Quaternary International xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Quaternary International

journal homepage: www.elsevier.com/locate/quaint

Colonisation and early peopling of the Colombian Amazon during the Late Pleistocene and the Early Holocene: New evidence from La Serranía La Lindosa

Gaspar Morcote-Ríos[a], Francisco Javier Aceituno[b,*], José Iriarte[c], Mark Robinson[c], Jeison L. Chaparro-Cárdenas[a]

[a] Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Bogotá, Colombia
[b] Departamento de Antropología, Universidad de Antioquia, Medellín, Colombia
[c] Department of Archaeology, Exeter, University of Exeter, United Kingdom

ARTICLE INFO

Keywords:
Colombian amazon
Serranía La Lindosa
Early peopling
Foragers
Human adaptability
Rock art

ABSTRACT

Recent research carried out in the Serranía La Lindosa (Department of Guaviare) provides archaeological evidence of the colonisation of the northwest Colombian Amazon during the Late Pleistocene. Preliminary excavations were conducted at Cerro Azul, Limoncillos and Cerro Montoya archaeological sites in Guaviare Department, Colombia. Contemporary dates at the three separate rock shelters establish initial colonisation of the region between ~12,600 and ~11,800 cal BP. The contexts also yielded thousands of remains of fauna, flora, lithic artefacts and mineral pigments, associated with extensive and spectacular rock pictographs that adorn the rock shelter walls. This article presents the first data from the region, dating the timing of colonisation, describing subsistence strategies, and examines human adaptation to these transitioning landscapes. The results increase our understanding of the global expansion of human populations, enabling assessment of key interactions between people and the environment that appear to have lasting repercussions for one of the most important and biologically diverse ecosystems in the world.

1. Introduction

The last great continental migratory challenge of *Homo sapiens* was the colonisation of the Americas. When humans crossed into the northwest of the continent via the Bering Strait between 25,000 and 15,000 cal BP (e.g., Braje et al., 2017; Dillehay, 2000), the migrating hunter-gatherers faced unknown landscapes, untouched by humans, with diverse ecosystems and previously unencountered flora and fauna. In this context, one of the most challenging and least explored chapters of the human journey across the Americas is the entry into the Amazon Basin. Foragers entering Amazonia required the capacity to successfully transit and adapt to a diversity of environments undergoing profound climatic and environmental change over a relatively short time during the Late Pleistocene/Early Holocene transition (~13,000–8,000 cal BP) (e.g., Borrero, 2015; Braje et al., 2017). In broad terms, rising temperatures and increasing precipitation at the start of the Holocene transformed a mosaic landscape of patchy savannas, thorny scrub, gallery forests and tropical forest with montane elements into the broadleaf tropical forests of today (Piperno, 2011). The interaction of people and plants during this period of landscape transformation defined environmental and cultural trajectories that shaped, to various degrees, today's Amazonian biodiversity. Recent excavations in the Serranía La Lindosa (SLL) on the northern edge of the Colombian Amazon, provide evidence of these earliest inhabitants and their environmental interactions. Multiple rock shelters, adorned with thousands of rock paintings depicting geometric shapes, human figures, handprints, plants and animals, contain well-preserved Late Pleistocene/Early Holocene cultural sequences. The results of our new excavations in three rock shelters in this region (Cerro Azul, Cerro Montoya and Limoncillos) (Figs. 1 and 2) provide a new radiocarbon chronology that establishes the earliest human contexts in the Upper Amazon, going back to ~12,600 cal BP. Our archaeobotanical and zooarchaeological analyses contribute to the understanding of the plant and animal component of their diet and subsistence strategies. Preliminary observations of the rock paintings indicate that these early settlers may have drawn a variety of now extinct megafauna with

* Correspondimg author.
E-mail addresses: hgmorcoter@unal.edu.co (G. Morcote-Ríos), francisco.aceituno@udea.edu.co (F.J. Aceituno), J.Iriarte@exeter.ac.uk (J. Iriarte), markrobinson.uk@gmail.com (M. Robinson), jlchaparroc@unal.edu.co (J.L. Chaparro-Cárdenas).

https://doi.org/10.1016/j.quaint.2020.04.026
Received 29 August 2019; Received in revised form 16 January 2020; Accepted 15 April 2020
1040-6182/

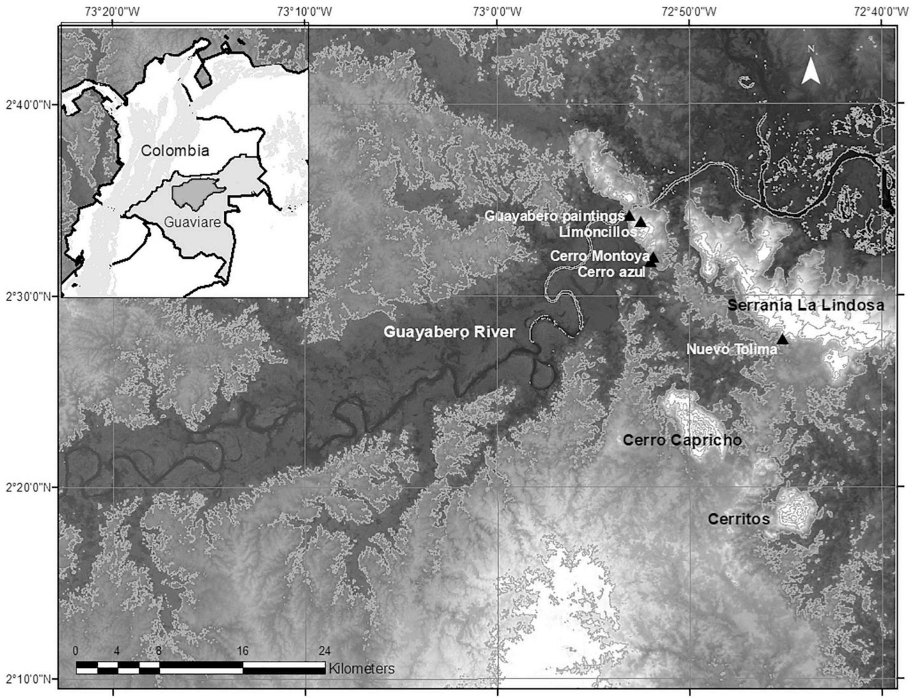


Fig. 1. Map of the Serranía La Lindosa showing site locations mentioned in the text.

