The Road Not Taken

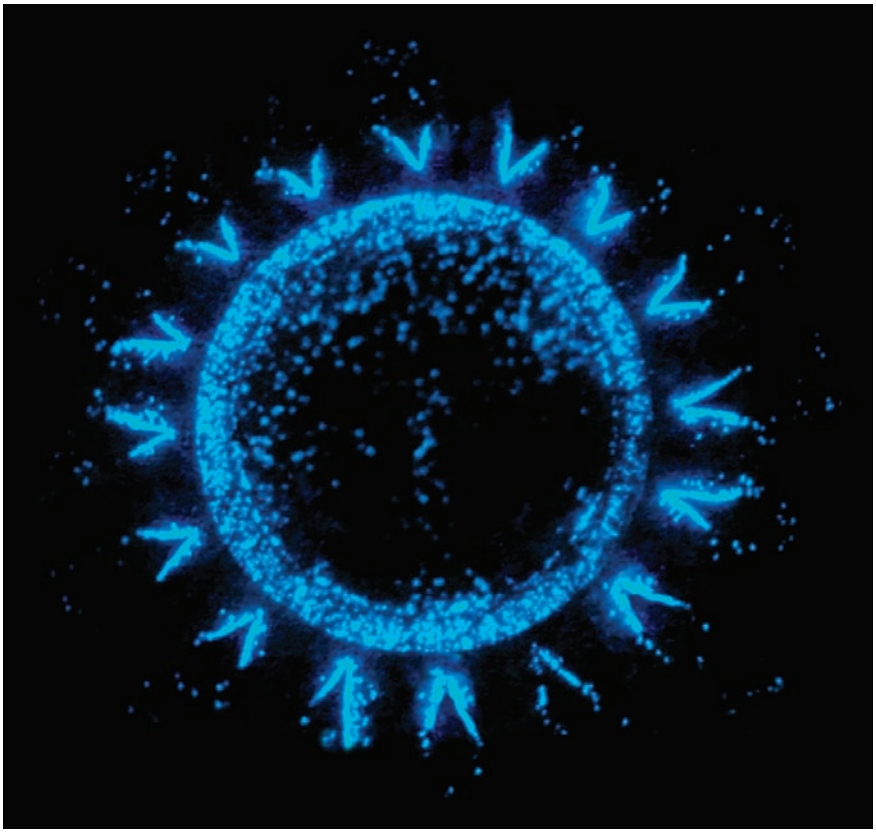
CHERYL LYN DYBAS

Paths to nonacademic careers in the biological sciences.

For years, scientists and educators have assumed that most people pursuing PhDs in the biological sciences would want a career in academia. But, in fact, the majority choose other paths. The academy has yet to shift gears, however, in its advice to biology graduate students. Moreover, many early- to midcareer faculty members are also looking to make a switch, to follow the road not taken. They may opt to work for a government agency; an independent research lab; a major pharmaceutical company; a start-up in the biotech field; a botanical garden, zoo, aquarium, or museum; or any of a myriad of organizations.

"The options reach wherever we think they do," says marine biologist Edie Widder, president of the nonprofit Ocean Research and Conservation Association (ORCA), which she founded in 2005. Widder's success followed a winding trail. Her tale reflects those of numerous other biologists who have chosen a career outside academia.

After receiving a bachelor's of science (BS) degree in biology from Tufts University, Widder went on to a master's of science (MS) in biochemistry and a PhD in neurobiology from the University of California, Santa Barbara. She then joined the faculty of Florida Atlantic University's Harbor Branch Oceanographic Institution, where she conducted research for 16 years. "If you'd have told me that I'd eventually be running a successful nonprofit, discovering new species of bioluminescent jellyfish, designing instruments that measure light in the pitch-black deep sea, and becoming a certified scientific research pilot for submersibles, I'd never have believed it," she says. "The key is that I was always open to exploration, whether of the ocean depths or of career options."



