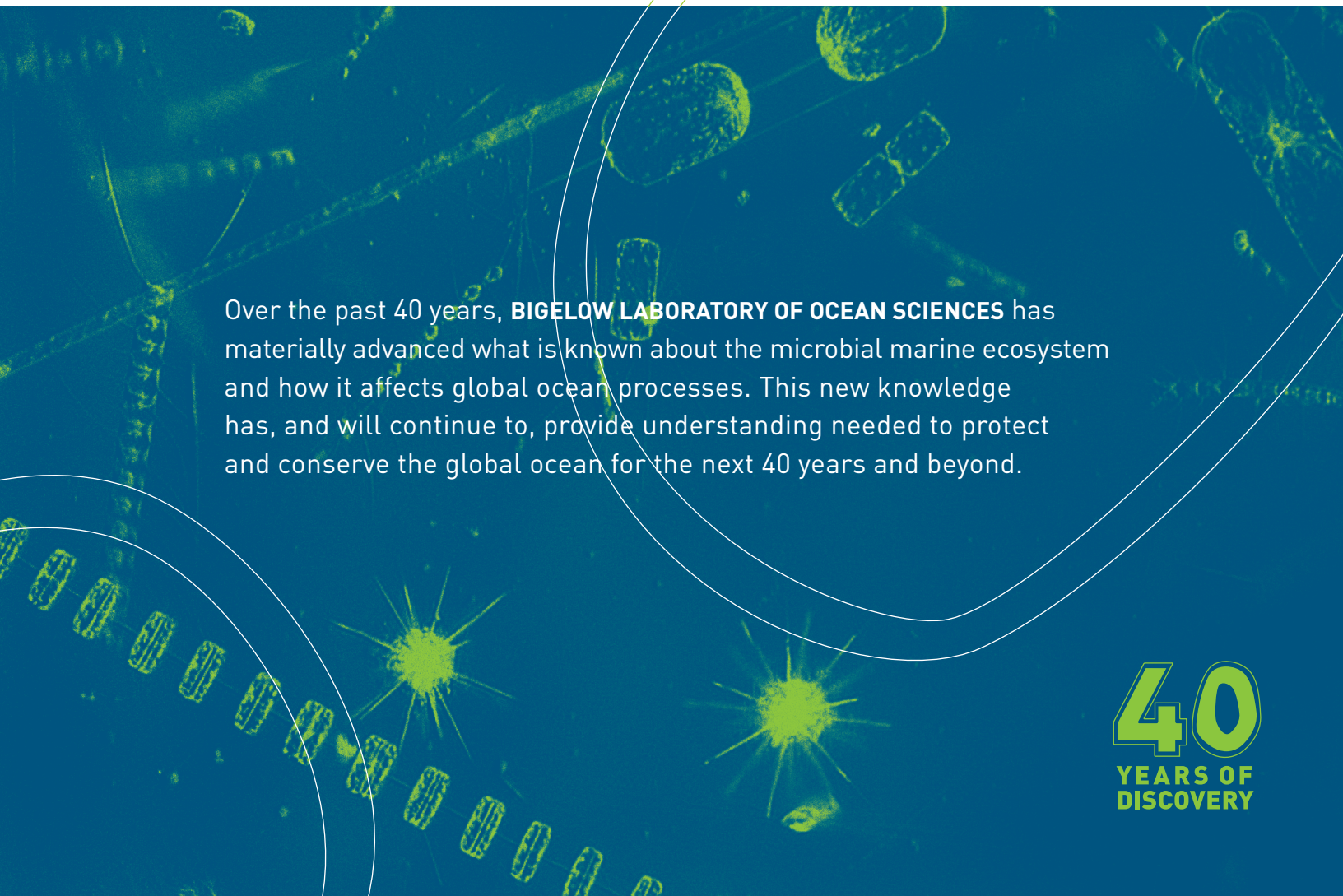

Over the past 40 years, **BIGELOW LABORATORY OF OCEAN SCIENCES** has materially advanced what is known about the microbial marine ecosystem and how it affects global ocean processes. This new knowledge has, and will continue to, provide understanding needed to protect and conserve the global ocean for the next 40 years and beyond.

40
YEARS OF
DISCOVERY