Like night and day. Fencing protects Addo land from overgrazing.

of the fund's first decade of operation. The panel, led by sustainable development specialist Leif Christoffersen of the World Conservation Union, concluded in January that the fund has achieved "significant results" in addressing global problems. The review drew attention to GEF-funded projects that have slashed emissions of ozone-depleting compounds and supported energy-efficient technologies. For example, a project on converting wood chips and sugar-cane waste into fuel in Brazil squeezed five times more energy out of the equivalent amount of biomass used previously; the technology is now being replicated in the United Kingdom.

GEF has moved more slowly on species conservation, but Peter Raven, director of the Missouri Botanical Garden in St. Louis, says the fund has done "invaluable work" in this area, such as funding the training of young taxonomists in SABONET, a network of botanical gardens in southern Africa. It is also contributing one-third of the $20 million budget of the Millennium Ecosystem Assessment. Under the 4-year effort, some 1500 scientists are gathering data on the world's ecosystems, assessing nature's ability to provide essential "services" such as food and clean water and projecting trends such as deforestation and species loss (*Science*, 8 September 2000, p. 1676). The analysis of this data is intended to help governments better steward their natural resources.

But GEF received poor marks for its efforts to reach out to the scientific community. Presenting the review's findings last month in The Hague, James Seyani, a Malawian botanist at the Commonwealth Institute in London, argued that "projects should be submitted to critical scientific review, which has not been the case in the past." Christoffersen's panel characterized the current process, in which one or more scientists drawn from a 400-strong roster reviews each proposal, as an "obligatory but sometimes meaningless checkoff." One reviewer told *Science* that implementing agencies are sometimes looking for a "rubber stamp" before a project goes to the council for approval. And experts in developing nations are rarely consulted, because the U.N. agencies prefer faster replies from Western experts with better communication links.

At the council meeting in Washington, outgoing STAP chair Madhav Gadgil, an ecologist at the Indian Institute of Science in Bangalore, recommended that the fund greatly expand its scientific links in the developing world and require agencies to tap local scientific networks during a project's design. His call has set in motion a long-term reassessment of scientific input into GEF projects. But given the fund's cash crunch, the council only endorsed steps that would cost a negligible amount to implement—such as consulting local experts more often.

Frantic negotiations are now under way to arrive at GEF's new budget, with some Western European nations and Japan pressing for a big boost. If the funds come through, new STAP member Peter Schei of Norway's Directorate for Nature Management says he hopes to see broader scientific involvement in GEF projects, along the lines of the Intergovernmental Panel on Climate Change.

"GEF was started as an experiment, but the experiment has grown up," says Hammond. Now, he says, is the time to take GEF to another level—by strengthening its independence and making input from scientific communities around the globe a priority.

–ADAM BOSTANCI

CREDITS: (TOP TO BOTTOM) G. KERLEY; COURTESY OF G. STROBEL

PROFILE GARY STROBEL

Biologist Gets Under the Skin of Plants—And Peers

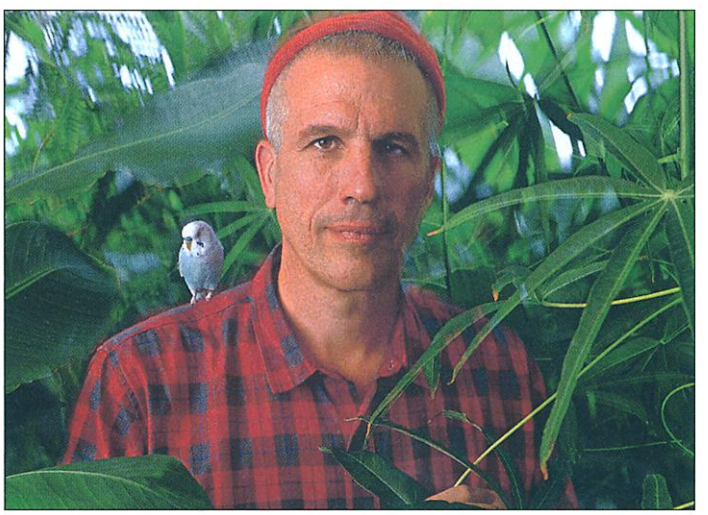
By doing things his own way, Gary Strobel has made himself a bioprospector par excellence, finding useful chemicals in the most unusual places