Wheel of light: The bioluminescent jellyfish* Paraphyllina intermedia *dwells in the deep sea. This jelly was collected on a submersible dive off the Bahamas, at a depth of 680 meters. The biological sciences offer a wheel of career choices for those with the imagination and initiative to investigate them. Photograph: Edith Widder, the Ocean Research and Conservation Association.

On the basis of her work at ORCA, Widder has been awarded a MacArthur Fellowship. "Designing submersible instrumentation and other

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equipment to allow us to have eyes in the sea is what brought me here," she says, "and by way of biochemistry and neurobiology. I followed my bliss—and it took me to wonderful places."

The need for encouragement for nonacademic careers

For career seekers in the biological sciences, Widder's and others' experiences lead to two main questions: What choices are there for someone with a graduate degree in the biosciences? And how does a job seeker decide which nonacademic fields may be right for him or her?

The answers, say most successful scientists in both traditional and nontraditional fields, may be summed up in one word: imagination. In choosing a life's work, they believe, there are as many possibilities as one can come up with.

For two decades or more, there has been discussion about the availability of fewer academic science positions, which has led to a need for new career options. But that is not to suggest that these options are second best. The aspirations of many scientists may be better matched with nonacademic fields.

Findings discussed in the National Academy of Sciences report *Reshaping the Graduate Education of Scientists and Engineers*, published in 1995, first indicated a sea change. That process has continued since the report, which highlighted the role of professional societies such as AIBS, came out almost two decades ago.

When the subject was first addressed, it was called *alternative careers*, then *nontraditional careers*; now it is *nonacademic careers* or simply *careers in science*, which reflects, many researchers say, a broader understanding of the possibilities open to scientists looking to find their career bliss.

We're not all the way there, however, according to results of a study published on 2 May 2012, in the journal *PLOS ONE*. In their paper, "Science PhD career preferences: Levels, changes, and advisor encouragement," coauthors Henry Sauermann, of the Georgia Institute of Technology, and Michael Roach, of the University of North Carolina at Chapel Hill, show that the attractiveness of academic careers decreases significantly over the course of a PhD program. Nonetheless, advisers still "strongly encourage academic careers over nonacademic careers," they state.

Biologist Edie Widder, president of the Ocean Research and Conservation Association (ORCA), a nongovernmental organization headquartered in Florida, turned her neurobiology background seaward. Widder has made dozens of submersible dives to discover the role of bioluminescence in the ocean's deepest realms. Photograph: ORCA.

The authors base this conclusion on a national survey of the preferences of junior scientists in the life sciences, physics, and chemistry at tier-one US institutions. "Our results suggest the need for mechanisms that provide PhD applicants with information that allows them to carefully weigh the

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Resources for choosing a biology career.

For those contemplating nonacademic ways of contributing to science and searching for a place to start the process, help has arrived in the form of several books and Web sites.

Among the best of these is Karen Young Kreeger's *Guide to Non-Traditional Careers in Science*. Although Kreeger focuses on biology fields in the book, the information that she presents is easily extrapolated to any other area of science. In individual chapters on career choices from science education to bioinformatics, Kreeger interviews practitioners in nontraditional fields. Readers get a sense of what it's like to work in these areas, what additional preparation might be needed, and how they accomplished the mindset switch often needed for a successful career that takes an alternative path.

Her advice includes the following: Do what makes you happy; a career change is a process of self-analysis to find a good fit. Don't go it alone; networking is often key to professional success and personal support. Try out a new area first by volunteering, doing internships, or otherwise gaining experience. Define yourself by your skills rather than your field. "For example," writes Kreeger, "if you're a meteorologist who uses computer modeling, start selling yourself as a computer modeler who applies that skill to meteorology."

In each career-specific chapter, Kreeger presents information on relevant professional societies, education and training programs, and job-hunting and networking outlets. "Often, you don't know the backgrounds of those with whom you work and interact," Kreeger writes. "There are scientists in places you may never have expected."