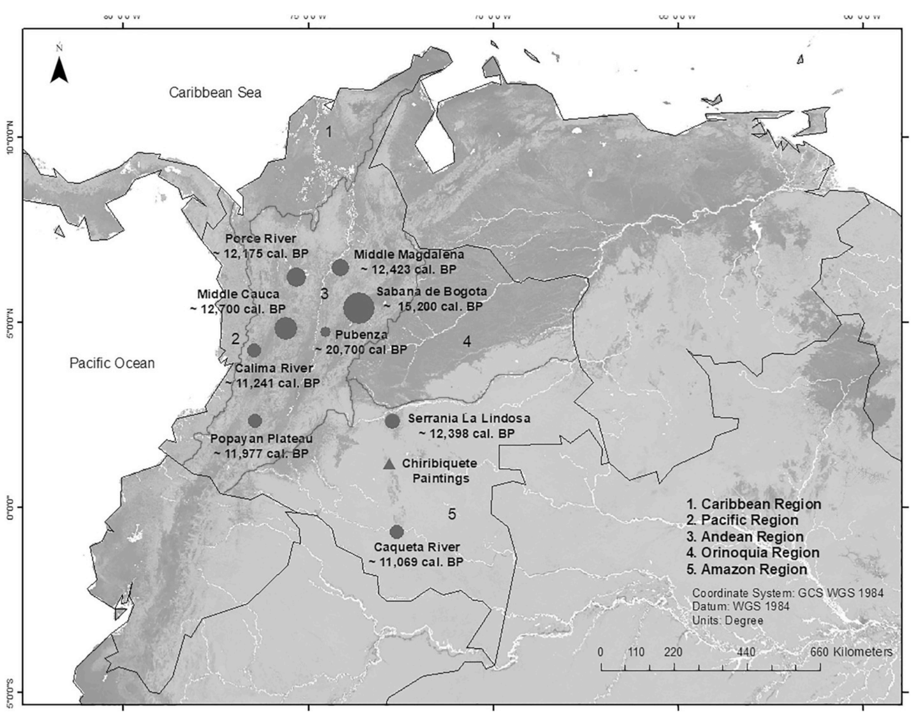


Fig. 2. Colombian archaeological areas showing the earliest archaeological sites with calibrated dates in each region.

impressive realism.

The new data presented here contribute to our understanding of the human colonisation of the Amazon, one of the larger biomes of the Americas, representing a globally significant chapter of the rainforest prehistory (*sensu* Roberts et al., 2017). The timing of the human migration into the Amazon coincides with the Younger Dryas (YD), a period of climatic upheaval during the broader Pleistocene to Holocene transition. These data are a step toward understanding the impact and role of the YD on the composition of the local vegetation composition, animal populations and the extinction of megafauna, and expanding human populations and their interrelationships with these resources. Our results are in agreement with mounting evidence from NW South America and the Lower Amazon, which shows that these early South Americans were not passively adapting to the environment and its resources; instead, the data hint at early plant management (Aceituno and Loaiza, 2018; Iriarte, 2007; Mora and Gnecco, 2003; Morcote-Ríos, 2017; Piperno, 2011; Roosevelt et al., 1996), which has implications for understanding the long-term legacy of human-plant interaction, and the potential role of humans in the current hyperdominance of useful plants in Amazonia (Levis et al., 2017; Ter Steege et al., 2013).

2. Brief archaeological background

In this section, we provide a brief summary of the archaeological investigations carried out in NW South America and the Amazon more widely. For a detailed synthesis, please see Aceituno and Loaiza (2018); Aceituno and Rojas-Mora (2015); Dillehay et al. (1992); Ranere and López (2007); Ranere and Cooke (2002). The earliest human contexts in Colombia are presently from Andean sites on the Bogota Plateau. The most secure contexts come from the Tibito site, dating to ~13,600 cal BP (Correal Urrego, 1981), and the Tequendama rock shelter, dating to ~12,850 cal BP (Correal and van der Hammen, 1977). At El Abra II, site excavations produced a date of ~15,236 cal BP (Correal, 1986), but the integrity of the cultural associations and the artefactual nature of the lithics have recently been contested (Muttillo et al., 2017). Archaeological research over the past two decades in the sub-Andean forest of the Middle Cauca region of central Colombia has documented numerous preceramic sites dating from the terminal Pleistocene to middle Holocene, starting at ~12,600 cal BP (Dickau et al., 2015). The archaeological assemblage shows distinct plant processing tools, evidenced by handstones and distinct adzes/hoes, with the archaeobotanical record revealing an early and increasing reliance on roots, such as *Xanthosoma* and sweet potato (*Ipomoea)* tubers, among others (Aceituno and Loaiza, 2018). Similar contexts are reported from the sub-Andean forests of the Upper Cauca Valley (Gnecco, 2000). In the seasonal tropical forest of the Middle Magdalena River Basin, at the site of Pubenza, charcoal from the same stratigraphic component where two entire mastodons and lithic tools were recovered yielded a date of ~20,700 cal BP (Van der Hammen and Correal, 2001). However, more detailed excavations need to be carried out to validate these early contexts.

In the Colombian Amazon, along the Caquetá River, lies the Peña Roja site, dated between ~11,069 and 9,168 cal BP (Cavelier et al., 1995; Gnecco and Mora, 1997; Mora, 2003; Mora and Gnecco, 2003; Morcote-Ríos et al., 2014). The lithic assemblage comprises unifacial flakes, choppers, drills, hand stones, milling stones, hammerstones, hoes and anvils, all of which were manufactured using local chert, quartz and igneous raw materials (Cavelier et al., 1995). Thousands of charred seeds were recovered including a diversity of palms and fruit trees (Morcote-Ríos et al., 1998, 2014). Phytoliths from squash (*Cucurbita* spp.), bottle gourd (*Lagenaria siceraria*) and leren (*Calathea* sp.) were also identified (Piperno and Pearsall, 1998). Starch grains of *Xanthosoma* spp. were also recovered from two stone tools (Morcote-Ríos et al., 2014). At the Taima-Taima site in the Venezuelan savannahs, Joboid points were found in association with *Haplomastodon* along with glyptodontid, horse, mylontid, ursid, and felid bones in the same strata dating to ~16,500 cal yr BP (Gruhn and Bryan, 1984). Similarly, the site of Provincial in the Middle Orinoco indicates that the northern tropical lowlands were colonised at least from the onset of the Holocene ~10,600 cal BP (Barse, 1990); however, the evidence has been disputed (Riris et al., 2018). Collectively, the evidence suggests that early on these initial settlers engaged in plant cultivation. Several investigators have noted that in Colombia there is an increase of archaeological sites between ~12,700 and 11,000 cal BP, suggesting that this was a period of human expansion, adaptive adjustments and population growth in the region (Aceituno et al., 2013; Delgado et al., 2015) (Fig. 2).

Current data show that the first human occupation of the Amazon occurred between ~13,300 and 11,000 cal BP. Projectile points associated with the remains of palms, fruit, fish, rodents, and turtles, alongside pictographs dating between ~13,245 and 12,388 cal BP were found in Caverna da Pedra Pintada, in the Lower Amazon Basin, Pará State, Brazil (Roosevelt et al., 1996; Roosevelt, 2017). Other early contexts south of Caverna da Pedra Pintada, dated to the Late Pleistocene are documented in the Cerrado and Caatinga biomes (e.g., Boëda et al., 2014; Bueno et al., 2013; Vialou et al., 2017).