Gary Strobel was returning from a bush walk in Australia's Northern Territory one afternoon when he encountered a wizened man on the outskirts of a village. They struck up a conversation, during which Strobel explained that he is an American scientist who had come to collect snakevine, a plant that indigenous Australians mash up and apply to wounds. Strobel, an expert on endophytes—organisms that make their homes inside other organisms—described how he would hunt for endophytic microbes in the snakevine that might help explain its medicinal properties. Reggie Munumbi Miller, an Aborigine, listened patiently, then asked, "Can you tell me where I came from?"

That sort of metaphysical rejoinder might put off most conservative middle-aged white guys with crewcuts. But it didn't faze Strobel, who got to know the tribal elder well over the next several days. Then he returned to his lab at Montana State University (MSU), Bozeman, in September 2000, with snakevine samples and a didjeridu, a deeply resonant Aboriginal wind instrument that he enjoys playing.

And just as Strobel has often done before in remote corners of the globe, he discovered a new life-form: a kind of streptomycete, a genus of bacteria that produces more than 50 licensed antibiotics. Whereas most streptomycetes live freely in soil, the new species appears to dwell inside the snakevine, in the interstices between cells. That November, Strobel sent some photos of the bacteria to Munumbi Miller. After waiting a few months for a reply, he dispatched a second set of photos, in case the first had been lost. Then in early 2001 he and postdoc Uvi Castillo found that the new streptomycete makes a clutch of potent antibiotics. Strobel's joy would be tempered, however, by the reply he would eventually receive from Australia.

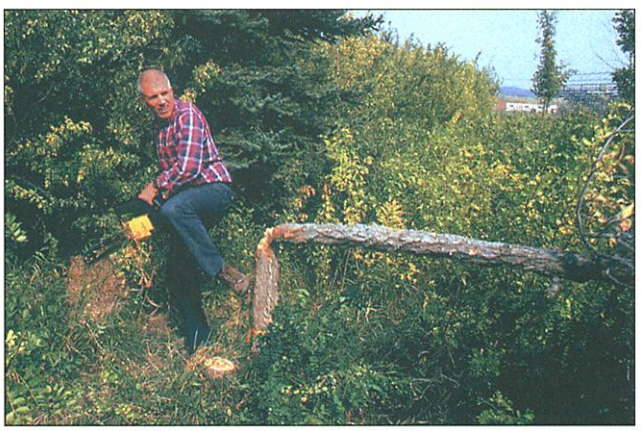
Strobel, now 63, has spent the past decade of a diverse career uncovering biochemical



Rare bird. Gary Strobel sees himself as a nonconformist.

relations between plants and endophytes that could prove beneficial to society. His most famous—and controversial—find came in 1993, when his team discovered an endophytic fungus inside yew trees in Montana that, like its host, produces the billion-dollar cancer drug Taxol. In the decade since, Strobel has embarked on an endophyte road show, having ferreted out fascinating species from Brazil to China. Back at the lab, he screens metabolites of these organisms in assays for potential drugs, pesticides, or other commercial properties.

Strobel's globetrotting makes him a rare bird: a prospector who is still working with indigenous peoples to identify promising sources of drugs. Most major pharmaceutical companies have sidelined that approach in favor of combinatorial chemistry and other high-throughput screens. "We need people like Gary to keep natural stuff in the pipeline," says industrial microbiologist Arnold Demain of Drew University in Madison, New Jersey. By playing that role, Strobel has become a rainmaker for MSU, which holds with him and his collaborators some 16 patents, with another dozen pending, on his lab's top finds. Strobel is an ardent advocate of returning a portion of the profits to the local communities in which he collects.



Timber! Drawing a line under a controversial experiment, Strobel takes a chainsaw to his infected elms in 1987.

