New View of Early Amazonia

Recent findings suggest complex culture was indigenous to the Amazon basin—upsetting some received opinions about environment and culture

WHEN EUROPEANS FIRST SAILED up the Amazon in the 1540s, they reported seeing large cities glistening white along the flood plains of the river. Their early accounts described settlements with tens of thousands of people ruled by warrior chiefs, some controlling territories hundreds of miles long. By 1700, however, there were no traces of these complex societies—only primitive bands of jungle-dwelling Indians. Puzzled anthropologists decided to discount the historical records, in part because they thought the tropical lowlands an unlikely cradle for any civilization. As a result, few archeologists worked in the Amazon and most concentrated their efforts on the remnants of the dazzling civilizations of Peru, Colombia, and Mexico.

Today, archeologists' view of the Amazon as a cultural backwater has begun to undergo a rapid and profound change. In recent years, a small group of archeologists and anthropologists say they have found evidence of the "lost" civilizations. "There is a hidden period in the history of the Amazon that's only now being researched out," says Neil Whitehead, a historian at the Guggenheim Foundation in Oxford, England, who specializes in South America.

But this reevaluation hasn't taken place without some sparks flying. As a new generation of researchers fills in the gaps and rewrites the textbooks on South America, its work is fueling a heated debate over the origins of native civilization in the Americas. The newcomers—led by Anna C. Roosevelt of the American Museum of Natural History—say they have found evidence that complex societies took root along the shores of the Amazon, growing in size and influence over the centuries until their culture reached as far as the Andes. Some even were responsible for the earliest pottery found in the Americas, made 2000 years before any ceramics are found in the highland cultures of the Andes and the coast areas of Peru and Ecuador, says Roosevelt.

This view is at odds with the conventional wisdom in the field, and, in particular, with the work of an influential husband-wife team of anthropologists at the Smithsonian Institution's National Museum of Natural History—Betty Meggers and Clifford Evans—who believed that complex culture was not born in the Amazon, that it was imported from outside and put down only very shallow roots there.

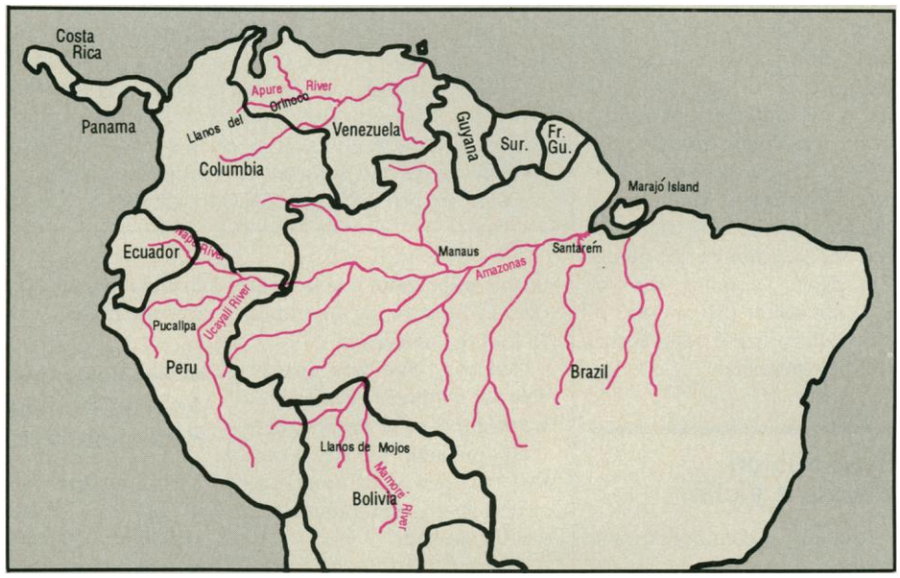
Theirs was an idea dating back to 1946, when Julian Steward of the Smithsonian Institution published a six-volume tome, called the *Handbook of South American Indians*, in which he advanced the theory that the tropical environment was too harsh to support large societies and that the people who lived in the Amazon before the arrival of the Europeans were probably similar to present-day Amazonian Indians—so-called "shifting cultivators" who were first studied extensively in the 1930s and 1940s.

That conceptual framework was further refined by Meggers, who in 1954 outlined a far-reaching theory of environmental determinism. Simply put, the proposition holds that humans are constrained by their environments and that complex cultures can develop only where people can obtain enough food, water, and other resources to sustain large populations. Meggers went on to develop a system for ranking different environments on the basis of their potential for nurturing and supporting the development of complex societies.