Approaching our study region, the first excavations in SLL were conducted in 1989 at the Angosturas II rock shelter that is also associated with rock art. The excavations recovered lithic artefacts, charred seeds, animal remains and ochre fragments, dating between ~8,155 and 3,977 cal BP (Correal et al., 1990). One hundred and sixty km to the south of SLL, in the Serranía de Chiribiquete (between the Ajajú and Apaporis rivers), 36 recorded rock shelters are associated with rock paintings similar to those at SLL. The similarities between the rock paintings of SLL and Chiribiquete suggest the existence of a large cultural area of interaction in this corner of the Amazon Basin. Excavation at Arc 1 rock shelter provided a date of ~5,550 cal BP, associated with a hearth, animal bones and fragments of ochre (Van der Hammen, 2006). Based on the similarities of rock art with the SLL, it would not come as a surprise to find similar early contexts in Chiribiquete.

3. Environmental and geographical background: present and past

The SLL is a 20 km^2 rocky outcrop located in the Department of Guaviare, in the northwest of the Colombian Amazon (Fig. 1). The SLL is on the banks of the Guayabero/Guaviare River in today's transitional ecotone between the savannahs of the Orinoco and the Amazon rainforest (Peplinsky et al., 2018). Geologically, SLL is located on the edge of the sedimentary basins of Vaupés-Amazon to the south and the Eastern Plains (Llanos Orientales) to the north. SLL outcrops are composed of cretaceous sedimentary rocks of the Araracuara formation. Quaternary rocks and colluvial deposits are found in the alluvial valleys and SLL foothills. In the valleys, the soils can reach up to 2 m in thickness, although they are far shallower in the upland areas.

The present climate is warm and humid. SLL receives ~2800 mm of rain annually with a dry season from November to February and a wet season from March to October (Cárdenas et al., 2008). SLL is characterised by a diversity of habitats. The SLL contains plant and animal species characteristic of the ecotonal nature of the region. The latest plant inventories have recorded 884 species of vascular plants, corresponding to trees, shrubs, vines, herbaceous plants and palms, although the total number is estimated to be higher. In areas where the rocky substrate is closer to the surface, the size of trees and shrubs is smaller (Cárdenas et al., 2008; Peplinsky et al., 2018). Similarly, the diversity of vertebrates is high, with a total of 449 species, including fish (89), amphibians (30), reptiles (56), birds (226) and mammals (48) (Peplinsky et al., 2018).

During the Late Pleistocene (LP), temperatures across the Neotropics were at least 6 °C lower and precipitation was reduced on the order of about 30–50%, in comparison to late Holocene conditions (Piperno, 2011), while sea-levels were 120 m lower than today (Groot et al., 2011). Gradual warming following the LGM was punctuated by an abrupt cold/dry episode between ~17,000–16,000 cal BP corresponding to the H1. The Bølling-Allerød warm period between ~14,000 and 12,800 cal BP, corresponding to the Guantavia Stadial in Colombian pollen records (Van Der Hammen and Hooghiemstra, 1995), was followed by a rapid return to glacial conditions, just before the start of the Holocene, during the Younger Dryas (12,800–11,500 cal BP). The YD is well documented in the pollen records of the El Abra (Colombia) and La Chonta (Costa Rica) stadials above 3000 masl (Islebe et al., 1995; Van Der Hammen and Hooghiemstra, 1995), as well as El Valle (Panamá) (Bush et al., 1992). The acquisition of new high-resolution localised climate records is making it increasingly clear how heterogeneous climate change is across different regions of SA. Depending on the area and elevation considered, LP climate conditions resulted in (i) the replacement of much of the seasonal tropical forest by types of open vegetation similar to today's thorn woodlands, thorn scrublands, and savannas, (ii) partial replacement and reduction of lowland evergreen rainforest by arboreal elements that are now primarily confined to drier types of forest and montane environments (e.g., *Podocarpus*, *Alnus*, *Myrsine*), and (iii) a downslope displacement of 800–1200 m of some forest elements that today are generally confined to cool and high mountainous areas above 1500 m (Piperno, 2011).

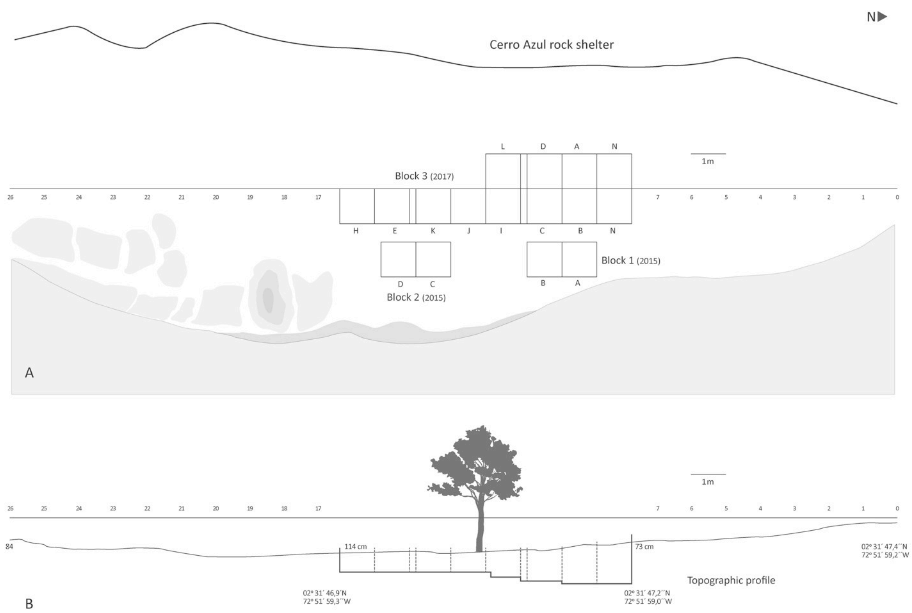


Fig. 3. Cerro Azul. A. Excavation provenance map; B. Profile of the site.

4. Methods

Archaeological research was conducted over two field seasons, including survey, test excavation, and analysis of recovered lithic and archaeobotanical materials. In 2017, a 12 m^2 excavation was opened at Cerro Azul to assess the archaeological history of the rock shelter (Fig. 3). The successful recovery of archaeological materials promoted further exploration of the region. In 2018, our survey discovered many more rock shelter sites in the region, each defined by the presence of panels of rock art and/or scatters of surface ceramics. Test excavations (1 × 1 m) were conducted at the two newly discovered Limoncillos and Cerro Montoya sites with a primary goal of establishing the timing of initial human activity in the region.

Cerro Azul (322 m asl) is a rock shelter located on the distinct Cerro Azul outcrop (2° 31′ 47,2″ N and 72° 51′ 59,0″ W). The outcrop contains one of the largest sets of rock paintings in the region with a total of 12 panels and thousands of individual pictographs depicting humans, animals, plants, handprints and geometric shapes. Cerro Montoya (273 m asl) located 467 m downslope from Cerro Azul (2° 32′ 0,3″N and 72° 51′ 51,3″ W) contains a series of rock shelters with faded paintings. Limoncillos (354 m asl) is a rock shelter located 4 km to the north of Cerro Azul (2° 33′ 51,7″ N and 72° 52′ 29″ W) also containing faded rock art.