Success as a bioprospector has provided a measure of redemption for Strobel, after an incident 15 years ago that nearly ended his career. In 1987, he deliberately infected a group of elm trees on the MSU campus with deadly Dutch elm disease, after injecting them with a mutated bacterium to see whether he could cure them. The unapproved study brought him head to head with the Environmental Protection Agency (EPA). Thumbing his nose at the feds transformed him into a cause célèbre of conservative groups and a darling of *The Wall Street Journal*'s editorial page. But many scientists denounced the experiment as irresponsible. "Strobel is a bright guy," says Anne Vidaver, chief scientist of the U.S. Department of Agriculture National Research Initiative. But "his view of ethical and appropriate scientific behavior is at odds with most scientists."

While defending his scientific record, Strobel acknowledges that he's a maverick. He eschews most scientific societies. "I dislike 'me too' science," he says. Membership of such organizations "does not foster thinking beyond or outside the box." That iconoclastic view generally does not endear him to his peers; some endophyte specialists who wished to remain anonymous grouse about Strobel's reluctance to come to their meetings and defend his findings.

At the same time, his folksy manner and ability to connect with people make him a consummate politician, a role he has used to champion Montana's homegrown scientists. Even friends and admirers call him an enigma—a characterization that Strobel clearly relishes. "You feel an excitement in your soul when somebody wants you to conform, and you choose not to," he says.

Civil disobedience

Strobel has been swimming far from the school ever since he was a youngster in Massillon, Ohio, forgoing football in favor of a passion for nature. Chasing the Boy Scouts' William T. Hornaday Award for conservation during high school, Strobel spent Saturdays on a variety of projects, including planting trees along the Tuscarawas River to help reclaim land denuded by strip-mining. He ended up sowing 30,000 seeds—and won the rare honor.

Shortly after graduating from Colorado State University with a degree in agricultural science, Strobel began sowing the seeds of his future peripatetic lifestyle. In 1960 he joined one of the first U.S. tour groups allowed into the Soviet Union. He spent the summer there and got to see much of western Russia, then returned to the United States to start his Ph.D. studies at the University of California, Davis. After graduating in 1963 he ended up in Montana, where he is now into his fifth decade at MSU.

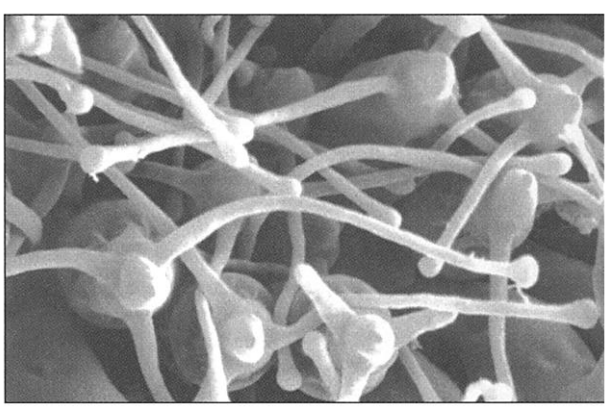
Strobel toiled in relative obscurity until becoming interested in Dutch elm disease. The disease, caused by a fungus, slipped into the United States in the 1930s, when it first showed up in Ohio. The fungus started killing elms by the thousands and spread into other states, carried by bark beetles that fly from tree to tree.

One day in the late 1970s, Strobel struck on the idea of waging biological war on the Dutch elm fungus, *Ophiostoma ulmi*. "I decided that I would take bacteria that I know make antifungal compounds and put them into trees," he says. He found a strain of the bacterium *Pseudomonas syringae* that produces a toxin that kills *O. ulmi* in culture, then bred a mutant that warded off Dutch elm disease in trees grown in a greenhouse. In early 1987, he told an MSU colleague that he was eyeing a stand of 27 scrawny elms near the university's football field for a field trial of his mutant bacterium. "He told me, 'Strobie, you've got to call the feds before you do that experiment.' " Strobel duly called EPA headquarters in Washington, D.C., described his experiment, and was told that he couldn't proceed without the agency's approval.

