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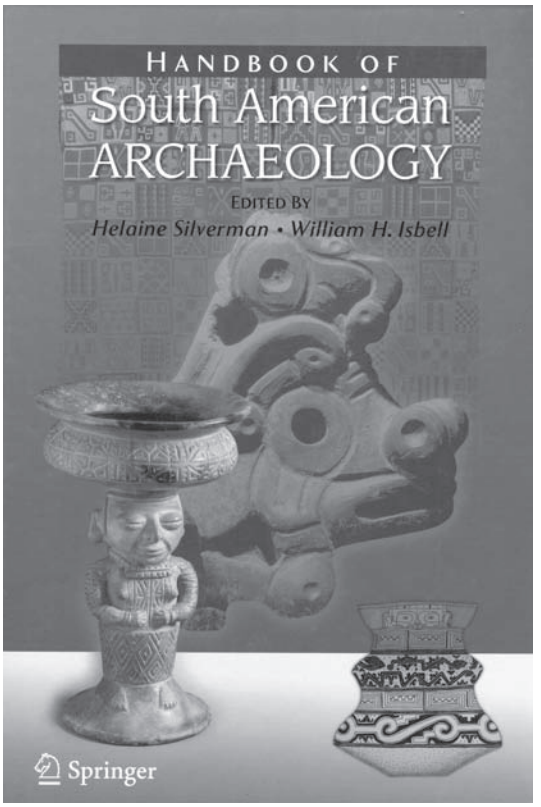
Handbook of South American Archaeology edited by Helaine Silverman and William H. Isbell. Springer, New York, 2008, pp. 1191.

Reviewed by Betty J. Meggers[1]



The *Handbook of South American Archaeology* is a landmark not only because of its continental coverage, but because it is the first multi-authored volume in English since the 7-volume *Handbook* edited by Julian Steward and published by the Smithsonian Institution more than half a century ago. Two other multi-authored overviews have been published in the interim, but both are in Spanish and consequently have received minimal attention from US archeologists. All the authors in *Prehistoria Sudamericana: Nuevas Perspectivas* (Meggers 1992) are natives of the countries they discuss and continental coverage is even, all countries represented by one or two Chapters except for Brazil, which is represented by six. All except five of the 26 Chapters in *Formativo Sudamericano: una Revaluación* (Ledergerber-Crespo 1999) are South Americans and national coverage is also relatively even, ranging from three to five Chapters for most countries.

In this *Handbook,* more than half of the authors are foreign and the geographical coverage is uneven. Although some parts of the continent provide a general overview of regional cultural development, specifically northern Chile (Chapter 48), South American pampas and campos (Chapter 14), the Guianas (Chapter 16), and Venezuela (Chapter 23), most Chapters focus on part of the local sequence, among them early occupations in the Southern Cone (Chapter 4), on the north coast of Chile (Chapter 3), and in the Peruvian highlands (Chapter 9); preceramic coastal adaptations in Peru (Chapter 10) and southern Brazil (Chapter18); the Formative period on the coast of Ecuador (Chapters 5, 24) and in the Titicaca Basin (Chapter 28); chiefdoms in Brazil (Chapter 19), Colombia (Chapters 21, 22), and highland Ecuador (Chapter 27); regional polities in Ecuador (Chapters 25, 26) and south coastal Peru (Chapter 29), and states and empires in the central Andes (Chapters 31, 36, 39, 40). Cultural development in the Amazon basin is discussed in Chapters 11, 12, 20, 33, 46, 47. Earthworks are described in lowland Bolivia (Chapter 11), on the coast of the Guianas (Chapters 13, 16, 17), and in eastern lowland Ecuador (Chapter 15). Three Chapters provide overviews of plant domestication (Chapter 7), animal domestication (Chapter 8), and the peopling of the continent (Chapter 2). Other specialized topics include the khipu (Chapter 41), ancestor images (Chapter 51), and trophy heads and human sacrifice in the Andes (Chapter 52).

Although the emphasis varies, the temporal and spatial distributions of settlements, artifacts, subsistence, burials, ritual features, and other cultural remains are described and interpreted in most of the chapters, often in the context of the impact of environmental fluctuations. Treatment is typically even-handed and objective, changes in interpretation as a result of new evidence are often described, and when experts disagree, the relative merits of their views are assessed. Interpretations of the social significance of architectural features, settlement pattern, site density, luxury goods, and other archeological remains are limited to general categories (elite,

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commoners, specialists). No effort is made to identify linguistic affiliations except in Amazonia. The existence of Chapters describing comparable levels of social complexity in different regions, such as the emergence of chiefdoms in the highlands of Colombia, Ecuador, and Peru, makes it possible to evaluate the impact of environmental differences on cultural adaptation.

The astute reader will notice a significant contrast between the content and interpretations in the Chapters on the Formative Period of coastal Ecuador and on Amazonia and those on the rest of the continent. In part, this reflects the fact that archeological evidence is limited primarily to pottery, both regions being characterized by warm humid climates in which stone is rare and perishable materials, including most artifacts, architectural features, human skeletal remains, and subsistence remains rarely survive. However, the discussions of these two regions also suffer from another deficiency; namely, the abandonment of traditional theoretical approaches for interpreting the archaeological record. Also, in contrast to the other chapters, these authors do not discuss the substantial evidence that disagrees with their views although it is unfamiliar to most archaeologists. Consequently, I appreciate the opportunity to explain the implications of their approach both for reconstructing prehistoric cultural development in the tropical lowlands and for the future of archaeology as a scientific discipline.