Today, some researchers say this view prejudiced the field against the notion of civilizations forming in the Amazon. "There's been a mindset about the Amazon that's based on our own image of the jungle rather than on well-drawn-out conclusions from extensive fieldwork," says James A. Brown, a professor of anthropology at Northwestern University and a specialist in the emergence of culture. "It's totally intuitive. We look at the jungle, and we think primitive."

But Meggers says her ideas crystallized out of fieldwork. "I did not start with that proposition," says Meggers. "I came to that conclusion after finding no evidence of cultures starting in the Amazon." And she supports her claim by referring to a site that has become a prime focus of today's debate. The site is called Marajo, and it is a 15,000-square-mile island at the mouth of the Amazon River in Brazil.

Meggers and Evans, whose fieldwork at Marajo began in 1948 and continued into the next year, were the first archeologists to work there. The site is remarkable for its 400 huge dirt mounds, the largest with a surface area of 50 acres and a volume of more than 1 million cubic yards. These



Cradle of complexity? *The Amazon basin includes several culturally complex sites, notably Marajo Island, which is at the mouth of the river.*

artificial mounds were platforms for villages that once perched safely above the Amazon flood waters. On these platforms, the Marajoarans occupied large houses made of mud, tree trunks, and thatch.

The complexity of this culture is not revealed only by its size and dwellings. In addition, there is evidence that the Marajoarans had regional influence, traveling the river and its tributaries as if they were highways. Chiefs shared allegiances to the same gods and engaged in trade and warfare. "We're not dealing with isolated and sort of backward, village-level organizations," says Guggenheim historian Whitehead. "We're dealing with Big Chiefs, the real thing."

Meggers and Evans had no quarrel with the idea that Marajo was the site of a complex culture. For four decades, however, they have argued that there is no proof that other complex societies prevailed in the Amazon. They have seen the Marajoarans as an exception. Says Meggers, "We don't have any complex societies in the Amazon—none has the same degree of complexity as Marajoara."

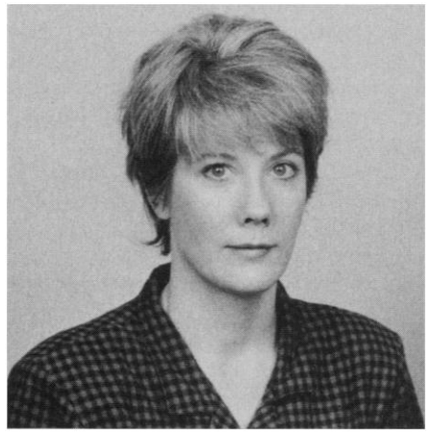
This uniqueness suggests to Meggers that Marajoaran culture came from someplace else—perhaps imported by invaders from the Andes who failed to last long in the Amazon. The evidence for that view, Meggers says, is provided by pottery related to that of Marajo that has been found in the lands between there and Peru.

Meggers is also convinced that few early Amazonian sites represent long periods of occupation by one group—the kind of continuity needed for developing full cultural complexity. She is now working on a monograph including evidence collected by Brazilian archeologists, showing that most sites in the Amazon are not villages inhabited continuously by one society, but places that have been reoccupied and abandoned by different groups.

In addition, she has found distinct changes over time in materials used to make ceramics at sites throughout the Amazon. These shifts could indicate that the inhabitants moved frequently, perhaps in response to climatic changes. Meggers thinks this cultural discontinuity also prevailed at Marajo, where primitive tribes occupied the site on and off for centuries—followed by the one brief flash of cultural brilliance.

Although these views were once very influential, today the scene has shifted so rapidly that Meggers is virtually alone. Her first challenge came more than 30 years ago when University of Illinois anthropologist Donald Lathrap sparked a controversy by taking a dramatically opposed view to Meggers'. Lathrap had been looking at pottery and soil stratigraphy in Pucallpa in the foothills of the Andes in Peru. Lathrap found pottery related to the pottery of Marajo—but his results suggested to him that the Marajo pottery was made first. He concluded that the Peruvian pottery wasn't the source of Marajo culture; on the contrary it was influenced by the Marajoarans.

"Lathrap turned Meggers' and Evans' model on its head and said 'No, civilization developed in the Amazon. It's an indigenous development and the population spreads weren't from the highlands to the lowlands,' " says Clark Erickson, a former student of Lathrap's, now an anthropologist at the University of Pennsylvania and assistant curator at the University Museum of Archeology and Anthropology.



