Elevating the Amazonian Landscape

In eastern Bolivia, human artifacts include a diverse flora, suggesting that human occupation in the past actually enhanced the landscape of today.

BY WILLIAM BALÉE

The conservation literature, for the most part, indicts a single species for the current deforestation and destruction of Amazonian rainforests. That species, of course, is us. This indictment—which is not just a rhetorical straw man but clearly a widely held view among conservationists, scientists, and lay persons alike—is a scatter shot that unfortunately takes down the innocent and guilty alike before there has been any trial by the evidence.

As a species, *Homo sapiens* displays fundamental sociopolitical variation. It is this variation, and not biological, linguistic, or cultural variations, that is relevant to environmental destruction in our time. Simply stated, hunting-and-gathering bands, horticultural village societies, and chiefdoms have been less associated with species extinctions and extirpations on continental land masses, such as that of Amazonia—the watershed of the Amazon River—than have states, ancient and modern.

The Roman, Aztec, and Inca empires are examples of archaic states; the United States, Bolivia, and Brazil represent modern states. Archaic states rely mainly on taxation and tribute, whereas modern state economies are manifested by markets, prices, and finances that consistently transcend territorial boundaries. Both archaic and modern states accumulate surpluses, which to some extent have come historically from unsustainable harvesting of nondomesticated resources and reduction in the variation of crop species in the fields.[1] Ironically, in today's world, it may be up to the state to ensure conservation.

Instinct for Survival

The background rate of species extinctions is merely a constant that reminds us that all life forms are doomed. Above and beyond this constant rate, the fossil record reveals cataclysmic events whereby large numbers of species—sometimes entire genera and suites of species—have perished together. The record of our own minuscule slice of geological time may one day prove to have been another cataclysm of species extinctions. Individual organisms harboring unique, unreplicable DNA, and all their fellow species members that shared the same code, in essence, vanished in these events.

Evolutionary forces alone probably would not have selected for a species that could be mostly or solely responsible for massive extinctions of other species, since one cannot show how species extinctions increase the fitness of individuals from other species. Massive disappearances of entire species, as are presumably occurring in the world's richest biomes—tropical rainforests and coral reefs—seem to bring no fitness advantages to any creatures. If a single species is responsible, that same species exhibits the variation on which natural selection does not act directly, if at all: sociopolitical and economic variation.

Assigning Blame

Some conservationists would not exempt the native peoples from some share of the blame in species loss. Paleontologist Paul Martin, for example, has made the point, widely accepted by many, that extinction of scores of taxa of megafauna in the Americas coincided with the arrival of the first humans and that their hunting technology was chiefly responsible for a blitzkrieg on those fauna.[2] That view in a sense blames the entire human species for the modern extinctions that exceed the background rate.

The argument goes that the destruction of other species is a natural artifact of the ingenuity of humans, who make and use destructive weapons. There is also an assumption that humans are indifferent to the survival of other organisms in their environment. But not all human societies can be so easily classified. In fact, recent evidence suggests that the hunting technology of Late Pleistocene people in South America was not geared toward dispatching megafauna anyway. Instead, prehistoric native peoples depended for food on a wide range of resources, including plants, shellfish, and small game animals.[3]

The native peoples of Amazonia were no exception. Moreover, their social organization was characterized by villages, bands, and sometimes chiefdoms; they never developed a state.

One of the problems in writing about extinctions in Amazonia is the relative paucity of scientific documentation and identification of contemporary taxa of flora and fauna. This paucity is not due to the purposeful neglect of the region but to its proportions. Amazonia is roughly the size of the continental United States and displays extreme richness of species overall, which is sometimes called "beta" diversity.

Though it's difficult to quantify with precision the rate of extinctions of organisms—since many of these species are endemic to the region, and because the area has such a rich diversity of species—deforestation and habitat conversion in many areas are causing extinctions of organisms above the background rate.