Excavations followed archaeological strata, with each distinct stratum sampled for artefacts, ecofacts and deposited sediments. Analyses were undertaken to define the material culture and assess plant availability and use. Carbon samples were selected from contexts to establish a preliminary chronology of initial occupation. Lithic tools and debitage were classified according to raw material and techno-morphological attributes (Andrefsky, 2005) to define technological strategies and activities carried out at the Cerro Azul site and compare it with other sites from NW South America and beyond. Sediment samples from each stratum of the Cerro Azul site were processed for phytolith analysis following standard procedures (Piperno, 2006). Phytoliths were identified and counted under a Nikon Eclipse E 400 connected to an Omni LW Scientific camera. Phytolith morphotypes were identified by comparison to the phytolith reference collection at the Laboratory of Archaeology of the Natural Sciences Insitute of the Universidad Nacional de Colombia (ICN-MHN-FIT) and published phytolith atlases by author Morcote-Ríos and his collaborators (2015). The phytolith diagram is based on a 200 count sum per slide and was plotted using Tilia 2.0.41. The results of these analyses are discussed below. This paper also addresses some of the images depicted in the rock art and their significance within the context. The results are integrated at a broader regional scale.

5. Results

5.1. Stratigraphy

5.1.1. Cerro Azul

The stratigraphy of the site is composed of sediments originating in or deriving from the Cerro Azul rock formation, plus the deposition of cultural materials resulting from the human occupations of the site. Depth of the deposits varies along the excavation block. In the north (N) sector of the stratigraphic sequence, sediments reach a depth of 110 cm b.s. (below surface), while in the south sector, maximum sediment depth is only 55 cm b.s. Given the lithological homogeneity of the excavated profile, the definition of the seven strata defined in the N sector was based on cultural layers detected during excavation, sediment characteristics (colour, texture and geochemistry), and the artefact and ecofact assemblage (presence/absence, density). The stratigraphy is described below, starting from the deepest contexts (Fig. 4).

Stratum I is formed by rocks of different sizes, from large, angular clasts to gravel-size debris that corresponds to natural detachments of the rock shelter wall. These blocks are mixed with sediments with a predominance of reddish-yellow (7.5 YR 6/6) coarse sands. Although this stratum was identified in all of the excavated units, its depth below the surface varies, with decreasing depth from north-south (Units M/N/A/D/B: 110 to 105 cm b.s.; Unit C/I: 90 cm b.s.; J/K: 70 cm b.s.; E/H: 55 to50 cm b s). A few charcoal fragments and small flakes of chert were recovered in this natural stratum, which we interpret as intrusions from above.

Stratum II is the first clearly defined archaeological layer, containing abundant charcoal, lithic artefacts, and plant and faunal remains. Depth and thickness of this stratum varies along the excavation block (Units M/N: 110 to 90-85 cm b.s.; Units A/D: 105 to 85-80 cm b.s.; and Units B/C: 100 to 85-80 cm b.s.). A marked feature of this stratum is the size of the stone blocks, with an average length of 25 cm, far larger than the upper layers. The matrix is a dark brown-black (B/C: 7.5 YR 3/4; A/D/L/M/N: 7.5 YR 2/3 to 3/3), loamy sand (LS) acidic (pH 5) sediment that contains very low amounts of organic carbon

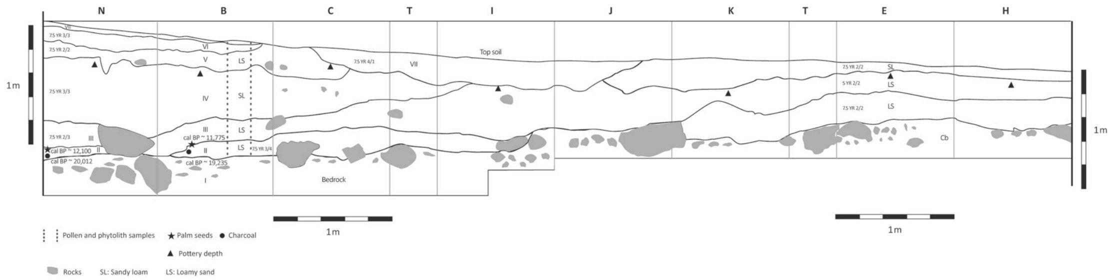


Fig. 4. Stratigraphy of the E wall profile of the Cerro Azul Rock shelter.

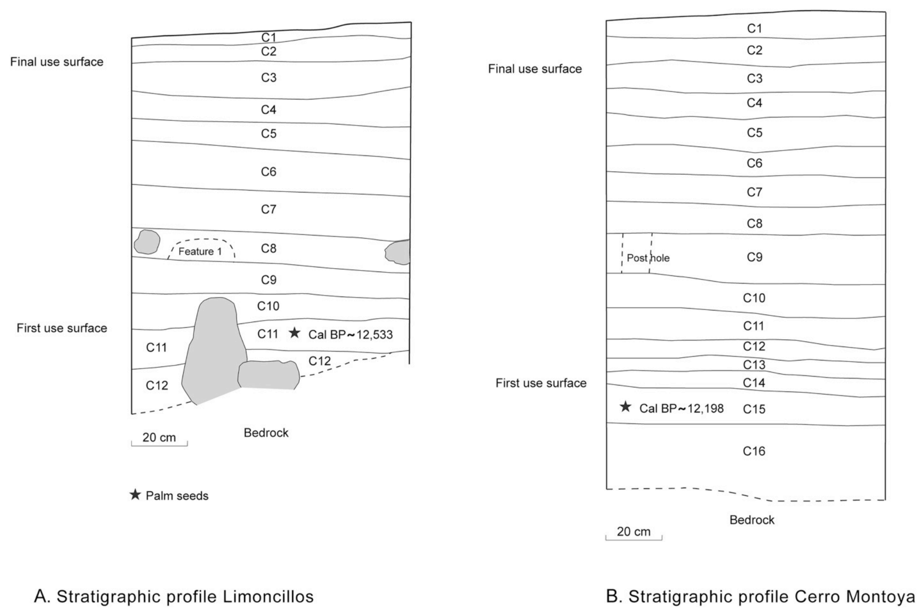


Fig. 5. Stratigraphic profiles. A. Limoncillos; B. Cerro Montoya.

(0.56%), nitrogen (< 0.08%), and phosphorus (21.3 meq/100g), while it bears a high value of NO3 (15.9 mg/kg). The latter is formed by the decomposition of proteins.

Stratum III is composed of a black (7.5 YR 2/3) loamy sand texture (LS) and varies in thickness along the excavation block (Unit M: 100-80 cm b.s.; Unit B: 80-68 cm b.s.; and Unit C: 70-50 cm b.s.). The stratum includes large stones, slightly smaller than the previous stratum (~10 cm), and a marked increase in the density of lithic artefacts. Sediments are acidic (pH 5.17) and there is a slight increase in organic carbon (2.01%), sharp decrease in NO3 (4.15 mg/k), and a slight increase in Cu (2.15 mg/kg) and Zn (4.43 mg/k) in relation to Stratum II. These values correlate well with an increase in archaeological material, indicating increased human activity at the site.

