





**C**LARK ERICKSON is picking his way through the Bolivian Amazon, which teems with snakes and malarial mosquitoes, when the visions start. This is the rain forest, seemingly a raw, untouched tangle of exotic plants and colorful birds. But for Erickson, an anthropologist-turned-archaeologist from the University of Pennsylvania, it is not the pristine wilderness it seems, but a heavily managed landscape. He reaches for a tree laden with mustard-colored fruit and seizes a waxy, oblong leaf. “This is like finding potsherds,” he says. The leaf belongs to the cacao tree, which grows throughout this part of the country, the Beni, in circular patches called forest islands—telltale signs, he believes, of early settlement.

Erickson has worked in Bolivia and Peru for three decades, and he hopes his research will bring the lessons of the past to bear on the present, perhaps guiding sustainable agriculture here and across the globe. He is part of a growing group of archaeologists who are engaging and helping shape the communities in which they work, but a few decades ago, other scholars would have thought him crazy.

# Amazonian Harvest

**Can prehistoric farming methods lead us to a sustainable future?**

by MARA HVISTENDAHL

The Beni is dominated by an erratic landscape called the Llanos de Mojos, where pockets of rain forest taper abruptly into savanna. It is the dry season now, but for half the year rain blankets the region and water creeps to the edges of the forest islands before receding into tributaries that feed the Amazon. When the water retreats, it takes nutrients with it, leaving sandy brown soil inadequate for most crops. Today, locals regularly employ slash-and-burn agriculture, a technique introduced by Spanish colonizers in the 1600s. Without this method, archaeologists long believed, the area’s climate and soil would make it largely uninhabitable by a significant number of people.

Beginning in the 1950s, Betty Meggers, a Latin America specialist at the Smithsonian Institute, helped popularize the idea that the Amazon is a “counterfeit paradise,” a deceptively lush environment that is mercilessly harsh on humans (“First Lady of Amazonia,” *May/June 2003*). This would explain why archaeologists had not found evidence of extensive settlement in the Llanos de Mojos. No-nonsense and at times brusque, Erickson sees something different: 30,000 square miles dotted with round forest islands somehow spared from the annual

floods. To him, the raw jungle is crisscrossed with signs of human interference.

**Bolivian archaeologists map a pre-Columbian ditch in a forest of wild cacao trees. The ditch may have been part of an extensive system of earthworks that allowed ancient residents to grow crops in the unforgiving Amazon.**

Beneath a mess of undergrowth, the forest island we stand on is a neat mound surrounded by a large circular ditch. Just ahead, Bolivian archaeologist Patricia Álvarez and Peter Stahl of SUNY–Binghamton map the



ditch on a GPS receiver. Erickson believes pre-Columbian people created the mound by shoveling dirt from the dug-out ring. The cacao tree, the source of chocolate, is “here because people planted it and kept the other plants out,” he says. “They were manicuring these forests, cutting down the stuff that’s not useful, and leaving things that are useful.” These early gardeners also left dark, nutrient-rich soil—a close relative of the potent “Amazonian dark earth” found across the border in Brazil.

Native people occupied the Llanos de Mojos from at least 1000 B.C. until the Spanish arrived. But the extent and complexity of their settlements were largely unknown until 1961, when University of Wisconsin geographer William Denevan flew over the region at the suggestion of oil company geologist Kenneth Lee. Part of the landscape was cloaked in forest, but in the savanna Denevan saw remnants of vast earthworks so geometrical they could only have been man-made. He and Erickson, his student, later found a collection of mounds, elevated rectangles, and razor-straight lines. Three decades later, Erickson led the first intensive archaeological investigation of these features.

Through excavations, agricultural experiments, and ethnographic and historical sources, Denevan and Erickson hypothesized that the structures were designed to raise fields

and manipulate water during the rainy season. The research suggests pre-Columbian inhabitants shaped an inhospitable landscape—*domesticated* it, Erickson says—into a productive hydraulic farm with fish weirs, paddy-like fields for aquatic crops, and more than 6,000 miles of causeways. Along with scholars such as University of Florida anthropologist Michael Heckenberger, who works in areas with dark earth in Brazil, Denevan and Erickson upended the theory that Amazonia is a false paradise. In 2001, Denevan estimated that the region once held 6.8 million people.

