

Who Reaps the Benefits of Biodiversity?

Call it bioprospecting, chemical prospecting, gene-hunting, or natural product research—the search for and collection of wild plants and animal products of potential value to medicine, agriculture, cosmetics, and other uses has been going on for hundreds, if not thousands, of years. Today's bioprospectors are gathering and studying extracts of everything from spider venoms to soil microbes to algae.

Bioprospecting had been shaping global cultures for centuries before a world trade organization came into being. A quick tour of almost any garden, farm field, or medicine cabinet should serve as a reminder that the global economy has in part been built on products of bioprospecting. According to Joshua Rosenthal, deputy director of the Division of International Training and Research at the NIH Fogarty International Center, more than 50% of the most prescribed medicines in the United States contain compounds derived from

natural products. And an even larger percentage of the world's people rely on natural products for their primary medicinal needs. Until the past decade, however, these natural products were collected without compensating the communities and governments of the source countries where the products were found.

For example, as recently as the 1980s, the plant rosy periwinkle (*Catharanthus roseus*) gave rise to two important drugs, vinblastine and vincristine, which are used to treat Hodgkin's disease and childhood leukemia, respectively. Together, the two drugs, manufactured primarily by Eli Lilly, net \$100 million dollars annually, yet the source countries have never received a penny in royalties or other compensation.

However, the rules of collecting have changed. For the first time in history,

bioprospectors are expected to compensate source countries, thanks to the Convention on Biological Diversity (CBD), signed at the 1992 United Nations Conference on Environment and Development in Brazil. The CBD was drafted in response to concerns by international organizations and governments about the loss of global biodiversity and the need for equitable sharing of benefits from bioprospecting. This treaty set new standards that more than 155 member countries are expected to follow when engaging in bioprospecting.

A Blueprint for Bioprospecting

Throughout history most countries considered biological resources to be the common heritage of humankind, says Richard S. Cahoon, vice president of the Cornell Research Foundation and





PhotoDisc, Christopher G. Reuther/EHP



Flower power. Rosy periwinkle has given rise to drugs used to treat childhood leukemia and Hodgkin's disease.

associate director of patents and technology marketing at Cornell University in Ithaca, New York. "This meant that there was no law or moral obligation requiring a company that collected biological material from another country to pay for access to that material," he says. "What has changed is that we've begun to recognize property rights in all biota. We also recognize how bioprospecting can be used to encourage economic development and conservation in Third World countries."

In effect, the CBD serves as a blueprint to help countries and companies draft equitable access and benefit-sharing agreements. It also offers a means for making conservation of biodiversity economically beneficial. The convention has three goals: the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of the benefits from the use of genetic resources. The CBD recognizes the interdependence of countries controlling genetic resources and those creating technologies that make use of those resources. One of the key articles (Article 15) of the convention states, "Recognizing the sovereign rights of States over their natural resources, the authority to determine genetic resources rests with the national governments and is subject to national legislation." Thus, individual countries, including signatories to the CBD, may establish their own guidelines for setting up equitable benefit-sharing agreements for conservation and rural development. Countries can establish legislation regulating access to genetic resources and, if they wish, require

payment for that access. Compensation can be made in the form of money, royalties, or support for conservation and local economic development.

The CBD also requires that any company or country collecting natural products obtain the prior informed consent of the source country. Countries may also exempt any species from patenting or intellectual property rights.

Models of Benefit Sharing

In the 10 years since the creation of the CBD, a number of groups have explored innovative ways to apply the convention's rules. Drug companies, universities, conservation groups, government leaders, and indigenous communities have formed unlikely consortia trying to turn bioprospecting into a panoply of opportunities.

One of the first bioprospecting groups that attempted to implement the goals and guidelines of the CBD was a collaboration between the pharmaceutical firm Merck & Company and Costa Rica's Instituto Nacional de Biodiversidad (INBio), a private, nonprofit conservation and research group. INBio agreed to provide Merck with a limited number of plants, fungi, and other samples from Costa Rica's protected areas for scientific and commercial evaluation. (INBio was given special permission by the government to follow relatively noninvasive collecting procedures that did not disturb or destroy protected habitat.) In return, Merck would pay INBio \$1 million every two years, in addition to approximately \$135,000 in equipment and training in the first two years of the deal. Merck also agreed to pay royalties to INBio for any commercial products that might result from the arrangement.

INBio pledged to give 50% of the royalties and 10% of its total budget for bioprospecting projects to the Costa Rican Ministry of Environment and Energy to help finance a national conservation program.