Stratum IV is composed of a black (7.5 YR 3/3) sandy loam texture (SL) also varying in thickness across the excavation block (Unit M 80-25 cm b.s.; Unit B: 68-24 cm b.s.; and Unit C 50-28 cm b.s.). Geochemical changes are also observed between Stratum III and IV; the most noticeable of which are calcium (0.46–3.41 meq/100g), magnesium (0.08–0.55 meq/100 g), zinc (4.43–11.5 mg/kg), and copper (2.15–3.09 mg/kg). The increase in the above elements from Stratum III to Stratum IV corresponds with an increase in faunal remains, including those of aquatic species.

Stratum V appears at ~28 -15 cm b.s. and is marked by a decrease in the density of lithic material from Stratum IV. This stratum marks the transition between the preceramic and the ceramic strata. The colour is 7.5 YR 2/2 and the texture is loamy sand (LS) with a marked increase in sand from the lower strata. Animal and plant macro-remains are abundant, especially in grid D. A black sediment feature (7.5 YR 2/1) is evident in the northern profile between grids A and B, where abundant charred seeds were recovered. Human bones were recovered in grids D and C. The geochemical values of NO_3 (18.5 mg/kg), Ca (9.58 meq/100g), Mg (2.37 meq/100g) and Zn (18.7 mg/kg), are the highest values in the stratigraphic profile. The Ca and Mg values are most likely related to the large presence of bones (animal and human).

Stratum VI appears at ~15-5 cm b.s. The colour is black (7.5 YR 2/1) and the texture is loamy sand (LS). At 15-10 cm b.s., human remains were found, and at 5–10 cm b.s. ceramic sherds show the highest density within the stratigraphy, which matches the increase in lithic artefacts. Abundant animal remains, charred seeds and charcoal between ~10 and 20 cm b.s. in grids A and B, indicate a probable hearth.

Stratum VII is only present in grids M, N, A, B, C and D. It disappears in grid J. Stratum VI is a very sandy soil, colour 10 YR 5/3 (brown) varying in thickness along the block (M-N: 5-0 cm b.s.; B–C: 3-0 cm b.s.). This unit includes lithic flakes, ceramic sherds, and charred seeds; the stratum is highly disturbed by agents such as animals, tourists and water.

5.1.2. *Limoncillos*

Limoncillos is a 30 m long, 6 m deep, northwest facing rock shelter. There is a large piece of breakdown and a pile of smaller rocks in the southwest of the shelter. The area is covered by a 2–4 m high overhang. Highly eroded paintings are present on the back wall. The sediment in the shelter is very loose and dry and due to the low light and moisture, there is almost no vegetation present under the overhang.

A 1 × 1 m test unit was excavated 50 cm from the rock wall to assess stratigraphy and recover datable material. A total of 12 strata were identified, primarily based on textural changes on the surface of each stratum. Bedrock was encountered at the base of the excavation,

Table 1
^{14}C dates from Serranía La Lindosa: Cerro Azul, Cerro Montoya and Limoncillos rock shelters.

Site	Code	Block	Grid	Sample	Depth (cm)	^{14}C Date	Cal BP (2 σ)
Cerro Azul	Beta- 492721	3	N	Charcoal	100–105	16,790 ± 60	20,464–20,044
Cerro Azul	Beta - 489157	3	B	Charcoal	95–100	16,120 ± 50	19,619–19,257
Cerro Azul	Beta - 492723	3	N	Seed	100–105	10,280 ± 40	12,180–11,826
Cerro Azul	Beta - 489156	3	B	Seed	80–85	10,130 ± 30	11,984–11,620
Cerro Azul	Beta - 492720	3	A	Seed	100–105	8160 ± 30	9246–9013
Cerro Azul	AA111448	3	A	Seed	95–100	8350 ± 35	9466–9288
Cerro Azul	AA111449	3	A	Seed	90–95	6205 ± 28	7179–7004
Cerro Azul	Beta - 489155	3	A	Seed	55–60	2820 ± 30	3002–2849
Cerro Azul	Beta - 489154	3	A	Seed	15–20	2760 ± 30	2929–2779
Cerro Azul	Beta 421468	1	A	Seed	85	10,360 ± 40	12,398–12,039
Cerro Azul	Beta 421467	1	A	Seed	27	330 ± 30	472–308
Cerro Montoya	Beta-509123	1	*	Seed	110	10,340 ± 40	12,388–12,008
Limoncillos	Beta-509123	1	*	Seed	136	10,560 ± 30	12,642–12,424

Calibration done using Calib Rev. 7.0.4.
Data set used: intCal3.^{14}C (Reimer et al., 2013).

150 cm b.s. The two basal strata are natural, with the surface of Stratum 11 representing the initial ground surface when people arrived in the area (Fig. 5A). The two upper strata are also natural, resulting from post abandonment deposition. The stratigraphy throughout the profile is fairly homogeneous, with slight variations in colour and texture between strata. The surface of each stratum is distinguished by greater compaction and, frequently, the presence of charcoal.

The surface of Stratum 11 is rich in charcoal and lithics and appears to be the original ground surface. There is some mixing of cultural material in the upper fill of Stratum 11, which quickly drops off into the sterile sediments above the underlying bedrock. A burnt patch on the surface of Stratum 9 represents a fire pit and a circular sandy pit, 17 cm in diameter and containing charcoal, is present on the surface of Stratum 10.

The surface of Stratum 7, 55 cm b.s., displays the most intense human activity and coincides with the appearance of ceramics. The surface is grittier than all others and is littered with charcoal, lithics, and ceramics. A few ceramics (<10) are present in the fill below, but likely result from mixing. The upper strata are rather homogeneous, containing charcoal, ceramics, and lithics within the sandy silt sediment.

5.1.3. Cerro Montoya

The Cerro Montoya rock shelter is a small isolated outcrop located approximately 500 m downslope from Cerro Azul. An overhang, which extends to a maximum of 6 m, on the southern side of the outcrop creates a relatively dry rock shelter beneath. The overhang at the back wall is 2 m tall before curving overhead to a height of 6 m. The rock wall retains the remnants of red pigment, although the designs of the rock art cannot be discerned. Vegetation is absent close to the wall and limited to a few small shrubs and roots in the middle area. Smaller trees and a greater number of shrubs are present within the shelter margins where there is greater access to light and precipitation.

A 1 × 1 m test unit was excavated 75 cm from the rock wall, in front of the faded paintings. A total of 16 strata were identified, primarily based on textural changes on the surface of each stratum. Bedrock was encountered at the base of the excavation, 180 cm b.s. Within the cultural layers, the more compacted surfaces were often also marked by the presence of charcoal. The two basal strata are natural, with the lowest sterile. There are twelve strata associated with human occupation, with the upper two strata formed through natural post abandonment deposition. The strata are remarkably homogeneous throughout, composed of relatively loose silty sand. (10 YR 2/1 to 10 YR 2/2). The sterile natural stratum at the base was lighter in colour (7.5 YR 3/3).