Criteria for Evaluating Cultural Similarities

Like biologists, who use genetic criteria to distinguish common ancestry from evolutionary convergence and independent development to explain morphological similarities in plants and animals in widely separated regions (such as columnar cacti in the southwestern US and northwestern Argentina), and geologists who use chemical composition to differentiate similar appearing rocks and minerals, archaeologists have traditionally used details of decoration on pottery to distinguish diffusion from independent invention. Pottery is ideal for this purpose because it can be decorated using an essentially unlimited number of techniques and motifs without affecting the utility of the vessel, making independent duplication of identical decoration unlikely. Several Chapters in this *Handbook* use differences in pottery to identify the origins of contemporary populations, but this criterion is ignored by James Zeidler (Chapter 24) in interpreting the origins of the Valdivia and Machalilla ceramic traditions on the coast of Ecuador and by Eduardo Neves (Chapter 20) in reconstructing the origin of pottery in Amazonia. Another widely accepted theoretical position involves identifying intrinsic environmental limitations and intermittent climatic fluctuations and estimating their impact on cultural complexity. Contrary to Sandweiss and Richardson (Chapter 6), who state that "understanding climatic change and natural disasters is critical to reconstructing cultural trajectories in the Andes" (p. 101), the authors of the Chapters on Amazonia (especially Chapters 11, 12, 33, 46, and 47) argue that "disturbance caused by human activities is a key factor in shaping biodiversity and environmental health" (p. 158). The consequences of ignoring these traditional approaches become evident when the evidence is examined.

The Origin of New World Pottery

The archeology of coastal Ecuador was essentially unknown prior to the 1950's when Emilio Estrada began his fieldwork. He identified three Formative ceramic traditions, which he named Valdivia, Machalilla, and Chorrera. His definitions of Valdivia and Machalilla were expanded by subsequent fieldwork by Meggers and Evans and detailed descriptions were published in 1965 in Volume I of the *Smithsonian Contributions to Anthropology*. Although he had no archaeological training, Estrada recognized that the diagnostic decoration of the three traditions was distinct, implying different antecedents, and searched the literature for similar complexes in the Andes and Mesoamerica without finding any significant resemblances. Being brainwashed by graduate training, we did not think of looking outside the Americas, but Estrada had no such inhibitions and wrote us one day that Valdivia decoration looked to him a lot like Jomon. We were able to get funding to go to Japan in 1963 and traveled from Tokyo to southern Kyushu armed with photographs of Valdivia sherds to compare with pottery from Early and Middle Jomon sites. The closest resemblances we found were concentrated in collections from Ataka, Sobata, and Izumi on the west coast of Kyushu dating from the Early Middle Jomon Period.

Valdivia pottery appears about 6,000 BP on the coast of Ecuador with no local antecedents and the decoration is diverse in technique and motif from the beginning. The Meggers, Evans & Estrada 1965 Smithsonian monograph contains 26 plates that illustrate the same range of variation in technique and motif in broad-line incised, zoned incised, zoned punctuate, pseudo corrugated, multiple drag-and-jab, shell combed bands, overall shell scraped, finger grooved, excised, rocker stamped, drag-and-jab punctuate, and cord impressed decoration from Valdivia and Jomon sites. A photograph of a distinctive early technique consisting of a row of finger-tip impressions on the interior of the shoulder producing a low boss on the exterior, which we did not encounter during our visit to Kyushu, was sent to us recently by a Japanese colleague. In spite of the diversity and identity of the duplications between Valdivia and Jomon decoration, Zeidler asserts that "technological convergence or parallelism would seem to be a more parsimonious explanation for the beginnings of Valdivia pottery than transpacific diffusion from the Jomon culture" and that "early trade… may have spread the *idea* of pottery making from antecedent

ceramic complexes in the Amazon basin" (p .462). In accord with his acceptance of an Amazonian origin for Valdivia pottery, Zeidler considers that "Lathrap has persuasively argued that Valdivia represents a tropical forest culture pattern… whose ultimate origins are linked to early population dispersals from the Amazon basin" (p. 462). He does not specify what these similarities are and the absence of evidence for sedentary communities earlier than Valdivia anywhere in the eastern lowlands, as well as the absence of any similarity between the environments of the two regions, make this theory unpersuasive.

These alternatives not only dismiss the significance of the duplication of multiple arbitrary features of abstract decoration for inferring cultural relationship, but fail to recognize the magnitude and diversity of other evidence supporting the Jomon origin of Valdivia pottery. Pottery was invented in Japan at least 14,000 years ago and by 6,000 BP had diversified into regional styles that differ more from one another than Kyushu Jomon does from Valdivia. A few years ago, another ceramic complex contemporary with Valdivia was discovered at San Jacinto on the north coast of Colombia that has decoration resembling the Jomon Flame Style on the west coast of Honshu, famous for its elaborate castellated rims decorated with zigzag appliqué, cord impression, and modeling. Like Zeidler, Augusto Oyuela-Caycedo (Chapter 22) denies a transpacific introduction in spite of the absence of local antecedents, the unique character of the decoration, and the contemporaneity of the Jomon and Colombian ceramic complexes (see Meggers 2005).

Since watercraft was available in Japan from at least the Paleolithic and its use for deep-sea fishing is documented by faunal remains in shell middens, why is there no earlier evidence of transpacific voyages? Given the antipathy of archaeologists to the possibility, it is likely that clues have been ignored, but the timing of the Valdivia-San Jacinto introductions can be explained by the catastrophic eruption of Kikai volcano off southern Japan about 6,300 BP, which deposited 40 cm of ash on Kyushu and lesser amounts as far north as central Honshu, causing landslides and slope erosion, decimating the population, and covering the land and the ocean with pumice. The impact of the eruption on the Jomon population is reflected in the density of one habitation site per 100 km² on Kyushu versus one site per 10 km² on the northern island of Hokkaido and one site per km² on Honshu during the Middle Jomon Period. Any fishing boats at sea would have been trapped in the pumice and swept north by the Black Current across the Pacific and down the west coast of the Americas as far as Ecuador. There, survivors would have encountered people living much as they did in Japan, but lacking pottery.