The INBio program is presented as a model program in *Biodiversity Prospecting: Using Genetic Resources for Sustainable Development*, a 1993 publication of the World Resources Institute. The book credits not only INBio but also the Costa Rican government for its efforts to create and enforce the necessary legislation that allowed for benefit sharing. One of the lessons learned in the past decade by bioprospecting groups, say the book's authors, is that the willingness and ability of a host country to implement bioprospecting agreements is a central factor in the success or failure of any such agreement.

Another organization that has explored a number of approaches to improve the value of benefit sharing is the International Cooperative Biodiversity Groups (ICBG) Program. This experimental effort, funded by the U.S. government in partnership with industry, seeks to integrate research in natural products drug discovery with efforts to build scientific infrastructure and economic capacity to enable conservation of biological diversity in developing countries.

The ICBG Program has three goals. The first is to improve human health through the discovery of new pharmaceutical, agricultural, and veterinary agents to treat diseases of importance in both developed and developing countries. The second is to promote scientific and economic activity in



Spider find.

A compound in the venom of black widow spiders found in the Negev Desert in Israel may hold promise for treating strokes.

Top to bottom: © 2000 Steven Foster; Arnold Greenwell/EHP; courtesy of N. C. Museum of Natural Sciences

less-developed countries by sharing the benefits of drug discovery and conservation research processes and products. And the third is to conserve biological diversity through the understanding and valuation of diverse biologic organisms and the development of local capacity to manage these resources.

ICBG projects have been conducted in 12 developing countries in Latin America, Africa, and Asia. Some programs have included extensive assistance in training and infrastructure construction for such countries to develop their own pharmaceutical industries. Others have developed extensive incentive mechanisms for conservation by governments and indigenous groups.

To date, ICBG teams have collected and tested more than 40,000 plant samples. The teams have had many “hits” (possible leads to new drugs), but it is still too soon to know if any of these will lead to the actual development of any new drugs. All but one of the ICBG teams uses ethnobotanical information from indigenous groups to identify potential medicinal substances. (However, most bioprospecting does not involve getting information from shamans.)

Just as important, the ICBG Program has succeeded in creating several models for bioprospecting agreements that encourage local economic development and conservation within the regions where the bioprospecting is conducted. For example, in Nigeria, ICBG teams are screening traditional medicines and other natural products for cures for malaria and other diseases that affect developing nations—diseases that most western pharmaceutical industries show little interest in. In Suriname, the ICBG Program worked in partnership with the Washington, DC-based Conservation International to set up an elaborate conservation trust fund called the Forest People’s Fund. Conservation International also acts as an intermediary, helping scientists explore the traditional medicines of two indigenous groups.

When Is Bioprospecting Biopiracy?

When Athula Attygalle, director of the Mass Spectrometry Facility at Cornell, returned to his home country of Sri Lanka a few years ago, he was greeted with photos of himself on the front page of the national newspaper captioned “herbal sucker” and “is this bioprospecting research or racket?” The chemist couldn’t understand his compatriots’ outrage. “I had come home to arrange a formal bioprospecting program with the government, similar to what InBio did in Costa Rica,” he says. Attygalle points out that it would have been much easier for someone to actually steal samples—to take a few handfuls of samples back in their pockets. “Instead,” he says, “I was doing it



It had to be yew. The drug Taxol, made from the bark of the Pacific yew, helps fight breast and ovarian cancers.

to help build the economy and biodiversity conservation for my people.”

As promising as the CBD and benefit-sharing agreements sound, bioprospecting has become a hotbed of controversy over the past decade, drawing attention from the media and opposition from antiglobalization groups. “Distrust is a problem,” says Cahoon. “Some people think that bioprospecting agreements are inherently unfair and outpriced for indigenous peoples from the outset. They assume that the cards are stacked against them.” In addition, although the CBD is a legal document, as Rosenthal explains, “It lacks bite. There is no way to enforce it.”

Bioprospecting is often painted by the Action Group on Erosion, Technology, and Concentration (ETC Group), a Winnipeg, Manitoba-based conservation group, as a north–south conflict, with people in the technologically richer but genetically poorer northern nations taking from the genetically

richer but technologically poorer southern nations. In her 1997 book *Biopiracy: The Plunder of Nature and Knowledge*, Vandana Shiva, founder/director of the Research Foundation for Science Technology and Natural Resource Policy, a network of agricultural and development researchers, speaks of the CBD as “an initiative of the North to globalize the control, management, and biological diversity of resources which lie primarily in the Third World.”