For those with an environmental science bent, Peter S. Fisk's *To Boldly Go: A Practical Career Guide for Scientists* is a tour through the often-foreign world of nonacademic science careers. It's a book about creating options and recognizing opportunities, two of the most important aspects of a successful nontraditional science career. Fisk cites the many transferable skills that scientists acquire along the way, from conceptualizing complex projects to working with the committee process to problem solving.

One of the first such guidebooks remains one of the best, according to scientists in nonacademic careers. *Outside the Ivory Tower: A Guide for Academics Considering Alternative Careers* was written in 1993 by Margaret Newhouse, of Harvard University. Her book tackles all areas of science, giving a mini-tour of nonacademic careers and demonstrating how the process of exploring such careers might work. The first line sums up what many say is among the most important points: "Know thyself. To know yourself is, of course, the task of a lifetime, but it is also an essential first step in exploring alternative careers."

These and other publications, such as *Careers Away from the Bench*, *Finding Your Personal Job Chemistry*, and *Industry or Academia: Where Do I Fit In?*, all by the American Association for the Advancement of Science (AAAS) and available at *www.sciencecareers.org/booklets*, will help bioscience career seekers answer the essential question: How do I discover what's out there that matches who I am and what I'd like to do with my life?

For those who like to plug in the variables, the AAAS has introduced what it calls an *individual development plan* (myIDP) for scientists (*http://myidp.sciencecareers.org*). In cooperation with the Federation of American Societies for Experimental Biology; the University of California, San Francisco; the Medical College of Wisconsin; and the Burroughs Wellcome Fund, myIDP is the first and, as of this writing, the only online app that helps scientists develop an individual plan for a career in science. A recent search of open jobs through the site showed positions in the biological sciences at Merck, Genentech, Life Technologies, Monsanto, the Temasek Life Sciences Laboratory, the Hawai'i Institute of Marine Biology, and the Istituto Italiano Di Tecnologia, among other organizations.

costs and benefits of pursuing a PhD, as well as for mechanisms that complement the job-market advice advisers give to their current students."

The researchers asked 4109 PhD students at 39 US research universities about their career preferences and how attractively they viewed academic, industry, government, and other options. The students were life scientists (59%), physicists (23%), and chemists (18%).

As these students progressed through doctoral programs, they became less likely to want an academic position after they graduated. "We always think that students desire a position in academia," says Sauermann, "but maybe that's far from the truth." He and Roach found that students in the later stages of their PhD programs had less favorable views of faculty research and teaching jobs than did students in earlier stages.

"Students may enter graduate school with overly positive views of a faculty career, and may change their expectations upon experiencing academic life firsthand," write the coauthors. "They may also learn about career paths outside academia and may come to appreciate their advantages."

Over the course of their graduate educations, 18.3% of the life science students found faculty research positions less attractive. The job sector with the largest increase in interest was government: Some 18.6% of the life sciences students said that they believed that government positions were more appealing. Although Sauermann and Roach are unsure of the factors involved, they think that the trend may be related to a perception that government jobs allow scientists to perform "academic research" without the stresses of tenure and teaching. Lifestyle—and the work–life balance—may also be a major concern.

Whether in government or other areas, Sauermann and Roach say, the majority of chemistry students—and

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significant percentages of those in the life sciences and in physics—ultimately prefer careers outside academia.

To what extent do advisers and departments support students in pursuing academic positions, and to what degree are they supportive of careers in other sectors? "Encouragement for faculty careers and discouragement for industry careers are especially pronounced in the life sciences," write Sauermann and Roach, "where the share of graduates obtaining tenure-track faculty positions is smallest." Even in chemistry, the authors state, where industry careers are more common, students feel that research careers in academia are still most strongly recommended.

"Administrators and advisors should consider career preferences when designing graduate curricula," the *PLOS ONE* paper states, "ensuring that students have opportunities to acquire the skills and knowledge required to perform in nonacademic careers that may not only be more readily available, but are also quite attractive to students."

Nonacademic careerists: From oysters to recycling

In fields from wildlife conservation to pharmaceuticals, from science funding to recycling, biologists have been plowing new ground.