The ceramic evidence for prehistoric transpacific immigrants from Japan is also supported by epidemiological and genetic similarities between Japanese and prehistoric Andean populations that could not have evolved independently or been introduced across the Bering Strait. Among them is the human T-cell leukemia virus HTLV-1, which is transmitted between adult males and females by sexual contact and between nursing mothers and infants. The highest occurrence of carriers today is in Japan, where it reaches 6% in Kyushu; in the Americas, it is restricted to the Andean area. Jomon influence may also be reflected in the sudden adoption of permanent settlement during the Valdivia period on the coast of Ecuador and other intangible innovations, but the assumption of the independent invention of pottery discourages investigation (Raymond, Chapter 5).

In contrast to Zeidler's denial of any relationship between the identical decoration of Jomon and Valdivia pottery, he accepts the "convincing arguments that the Machalilla ceramic style evolved directly out of the Late and Terminal Valdivia ceramic style" (p. 466), in spite of the absence of any shared characteristics. Machalilla pottery is decorated by double-line incision, embellished or nicked shoulder, black-on-white painting, fine zoned hachure, incised or punctated and red zoned, and narrow or wide red bands, none of which occur in Valdivia. Vessel shapes are also different, including bowls with angular shoulders and jars with stirrup spouts. He does not specify what "convincing arguments" favor local development and the overlap between the initial Machalilla and terminal Valdivia dates leave no space for such a drastic transformation. Nor does he mention the similarities noticed by other archaeologists between Machalilla and several highland Ecuadorian complexes.

A similar discrepancy exists in the acceptance by Zeidler and other authors of the *Handbook* (Neves, Oliver, Rostain, Isbell) of the pottery from the Taperinha shell midden on the middle Amazon as the earliest in the Americas, in spite of the lack of association between the pottery and the radiocarbon dates (Roosevelt et al. 1991) and the absence of any similarity between Valdivia decoration and that on the three sherds from Taperinha. The lower half of the deposit consists of amorphous shell and is separated from the upper half by a clearly defined sterile layer that implies long-term abandonment of the site. The upper half consists of irregular overlapping strata. All of the dates are from the lower half and most of the pottery is from the upper half. The few sherds encountered below the sterile layer can be attributed to intrusion via pits dug by iguanas or armadillos that frequent the mound. The eleven AMS dates obtained from below the sterile layer extend from 7,090 ± 80 to 6,300 ± 90 BP, making them a millennium earlier than the initial Valdivia and San Jacinto dates and compatible with their preceramic context.

Assuming that Taperinha pottery is earlier than Valdivia and San Jacinto, Roosevelt argues that it could not be derived from them, but she does not consider the possibility that it might be affiliated with a later complex. In fact, the decoration on the only three sherds she has

illustrated, consisting of "feathered" incision, zoned parallel lines, and double-line incision, is diagnostic of the Barlovento Phase on the north coast of Colombia, which extended from about 3,600 to 2,800 BP. The most reasonable interpretation of the archaeological evidence is the migration of a few families from a Barlovento site to the central Amazon and their settlement on the abandoned shell midden of Taperinha. The absence of any other sites with similar pottery along the Amazon testifies to their failure to introduce pottery making to the indigenous population.

Whereas accepting an association between the pottery and the radiocarbon dates from Taperinha is a dead end, identification of its Colombian origin raises the question of what motivated the immigrants to leave their homeland. The ceramic sequence on the Caribbean coast of Colombia is the best documented in South America as a result of detailed investigations and publications by Gerardo Reichel-Dolmatoff (1985) and Carlos Angulo Valdez (1981) and the chronology of change in decoration is well defined. The history of climatic fluctuations is also well documented and indicates that parts of the region suffered episodes of drought during this period that affected traditional subsistence resources and stimulated dispersal to adjacent regions (Sanoja and Vargas 2007). The appearance of Barlovento-related pottery on the middle Amazon adds important evidence to the reconstruction of this event.

Amazonia: Anthropogenic Landscape or Counterfeit Paradise?

Although the unique environment of the Amazonian Basin and its limitations for the development of permanent settlements and intensive agriculture have been documented by geologists, paleoecologists, climatologists, botanists, and other natural scientists for decades, Erickson insists that "Rather than adapt to or be limited by the Amazonian environment, humans created, transformed, and managed cultural or anthropogenic (human-made) landscapes that suited their purposes " (Chapter 11, p. 158) and that "archaeologists have demonstrated that much of Amazonia was occupied by dense populations of urbanized societies practicing intensive agriculture that significantly contributed to creating the environment that is appreciated today" (p. 161). He contrasts this approach, which he calls "historical ecology," with cultural ecology, which he claims "treats the environment as a static, fixed, often limited resource to which humans adapt" (p. 165) and identifies me as "the main spokesperson" of the latter approach (p. 162).

The goal of historical ecology is to "carefully document and analyze the evidence within its temporal and spatial context for insights into original logic, design, engineering, and intentionality of human actions" (p. 159). The principal authorities he cites, in addition to anonymous "scholars" and "archaeologists," are William Denevan, a geographer; William Balée, an ethnobotanist; Peter Stahl, a faunal specialist, and Donald Lathrap, an archaeologist who did his doctoral research 50 years ago on the Ucayali. Erickson's own Amazonian experience is limited to the Llanos de Mojos in eastern Bolivia. The only Amazonian archaeologists mentioned are Eduardo Neves, Michael Heckenberger, and Anna Roosevelt.

Defining "Amazonia". Amazonia is defined by geographers and ecologists as the portion of tropical lowland South America below 1,500 meters elevation, where the average difference in annual temperature does not exceed 5ºF, rain falls on 130 or more days of the year, and relative humidity normally exceeds 80%. Typical vegetation consists of rainforest, with small enclaves of savanna where soil conditions inhibit plant growth.