The surface of Stratum 15 represents the ground surface when people first arrived in the area (Fig. 5B). Charcoal is present on the surface, but lithic artefacts and charcoal abruptly declines below the surface. The subsurface fill includes larger rocks and appears largely sterile.

The surface of Stratum 10, 1 m b.s., contains seven shallow concave depressions, varying in diameter from 12 to 19 cm, and depth from 3 to 10 cm. Each depression is burnt and includes charcoal. The matrix within each pit was very sandy. Ceramics and lithics are present on the surface, with both artefact classes also present within the matrix of a single depression. A few loose ceramics are present in the fill of Stratum 10, but are likely mixed from above, with the surface of Stratum 10 representing the first occupation of the rock shelter by a ceramic making culture. A post hole is present on the surface of Stratum 9, alongside evidence of burning on the surface (burnt clay and charcoal).

Ceramic artefacts are present in Strata 1–10. Lithic material and charcoal appear throughout the whole stratigraphic sequence. Small rocks are present in varying densities throughout the sequence. With higher concentrations at the surface of Stratum 6 and in the fill of Stratum 10.

5.2. Chronology

Eleven AMS radiocarbon dates (Table 1) were obtained from preceramic layers at the Cerro Azul rock shelter, marking the start of occupation (Late Pleistocene) and subsequent activity into the Middle and Late Holocene (Fig. 6). An AMS radiocarbon date was obtained from the start of human activity at both Cerro Montoya and Limoncillos.

At Cerro Azul, two charcoal samples yielded LGM dates ~20,500–19,200 cal BP. Both dates were obtained from charcoal recovered in Stratum II, which is composed of natural sediments mixed with some chert flakes, charred seeds and charcoal. Until future excavations can provide a more securely defined context for the lower strata of the site, clearly identifying the cultural origins of the LGM dated charcoal, rather than charcoal fragments produced by natural fires, we presently only accept the Terminal Pleistocene dates of the site as firm evidence of human activity. Two radiocarbon assays made on charred palm seeds from secure cultural contexts provide Terminal Pleistocene dates between ~12,100 and ~11,800 cal BP. These dates mark the start of stable, repeated human activity in the region. Three dates from charred palm seeds through the Early to Middle Holocene (~9,090–~7, 004 cal BP) demonstrate continued activity in the region. A Late Holocene date of ~3,002–2,849 cal BP marks the last preceramic strata. Ceramics are present by 2,929–2,779 cal BP, 15–20 cm b.s.

Charcoal from the initial ground surface at the time of the earliest sustained human activity at Limoncillos and Cerro Montoya were dated by AMS. The two contexts provide terminal Pleistocene dates of ~12,642–12,424 cal BP at Limoncillos (Stratum 11) and ~12,388–12,008 cal BP at Cerro Montoya (Stratum 15).

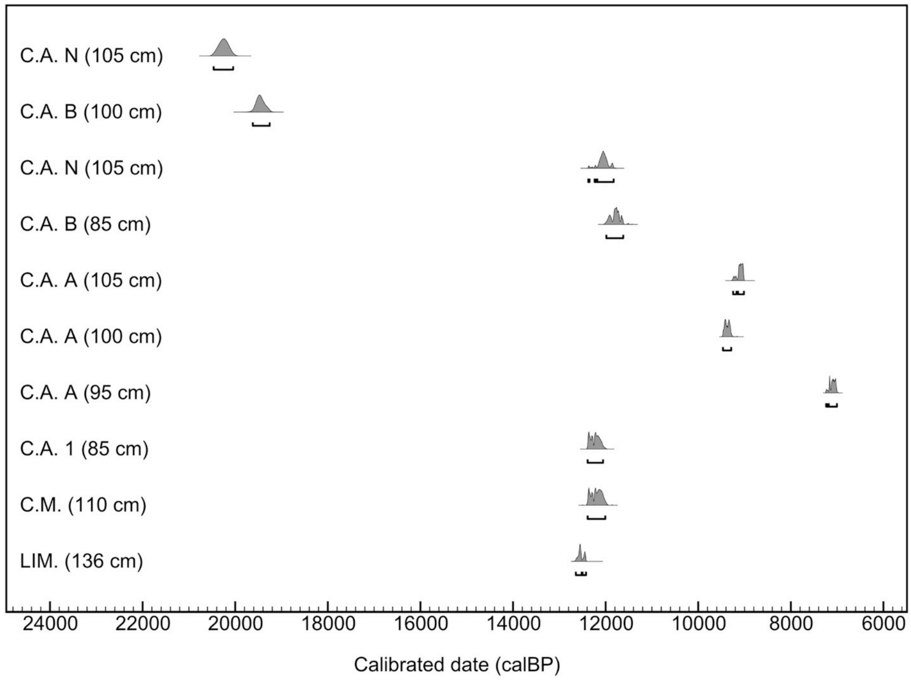


Fig. 6. Depth-age graph for radiocarbon dates from archaeological sites. C. A. N, Cerro Azul, grids N, B, A (block 3); C.A. 1 Cerro Azul block 1; C.M. Cerro Montoya; LIM. Limoncillos.

The radiocarbon dates obtained so far, with the addition of the Angostura II dates from the excavations in the 1980s, imply human occupation of SLL throughout the Holocene, from the end of Ice Age and probably up to historical times. The dates from Cerro Azul suggest potentially long periods of abandonment of the site.

5.3. The lithic assemblage

Lithic artefacts were recovered from all cultural strata in all excavations. Here we only present the results from Cerro Azul excavation. The lithic assemblage of Cerro Azul was manufactured on quartz and chert and is composed of a total of 2478 manufacturing debris, 289 tools and 128 cores. No polished lithic artefacts were recovered.

Debitage correspond to a total of 1772 chert and 442 quartz manufacturing debris. For both raw materials, the average length of debitage is around 20 mm. The maximum length in chert is 58 mm and the minimum 7 mm. In the quartz assemblage, the maximum length is 41 mm and the minimum 9 mm. The prevailing shapes are conchoidal flakes with a predominance of secondary and tertiary flakes in both cases, with a very low percentage of cortical flakes, 2.8% in chert and 18% in quartz. The percentage of secondary flakes is around 64% (chert) and 59% (quartz). The tertiary percentages are 33% (chert) and 23% (quartz). Among the debris, flat striking platforms predominate and the percentage of ridges on the dorsal side is around 21%. The low presence of negatives and ridges are a clear indicator of a low number of flake removal sequences. Another outstanding feature in the debris assemblages of both chert and quartz is the high number of broken flakes, around 30%.

