

Brave New World of Biosphere 2?

New operators of the desert greenhouse aim to save the planet

By DAN VERGANO

Last month, after 18 years of government service, William Harris abandoned the no-nonsense National Science Foundation for the fringes of science: He took over as director of Biosphere 2. Harris' new boss, Columbia University, began managing the controversial megaterrarium, located in the cactus-filled desert of Arizona, early this year.

Originally conceived as a sealed laboratory for would-be explorers of Mars, Biosphere 2 fell into scientific disrepute when its eight original residents suffered from a lack of oxygen in their artificial atmosphere (see sidebar).

The prestigious university hopes not only to establish a sterling research facility at Biosphere 2 but to experiment with the education of environmental scientists and save the planet into the bargain. "Columbia is going into this with its eyes wide open," says Harris. "The question is whether Biosphere can be converted into a place for real science."

Still, the question remains: Why perform vital research at the site that spawned a thousand late-night television jokes?

"It's a national treasure," says Bruno Marino, a Harvard University researcher who managed the site for much of the last 2 years. Marino took up the reins after Biosphere 2's owner, Texas billionaire Edward P. Bass, banished the original management and decided to make it a facility for environmental science research.

Marino, who still operates an experiment at the site, compares it to the Sphinx. "Its allure is magnetic. It suggests numerous opportunities for research, but it's a difficult riddle to solve."

While the mythological Sphinx tended to kill those who failed to solve the riddle it posed, the only thing Biosphere 2's new management has to lose is its reputation. The crew of researchers, educators, and tour guides plans to operate the site as a respected center for environmental science research and education. With a few alterations, they hope this westernmost sprig of the Ivy League will become a center for predicting nature's response to a changing atmosphere.

An intriguing arrangement between the university and Bass allows for long-lasting improvements to the facility. At the end of the contract, the school will either turn in its keys, extend the management operation, or receive outright ownership, says Bass.

For the next 5 years, Columbia agrees to manage Biosphere 2 in much the same manner that other universities run federal laboratories. The deal reportedly pays Columbia \$50 million, which it plans to plow back into maintenance and renovations. Simply cooling the greenhouse costs \$1 million a year.

"Columbia University's leadership of Biosphere 2 has already proven to be tremendous," says Bass.

In 1991, the first Biospherians stepped into a 3-acre world consisting of living quarters, three agricultural greenhouses, and a photogenic wilderness area that contained a tiny desert, rain forest, savanna, and ocean. They called the facility Biosphere 2, explaining that Biosphere 1 is Earth. The adventurers tried to subsist in a sealed habitat, but true isolation proved impossible.

As a first step in the new vision of Biosphere 2, the living quarters have been opened to the public as a museum. In addition, the 40-foot-high agricultural bays are being sealed off from each other and from the 2-acre wilderness area. "Given an apparatus that was built for some other reason, converting it is difficult," says Wallace Broecker, chief scientist for Biosphere 2 and a researcher at Columbia's Lamont-Doherty Earth Observatory in Palisades, N.Y.

To predict the effect of Earth's rising greenhouse gases, the plans call for keeping one of the agricultural compartments at a temperature and carbon dioxide con-

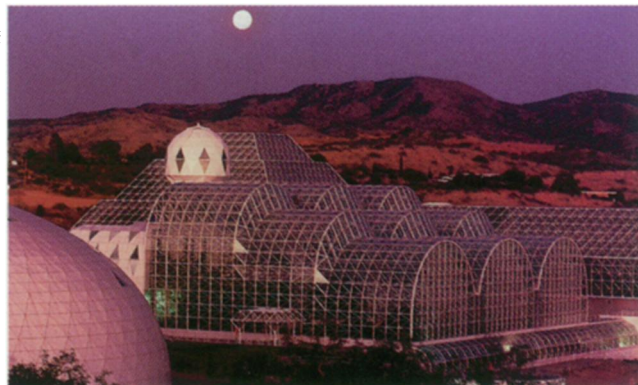
centration that reflect local conditions. The remaining bays could be controlled to test the effects of either increased carbon dioxide concentration or increased temperature.