Erickson expands the definition to encompass "the entire region drained by the Amazon River and its tributaries" (p. 158). This allows him to cite any kind of archaeological evidence up to the highland headwaters of all the tributaries to support his contention that Amazonia is a "domesticated landscape," regardless of the characteristics of the soil, climate, elevation, topography or vegetation. The principal evidence he provides for the creation, transformation and management of domesticated, engineered, humanized landscapes is the existence of anthropogenic forests, large permanent settlements, earthworks, and Amazonian dark earth (ADE).

Anthropogenic Forests. According to Erickson, "Countering the view of Amazonian forests as pristine and natural, historical ecologists show that these forests are, to a large degree, the cultural products of human activity" (p. 175). He contends that "Rather than adapt or respond to the environment, Amazonian people created, transformed, and managed those very environments in which they lived and thrived through their culture" (p. 165); "The long-term strategy of forest management was to cull non-economic species and replace them with economic species" (p. 175); "Much of what was originally misinterpreted as natural change due to climate fluctuations is now considered anthropogenic" (p. 175) "Many game animals of Amazonia would have a difficult time surviving without a cultural and historical landscape of human gardens, fields, orchards, and agroforestry" (p. 176). "Through the domestication of landscape, native people shaped the landscape as they wanted it and made it work for them" (p. 177).

Whereas Erickson provides neither examples nor references to support these interpretations, botanists, ecologists, and climatologists have published hundreds of articles and dozens of books linking past and present changes in the composition of rainforest vegetation to climatic fluctuations and identifying environmental factors responsible for contemporary biodiversity. For example, an inventory of patches of secondary forest visible on Landsat images across the Brazilian Amazon indicates that they are similar in origin to recent blowdowns confirmed north of Manaus, rather than remnants

of cultivated fields (Nelson et al. 1994). Analysis of pollen cores in the rainforest of French Guiana where no archaeological sites have been encountered indicates that "the tropical rain forest, thought to have remained stable since the last glacial event, has in fact undergone deep modifications" (Charles-Dominique et al. 1998:296). After reviewing the paleoecological record, Bush and Silman (2007:457) conclude that "we see no evidence suggesting that large areas at a distance from rivers or in the less seasonal parts of Amazonia were substantially altered by human activity". According to Piperno and Becker (1996:202, 207), analysis of phytoliths and macroscopic charcoal from soils near Manaus indicates that "closed forest has existed in the area since at least 4,600 yr BP. Vegetational changes and fires appear to be the result of climatic drying that may have affected large areas of the Amazon Basin over the past 5,000 to 7,000 years. Thus, it appears that this one sector of Amazonian *terra firme* forest was never significantly altered by humans". Identification of fossil pollen in two sediment cores in eastern lowland Ecuador also implies the persistence of moist tropical rain forest throughout the Holocene and provides no evidence for human impacts or land use (Weng et al. 2002). Finally, cores from lake districts in eastern Peru and eastern Brazil do not support the contention that all of Amazonia is a built landscape (Bush and Silman 2007).

Large Permanent Settlements. Erickson states that "Archaeologists [unidentified] have demonstrated that much of Amazonia was occupied by dense populations of urbanized societies practicing intensive agriculture that significantly contributed to creating the environment that is appreciated today" (p. 161). Although he asserts that "Traditional communities had large, open, clean plazas and streets along which houses were arranged in linear, grid, radial, or ring patterns" (p. 166), he mentions only Santarem and the Sangay site in eastern Ecuador, neither of which has this configuration. Based on the description of a modern Bari communal house in eastern Colombia that was constructed using 750,000 fronds from 125,000 palms, he estimates that a pre-Columbian population of 6.8 million for Amazonia would have required 1,360,000 communal houses "in a single moment," which would have had to be replaced every 10 years. Huge additional amounts of wood would have been needed for cooking fires, palisades, watercraft, and artifacts. Even though admitting that "A community's permanent transformation of the environment for these basic needs and infrastructure is staggering," he asserts that "these communities were stable, long-lived, and sustainable despite this impact" (p. 166-167). He [Erickson] gives no archaeological example and the modern *caboclo* house and associated clearing he illustrates (Figure 11.2) bear no resemblance to traditional indigenous dwellings.

None of the other proponents of the existence of large permanent settlements has supported their interpretation by archaeological evidence. No systematic excavation has ever been done in Santarem to identify dwellings or features that might reveal how much of the area was simultaneously occupied and the estimate of a population of 100,000 is based on the dimensions of the *terra preta*. The only well documented investigations are on Marajó, beginning with Evans and Meggers in 1948-1949, followed by Roosevelt and Schaan (Chapter 19). Although Roosevelt has estimated a population of one million for the island, Schaan has reduced this substantially based on her evidence that the maximum population of the Camutins, the largest group of habitation mounds, would have been only about 2,000 (p. 347). A decade of survey and excavation on the left bank of the lower Solimões has identified several periods of occupation, but the size and permanence of each settlement are not clear (Neves, Chapter 12).

Extensive survey along the principal tributaries of the Amazon during the past 30 years by Brazilian archaeologists, which the historical ecologists do not cite, produces a very different picture of prehistoric settlement behavior. Beginning before 2,000 BP, when pottery making became sufficiently widely distributed for detecting habitation sites, the subsistence and semi-permanent settlement behavior characteristic of surviving indigenous tropical forest communities had been adopted. (see below for discussion).

Earthworks. According to Erickson, "Many Amazonian cultures were impressive mound builders" (p. 168), citing constructions on the Llanos de Mojos in Bolivia, the Llanos del Orinoco in Venezuela, Marajó, Sangay in eastern Ecuador, and the Guayas Basin, none of which is rainforest and the last of which is not in Amazonia. Although he asserts that raised fields constitute the "most impressive example of landscape engineering at a regional scale," he mentions only those in lowland Bolivia (p. 171). He also contends that "all Amazonian societies use elaborate networks of paths and trails and roads between settlements, gardens, fields, rivers, resource locations, and neighbors" and that "Some advanced Amazonian societies built impressive formal roads, causeways, and canals of monumental scale" (p. 173), but the only examples he describes are on the Llanos de Mojos.