Leader of the pack. *Anna Roosevelt led effort to show cultural complexity arose in Amazonia.*

Lathrap stood by that view until his death in May of this year, but for years his consistency represented the fruit of a lonely effort. Few U.S. anthropologists wanted to leap into a fray pitting Meggers and Evans against Lathrap and his few students. "These two groups were in a terrible feud," says Roosevelt. "It scared everyone away. Only people who didn't care what other people thought got into it." The result was that no Americans returned to Marajo for 30 years, although Lathrap and his students continued to work in other parts of the Amazon.

Then, in the early 1980s, Roosevelt came to dig in Marajo, finding evidence that changed the minds of many anthropologists—and won her a $265,000 MacArthur Foundation award. She had already done her doctoral research on the site of early complex cultures on the Orinoco plains of Venezuela, where researchers had found raised fields used to cultivate maize and other crops. That work prompted Brazilian geophysicist Jose Laurenco to invite her to have a go at Marajo, making her the only American other than Meggers to have led an expedition in the region.

In 1983, Roosevelt and a team of Brazilian and American geophysicists, using methods much more sophisticated than those that had been available to Meggers, began the first extensive scientific excavations in Amazonia. They figured out where to dig by using remote sensing with radio waves that helped them pinpoint underground burial and garbage pits. They also measured magnetic fields and electrical resistivity in soils in order to identify small-scale underground features and find artifacts. These methods helped unearth hearths, earthworks, houses, and a trail of trash and pottery.

These methods, and other, more traditional archeological techniques, enabled Roosevelt and her colleagues to paint a picture of Marajo culture. In their five fieldwork seasons they found house sites with abundant remains of continuous human occupation. Some mounds had as many as 20 house foundations superimposed on top of each other, and others had rubble piled 20 feet high in places. Radiocarbon dating of the rubble, as well as an analysis of the stratigraphy of the soils where pottery was found, showed that people had occupied the sites continuously for over 1000 years—surely a sign, Roosevelt thinks, that their culture developed there.

The archeologists also found elaborate pottery, including enormous burial urns with designs that seem to have become more complex over time. Some urns had contained bodies, and the morphology of the nearby bones showed that the Marajoarans were more closely related to present-day Amazonians than to Andeans—more evidence for their local origins.

While the findings at Marajo provide the most dramatic example of early culture in the Amazon, evidence also has been found of long-lived societies in other corners of the Amazon. Since 1987 Roosevelt has been working at Santarem, a region with extensive mounds on the Tapajos River in Brazil where ancient people left elaborate pottery, finely carved jade, and large statues of chiefs. New accelerator radiocarbon dates give evidence for cultural development over 7000 years, including pottery made at the site earlier than anywhere else in the Americas, she says.

And her work is merely an extension of what others had already begun to find. Several of Lathrap's students backed up his early work by finding similarities between Marajoaran pottery and shards found as far away as the Andean foothills, suggesting that the Marajoarans and other nearby chiefdoms were the center of an advanced culture that ultimately spread throughout the region. Ronald Weber, a research associate at the Field Museum in Chicago who also was

a student of Lathrap's, found similarities between the pottery at Pucallpa in eastern Peru and pottery described by Meggers that had been found along the Napo River in Ecuador. And both of those show similarities to the shards from Marajo Island.

Others found tens of thousands of hectares of raised fields built in the wetlands by prehistoric people in other parts of the Amazon, along the Orinoco River in Venezuela, Guiana's coasts, and the plains of Bolivia, known as the Llanos de Mojos. University of Pennsylvania's Erickson says it was "a real eye-opener" when he first saw raised fields in Llanos de Mojos "in almost every direction, tied by causeways."

"I'm convinced these were complex societies," says Erickson. "In earth-works, they were doing comparable work to the pyramids in terms of earth moved—probably much more in terms of the amount of material moved and landscapes that were completely altered by human occupation."

While most scholars in the field say the new evidence has convinced them that there were complex cultures in the Amazon, the field is still filled with unresolved questions, partly because so few full-scale archeological expeditions have been carried out there. "There's no debate over whether there were complex cultures (anymore)," says William Denevan, a professor of geography at the University of Wisconsin who discovered the first raised fields in 1961 in eastern Bolivia. "The debate is how common these cultures were, where they came from, and how large the populations were."

Some observers, however, are afraid such issues will be difficult to resolve, because researchers may never be able to follow up the preliminary work with a more detailed, closer look. Obstacles to working in the Amazon are considerable. Funding is scarce and problems in the field include such real-world considerations as malaria-bearing mosquitoes and piranhas. The final blow for Weber, who has financed much of his own field-work, is the Shining Path revolutionaries, who have made it unsafe for him to return to the Peruvian Amazon.