Strobel did fire off an application to EPA, but he didn't wait for the reply. On 17 June 1987, he injected half the MSU trees with his mutated bacterium; a month later, he infected all the trees with the Dutch elm fungus. "Montana independence and resistance boiled over in my soul" is how he puts it now.

Strobel called EPA and told officials what he'd done. An EPA investigative team dispatched to MSU in late July determined that Strobel had violated the agency's recently introduced rules on field trials involving genetically modified organisms and issued a letter of reprimand. In the meantime, MSU's biosafety committee was on the case, and on 12 August held an inquiry. "It was what you call a kangaroo court," Strobel contends—a characterization rejected by scientists who served on the panel. When asked at the hearing why he undertook the experiment, he blurted out "civil disobedience."

The comment made the front page of the local newspaper, triggering an avalanche of coverage in the national press the next day. An article in *The New York Times* recited the



Surely you jest? The fungus *Pestalotiopsis jesteri*, so named because it resembles a jester's cap, makes an antifungal compound called ambuic acid.

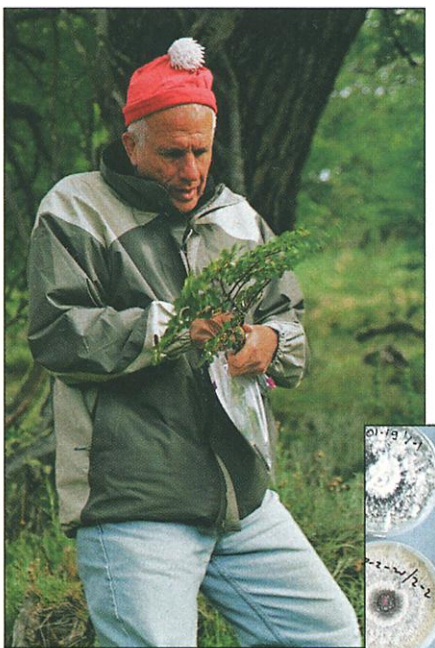
CREDITS: (TOP TO BOTTOM) COURTESY OF G. STROBEL; BILL HESS

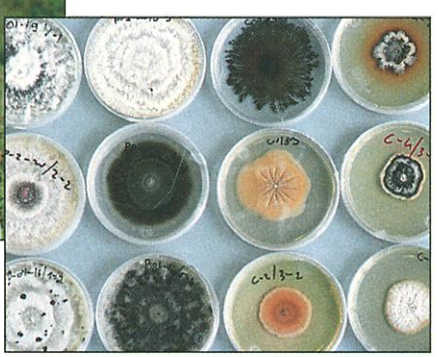
possible consequences of Strobel's action: fines, imprisonment, even closure of the university. Nevertheless, Strobel says he felt a strange equanimity: "For the first time, I realized there was a cause bigger than myself."

The situation became even more surreal when a *Wall Street Journal* editorial in late August derided the EPA regulations and likened Strobel's plight to Galileo Galilei's standoff with the Catholic Church. He ended up escaping with a slap on the wrist.

Strobel was out of the woods, but he still had his trees to worry about. The treatment appeared to have worked: The control trees sickened, and the treated trees thrived. Although no one compelled him to do it, he took out a chainsaw and felled the seemingly healthy trees. Strobel admits that he worried about the possibility of the disease spreading. But he also wanted to close this chapter in his life. "I just wanted to obliterate it," he says.

The fallout did not end there, however. During the weeks he was in hot water, grant money for his lab ran out and members of his staff departed one by one. Things were rough on the home front as well: His marriage was breaking up. "I saw everything just sort of disappear," he says. "All I had left was two hands and a brain."





Prospecting in Patagonia. Some 10% to 15% of the endophytic fungi (*right*) that Strobel collected last fall have antibiotic activity.

CREDITS: (TOP TO BOTTOM) MUTSUMI STONE; G. STROBEL

New territory

On a blustery spring day last November in Patagonia, with the awe-inspiring southernmost part of the Andes chain as a backdrop, Strobel snips a branch from a gnarled nirre, also known as the Antarctic southern beech. "This is ancient forest, the same kind of trees that were here millions of years ago," he says. In this dry climate, he expects far fewer endophytic fungi than he'd normally find on a rainforest jaunt, but he nonetheless predicts "interesting chemistry" from the ones he does find, because the plant-microbe interactions have developed for so long in relative isolation.