With the exception of Marajó and the Açutuba region in the central Amazon, all the earthworks are outside the limits of Amazonia as traditionally defined. Roads, causeways, and canals are limited to the Mojos. Raised fields are also in marginal locations, among them the coast of the Guianas. Paths in the forest quickly disappear if not used regularly. Evidence that the construction of mounds, causeways, ridged fields, and other kinds of earthworks does not require a large organized labor force is provided by Erickson's own experience. When he revisited a village on the Llanos de Mojos after several years, he found a new causeway 12 feet wide, 3 feet high, and half a mile long that had been constructed by members of the small local community in a week.

Amazonian Dark Earth (ADE). The most sensational recent discovery is the existence of patches of fertile black soil in many parts of the lowlands. According to Erickson, "Scholars believe that these soils were created specifically for permanent farming" (p. 171) and "are capable of continuous, high yields and are associated with dense populations, large permanent settlements, and complex society" (p. 163). "ADE was probably used for settlement, house gardens, and permanent fields rather than slash-and-burn agriculture, the common practice today"; "ADE is an excellent example of landscape domestication below the ground" (p. 171). Since it is assumed that slash-and-burn agriculture **"**depends on metal axes and machetes to efficiently clear primary forest. [and] These tools were unavailable until after 1492, Pre-Columbian farmers, using digging sticks and stone axes probably continuously cultivated fields and practiced agroforestry rather than clear primary forest" (p. 163).

The allegation that slash-and-burn agriculture would have been unproductive prior to the acquisition of metal axes is invalidated by its global distribution during millennia prior to the invention of metallurgy and survival in remote regions today.

Furthermore, the assumption that Amazon Dark Earth was created intentionally and would have solved the problem of intensive agricultural production for large sedentary populations is not supported either by observation of current practices or by archaeological evidence.

Agronomic, pedological, and ethnographic research on the productivity of food plants on ADE has been conducted by Laura German (2003) among *caboclos* along the Rio Negro and Rio Urubú in Central Amazonia. Comparison of the yields of bitter manioc, pineapple and star nut palm with those of 10 other New World crops and 10 Old World crops on ADE and on local soil revealed higher yields for the three Amazonian crops on the natural soil. She asserts that "linkages between intentional agricultural intensification and Black Earth formation, and between Black Earth and an increase in human carrying capacity, have been insufficiently established" and concludes that "Observations on the degradation caused by continuous cultivation clearly show that in the absence of ongoing cultural amendments, the carrying capacity of these [black earth] environments would not be significantly greater than that of adjacent sites" and that "the suggestion that these richer pockets of soil made possible the transition to a more sedentary life style is as yet untenable" (German 2003:327, 313).

With regard to slash-and-burn agriculture, Weischet and Caviedes, the authors of the leading synthesis, *The Persisting Ecological Constraints of Tropical Agriculture* (1993) specify that "a differentiation should be made… between natural conditions that are unalterable and those that can be compensated for by man" (1993:41) and conclude that "On the basis of ecological reasoning it can be proven that this particular mode of rotating food crop and forest or bush fallow [i.e shifting cultivation] is a specialized adaptation to the environmental conditions of the tropics which not even modern agrotechnology has been able to replace" (1993:275). They also state that the "unveiling of certain persistent myths about tropical fertility […], by now widely known and dismissed" and explaining "how these myths could be perpetuated and fundamental laws that govern the tropical environments ignored for so long " are crucial for sustainable exploitation of Amazonia (1993:281). Unfortunately, the Chapters by Erickson and others in this *Handbook* indicate that these myths have gained rather than lost their credibility among anthropologists.

The Unique Environment of Amazonia

Amazonia differs from all other tropical forest environments in combining great geological antiquity with abundant rainfall and constantly warm temperature. The Brazilian and Guayana shields preserve some of the most ancient terrestrial landscapes on the planet, which millions of years of chemical and physical weathering and erosion have reduced to inert granite and white sand. Whereas in temperate regions more than half of the organic carbon, some 90 percent of the nitrogen, and the most important minerals are contained in the soil where they remain available to the vegetation, in Amazonia most of the nutrients and all of the calcium are stored in the biomass. According to Weischet and Caviedes, "This is an ecologically decisive difference with far-reaching consequences" (1993:62). "The part of the forest above ground works like a filter system in that the nutrients supplied by the rain are used several times before they arrive at the soil surface… Only with the decomposition of the different members of the subcycles does a certain portion of the nutritional elements finally reach the soil surface. Here, a substantial nutrient loss is essentially prevented by another agent known as the mycorrhizas" (1993:130). The interspersed distribution of plants of the same species with different nutrient requirements and the rapid disintegration and uptake of litter rescue nutrients that reach the soil so successfully that "as long as the forest is undisturbed, no net loss of macronutrients through outwash occurs as proven by the fact that (1) the autochthonous black- and clear-water streams of the tropical lowland forests may best be likened to slightly contaminated distilled water, and, (2) the waters of small creeks in virgin forest areas contain even less macronutrients than rain-water" (1993:276).

In addition to infertile soil, Amazonia is characterized by the absence of a dormant season, which makes the vegetation continuously susceptible to decimation from pathogens. Their dispersal is minimized by the heterogeneous distribution of wild plants of the same species in the forest, which is replicated by the interdigitation of

crops in indigenous fields. Only palms have the ability to maintain large uniform stands.

Archaeological Evidence of Population Density

Whereas no systematic stratigraphic excavations have been undertaken in habitation sites in any of the regions identified by Erickson as "occupied by dense populations of urbanized societies practicing intensive agriculture" (p. 161), archaeological surveys along the principal tributaries of the Amazon and ethnographic evidence demonstrate that patches of ADE are the product of intermittent occupation of habitation sites during hundreds of years, and were never cultivated prehistorically.