The existence of such a sophisticated pre-Columbian culture is also challenging modern environmental protection strategies. What does it mean that supposedly pristine areas such as the Llanos de Mojos were widely inhabited and manipulated for human use? Slash-and-burn agriculture destroys forest habitat and sends hundreds of millions of tons of carbon dioxide into the atmosphere each year. Could archaeological study of those early farming techniques provide a more ecologically responsible alternative?

**E**RICKSON THINKS THE ANSWERS to these questions lie in chocolate. He and other archaeologists have identified thousands of forest islands—which locals call simply *chocolatales*—throughout the Bolivian Amazon,

ranging in size from a few trees to dozens of acres. Some, like the one they are surveying, are in the rain forest, while others emerge from the savanna. Erickson believes they were both settlements and farms, with weirs and raised fields fanning out around them. Today, their dark soil makes them sought-after sites for gardens and small-scale agriculture.

In an era in which farming is considered a threat to the jungle, forest islands suggest pre-Columbian



**The Spanish brought slash-and-burn agriculture to Amazonia, where it is still widely practiced. Archaeologist Clark Erickson is looking to the past for less destructive alternatives.**



people not only cultivated jungle land, but also contributed to its biological richness. “It’s an indication that humans have something to do with biodiversity,” Erickson says, “rather than being destructive of it.” He is working to apply that knowledge, partnering with locals to promote the use of some cultivation techniques of the area’s early inhabitants.

Erickson’s work here is only one example of a growing movement toward applying archaeological research to modern resource conservation and management. This approach can be as simple as giving communities a voice in shaping tourism attracted by an excavation. In Guatemala and Belize, archaeologist Anabel Ford of the University of California at Santa Barbara discovered jungle farms similar to the forest islands (“forest gardens”). She’s enlisted indigenous people to maintain the farms’ mahogany, legume, and palm crops, and contribute expertise to a binational preserve.

At its most far-reaching, this approach means identifying promising but forgotten historical techniques and trying to implement them locally or globally. For example, University of Cincinnati anthropologist Vern Scarborough’s work on water use in the late Maya period in Mexico—and how deforestation and agriculture strained perennial water sources—is being applied to modern water management around the world. Applied archaeology, or “action archaeology,” is transforming the archaeologist from scholar to community activist and, in some cases, sought-after advisor. “The whole attitude of the field has changed in recent years,” says Jeremy Sabloff, former president of the Society for American Archaeology and author of *Archaeology Matters: Action Archaeology in the Modern World*. “The idea that archaeology can play a critical role in the world today is a rising trend—and a very exciting one.”

Some of the field’s most cutting-edge work is in historical ecology, an emerging specialty concerned with the relationship between humans and their landscapes. As the world grapples with climate change, water and food security, and deforestation, archaeologists who study such issues in the ancient world have become an important resource. In Burgundy, France, for instance, University of North Carolina at Chapel Hill archaeologist Carole Crumley leads the French Project, a multidisciplinary effort to compile long-term historical infor-

**Ring ditches, raised fields, forest islands, and causeways (left to right) in the Bolivian Amazon have convinced Erickson that this was once a heavily managed landscape that supported millions of people. He hopes that the techniques used here can be reapplied to create a more sustainable and locally adapted form of agriculture. Wild cacao, below, may play an important role in that future.**

mation—including archaeological findings—into a database that can be used for research such as climate modeling.

As policymakers discuss stewardship of the future, archaeologists offer crucial insight into the past, making it possible for us to learn from our mistakes or, in the case of the Llanos de Mojos, our successes.



**T**HE TOWN OF BAURES is a smattering of colorful wood homes around an aging church. Locals prepare elaborate meals by harvesting the jungle’s bounty, especially wild cacao.

