REAL LIFE III

The Greening of 'Green Science' Means New Jobs

Doubling in a decade, the ranks of environmental scientists are supplied from all disciplines and are welcomed in industry and academia.

The pursuit of scientific knowledge has evolved much like the universe did after the Big Bang: Disciplines and subdisciplines blast apart regularly, propelled after their esoteric bits of information. But while cosmologists are still hunting for the critical mass that's going to reunite the galaxies, a different bunch of scientists thinks that it has found its "Great Attractor"—a force that will if not unite, at least begin to build bridges to connect scientific disciplines. And that force is the combined weight of the environmental perils facing the Earth.

Enter environmental science. Their ranks having roughly doubled in the past decade, environmental scientists, who make their livings by diagnosing and treating a sickly Earth, hail from nearly every scientific discipline—from biology to chemistry to physics. These people see themselves as the jacks-of-all-trades of the scientific world and are assembling in entirely new departments in some U.S. universities. In fact, a few universities are breaking down barriers between departments and scrambling to form multidisciplinary units geared toward solving global environmental problems. Nowadays there's funding in the pursuit—an estimated $2.4 billion that the government spends annually on its own environmental research as well as in academia and industry, according to the Committee for the National Institutes for the Environment.

Meanwhile, industry is opening its coffers to those wanting to do environmental work. Fortune 500 companies are beginning to hire environmental specialists to cope with a cascade of regulations. And some companies, including General Electric, have recently gone so far as to form their own environmental laboratories. Established environmental consulting and cleanup firms also say they're hiring scientists.

Gazing into his crystal ball, Franklin Harris, deputy assistant director of the biological sciences directorate at the National Science Foundation (NSF), which funds "environmental biology" to the tune of roughly $70 million a year, says: "Clearly, some of the hot fields will be in the areas of green technologies." What will life be like for "green" scientists?

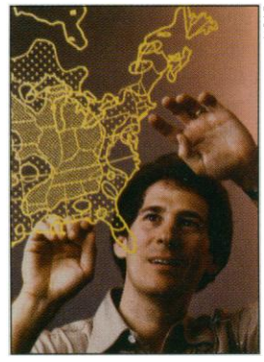
Universities: Still behind the times

In universities, change comes slowly. Compared with companies, they are the johnny-come-latelies of environmental science. "Academia has had a hard time doing interdisciplinary science," says Rutgers biologist Judith Weis. "The walls between departments can be quite tall." Despite this handicap, academia increased its R&D spending on environmental sciences from $453 million in 1979 to $983 million in 1989 (adjusted for inflation), according to the NSF.

At a time when many universities are downsizing, some are bucking the trend and expanding their environmental programs. On the undergraduate level, as an extreme example, the number of students enrolled in the environmental engineering major at Michigan Technological University has grown from 20 to 300 in the past 6 years—making it the second largest environmental engineering program in the nation after the one at Montana College of Mineral Science and Technology. "We haven't even done any intensive recruiting," says Neil Hutzler, director of Michigan Tech's environmental engineering center. "It's kind of like in 'Field of Dreams': You build an interesting program and they will come."

Meanwhile, Duke University recently created what it calls the "nation's first" School of the Environment when it wedded its School of Forestry and Environmental Sciences with the Duke Marine Laboratory. Says Norman Christensen Jr., the school's dean: "The goal is not to turn chemists into biologists, but to get chemists working with biologists." Christensen's first faculty appointment, physical oceanographer Susan Lozier, says she's eager to start collaborating with people outside her field. Lozier compares her field to atmospheric physics—instead of studying the physics of air, she studies the physics of water. And her first collaborations may be with an atmospheric physicist. "Global warming is a typical problem in environmental science," she says. "We're trying to couple the ocean with the atmosphere. Traditionally these two sciences have been apart." But Lozier, as an environmental scientist with a tenure-track position, appears to be a rarity in academia. Harvard evolutionary biologist Edward O. Wilson says that at least in the fields of ecology, animal behavior, systematics, and biodiversity, "there are relatively few mainline job opportunities in academia." Yet Wilson says, "I foresee more positions opening up in these areas if the tide of environmental concern continues to rise."

At present, though, some environmental scientists charge that academia is freezing out young environmental scientists, and they contend that it will take more than a healthy economy to change the way they are perceived. Take climatologist Steven Schneider, head of the interdisciplinary climate systems section at the National Center for Atmospheric Research in Boulder, Colorado, who will join the Stanford faculty in the fall to help nurture the university's fledgling earth sciences program. One of Schneider's main reasons for making his mid-career move, he says, is that he wants to change the way universities recruit environmental scientists. He hopes to help wean institutions off the likes of himself—well-established scientists who have had to labor in a discipline for years before getting a chance to do multidisciplinary work—and get them to start seeking out environmental scientists at the beginning of their careers. "It's not a big risk hiring me. I want to be able to hire a postdoc who's promising as a tenure-track faculty," he says. "I want them to be just as bright and just as tough" as young scientists who plan careers in specific disciplines, "but selected according to different criteria." The kind of young scientist that Schneider's thinking of is one who's trained in a specific discipline, but who's already thinking about multidisciplinary problems and is will-



NCAR

Setting an example. Steven Schneider.