Strobel's second wife, Suzan, jots their Global Positioning System location and other information in a notebook. She has helped him bounce back from his Dutch elm ordeal. A few years after his divorce, Strobel was invited to Brigham Young University (BYU) in Provo, Utah, by his longtime friend and collaborator, Bill Hess, a microscopist. Like Strobel, Hess is a Mormon, and he wanted to introduce Strobel to a few nice Mormon ladies. "We had a plan of going through the BYU directory," Hess jokes. Suzan's daughter worked in Hess's lab and brought in a photo and résumé of her divorced mother. When Strobel saw Suzan's photo, he stopped and looked at it for 5 minutes, then said, "I've got to meet her."

Strobel hasn't looked back since. A parade of intriguing findings followed his team's 1993 discovery of a Taxol-producing fungus, including three more species of endophytic fungi around the world that make Taxol. Still, the minuscule quantities leave many researchers wondering if Strobel and others aren't seeing an artifact. "A large percentage of the natural products and mycological community is still unsure whether fungal Taxol is real or not," says one mycologist.

Other finds are less controversial. Bounty of the past few collecting trips includes a fungus from inside the bark of the cinnamon tree that does gas warfare with other microbes; the ecomycins, antifungal peptides made by the bacterium *Pseudomonas viridiflava*; and ambuic acid, an antifungal derived from a fungus in Papua New Guinea. Ambuic acid is complex, says chemist James Harper of the University of Utah, Salt Lake City: a cyclohexanone with a seeming shortage of hydrogens that doesn't form crystals. "They would never be able to come up with something like this using combinatorial chemistry," Harper says. "Gary finds some really weird molecules."

Montana's finest

As much as Strobel wants to pioneer new territory on his own, he also yearns to be appreciated as a fatherly figure who has nurtured two generations of young scientists in Montana. For years he served as state project director for the Experimental Program to Stimulate Competitive Research (EPSCoR), an effort at the U.S. National Science Foundation (NSF) and other agencies to strengthen science in states such as Montana, Nebraska, and South Carolina that do not win their share of federal research funds. Strobel showed a knack for the right political moves: He arranged visits to Montana by power-brokers such as former NSF director Neal Lane, current director Rita Colwell, and Bruce Alberts, president of the U.S. National Academy of Sciences.

But cultivating political goodwill isn't Strobel's only strong suit. "One of his greatest accomplishments was recognizing talent," says Richard Anderson, NSF's senior adviser for EPSCoR. Perhaps the best example is that of a young museum curator who came to Strobel's office one day in the early 1980s to ask for help in winning a grant. He didn't have a bachelor's degree, but he was obsessed with dinosaurs and claimed to have made an unprecedented find: a nest of dinosaur eggs. Strobel sent Jack Horner's proposal out for review. Two reviewers pronounced Horner's nests, if they were for real, the paleontological find of the century. A few years later, Strobel says, a couple of project officers from different NSF divisions were out at Horner's field site in Montana arguing over who was going to have the honor of funding him.

Last week, Strobel headed back to Australia's Northern Territory for more prospecting, but it was a bittersweet return. A year ago, he got a letter from a doctor in Munumbi Miller's village. She had seen Strobel's letter, along with the images of the bacterium, on a nightstand at the tribal elder's bedside. He had passed away on Christmas Eve 2000. The bacterium produces several novel, broad-spectrum antibiotics, including one that obliterates the malaria parasite in culture. In honor of his friend, Strobel has named these compounds the munumbicins. He intends to ensure that if any of the munumbicins do reach the market, that some of the profits get funneled back to Munumbi Miller's community.

Now that he's approaching the sunset of his roller-coaster career, Strobel has started thinking of his own mortality. He doesn't expect to embark on any new radical change in direction. "I'll probably finish my days on this Earth scrounging around in the ground to see what's there," he says. "I wish I had 10 more lifetimes—everything we touch is novel."

–RICHARD STONE