But there are other causes for declines in the diversity of species. In some cases, human population decline has resulted in losses of other species and losses in the varieties of species. Such species, to be sure, were domesticated by humans. That is, they either had their genotypes altered or in some way had become dependent on human technological interventions, including agricultural intervention, for survival. Plant geneticist Charles Clement has presented compelling evidence that the inventory of crops in Amazonia in 1492 stood at 138 species—about half the total of all crops in the Americas at the time. That is a higher number of domesticates than exist in that region today.[4]

Minding the Farm

Though high population densities in some parts of the world have been implicated in the loss of certain species, low population densities can also lead to species loss. The native population in Amazonia numbered in the millions at that time, whereas today it is only about 300,000. The rest of the non-native population of today are the townspeople and city-dwellers, who number in the millions.

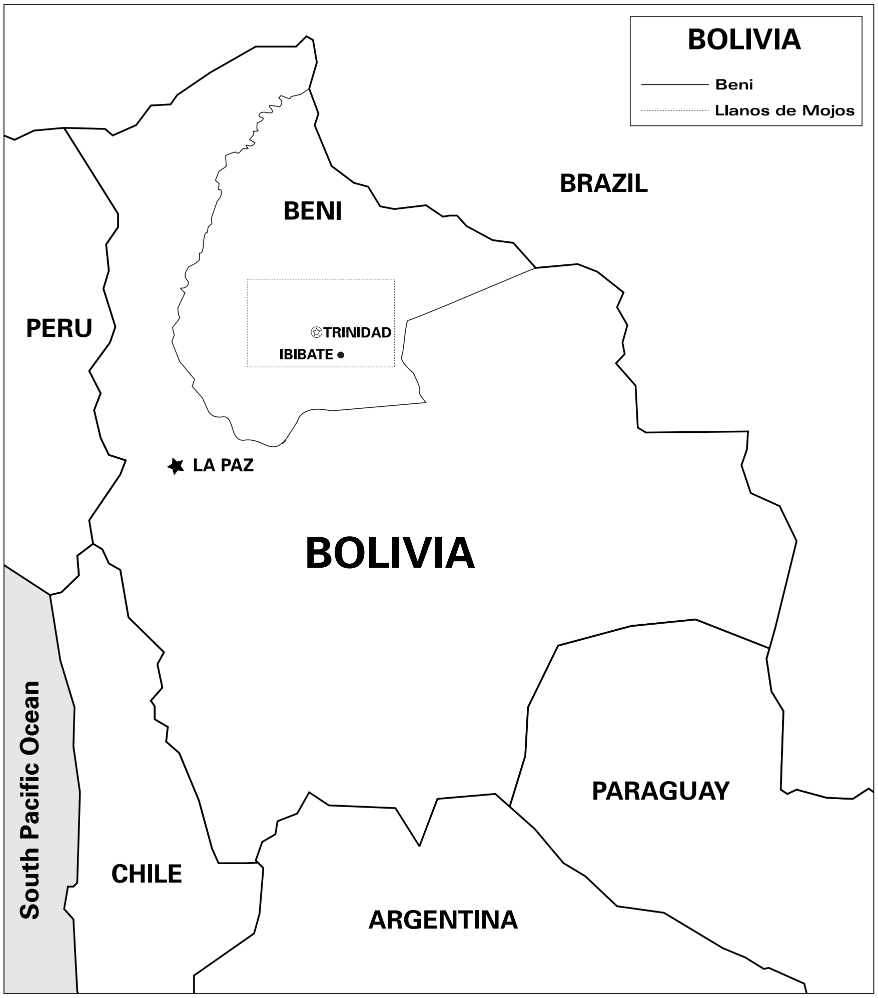
Clement shows that genetic erosion has occurred within many domesticated crop species in Amazonia because the genetic variability of these species is quite low. Presumably, when people were more numerous and their crops more disseminated across the Amazon Basin, variation within crops was also much higher. In many areas, some tree crops, including peach palm, genipapo, and caimito, have reverted to a wild state and, intriguingly, lost some degree of infraspecific variation, that is, variation within a crop. Clement's point is that the great depopulation of humans in the Americas that followed from contact and the incidental introduction of Old World diseases, to which the native Americans had no acquired immunity, along with an urban revolution that had occurred about 2000 years before European colonization, left too few people to tend the existing diversity of crops that they and their ancestors had, in effect, created.[5]

Prehistoric Amazonian Indians accomplished more than simply domesticating wild species and diversifying genomes within crops. They also created forests where none had existed before.[6] Evidence suggests that at least 12 percent of the Amazonian forests seems to reflect ancient human influences.[7] More to the point, some forests are arguably artifacts—like potsherds and other refuse that people make and discard and which show up in the layers of time represented as strata in the ground that archaeologists, as a matter of course, excavate and reconstruct as cultural horizons and traditions. Such cultural forests can be found in the eastern Bolivian Amazon, in a region known as the Llanos de Mojos, or Moxos Plains, in the department of the Beni. (See figure 1.)