Through the eyes of shellfish. "The key is [to] never stop doing what you love," says shellfish researcher Dorothy Leonard, president of Ocean Equities, in Stevensville, Maryland. From a career start catching crabs in New Jersey's Metedeconk River at the age of 6, Leonard went on to earn degrees in international relations and political science at Syracuse University. After conducting land-use analyses at the state level, she moved to the federal level at the National Oceanic and Atmospheric Administration (NOAA), specializing in water quality assessments for shellfisheries. "I spent several years reviewing more than 4200 coastal sites in 21 states, including 12 estuaries," says Leonard. "Needless to say, I learned a lot along the way." The analysis became the first *National*

Through the eyes of shellfish: Oyster reefs in South Carolina and in many other states have been studied by nonacademic careerist Dorothy Leonard, president of OceanEquities, in Stevensville, Maryland. A career in fisheries management or aquaculture is an option for those trained in biology. Photograph: Jstuby.

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Register of Classified Shellfish-Growing Waters. From NOAA, Leonard went on to become the director of fisheries for the state of Maryland before starting Ocean Equities, an aquaculture consulting firm.

Leonard compares her career path to a canoe trip, one filled with unexpected twists and turns, quiet ripples, and thundering rapids. "You have to be willing to fully explore your options," she says, "and to be both patient and determined. The right stream might be around the next bend, one you can't see until you get there."

Conserving savanna wildlife. From 7600 miles away, on a savanna instead of in an estuary, Simon Mduma would agree. Mduma is director general of the Tanzania Wildlife Research Institute (TAWIRI), which was established in 1980 by the government of the United Republic of Tanzania. TAWIRI is charged with coordinating and supervising all wildlife research that takes place in Tanzania, including in such iconic places as the Serengeti.

Mduma received a BS in wildlife ecology and zoology and an MS in zoology at the University of Dar es Salaam, and a PhD in zoology at the University of British Columbia. Before joining TAWIRI in 2003 and working his way up to director general in 2008, Mduma was affiliated with the Frankfurt Zoological Society's Africa program and was a research associate at the University of Minnesota. "My love of wildlife began at an early age," says Mduma. "In the town in Tanzania where I grew up, one could hear hyenas and lions. We were surrounded by these and many other animals of the savanna. Today, Tanzania and other African nations are facing a wave of poaching and significant loss of habitat. Species extinctions have become a great threat."

In choosing a career, Mduma advocates learning from your first love—in his case, appreciation of the natural world. "For me, everything that followed began with that. It led to the knowledge that understanding wildlife populations is crucial to the future of all of us."

Ecologist Simon Mduma, director general of the Tanzania Wildlife Research Institute, works to conserve savanna wildlife in iconic places such as Africa's Serengeti. His efforts are instrumental in the war against the poaching of species such as elephants and rhinos, which is at a nearly all-time high. Photograph: Tanzania Wildlife Research Institute.

Medicine in a beaker. Pharmaceutical companies, such as the New Jersey–based Merck, employ chemists, physicists, and biologists "of every description, including those in fields such as entomology," says Sheo Singh. Until his retirement this fall, Singh was the senior principal scientist in charge of discovery chemistry at Merck Research Laboratories. He earned a BS in chemistry and biology and an MS in organic chemistry from Gorakhpur University and a PhD in chemistry from Avadh University (now Dr. Ram Manohar Lohia Avadh University). After postdoctoral positions at the University of Glasgow and Arizona State University (ASU), Singh joined Merck in 1989.

"Throughout my career," he says, "there have been forks in the road. Each time, looking back, things worked out exactly right. For example, I could have continued at ASU, and opportunities at NIH [the National Institutes of Health] came along as well, but I'm glad I chose Merck. It's been an exciting time in drug discovery." At the end of the day, says Singh, like all companies, Merck has been product driven, but that is not to say that the work is not academic, he believes. "It's a hybrid of academia and industry. It all turns on making new discoveries." Many such breakthroughs have saved millions of lives, such as a drug that treats river blindness, a tropical disease that afflicts people in Africa and Latin America. Merck provides the drug through its Merck Helps program.