Both chert and quartz artefacts include small unifacial tools, displaying use-wear along the edges, including micro-serrations. The assemblage consists of 216 made from chert, 48 from quartz and 25 from quartzite and sandstone. All were manufactured using direct percussion, resulting in sharp-edged flakes, of which 33.3% of chert and 73% of quartz tools were retouched (Fig. 7). Bipolar percussion was also used to reduce small quartz cores. A main feature of the lithic technology is the small average size of the artefacts, with an average length of 28.34 mm, width 23.73 mm and 8.9 mm thick. The small size is likely due to the size of the local natural resources. The size of cores recovered at Cerro Azul, with an approximate average length of 60 mm, matches the size of the natural nodules in the area. Small cobblestones of chert and quartz are abundant in the fluvial deposits along the Guayabero River, the majority of which do not exceed 100 mm in length.

Overall, the lithic assemblage of Cerro Azul is characterised by (i) absence of polished stone, (ii) a lack of evidence of bifacial forms, sophisticated artefacts and complex strategies for knapping cores (e.g. blade or micro-blades), and (iii) the lack of technological changes across occupations. In broad terms, lithic technology in Cerro Azul is part of the tradition of unifacial forms and expedient tools distributed across many South American regions from the Late Pleistocene (Dillehay et al., 2017) (see Discussion section below).

5.4. Carbonized seeds and charcoal

Thousands of plant remains were recovered at Cerro Azul through wet and dry screening through 5.0, 2.5 and 2.0 mm mesh. Study of the archaeobotanical material was focused on Units A and N, from which 32,489 carbonized seeds were recovered. The palm family (Arecaceae) has the greatest representation of seeds, of which ten taxa could be identified: *Astrocaryum chambira*, *Attalea maripa*, *Attalea racemosa*, *Attalea* sp., *Bactris* sp., *Euterpe precatoria*, *Mauritia flexuosa*, *Oenocarpus bataua*, *Oenocarpus minor*, *Syagrus orinocensis*. A significant number of palm endocarps could not be identified to genus due to poor preservation, but some morphological features were preserved that correspond to the subfamily Arecoideae (possible genera: *Astrocaryum*, *Bactris* or *Sygrus*).

Palms are one of the dominant groups in the landscape of the SLL today. They grow on *terra firme* seasonally flooded forests, flooded forests and forests of the Guyana Shield rock outcrops, with some species forming large populations, as in the case of *A. maripa* and *M. flexuosa*. The palms identified in the archaeological assemblage are characterised by having a fruiting period of several months of the year and high productivity of fruits and seeds that are rich in oils and proteins. Palm leaves are also used by modern humans for thatching of homes and temporary campsites and their fibres are extracted for the fabrication of various implements. The trunks are used as posts or walls

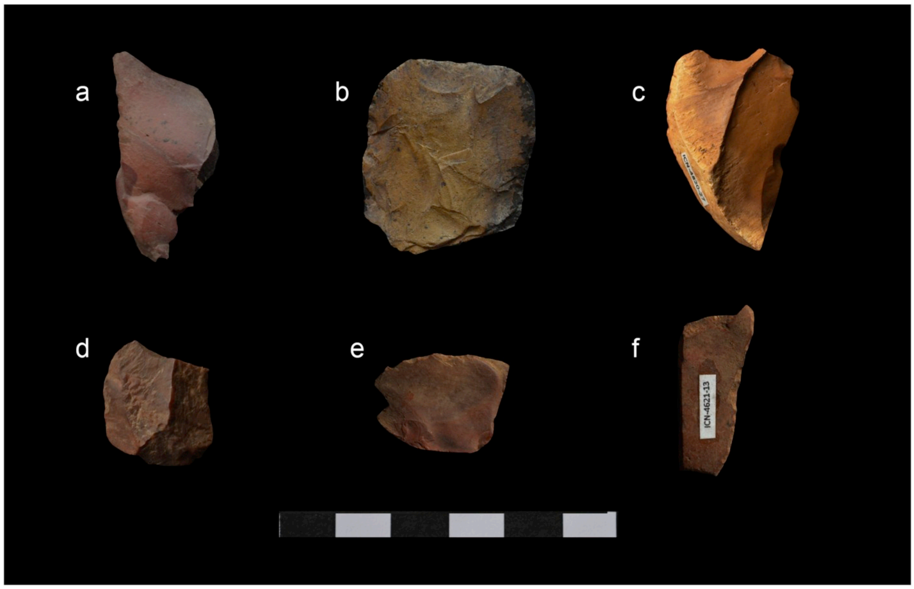


Fig. 7. Lithic tools from Cerro Azul. a. Grid A, level 100–105 cm b.s.; b. M, 45–50 cm; c. N, 95–100 cm; d. N, 100–105 cm; e. A, 95–100 cm; f. A, 90–95 cm.

in the construction of homes or for the elaboration of blowguns, darts, bows and harpoons for hunting and fishing (Galeano and Bernal, 2010).

The seed diagram in Fig. 8 represents the diachronic variation in the principal species that were identified in Units A and N. The most abundant palm species include *S. orinocensis, A. chambira, A. maripa y A. racemosa*, while *E. precatoria*, *M. flexuosa*, *O. bataua* and *O. Minor* were also present but at lower abundances. Carbonized seeds of *Brosimum lactescens* (Moraceae) were present across the entire sequence of human occupation at Cerro Azul, demonstrating the importance of this species as a food source for humans in antiquity. *B. lactescens* is one of the dominant tree species of *terra firme* Amazon forests (Ter Steege et al., 2013), producing a massive quantity of fruits that are also consumed by fauna. Ethnographic observations of the Nukak communities in the Colombian Amazon demonstrate that the fruits are harvested and the seeds processed to obtain edible flour (Berg, 1972; Cárdenas and Politis, 2000; Sánchez, 1997). Archaeological seeds of *Brosimum* have been identified in excavations from Peña Roja, associated with Early Holocene hunter-gatherers (Mora, 2003). Remains of seeds belonging to the families Humiriaceae, Euphorbiaceae, Araceae and Poaceae were recovered from the upper strata of Cerro Azul, associated with more recent human occupations. Plant charcoal was also recovered from Cerro Azul. A total of 2388 fragments were found, those from the upper levels measuring between 3 mm and 3 cm in length and from the lower levels, 2 mm to 1 cm (Fig. 1). The charcoal is probably associated with various