Mound Builders

The Llanos de Mojos is about the size of Iowa and reminds me, a native Floridian, of the Everglades,

Figure 1. The Llanos de Mojos where the Ibibate mounds are located within the Beni department.



as it consists of two-thirds wetland savanna and one-third tropical forests that are located in a patchy distribution across the landscape.

Sometime in the first millennium A.D., the native inhabitants of the region began erecting large earthworks scattered across the savanna. Some of these earthworks, which are mounds like the Indian mounds of the Ohio River Valley, were linked to each other by means of causeways that stretched out for miles straight across the savanna.

In the summer of 1993, and off and on until 1997, I undertook a study of the vegetation on one of these forested mounds. In the Sirionó Indian language, this mound is called Ibibate, meaning "high earth." The mound is about 18 meters (59 feet) tall according to measurements taken by archaeologist Clark Erickson and his research team from the University of Pennsylvania, who conducted a preliminary survey of the prehistoric cultural characteristics of the mound.[8] The 2.5 hectare (6-acre) mound is found inside Sirionó Territory, a federally recognized land reserve.

The Sirionó themselves, who number about 600 persons, have evidently lived in the vicinity of Ibibate for the last several hundred years.[9]

I carried out an inventory of one hectare (2.5 acres) of the forest growing atop Ibibate mound. On this inventory plot grew 448 individual trees four inches or more in diameter; these trees accounted for 55 species in all. In contrast, the surrounding savanna is mostly composed of sedges and grasses of low diversity with an occasional palm or other tree growing on some slight, unusual relief. In other words, the forest grows where the ground is elevated and free or mostly free from seasonal flooding.

The forest grows not because it is on some naturally elevated surface—such as a berm or a hill—but because it is on an earthwork, an artificially constructed mound. There are many such Indian mounds and artificial forest islands found in the Llanos de Mojos, perhaps thousands, according to Erickson.

Some natural elevations above the low-lying savanna do occur. Besides forests growing on old river levees and gallery forests—forests on active river margins—occasional groupings of trees are found on termite mounds in the savanna.[10] But these mounds are small and low in comparison with those built by prehistoric people in the area.

It may be that the mound of Ibibate began as a small complex of termite mounds that was used as a temporary campsite by fisherfolk or hunters. After several such encampments, some refuse may have accumulated, elevating the former termite mound complex even more.

At some point, the site may have seemed appropriate for a more or less sedentary village lifestyle.

Ensuing years of occupation and accumulation of refuse could have built it up higher. Later, people most likely deliberately built the mound up toward the sky, as it terminates in a peak or pinnacle that seems to have been planned, not a haphazard feature.

No rock occurs naturally in the savanna; had there been limestone as there is in such abundance in the lowland Maya area of Yucatán, Mexico, for example, perhaps pyramids would have been built here instead of earthen mounds.

The mound of Ibibate is littered on the surface, and potsherds are found in its stratigraphy; Erickson and his team encountered entire bowls and urns on and near the surface beneath the forest shade.

Since the mound was last occupied by a sedentary prehistoric people, perhaps in the period AD 1200 to 1600, an average precipitation of about 152 centimeters (60 inches) per year there has surely caused erosion. So at one time, the mound of Ibibate was even higher than 18 meters.

Because the mound builders made and used a large quantity of ceramics, as is obvious from casual inspection of the mound today, the geographer Roberto Lanstroth appropriately called Ibibate and mounds like it "ceramic forests."

The long-time amateur student of the earthworks and causeways of the Llanos de Mojos, Kenneth Lee, told me in 1997—shortly before his death—that the soil composition of a mound he had studied near Ibibate was 13 percent pure ceramics.