The secret to success in a nonacademic career is in how one uses his or her expertise, Singh believes. "And it's in pursuing what's in your heart."

Funding the microbes. Understanding the role of microbes is at the center of marine microbiologist Ajit Subramaniam's path. Subramaniam is the program director for the Gordon and Betty Moore Foundation's Marine Microbiology Initiative. "The Moore Foundation established the Marine Microbiology Initiative to build a global understanding of the role of

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Discovering new therapeutic uses for existing molecules is the goal of a National Institutes of Health (NIH) pilot program to develop partnerships between pharmaceutical companies and the biomedical research community. Photograph: NIH.

Microbiologist Ajit Subramaniam (center), program director for the Marine Microbiology Initiative at the Gordon and Betty Moore Foundation, has studied microbial life in rivers such as the Amazon and in the open seas. Now, he makes funding decisions to help build a global understanding of the tiny organisms that occupy the world's oceans. Photograph: Moore Foundation.

the tiny organisms—microbes—that occupy our oceans," says Subramaniam. "The oxygen we breathe is produced by these diverse and abundant microbes, yet we know very little about them."

Subramaniam came to Moore from the Lamont–Doherty Earth Observatory at Columbia University. He earned a BS in physics at the American College in Madurai, India; an MS in marine environmental science at the State University of New York at Stony Brook; and a PhD in coastal oceanography, also at Stony Brook. "It's phenomenal to learn where gaps are in the science, then [to] be able to help fill them," he says. "At Moore, you can think out of the box and take advantage of opportunities as they come along."

A career outside academia, Subramaniam says, is just that: thinking outside the box. "It's a certain amount of serendipity. But more than anything, it's making your own luck by hearing the knock of opportunity and responding. And by doing the knocking, too."

Environmental pollution: The last word may be trash. What happens to all the waste material that we're producing? If biologist Howard Levenson of the California Department of Resources Recycling and Recovery, or CalRecycle, has anything to say about it, it gets recycled.

Levenson is the deputy director of CalRecycle's Materials Management and Local Assistance Division. He earned BS and MS degrees in natural resources management from Humboldt State University and a PhD in biology from the University of Kansas, then joined the staff of the former US Congressional Office of Technology Assessment (OTA) in Washington, DC. There, he served as a senior associate in the Environment Program, conducting reviews of issues such as marine pollution, groundwater pollution, and municipal and industrial solid waste management. Levenson is the primary author of the OTA report *Facing America's Trash: What's Next for Municipal Solid Waste?*

"After OTA, it was a great next step to 'go west' to join the California Integrated Waste Management Board," says Levenson. After a decade there, he joined CalRecycle. His responsibilities include determining how best to dispose of everything from plastics and packaging to pharmaceuticals

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What happens to the waste material we're producing? Finding new waste-treatment methods is a goal of Howard Levenson, deputy director of the Materials Management and Local Assistance Division of the California Department of Resources Recycling and Recovery, or CalRecycle. A biologist by training, Levenson specializes in environmental pollution analysis. Photograph: CalRecycle.

and paint, and the list goes on. "If it's used in California," he says, "we have to find ways of disposing of it sustainably."

Levenson's group has developed innovative waste-management initiatives with industry, such as the Wal-Mart Packaging Scorecard and Starbucks' Cup Working Group. "The next time you order a Starbucks coffee," says Levenson, "think about where your cup goes after you throw it away.

From coast to coast, our trash litters the landscape, but it doesn't stop at the shoreline. On submersible dives, scientists have spotted human-made objects in the deep: crushed soda cans, ripped plastic containers, tangled fishing lines. "We need to find new ways of addressing pollution," says Levenson, from the micro- to the macroscale, and in every environment on Earth. "That leaves openings for as many answers—and careers developing them—as you can imagine."

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