They turn seeds from the dense, tangy fruit into an oily hot chocolate for breakfast, eat the fruit’s meat, and collect seeds for export. Dealers come from as far away as Argentina. Cacao trees are so abundant here that little attention is paid to ownership. Bananas and potatoes are produced on farms through labor-intensive slash and burn, but cacao is harvested by collectives that divvy up the chocolatales.

The trees are everywhere, Erickson and others believe, because Amazonia’s early inhabitants enriched the poor soil. In the Ecuadorian Amazon, Erickson found rings of dark soil, suggesting people practiced natural composting by sweeping garbage behind their houses. But that doesn’t entirely explain the phenomenon. “Every society dumps organic trash, so why don’t we have black earth everywhere?” Erickson asks. “One of the hypotheses is that they were creating these soils intentionally.”

A more elaborate and provocative explanation for the rich soil is low-grade, contained, smoldering fires covered with straw and dirt that left deposits of charcoal to encourage the growth of essential microorganisms. In any case, Erickson believes the cacao trees thrive centuries later because of deliberate tinkering with the landscape.



**Cacao producer Oscar Ferrier Toledo would like to see pre-Columbian agricultural techniques applied to a wider range of crops than just cacao.**

Most of the locals today knew nothing about the history of wild cacao until Erickson started working here. Before the 2007 field season, he gave a presentation at the Baures mayor's office. Eighty people watched raptly as he clicked through photos, explaining how chocolatales and other formations might have been used.

Cacao producer Oscar Ferrier Toledo, a broad-shouldered man with a mustache, was in the audience. A few days after joining Erickson in the field, I sit with Ferrier Toledo on a porch overlooking the dusty town square. "Everyone knew about [the earthworks]," he says, "but we didn't know that they were left by another civilization. When it was over, someone said, 'Look at the gringo! He has come from so far away to research our past.' They wanted to carry him out on their shoulders."

Erickson's thinking dates to the 1950s, when anthropologist Julian Steward theorized that a society's evolution could be understood through its relationship to its environment. In 1956, archaeologist Patty Jo Watson issued a call for "action archaeology" with Maxine Kleindienst of the University of Toronto. The next year, Israeli ecologist Michael Evenari uncovered stone walls and depressions near the ruins of Shivta, a Byzantine settlement in the Negev Desert. They suggested there was farming in the unforgiving landscape, where it had been thought impossible. Over the next decade, Evenari worked with archaeologists, agronomists, and botanists to reconstruct the farms at Shivta and nearby Avdat, with ancient wells and cisterns forming the basis of a complex water management system. The farms produced promising yields of apricot, peach, and pistachio trees, and inspired other desert farming projects.

Today, the idea that early practices might improve land

quality is gaining currency. Chris Fisher, an archaeologist at Colorado State University, has been working in highly eroded areas around Lake Pátzcuaro in Mexico. While the most widely accepted theory is that erosion was caused by overpopulation in the Postclassic (A.D. 900–1520) Tarascan Empire, Fisher found the erosion was more significant after the Tarascans abandoned the land during Spanish occupation, suggesting their terraced fields served an important ecological function. "The only way we're going to find solutions to erosion," he says, "is to look at the sequence of activity on the landscape."

In the Llanos de Mojos, the historical landscape has been disrupted. The Jesuits established a mission in 1708, introducing new agricultural techniques, a town plan, and a foreign religion. Locals still recite the Spaniards' farming mantra: "Cut it, fell it, burn it, and farm it."

Erickson's research draws attention to alternatives. He works closely with Ricardo Bottega, a Bolivian activist and enthusiastic promoter of pre-Columbian techniques such as raised fields and fish weirs. "It hurts the eyes to see how much smoke fills the air now," Bottega says. The early people, he tells anyone who will listen, "occupied the land for 1,000 years—without deforestation. That's what might be called sustainable development."

**W**HEN THE JESUITS ARRIVED in the Llanos de Mojos, they found a people called the Baure wearing cotton tunics and jewels and living in chiefdoms with large public plazas, communal men's houses, and defensive moats. In a 1772 text, Jesuit priest Francisco Javier Eder called them "civilized peoples," and according to missionary records, they were renowned for their chocolate.