Polluted Land of Opportunity: Bioremediation

Perhaps one of the hottest fields in environmental sciences is bioremediation, the use of biological materials such as microbes to clean up toxic waste sites. Nearly everyone contacted by *Science* fingered bioremediation as a burgeoning subdiscipline. "We're unable to satisfy the demand for well-trained, competent people," says Cornell University biologist Martin Alexander, one of the deans of the pursuit. The field has really taken off in the past 5 years, he says, as scientists develop microbes, both naturally occurring and bioengineered versions, that can eat everything from oil to PCBs.

Industry is especially hot for bioremediation as an alternative to incineration and other methods for disposing of toxic substances. General Electric, for instance, is exploring ways of stimulating naturally occurring microbes to digest PCBs, says chemist Daniel A. Abramowicz, manager of GE's bioremediation program. GE recently struck up a joint project on PCB bioremediation with Oak Ridge National Laboratory and is negotiating terms of a project with the Environmental Protection Agency (EPA) research laboratory in Gulf Breeze, Florida, he says.

VU/PAUL BIERMAN

Field of nightmares. Washington state hazardous waste site is a good candidate for bioremediation.

Bioremediation researchers are not thrilled with the level of government support for their field, however. "You need an appreciable amount of funding to actually move the science forward, and that funding's still not there," contends microbiologist Ananda Chakrabarty, a bioremediation researcher at the University of Illinois Medical Center. As an example, Chakrabarty points to work that he's doing with the U.S. Army's Chemical Research, Development, and Engineering Center in Aberdeen, Maryland. "We do have bugs that completely detoxify mustard," he says, referring to a component of the U.S. chemical weapon stockpile that the Defense Department plans to destroy over the next several years. "But we don't have enough encouragement to go ahead and build [a scaleup] plant," he says, because the Army is pouring most of its money into controversial incineration facilities to destroy the weapons. "After young researchers come to work in [bioremediation], that's when they see the funding hurdle," he says.

Nevertheless, Cornell's Alexander remains confident that the field will continue to grow and attract outstanding young scientists. "As long as the country is committed to cleaning up [hazardous waste] sites," he says, "bioremediation will remain a hot field."

–R.S.

ing to forgo publishing esoteric papers in prestigious journals. "Right now it's tough to get such people through the system," he says.

Truly multidisciplinary research is such a rare thing that a lot of universities don't know how to go about it, says biologist Henry Howe of the University of Illinois in Chicago. He offers a general warning to university officials who are thinking about starting up environmental science programs: "The last thing we need is graduate programs that give their students little specialized training."

Small enterprises: Raking in the green

As Schneider points out, young environmental researchers today tend to see greener pastures off campus. "I always envisioned going through graduate school and getting a tenure-track position," says Sean Chamberlin, a 36-year-old marine biologist at Ecomarine, a New York City-based environmental service company. Instead, Chamberlin recalls spending nearly 2 "discouraging" years searching for an academic position before, out of "sheer desperation," he wound up taking a job in industry. Now he's not sorry because, as it turned out, "I've been able to keep my hands in science." Two years ago, Chamberlin created his own position as a scientific point-man for Ecomarine, which builds and operates workboats equipped with cleanup gear for oil spills and marine fires. But unlike other, similar firms, Chamberlin says, Ecomarine's boats are also used as research platforms for environmental surveys, such as a "weather map" of water quality.

Chamberlin is just one of thousands of young environmental scientists who have found happiness outside of academia. Take, for example, Peter Gleick, a 1986 graduate of one of the premier multidisciplinary programs in the country, Berkeley's Energy and Resources Group. Within a year after getting his doctorate, Gleick and three colleagues launched a nonprofit think tank, the Pacific Institute for Studies in Development, Environment, and Security. The Oakland-based institute does research and policy analysis in sustainable development, international security, and the global environment, and recently completed a case study of the relationships between environmental degradation and development in the Philippines. Says Gleick: "Looking back, sometimes I'm amazed that we [started the institute]" rather than pursuing the normal postdoctoral route into academia or industry. He gives the Berkeley program credit for getting its students to "deal with the big environmental issues."

According to Schneider, who serves on the institute's board of directors, Gleick is precisely the type of young scientist that academia ought to be courting. But until universities more widely appreciate the value of multidisciplinary thinking, he contends, it looks as though the go-getters are going to find their skills better appreciated elsewhere.