Orchard Keepers

For obvious reasons, people do not tend to live in villages covered by large trees. Thus, if the people of the mound had lived there without the forest cover now apparent, some tract of forest probably remained nearby. Even if they obtained most of their food from agricultural fields,[11] they probably also hunted, fished, and gathered nondomesticated fruits from trees in the forest.

But what forest? About one-fifth, or 12, of the 55 species I recorded were fruit trees for the Sirionó people of today and probably were gathered by earlier people also. These trees included genipapo with mildly sweet fruit; a variety of caimito with very sweet, pulpy fruit; several species of palms with edible fruits, one of them with a most desired palm heart, a real delicacy; a kind of mulberry with tart fruit; and hogplum with juicy, acidic fruits rich in vitamins A and C.

What is more significant, though, is that these 12 species accounted for 204, or 46 percent, of the 448 individual trees on the entire plot. In short, the Ibibate forest is an orchard—a cultural forest representing a substantial food resource for modern people, not only in terms of the numerous game animals that take refuge in it today, but because of the abundance of fruit trees.

The ancient people would also have needed firewood. They must have burned up large quantities of wood to fire their ceramics, to cook their food, and to produce enough heat to keep warm from the periodic Antarctic cold fronts, known as surazos, that sweep in from the south bringing the ambient temperature down to the low 40s Fahrenheit, even in the Amazon. I believe they used the lower part of the mound, where it begins to interface with the savanna, as a fruit tree and fuel reserve. In other words, I suspect the mound was denuded, for the most part, of tree vegetation at its height, where people's homes would have been located.

At the mound's base, where it is surrounded by a moat, there was a general declivity toward the wetland savanna. On this declivity today, which is seasonally flooded, there is forest, and many of the species here seem to be the same as those that grow on the mound.

One fruit tree that grows on the mound but apparently not in the savanna is a member of the genus *Sorocea* in the mulberry family; it is called turumbúri by the Sirionó, who use its tart, grape-like fruits for making an intoxicating beverage drunk by all on ceremonial occasions.

My Sirionó consultants report that turumbúri is grown only on the mound. In fact, 20, or about 4 percent, of the 448 trees I sampled were of this species, whereas in another plot of one hectare in the low forest near the savanna that I surveyed in 1997, at the base of the mound, there were no turumbúri trees. In other words, turumbúri most likely does not tolerate flooding, even mild, seasonal flooding.

Perhaps it also has special soil requirements. Whereas the soils of the savanna are poor for agriculture, those of Ibibate are extremely rich in nutrients such as carbon, nitrogen, and phosphorous—essential to plant growth—according to soil samples I had analyzed in Santa Cruz in 1999.

In a sense, the ancient mound builders made a habitat for the growth and expansion of a species that was culturally very useful, at least to the Sirionó people. Whereas the turumbúri trees were probably not planted, as their seeds are easily dispersed by birds,[12] these trees grow on Ibibate as a result of habitat modification by people in the past.

It is likely that many of the species at the base of the mound would not grow there if the area was not slightly elevated above the surrounding wetland savanna. The trees there, with the notable exception of the absent *Sorocea*, may have existed as a seed source for the forest on Ibibate after the original prehistoric mound builders abandoned it.

The Ibibate forest was arguably the source of fuelwood and fruit trees in the past for the people who lived on the mound; perhaps it served as a kind of forest reserve for that ancient culture.

In any event, by the time the Sirionó ancestors came into and occupied this area, Ibibate and many other mounds like it were covered in tropical forests that from the air seem indistinguishable from primary, or virgin, forests. And the Sirionó, who were traditionally a trekking people but had some agriculture despite their relatively high mobility, seem to have had a minimal impact on the forest cover over Ibibate.

The principal conclusion that can be drawn from this study is that people of the past did create structures—in this case, mounds that resembled enormous elevated platforms above the low-lying, wet savanna—that later accommodated tropical forests, in specific locales where there were no forests before the people were there. Thus, the ancient inhabitants of the Llanos de Mojos were not just mound builders, they were forest builders too. And the people who succeeded them in the savanna did not tend to convert these forest mounds into clear-cut areas for agriculture and like purposes. Perhaps that could all change, and the forests of eastern Bolivia, as elsewhere in much of Amazonia, could be cut down for whatever economic purpose. My point is that the forests themselves would not be there to cut down today had people not created them in the past.