**Erickson (blue shirt, center) oversees excavation trenches that cut across pre-Columbian causeways and raised fields.**



A number of experimental farm projects have been started as a result of Erickson's research. This one, at the Kenneth Lee Ethno-Archaeological Museum in Trinidad, Bolivia, uses raised fields to grow promising yields of maize.

The groups coexisted until 1703, when the natives killed a priest for insulting a chief. The Spaniards retaliated, conquering the Baure and organizing them into mission towns. In the following decades, many locals fell to European diseases. The Jesuits later abandoned most missions; their potential converts had died off.

The missionaries succeeded, however, in leaving an indelible mark, introducing the machetes and metal axes that made slash and burn possible. Today, the area around Baures is covered by stretches of blackened soil dotted with charred, twisted trunks. A field that has been cleared through slash and burn can only be used for five years before it must be left to regenerate. At any given time, most of this land lies fallow; the technique is land-intensive as well as polluting.

By contrast, the process that produces the rich soil of the forest islands may reverse pollution and deforestation. The charcoal generated by smoldering fires actually captures carbon rather than releasing it. After it is created, the soil appears to encourage forest growth. When Erickson started working here, he assumed earthworks would be concentrated in open savanna, where crops could receive lots of light. He has since found raised fields and fish weirs covered with palm trees, and forest islands surrounded by jungle—suggesting the soil invited new growth. Much of the rain forest here may just be abandoned fields.

In 1990, Erickson decided to apply the techniques to the contemporary Llanos de Mojos. Working with a Bolivian team, he oversaw the construction of experimental raised fields a couple hundred miles from Baures. Despite heavy rainfall and animal attacks, they produced above-average yields of maize and manioc. The project was discontinued because of management problems and the difficulty of staffing the farm—young people here often leave their villages for work or education. But promising crop yields galvanized local and international development organizations, which continue to roll out projects based on his work.

In other parts of the world, enthusiasm for “biochar,” Amazonian dark earth and its cousins, has taken off. At a 2006 meeting of the American Association for the Advancement of Science, Cornell biogeochemist Johannes Lehmann said that Amazonian soil “not only teaches us how to restore degraded soils, triple crop yields, and support a wide array of crops in regions with agriculturally poor soils, but can also... prevent critical changes in world climate.” A few months later, at the World Congress of Soil Science in Philadelphia, scholars formed the International Biochar Initiative to encourage its use. And Georgia-based company Eprida



recently developed a technology for dealing with agricultural waste based on the idea of Amazonian dark earth.

**C**RAMMED IN A CESSNA, flying low over the savanna, Erickson and Stahl frantically snap photos. When the plane descended to an outpost north of Baures to drop off eggs and chickens, Erickson spotted five D-shaped ditches. As we pass over them again, the scientists hurry to capture images that might help in their research. From here, it is possible to imagine the heavily managed landscape Erickson envisions. Below us, the savanna seems like an orderly network of fields and canals, rather than the mish-mash of jungle, floodplain, and scorched fields visible from the ground. We see several forest islands, green disks that look like they were shaped with a cookie cutter.

A few minutes later, we spot large rectangular depressions—rice paddies. Erickson says he's glad to see people farming the savanna, something he's been fighting for since 1990, but the paddies use conventional methods such as pesticides and mechanization. He also worries about bulldozing before archaeologists have a chance to explore. “They're destroying the vestiges of pre-Columbian agriculture,” he yells over the roar of the propeller.

Since his experiments in the 1990s, Erickson has grown hesitant about getting too involved in local agriculture, but the people of Baures may do it themselves. “If we were to apply [pre-Columbian] techniques, it would be much better for the world,” Ferrier Toledo tells me from his porch overlooking the square. “We have a lot of land in the savanna that we aren't using.” In his vision, cacao won't be the only crop to benefit from early farming techniques. He sees forest islands supplemented with raised fields of corn, tobacco, beans, and pumpkin—an agricultural cornucopia that will enrich the earth for future generations. ■

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