Environmental consulting jobs, for example, are being created hand over fist in response to the torrent of new environmental regulations that have come into being in recent years. "It's a very broad, if not incredibly deep market," says Dan Lashof, a classmate of Gleick's who is now a global warming expert at the Natural Resources Defense Council in Washington, D.C. Several newly formed or expanding environmental consulting firms contacted by *Science* say that they're looking to hire scientists. "We don't want generalists—we want people with specific skills who can work on a multidisciplinary team,"

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Industry in the '90s

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matter what your Ph.D. is if you're an engineer." Snediker adds that as academic scientists are trained, "we learn how to do research kind of in a vacuum. We don't know how to plan, how to manage a project, and we have no idea whatever of the concept of team." Scientists thinking about industry work should be sure they have some hands-on experience with their area of expertise, adds Isaac Dvoretsky, a recruiter for Shell Development Corp. in Houston. "Some people get their whole Ph.D. on nothing but a computer."

And there's more to the challege in industry. "Even at the very high tech end of things, people who stay in the lab without understanding the business side of things are just gone," says Paul Villella of Source EDP, a computer and communications recruiting firm in Washington, D.C. At Hewlett-Packard, for example, physicist Leonard Cutler says the company has set up a cooperative effort in high temperature superconductivity with DuPont and Los Alamos National Laboratory, which involves holding meetings between scientists, managers, and lawyers to discuss issues such as intellectual property rights.

New knowledge is flooding in at such a pace that, as Westwood puts it, "it's not 40-year careers any more. It's 7-year careers." Now, says IBM's John Armstrong, "we hire people as people rather than for specific jobs. No one does the job for which they were hired for very long." Industry wants Ph.D.s not as much for their specialized knowledge as for the fact that the degree means you have successfully done some creative high-level problem-solving, says IBM's Jim Comfort. Indeed, at IBM the question now asked about job applicants is: "Is this a person that one would hire independent of any known need?"

Working in industry is now more fast-paced, highly structured, and bottom-line-oriented than ever. Despite (or maybe because of) the increased pressure for results, virtually everyone *Science* talked to said that their jobs are a lot more exciting than they used to be. There are inevitably those researchers who feel constrained by having to follow company priorities or who resent not being able to work alone. But complainers are hard to find. In industry, being a happy camper is part of your job.

–Constance Holden

Plus Ça Change...

Engineer Donald Frey of Northwestern University says a young academic scientist considering jumping to industry might well harken to words uttered in 1966 by Nobel laureate chemist Peter Debye: "You should not ask for people who have already done in university what they're going to apply in industry—this is the most nonsensical way of doing it. You should ask for people who have a feel for how to handle a new problem. The specific nature of the problem is not important."

'Green Science'

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says Elizabeth L. Anderson, president of Clement International Corporation, an environmental consulting firm based in Fairfax, Virginia that employs 200 people, most of whom are scientists. "I don't see any shortage of jobs in this area, thanks to the momentum of all the environmental statutes and international agreements," says Anderson—not to mention the publicity over events such as the U.N.'s June "Earth Summit" in Rio.

Big companies redefine their roles

Big industry also has jumped on the green bandwagon. Firms such as DuPont, General Electric, and Monsanto employ several dozen environmental scientists. "We're not in the environmental business, so to speak," says Samuel A. Shulof, head of GE's new environmental research center in Schenectady, New York. Instead, he says, "we look to solve GE's problems" such as "reducing the cost of compliance" with environmental regulations and cleaning up PCBs that GE's transformer manufacturing plants released into New York's Hudson River over the years. What started as a handful of regulatory experts two years ago has mushroomed into a 60-scientist laboratory filled with experts in a variety of disciplines, from polymer chemists to microbiologists. Schulof says it's hard to predict who the center might hire in the future—"the whole field is moving, evolving."

Monsanto's environmental sciences center has a mission similar to GE's, says Allan Ford, the center's director. "We're looking at new technology for reducing our environmental costs and reducing our environmental impact." Although Monsanto has "Superfund sites like any other company," one of the chief goals of his center is to identify environmental problems before they happen, says Ford. So he has put together a team of 40 scientists, with backgrounds ranging from chemical engineering to agronomy, to investigate three basic areas of research: analytical chemistry, ecological risk assessment, and cleanup technologies. "We like to take people who do different kinds of science and put them together on the same problems," he says.

Government—slim pickings

One of the few environmental organizations in the country that reports bad news from the job front is the largest of them all—the Environmental Protection Agency. From January through July of 1992, the agency had hired 294 permanent and temporary scientists and engineers. This was well off the pace of 1991, when it hired 832 scientists, and 1990, when it hired 913. "And it isn't looking very good over the long term," says an agency spokeswoman. But some policy experts predict that the job market for environmental scientists at the EPA and elsewhere might get a boost with a Democratic victory in November, given that the vice-presidential candidate, Senator Al Gore (D–TN) is a strong advocate of environmental protection. Nevertheless, with legislation to establish a National Institutes for the Environment possibly heading for congressional action in 1993, and such issues as global warming, biodiversity, and the ozone hole firmly embedded in the public consciousness, it's likely that environmental science will remain a hot topic regardless of who inhabits the White House. "These problems aren't going to disappear overnight," Chamberlin says. Neither, hopes Weis, will the bridges that are beginning to form between the scientific disciplines.

–Richard Stone