Most agree, however, that they've made tremendous progress in the past decade at reconstructing the picture of these lost societies—and showing that the Amazon did indeed have a richer past. "This has certainly changed the static view of the Amazon as an area that was forever primitive and unchanging," says Brown of Northwestern University. "We've begun to pick up a great appreciation for the ways in which large numbers of people were supported in what now are considered marginal environments. I think it's something we're just now beginning to understand." ■ ANN GIBBONS

Quake Prediction by Seismic Oxymora?

As if the term "slow earthquakes" were not sufficiently self-contradictory, seismologists at the recent meeting of the American Geophysical Union meeting in Baltimore were subdividing the category into quiet earthquakes and even silent earthquakes. This proliferation of oxymora is the fallout of an effort to better understand how ordinary, rock-em-sock-em earthquakes get started.

Practically speaking, understanding slow earthquakes could help researchers with the recalcitrant problem of short-term earthquake prediction. The most encouraging news from the AGU session was that slow earthquakes appear to sometimes precede and presumably trigger fast, destructive quakes. That means that some of the instruments being strewn along dangerous faults may provide short-term warnings by noting slow tremblers.

But slow quakes have long lingered on the fringes of detection. Seismologists have had difficulty showing they exist, much less figuring out how large a role they might have in triggering ordinary, potentially dangerous quakes. The problem is that slow quakes do not register on seismographs the way fast earthquakes do.

Quiet earthquakes detected in Earth's bell-like ringing may trigger fast, damaging quakes

Still, seismologists Alan Linde and Selwyn Sacks of the Carnegie Institution of Washington's Department of Terrestrial Magnetism wouldn't say no to a challenge. They told session attendees of their long search for the slowest of the slow earthquakes, the silent earthquakes.

Seismologists' nomenclature has not settled down yet, but two extremes have been clearly defined. Fast and therefore noisy quakes are ruptures that rip along faults at more than 3600 kilometers per hour while rattling off seismic waves, the strongest of which are easily recorded on seismographs around the world. At the other end of the spectrum, silent earthquakes are far pokier, rupturing at less than 36 kilometers per hour—so slow that they go undetected by standard seismographs.

Conventional instruments being of little use, Linde and Sacks installed strainmeters, which can sense these silent ruptures by the crust deformation they cause, near faults in quake-prone Japan and Iceland. With patience and luck, Sacks and Linde detected silent earthquakes at three places in a dozen years. In the Japan Sea in 1983, for instance, they recorded about 100 silent events lasting 3 hours, each where a magnitude 7.7 quake subsequently struck. Sacks and Linde believe that the events were silent ruptures propagating upward along 60 kilometers of fault toward the site of the eventual fast rupture. Each silent rupture would have increased the strain on that section of the fault until it broke in a fast earthquake.

Seismologists Gregory Beroza and Thomas Jordan of the Massachusetts Institute of Technology reported that they have found another means of detecting some kinds of slow earthquakes, one that does not require an instrument near every fault. They looked at data from accelerometers located around the world. These instruments detect the ground motion touched off when a large earthquake sets the planet ringing like a bell, a phenomenon known as free oscillations.

Over 10 years, Earth rang with free oscillations 1500 times. In most cases, seismographs recorded ordinary earthquakes that set off the free oscillations. But in a number of cases, the accompanying quakes appeared to be too small for the job. Beroza and Jordan argue that these are earthquakes fast enough to generate some seismic waves—they are not silent—but slower than ordinary quakes. Most were located on the faults connecting sections of mid-ocean ridges, supporting the idea that the hot rock there can rupture slowly.

Another 164 of the 1500 free-oscillation events had no recorded earthquake associated with them. These Beroza and Jordan call quiet earthquakes, which are not as slow as silent quakes but produce only the slightest whisper of certain low-frequency seismic waves. Using his own mathematical technique, Jordan believes he can show that at least a few of these quiet quakes, which last some minutes and release as much energy as a magnitude 6 or larger quake, immediately preceded and probably triggered fast earthquakes of comparable size.

Beroza and Jordan must now convince their colleagues that their methods are as reliable as they claim. If they do, the continuing proliferation of slow precursory earthquakes would provide further reassurance to those in the prediction business—there really may be something to measure immediately before some faults fail in destructive earthquakes. ■ RICHARD A. KERR