Archaeological survey conducted along a 240 km sector of the Rio Jamarí, a tributary of the upper Madeira in southwestern Brazil, identified 121 sites representing 16 preceramic occupations, 16 lithic workshops, 89 ceramic sites, 8 campsites with pottery, and 2 Neobrazilian sites. All the ceramic sites are *terra preta* (ADE). Unselected surface collections of pottery were made at 42 sites, and one to nine stratigraphic excavations in 10 cm levels were made at 22 sites. Classification and seriation identified five ceramic phases representing the same pottery tradition and permitted construction of a relative chronology that is complemented by 137 radiocarbon dates. The initial ceramic phase, the only one distributed throughout the region, was introduced ca 2,400 BP. By about 1,500 BP, it had differentiated into two phases that occupied contiguous territories characterized by differences in aquatic resources. Each of these was replaced by a later phase of the same tradition about 700 BP (Meggers and Miller 2006).

Comparison of the locations of the ceramic sites with their phase affiliations shows that only 6 were occupied during three successive phases. Seventeen were occupied during two phases and 26 were occupied intermittently during a single phase. All the phases were divided into two moieties distinguished by minor differences in the presence or relative frequency of a rare pottery type and most sites were occupied and reoccupied by the same moiety. When reoccupied by a different moiety or a different phase, the new house was adjacent to rather than on top of the earlier refuse, increasing the surface dimensions of the site. Although there is no visible stratigraphic evidence of the abandonment and reoccupation implied by the discontinuities in the seriated sequences, they are supported by large differences in the radiocarbon dates from successive levels in the same excavation. At RO-PV-35, for example, dates from consecutive 10 cm levels in four excavations distributed across the site are in chronological order but differ by 1500, 900, and 120 years and dates from the same depth in different excavations also differ by hundreds of years. Similar discrepancies between the dates from consecutive 10 cm levels have been identified at 14 other sites, contrary to what would be expected if these sites had been continuously occupied.

The number of sites allocated to each phase and their distribution within the territory provide other clues to settlement behavior. For example, the 14 sites occupied during the Jamarí Phase, which lasted ca 800 years, are widely separated giving the impression that the territory was under populated. A different interpretation is suggested by comparison with the settlement behavior of a modern Yuqui community in eastern Bolivia. Their territory is divided into a nuclear area about 10 km in diameter, where the village is located and most of the hunting is performed, and a peripheral ring about 5 km wide, which is hunted infrequently and serves as a source of replacement for game removed from the nuclear area. This allocation provided sustainable subsistence for a population of ± 100 during 22 years, but is now being compromised by the intrusion of colonists from the adjacent region into the peripheral area. Projecting the diameter of the nuclear area around the locations of the sites of the Jamarí Phase reveals that the boundaries of all but four overlap, and that three more would also overlap if the surrounding ring were included, supporting the interpretation of intermittent occupation based on the seriated sequences.

Another independent estimate of sustainable population density has been provided by biologists concerned with the growing impact of commercial hunting on the survival of preferred species of mammals. Combining age of reproduction, number of progeny, longevity, impact of other predators, and natural death rate for each species permitted estimating the maximum number of individuals per km² that could be eliminated sustainably. Converting the result into biomass and dividing the total by the nutritional requirement of a human consumer produced estimates between 0.2 and 1.0 persons per km² for sustainable hunting. The similarity between these estimates and those ranging between 0.2 and 1.5 per km² provided by ethnographers for the population densities of 12 contemporary indigenous Amazonian communities that maintain their traditional behavior is unlikely to be coincidental.

Historical Ecology versus Environmental "Determinism"

Cultural ecologists, erroneously labeled "environmental determinists," assume that humans, like all other biological organisms, are subject to natural selection and evolutionary drift, but that unlike other animals these affect not only their biological features but also their cultural behavior. Among the impediments to applying evolutionary theory to the interpretation of archaeological remains, especially pottery, is the absence of a standard classification. In contrast to other categories of phenomena (rocks, stars, plants, animals, soils, etc.), where evidence is ignored unless it conforms to the

recognized definitions, every archeologist is free to select whatever criteria he or she prefers and interpret them at will, making comparison possible only at a very general level of similarity. The opportunity to change this situation was provided in Brazil in 1964 by the creation of the Programa Nacional de Pesquisas Arqueológicas (PRONAPA) on the coast, followed in 1976 by the Programa Nacional de Pesquisas Arqueológicas na Bacia Amazônica (PRONAPABA). The participants in these programs adopted standard criteria for collecting, classifying, describing, and interpreting pottery that permitted identifying endogamous communities and the temporal and spatial distributions of their constituent sites.

When the PRONAPA began, we accepted the traditional view that although the samples from surface collections and stratigraphic levels were unselected, they were not random and thus irregularities in the trends in seriated sequences were attributable to sampling error rather than to differences in behavior. As the number of seriated sequences composed of levels from excavations in multiple habitation sites increased, comparison showed that the principal undecorated types, which normally accounted for 90% or more of each sample, usually displayed consistent trends of increasing or decreasing relative frequency, whereas one or more of the decorated types often exhibited minor fluctuations throughout the seriation. On the possibility that these might have cultural significance, the levels were separated into two seriations based on the difference in relative frequency. Comparison of the locations of the sites included in each sub-seriation showed that the majority were different and when they were the same, the portion of the site occupied was different. Since the differences in relative frequency were minor (typically ± 5%), they would not have been apparent to the potters, making the most obvious explanation the impact of evolutionary drift on the products of women isolated by matrilocal residence.

The impact of evolutionary drift on cultural behavior not subject to adaptive constraints has frequently been reported by ethnologists, including minor differences in the relative frequency of the decoration on pottery made for domestic use by women in different communities and by those in the same community isolated by matrilocal residence. For example, among the Shipibo, intensive interaction among women in the same and little between those in different houses ensures that girls learn from their mothers, creating a different micro-style in each community. Among the Bororo, the village is divided among two moieties that exhibit slight differences in decoration and vessel shape. Among traditional potters in Guatemala, where the household is also the unit of production and girls learn from the oldest relative, each local group has a distinctive style. An experiment conducted decades ago, in which a sequence of potters was told to copy the preceding vessel, demonstrated minor unconscious modifications.