Broecker leans toward the first option. "We know carbon dioxide levels are going to go up."

The first step in either plan is to remove the 2,000 cubic meters of rich soil that sucked oxygen out of the air, drastically weakening earlier Biospherians. At the insistence of the Arizona Department of Agriculture, the dirt—some of which was imported from the Everglades—will be fumigated to kill any nonnative nematodes.

One-third of each agricultural bay will be planted with loblolly pine, redbud, and sweet gum trees, to demonstrate how the forests—and the timber industry—of the Southeast would hold up under increasing concentrations of carbon dioxide. The remaining sections would hold experiments with food crops. "If we look at something on a 10- to 20-year time scale, it will be useful 100 years from now," says Broecker.

In his view, Biosphere 2 offers an unparalleled opportunity to look at the growth of a forest from seed to treetop canopy in an enclosed environment. Short-term studies in the wilderness area, when compared to long-term studies in the agricultural bays, should indicate the



Columbia hopes the sun hasn't set forever on Biosphere 2.

reliability of 1- or 2-year experiments.

"It flabbergasted the world when Columbia took over," says Boyd Strain, a botanist at Duke University in Durham, N.C. Strain pioneered the kind of large-scale research on carbon dioxide and trees now proposed in Arizona. He liked the newest plans for Biosphere 2 enough to join its board of external advisers. "I think they're doing the right thing, and they're a good group of people."

Another prominent scientist who endorses Harris and Broecker's plan is ocean physicist Russ Davis of the University of California, San Diego. Davis affirms that the superb engineering controlling the greenhouse makes it possible to carry out realistic, large-scale experiments not possible anywhere else.

"Biosphere gives Columbia a great new tool for dealing with its crusty critics," quips Davis, who occasionally numbers himself among them. After one rancorous meeting held at the site's conference center and hotel, he says, "they stuck me in room 105, and in the middle of the night I woke up with one of their trained scorpions stinging the hell out of me."

With Harris on board, the campus is finally open for scientific business. He completes a team of experts in ocean biochemistry, crop modeling, and forestry hired to manage the various experimental sections.

Eight research projects funded by grants from Columbia are scheduled to begin next spring. Broecker hopes that these seed money grants of under \$20,000 each will attract outside funding, because future projects will have to rely on external dollars. "If you can get funded to do an experiment, we will allocate the space," he says. Some of the scientists from the Carnegie Laboratory at Stanford University, the University of California, Irvine, and the Scripps Institution of Oceanography in San Diego who have received these initial grants plan to study atmospheric methane and nitrous oxide, model plant life cycles, and plot coral growth.

Students labor alongside researchers at Biosphere 2. Columbia calls the 250-acre outpost its western campus and inaugurated the first class of 25 Earth Semester undergraduates this fall. A biologist, earth scientist, and social scientist team-teach classes in an effort to break down barriers among disciplines. The students focus on gaining field experience and thinking holistically about humanity's impact upon the planet.

"It is really well suited to an educational mission, there are so many different ecosystems," says geochemist Debra Colodner, who heads the education program. The students are conducting conventional studies of vegetation, as well as assessing the North Atlantic Free Trade Agreement's (NAFTA's) effects on carbon dioxide emissions from the United States and Mexico. In the next 2 years, Colodner hopes to expand the program to 75 students per semester. "The best thing they'll learn is how hard it is to play God with this 3-acre parcel, let alone the whole Earth."

Since 1991, Biosphere 2 has become one of the biggest tourist attractions in Arizona—it received its millionth guest this September. For \$12.95, the visitor still gets a look at the original Biospherians' attempt to create a proto-Mars habitat, "but we are [also] telling people dynamic things are happening on this planet," Harris says.