Even the terms of bioprospecting are a source of disagreement. The appropriation of biological resources and knowledge through patents and intellectual property rights without fair compensation is considered biopiracy, and the rosy periwinkle discoveries are frequently cited by the media and in non-governmental organization literature as examples. James S. Miller, curator and head of the Applied Research Department at the Missouri Botanical Gardens in St. Louis, contends, however, that it’s unfair to label the



One bean, two bean, yellow bean . . . Little yellow beans from Mexico are the source of an international biodiversity ownership debate.

rosy periwinkle discoveries or any other bioprospecting done before the CBD was signed as biopiracy. It was, he says, just the normal way of doing things. "There wasn't anything malicious or malevolent about it," says Miller.

One of the most publicized recent attacks on bioprospecting was made against an ICBG team that was collecting and recording indigenous medicinal plant knowledge of Mayan healers in Chiapas, Mexico. The team had a bioprospecting agreement with the local Mayan healers, but not with healer groups outside the immediate area. A consortium of 11 other healer groups in the region (with the help of the ETC Group) opposed the project on the grounds that they did not want commercial exploitation of their traditional knowledge by outsiders. The taint of heavily publicized biopiracy accusations forced the ICBG group leader, David Berliner, to discontinue the group's program in Chiapas, and the issue of whether traditional knowledge qualifies as intellectual property rights was not addressed. Such rights continue to be a major obstacle to resolving bioprospecting conflicts.

Who Owns Biodiversity?

When the CBD was signed in June of 1992 by 153 nations, the United States was the only attending nation that refused to sign the agreement. One of the major reasons

cited was concern over inadequate protection of intellectual property rights for U.S. biotechnology firms. Some U.S. officials felt that the financial mechanism represented an open-ended commitment with insufficient oversight and control by the companies or countries funding the bioprospecting. They further felt that the benefit-sharing provisions were incompatible with existing international regimes for intellectual scientific research institute property rights, and that the requirement to regulate the biotechnology industry would needlessly stifle innovation. President Clinton signed the CBD in 1999, but the U.S. Senate has yet to ratify the agreement. Many feel that the lack of U.S. participation in the CBD sends a poor message to other nations about the intent of the United States to share profits.

At the heart of the controversy is the global debate over patents and other intellectual property rights. Such rights are legal devices designed to confer ownership of inventions and also determine the nature of access to inventions and ideas. Drug and agricultural companies depend on patents and other intellectual property rights to protect their investment in product development from natural products or otherwise. "Yet many people are fundamentally opposed to intellectual property rights," says Cahoon. "The almost intuitive thought is that [such a

right] is a bad idea because it allows us to privatize something that should be part of the public good/public domain," he says. "We may think that all knowledge should be in the public domain."

Some of the most fervent objections to bioprospecting come from activist groups that equate bioprospecting and intellectual property rights with biopiracy. Says Hope Shand, research director of the ETC Group, "Pharmaceutical corporations are winning exclusive monopoly patents on someone else's knowledge and resources. Indigenous peoples and farming communities have been developing these plants and other biological resources for generations."

Many indigenous groups fear that they will lose access to their own plants and traditional medicines if drug companies are allowed to take out patents. Two recent cases test this very concern. In 1996, a U.S. citizen obtained a patent on a little yellow bean that Mexicans have been eating for centuries. According to the patent, Larry Proctor brought a bag of mixed-color dry beans from Mexico in 1994, picked out the yellow beans, and planted them. He then claimed to have invented a distinctively colored yellow seed. The International Center for Tropical Agriculture and the Mexican government are challenging the U.S. patent on the grounds that there is nothing new about the bean, so the patent should never have been granted.

The next year, a Texas-based company won a controversial patent on basmati rice and grain lines. The patent applies to 22 basmati varieties from Pakistan and India. Basmati rice has been grown for centuries in what was the Greater Punjab region, now divided between India and Pakistan. According to Shand, farmers from the area are concerned that they will have to pay royalties to the patent holder in order to grow and sell their own rice. However, India is not contesting the patent because it is only for select varieties of basmati rice and does not affect the country's overseas sales of basmati.

Educating Source Countries in Bioprospecting

Educating both the governments and citizens of source countries about bioprospecting can help them get a more realistic expectation of the benefits of bioprospecting so that they can make informed decisions on whether to allow it or not. "The danger in focusing on the big collaborations is that it raises the expectation of the host countries," says John Kilama, president of the Global BioDiversity Institute, a Wilmington, Delaware-based group that teaches people in developing nations how to benefit from bioprospecting programs. "A lot of people expect that their countries

could get bioprospecting agreements with big multimillion-dollar drug companies. The truth is that most collaborations are small and discoveries are infrequent. . . . The last time a drug derived from natural products reached the market was in the nineteen-eighties, well before the CBD.”