Other interpretations based on archaeological evidence and confirmed ethnographically include matrilocal residence, endogamous communities, permanent territorial boundaries, reoccupation of sites by the original community or moiety, avoidance of earlier sites by later communities both for settlement and cultivation, and low population density.

The assumption that ADE is the product of permanent residence is invalidated by the archaeological evidence for abandonment and reoccupation of all but the smallest habitation sites wherever systematic survey has been conducted along the tributaries of the Amazon. The avoidance of previously occupied locations by subsequent occupants of the region detected by the seriations is explained by the ethnographic evidence that prehistoric sites are neither cultivated nor reoccupied by traditional indigenous communities today because they are recognized as cemeteries and the spirits of the deceased are respected.

The existence of detailed reconstructions of settlement behavior along the principal tributaries of the Amazon since about 2,000 BC makes it possible to evaluate the credibility of the prehistoric population density and social complexity inferred by the historical ecologists not only with the archeological record, but also with independent climatic and ethnographic evidence. In the case of the Jamarí sequence, for example, comparison of the durations of the five ceramic phases with the radiocarbon dates indicates that the replacements occurred ca 1,500, and 700 BP. Examination of other well dated sequences across the lowlands shows additional discontinuities on the Llanos de Mojos and the lower Orinoco ca. 1,000 BP. The coincidence between the timing of these replacements and the impact of mega-Niño events implies that the associated episodes of aridity depleted subsistence resources sufficiently to force people to abandon their villages and revert to hunting and gathering until conditions returned to normal. Whereas the relatively brief durations of the mega-Niño events limit their identification in Amazonian pollen cores, the reduced intensity of the 1,000 BP event in Amazonia is clearly documented archaeologically by the absence of discontinuities in the tropical forest sequences.

Although minor El Niño droughts leave no archaeological imprint, the climatic record indicates that they occur at intervals of about seven years between the catastrophic events. Observations of the impact of a brief El Niño episode in 1983 on the rainforest of Barro Colorado Island in Panama indicate that their consequences can be dramatic. Thirty-three out of 37 moisture-demanding species of plants declined significantly and the abundance of small shrubs fell by 35% during the following 13 years. “The failure of many plants to flower or fruit during an abnormal weather cycle […] in 1970-1971 and the resultant famine and death among frugivores testify to the subsistence stress longer episodes would have inflicted on humans”. The description of the impact of the 1972-

1973 drought on a Yanomami community in southern Venezuela is equally dramatic. Fires set to prepare new gardens spread to adjacent clearings, destroying the producing crops. Adjacent vegetation remained nonflammable, however, and the population reverted to hunting and gathering until normal rainfall returned. "Working harder than normal, they remained constantly hungry but survived" (Meggers 2007a:135, 143).

Similar brief El Niño droughts would have impacted Amazonia between major events in the past and would have stimulated the adaptive behavior among indigenous communities documented by ethnologists. Children learn at an early age to identify all wild plants from a leaf, seed, or branch, as well as their uses and the animals that pollinate or feed on them. Adults continuously search for new edible plants. They avoid some edible tubers until those usually consumed fail and possess detailed knowledge of ecological relationships among flora and fauna. Short-term and permanent taboos against consumption of deer and tapir are widespread, although they are the largest terrestrial mammals. The likelihood that caymans were tabooed at least in the lower Tapajós region is suggested by their critical role in the aquatic food chain (Fitkau 1970). It seems likely that prehistoric communities reverted to hunting and gathering, like the Yanomami, during these episodes and enhanced their knowledge of the biota and their chances for survival. The discontinuities in the archaeological record indicate that this knowledge and the cultural measures that promote sustainable exploitation of the environment were insufficient to overcome the detrimental impact of mega-Niño droughts.

Erickson's assertion that "archaeologists have demonstrated that much of Amazonia was occupied by dense populations of urbanized societies practicing intensive agriculture that significantly contributed to creating the environment that is appreciated today" (p. 161) is being discredited not only by the archaeological evidence, but also by the increased abundance and variety of paleoclimatic evidence. For example, numerous pollen cores have produced detailed records of intermittent droughts along the Brazilian coastal strip, which correlate with human abandonment of vast areas during the Mid-Holocene there, as well as in the Guianas and Eastern Colombia (Meggers 2007b). Geological, ecological, palynological, and climatological investigations in French Guiana provide a detailed reconstruction of environmental change during the past 8000 years and a marine core from the Cariaco Basin off the coast of Venezuela documents four episodes of severe drought between AD 760 and 910. Analysis of lake sediments in the Carajás region of northeastern Brazil indicates that the major cause of perturbations in the tropical forest during the Holocene was climate change that modified the water balance. The RAINFOR network of 136 permanent plots in old growth forest throughout the Amazon created 25 years ago provides daily records of temperature and rainfall that may reveal local fluctuations that will be helpful in interpreting archaeological evidence (Phillips et al. 2009). Paleoclimatologists concerned with reconstructing paleoenvironmental climatic changes in eastern Brazil during the Holocene have recently suggested that "humans might be regarded as good paleoenvironmental markers for the Holocene. In this light, we propose that archaeological data should be better explored, and regarded as a valuable basis for paleoenvironmental inferences" (Araujo et al. 2005/2006:28).

Taking advantage of these kinds of opportunities for collaboration requires that archeologists adopt standard criteria for collecting, classifying, and interpreting their data. The territorial distributions of the ceramic traditions identified by the PRONAPA on the coastal strip more than forty years ago have been expanded by more recent investigators, but their failure to classify the pottery and apply quantitative analysis and seriation has prevented the kinds of social and settlement interpretations obtained from the survey of the Jamarí and other rivers in Amazonia. Although the ceramic traditions recognized in Amazonia decades ago are criticized by several authors in the *Handbook*, they have not supplied the archaeological evidence necessary to suggest alternatives. Hopefully, this will change.