Columbia hopes to draw the curious into hands-on exhibits about environmental science and current research. A

climate change exhibit now on display at the Smithsonian Institution's Museum of Natural History will find a permanent home at the site in 1997. "Our goal is to demystify science for the public," says Harris.

University officials describe their involvement with Biosphere 2 as an attempt to reduce the threat of global climate change. Education, tourism, and research add up to a larger plan, according to Harris. In his view, scientists need to aim their research directly at battling the ill effects of humanity's century-long flirtation with fossil fuels and start educating the public about the dangers of greenhouse gases.

"Lamont-Doherty is like a monastery, removed from the public," says Michael Crow, a vice-provost at Columbia. He envisions decreasing science's distance from the public eye and "putting Biosphere 2 in the driver's seat" of efforts to predict the next century's climate.

"We believe we've reached a point where human beings have got to take a completely different view about the plan-

et," says Crow. "It's all related to the long-term future of the planet—and I don't mean in just an environmental sense, but in what I would call a stewardship sense. How do you build planetary managers of the future?"

How indeed? Hubris, the sin of pride, doomed many a challenger of the Sphinx, and some critics wonder whether this key ingredient of tragedy still lingers around Biosphere 2.

At the same time, others contend that a holistic vision, which can only be explored in a complex system, is just what's needed—carbon dioxide concentrations in the air are increasing worldwide, and most scientists consider global warming a reality.

"All I can say is we have great people, and we're working very hard," says Broecker. He's convinced there's something unique about the glass-walled temple of science in the Sonora Desert. The real riddle of Biosphere 2 to him is its existence. "I wander around it sometimes, just bewildered, wondering how it ever happened." □

Science Under Glass

November 1986: Ground broken for construction of Biosphere 2.

September 1991: Early in the month, facility engineers install carbon dioxide scrubbers to remove unexpectedly high concentrations of the gas from the greenhouse. Later, eight Biospherians begin their 2-year tour inside Biosphere 2.

October 1991: A Biospherian leaves the dome to visit the hospital after a thresher accident. She returns with replacement computer parts stowed in a duffel bag.

May 1992: Alarmed by a decrease in oxygen concentrations, John Allen, head of Biosphere 2 and a former leader of a nearby commune, seeks out geochemist Wallace S. Broecker of Columbia University's Lamont-Doherty Earth Observatory for advice. No action was taken.

August 1992: The committee of external advisers recommends hiring a scientific director, designing a research plan, and opening data to outside scrutiny.

February 1993: After oxygen concentrations drop to 15 percent of the Biosphere atmosphere, fresh gas is pumped in, violating the original plan. All 11 science advisory committee members resign, citing lack of progress.

March 1993: Biospherians quietly import six species of insects to prey on crop-eating mites, again violating their rules regarding a sealed system.

September 1993: The original Biospherians decamp. All have lost weight; one has published a cookbook called *Eating In*.

February 1994: Columbia student Jeffrey Severinghaus finds that microbes in the excessively rich organic soil of Biosphere 2 were responsible for the low oxygen. Advisers had originally counseled against using such rich soil, but Biosphere 2's designers had ignored the warnings. If the terrarium's concrete had not been absorbing carbon dioxide at the same time, the air would have become completely unbreathable.

March 1994: Eight new Biospherians seal themselves in for a 1-year tour.

April 1994: Facility owner Edward P. Bass calls in federal marshals to throw out Biosphere 2 officials, accusing them of mismanagement. A few days later, two original Biospherians sabotage the site, smashing windows. They claim to be acting out of safety concerns. The second team emerges.

January 1996: Columbia University begins management of Biosphere 2. Plans are made to convert the facility to a research campus devoted to earth science. Later in the month, comedian Pauly Shore's parody, *Bio-Dome*, reaches theaters.

September 1996: Columbia names William Harris the new director of Biosphere 2, effective Oct. 15.