Human Nature?

The blanket statement that humans alone are responsible for the massive environmental degradation and loss of diversity seen in tropical habitats today needs to be tempered with lessons from history and prehistory. Just because humans alone as a species may be the ultimate agents of decreasing biodiversity in our own time does not mean that it is human nature to cause other species to go extinct.

It is debatable whether the first people in the New World, who arrived at least 12,000 years ago and probably long before that, had any major responsibility for the extinctions of the megafauna that occurred in the Late Pleistocene. The mound builders at Ibibate are at least one example of ancient Native Americans whose activities actually increased biodiversity in specific milieus.

These peoples prove that some sociopolitical systems very unlike our own, industrialized one—whose subjects spoke unwritten languages, lived on high hills above tropical savannas, and had no inkling of Western Europe, Christendom, and market exchange—were not threats to biodiversity, but rather contributed to expanding and maintaining it, wittingly or not.

The accurate assessment of Amazonian diversity, which has the most species in the world in relation to comparable land masses, can never be completed until the historic, human factors that have also contributed to it have been taken fully into account. Perhaps it is time to recognize that one possible solution to vanishing biodiversity would be to leave Amazon forests in the hands of those who inherited them in the first place. If the state, or any state, did that, it could become a genuine agent of conservation in our time.■

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NOTES

1. Considerable documentation on this process in the Peruvian Andes, both in Inca and post-Inca times, has been provided by geographer Karl S. Zimmerer. See his *Changing Fortunes: Biodiversity and Peasant Livelihood in the Peruvian Andes* (Berkeley, CA: University of California Press, 1996).

2. Paul S. Martin and Richard G. Klein, eds., *Quaternary Extinctions: A Prehistoric Revolution* (Tucson: University of Arizona Press, 1984).

3. Thomas D. Dillehay, *The Settlement of the Americas: A New Prehistory* (New York: Basic Books, 2000).

4. Charles Clement, "1492 and the Loss of Amazonian Crop Genetic Resources. I. The Relation between Domestication and Human Population Decline," *Economic Botany* 53 (1999), pp. 188-199; Charles Clement, "1492 and the Loss of Amazonian Crop Genetic Resources. II. Crop Biogeography at Contact," *Economic Botany* 53 (1999), pp. 203-216.

5. Francis Black, "Why Did They Die?" *Science* 258 (1992), pp.1739-1740.

6. William M. Denevan, "The Pristine Myth," *Annals of the Association of American Geographers* 82(3) (1992), pp. 369-385.

7. William Balée, "The Culture of Amazonian Forests," *Advances in Economic Botany* 7 (1989), pp. 1-21.

8. Clark Erickson, "Archaeological Methods for the Study of Ancient Landscapes of the Llanos de Mojos in the Bolivian Amazon," in Peter W. Stahl, ed., *Archaeology in the Lowland American Tropics* (Cambridge: Cambridge University Press, 1995), pp. 66-95. The mound is connected to another 1.6-hectare (4-acre) mound. The entire complex, including nearby elevated surfaces, trails, and causeways, is about 6-8 hectares (15-20 acres) in extent.

9. William Balée, "The Sirionó of the Llanos de Mojos, Bolivia" in Richard Lee and Richard Daly, eds., *Cambridge Encyclopedia of Hunters and Gatherers* (Cambridge: Cambridge University Press, 1999), pp.105-109.

10. Roberto Langstroth, *Forest Islands in an Amazonian Savanna of Northeastern Bolivia*, Ph.D. dissertation (University of Wisconsin-Madison, 1996).

11. I do not yet know where these fields were located, but I am rather certain the mound builders were an agricultural and not a hunting-and-gathering people, since other mound builders in the region were associated with the cultivation of a wide array of domesticates, as Clement and Erickson independently have noted.

12. Roberto Langstroth agrees with me on this point as to the likely dispersal agents of *Sorocea* .