The Founder Effect and Evolutionary Drift

Pottery is ideal for tracing cultural contact because it can be decorated in an essentially infinite number of techniques and motifs without affecting the function of the vessel. Some similarities, such as depiction of the same birds or animals, can be attributed to independent invention, and a few duplications in a long series of abstract elements can be dismissed as accidental. Multiple independent duplications of the same combinations of techniques and abstract motifs, such as those between Jomon and Valdivia, are unknown.

The evidence that the decoration on pottery is subject to unconscious evolutionary drift, that each endogamous community develops a distinctive ceramic configuration, that members of a community will possess a slightly different proportion of the diagnostic traits, and that dispersal of a segment of the ancestral population is consequently subject to the founder effect makes it possible to demonstrate that the initial ceramic complexes in lowland South America are derived from Valdivia-San Jacinto antecedents. The earliest offshoot identified thus far is the Monagrillo Phase, decorated with incisions ending in a punctation, small excised zones, a band of short vertical incisions, parallel incised lines, and zoned punctuate, which appeared in adjacent Panama ca 4,500 BP (Meggers 1997). The second dispersal, represented by the Waira-jirca Phase in the north highlands of Peru beginning ca 3,800 BP, exhibits a different set of the ancestral traits, including undulating and double-line incisions, rings with a central punctate, bands containing

closely spaced vertical lines, and equilateral crosses. The Ananatuba Phase, which appeared at the mouth of the Amazon about 3,400 BP, contains some of the same diagnostic traits as the Waira-jica Phase, including the ring with a central punctation, undulating incisions, and the equilateral cross, as well as parallel lines and feathered incisions. The decoration of the Barrancas Phase that arrived on the lower Orinoco ca. 2,900 BP consists of small excised zones, rings with a central punctation, incisions terminating in a punctation, miniature biomorphic *adornos*, and small vertical handles adjacent to the rim. It is noteworthy that several of the same ancestral techniques occur in most of the regions, whereas others do not. The differences are exactly what can be predicted based on the founder effect and evolutionary drift.

The Future of Scientific Archaeology

The most notable contrast in this volume is between the theoretical perspectives of the US authors working in Ecuador and Amazonia and those working in other parts of the continent. Denial of the existence of adaptive constraints on cultural development, the impact of evolutionary drift, and the importance of cultural diffusion distorts their interpretations of the archaeological record. It also prevents archaeology from making a significant contribution to the reconstruction of climatic and environmental change in the tropical lowlands since the beginning of the Holocene, and especially during the past four millennia.

The contrast between the detailed reconstruction of settlement and social behavior along the Jamarí in southwestern Amazonia based on applying evolutionary theory to the interpretation of the archaeological evidence, especially the characteristics of the pottery, and the vague temporal and spatial correlations among habitation sites occupied during the early Formative Period on the coast of Ecuador is striking. The Jamarí data permit identifying endogamous territories, matrilocal residence, village movement, contemporary settlements, and reoccupation of sites, as well as the impact of intermittent severe droughts that leave no permanent imprint on the biota. Even when radiocarbon dates can be obtained for past climatic events, they are less precise than those from archaeological contexts, which can also provide more specific identification of the locations and severity of their impact.

The negation of the evidence for cultural diffusion, particularly obvious in the refusal to consider the Jomon origin of the earliest pottery in Ecuador and Colombia, is another remarkable rejection of traditional cultural interpretation. The fact that pottery can be decorated using hundreds of different arbitrary techniques and motifs has always made it a primary tool for differentiating independent invention from common ancestry. The probability of independent duplication of the decoration on Jomon, Valdivia, and San Jacinto pottery is nil. Similarly, the presence of several of these motifs in the initial pottery complexes in Panama, at the mouth of the Orinoco and the mouth of the Amazon, and the north highlands of Peru testifies to migrations at different times from the northwestern part of the continent attributable to otherwise invisible fluctuations in the local climate.

Its geographical isolation prior to European colonization makes prehistoric South America a unique laboratory for examining the relationship between temporary and permanent environmental conditions and cultural development. In contrast to the rest of the planet, most of which has been continuously occupied since the early Paleolithic, it remained isolated from the continuous biological and cultural interactions that affected the course of history throughout Europe and Asia. Whereas the latter regions are dominated by temperate climates and fertile soils, deserts are mild, and forests and plains blend into one another, South America has large unbroken extents of distinct environments, including barren deserts, treeless plains, dense rainforest, snow-capped mountains, highland basins, and sea coasts that extend from tropical to subarctic latitudes. Large sectors of all these regions remain free from significant disruption by cities, roads, mechanized agriculture, and other kinds of modification that have altered the original characters of the landscapes in most of the Old World and destroyed archaeological evidence of conditions in the past. Isolation from modern encroachment has also permitted indigenous populations in many parts of the continent to pursue their traditional ways of life, providing examples of tangible and intangible behavior that can be compared with the archaeological evidence.

Suddenly much of this picture is changing. Rampant globalization is attracting foreign invaders, who have the technology to make drastic modifications in topography and biota, destroying the cultural configurations that maximize sustainable exploitation of unique environmental constraints, especially in the tropical lowlands. Their impact has eliminated key species from the food chain, interrupted the closed system of nutrient transfer that protected the infertile soil from further depletion, and disrupted the rainfall regime. Unfortunately, the insistence by the historical ecologists that prehistoric humans learned to "domesticate" the landscape to suit their needs is even less true today than it was in the past. I urge readers of this *Handbook* to take seriously the potential of archaeology to make a significant contribution to our understanding of prehistoric cultural adaptation in this unique and fascinating part of the world.

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