Kilama, a former DuPont scientist, trains leaders from developing countries in using bioprospecting to support their local economies and setting up conservation programs. The Global BioDiversity Institute has held multiple month-long workshops across Africa in the last two years to teach lawyers, scientists, economists, and policy makers about the business of biodiversity, benefit-sharing agreements and contracts, intellectual property rights, and biotechnology.

David Kingston, a professor of bioorganic and natural products chemistry at Virginia Polytechnic Institute and State University in Blacksburg, has been teaching Surinamese scientists how to extract chemicals from plants. He sees bioprospecting as a win-win situation for bioprospectors, public health, and source countries when treaties are equitable. “The host country has nothing to lose,” he says. “If we find something, the host country gets royalties. If we don’t find anything, they still have all of the other resources we’ve invested in their people, such as the conservation trust fund, the training we gave their people, and more than a million dollars’ worth of other resources. This is all in exchange for allowing us to collect plant samples. The United States wins because we’ve gained new knowledge about plant compounds. If we get a new drug out of it, we win big.” But determining what is equitable seems to be the biggest problem plaguing the issue of bioprospecting.

“If an indigenous group understands what its rights are and how to perfect and assert them, it can choose to negotiate benefits or refuse access,” says Cahoon. However, most indigenous groups depend on having assistance from the government or a concerned intermediary group to help them understand and assert their rights. “No one can be expected to sit down at the negotiating table with leaders from a multinational organization without support. Intermediaries are especially important where the government is corrupt,” says Cahoon. “Rights mean little in practice unless they are clearly defined and strongly defended by local and national governments.”

Still, indigenous information often does not lend itself to global law. And as Cahoon puts it, the current intellectual property right laws “were designed for individuals inventing gadgets in their garages, not for the wide variety of groups that are involved in bioprospecting property rights.” The Food and Agriculture Organization of the United Nations and the Consultative Group on

International Agricultural Research are two groups working to develop new standards and mechanisms to guide future international law and practices in the area of bioprospecting.

Into the Next Decade

By one measure at least, the CBD has seen success in its first decade: most nations now expect bioprospectors to enter into benefit-sharing agreements before delving into a country’s natural products. The question arises, though, whether bioprospecting agreements, which can be both time-consuming and costly, will have the effect of discouraging bioprospecting and the sometimes-resultant drug discovery.

“Bioprospecting is not solely driven by interest in money,” says Kingston. The hope that cures to cancer, AIDS, and other diseases are hidden in some endangered habitat still fuels enthusiasm for bioprospecting, he says. Kingston believes we can’t afford to stop looking at natural products. “No chemist could ever dream up the chemistry of Taxol,” he says, referring to the drug for fighting breast and other cancers that is derived from the bark of the Pacific yew tree (*Taxus brevifolia*).

Many people also support bioprospecting as a “wonderful device to stimulate both internal economic development and conservation at the same time,” says Lisa Famolare, senior director for the Guianas at Conservation International. Projects such as the ICBG Program are just beginning to see the fruits of the first 10 years of conservation and economic development efforts initiated since the CBD came into effect.

But the costs of bad publicity associated with accusations of biopiracy can be high. Some scientists fear that many pharmaceutical and agricultural companies will abandon bioprospecting in favor of cheaper and less controversial approaches such as combinational chemistry, which can produce millions of modestly priced compounds. Combinational chemistry may also be more attractive because companies can patent the by-products without running the risk of being labeled “biopirates.”

Against the grain? Patents on basmati rice, which has been grown in India for centuries, have farmers worrying whether they can plant.

However, says Jerrold Meinwald, a professor of chemistry at Cornell, “The chemistry of natural products may give you access to a much more diverse universe of complex compounds than compounds created through combinational chemistry. Nature has had more than three billion years to create its library of chemicals.” In Meinwald’s experience, companies that have participated in bioprospecting consortia seem to be sincerely committed to the long-term goals of conservation and helping local economies. But money is still the bottom line.

The experience of Merck & Company offers plenty of evidence that bioprospecting can pay off, at least for the companies that develop drugs. Last year, for example, sales for just one of Merck’s drugs derived from nature—the cholesterol-lowering treatment Zocor, derived synthetically from a fermentation product of *Aspergillus terreus*—totaled \$5.28 billion. The hope of the drafters of the CBD is that, in the future, bioprospecting will also pay off for the source countries of natural products, the people who may one day benefit from as-yet undeveloped drugs, and the Earth itself, as agreements are put into place to protect its fragile and treasured resources.

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