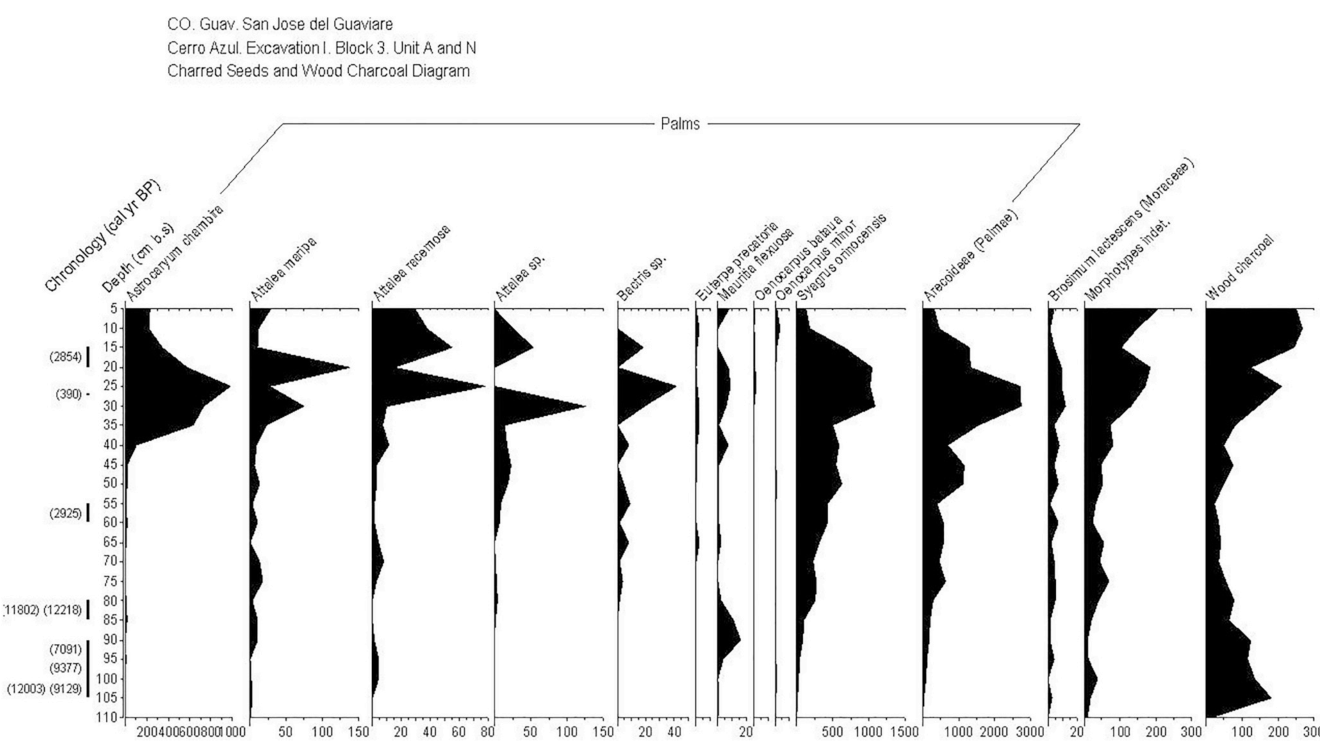


Fig. 8. Frequency stratigraphic diagram of charred seeds and charcoal from Cerro Azul, Grids A and N.

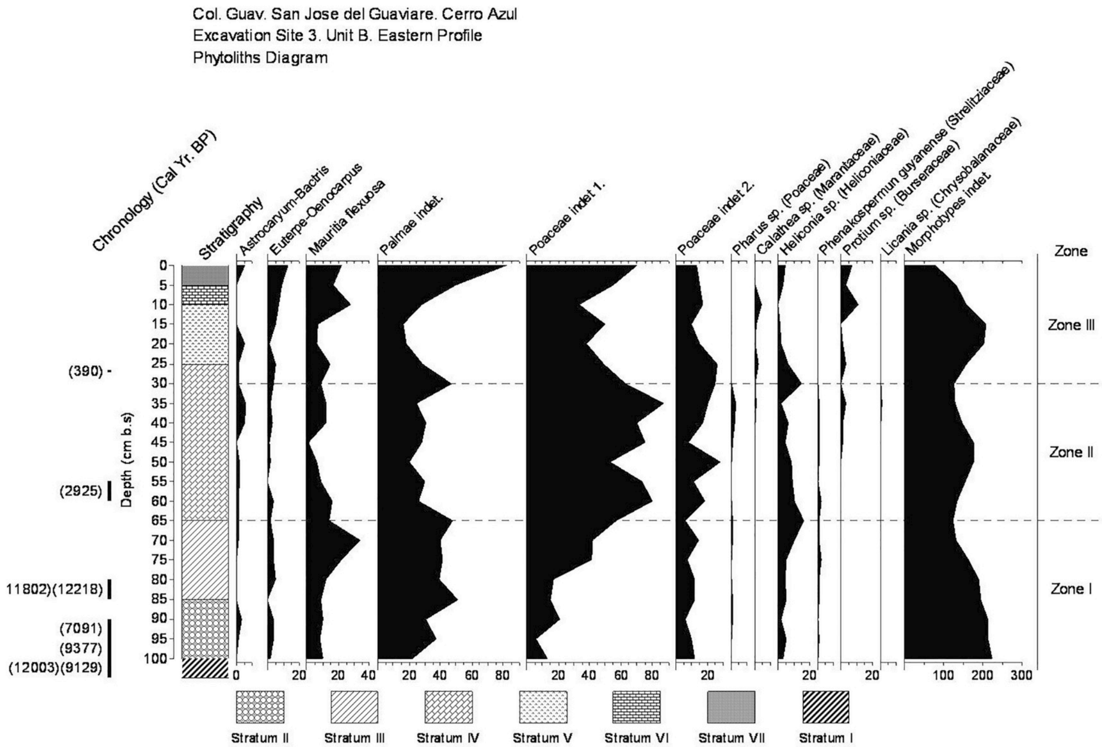


Fig. 9. Phytolith percentage stratigraphic diagram from Cerro Azul, Grid B.

domestic activities, including food preparation. Some of these fragments correspond to palm trunks, which might indicate their use as fuel.

5.5. Phytoliths

In the phytolith diagram in Fig. 9 taxa are shown as they vary through time at Cerro Azul. Palms are the best-represented group, with *Mauritia flexuosa* and the groups *Astrocaryum-Bactris*, *Euterpe-Oenocarpus* and Palmae indet. (globular echinate) being the most abundant. Grasses are represented by trapezoidal, rectangular and bilobate phytoliths as well as bulliform cells, which indicate that the area adjacent to the archaeological site was cleared of arboreal vegetation over multiple occupations of the site. Other taxa that could be determined include *Heliconia* sp. (Heliconiaceae), of which at least one species has edible rhizomes that are still consumed in the Amazon region (*H. hirsuta*). Leaves of this species are also used to create make-shift baskets. Phytoliths of *Phenakospermun guyannense* (Strelitziaceae) were also found at Cerro Azul. This species has edible seeds and its leaves are used in the construction of temporary campsites by the Nukak (Cárdenas and Politis, 2000; Kress et al., 1999). A large group of phytoliths could not be identified (indet. morphotypes) and were present across the entire temporal sequence of the archaeological site. These correspond to arboreal and herbaceous elements from the upper strata of the forest and the understory.

5.6. Faunal remains

For the study of the archaeozoological remains, Units A, B, M and N were analysed from Cerro Azul. The faunal remains were thermally altered and measured between 5 and 8 mm. A total of 81,669 fragments were recovered of which 14,594 (18%) were diagnostic and 67,075 (82%) were non-diagnostic. The high degree of fragmentation of the remains made it difficult to estimate a minimum number of individuals (MNI) and results are presented here using number of fragments instead (Fig. 10). 58% (8,484) are fish, represented by remains of spines, vertebrae, teeth and cranial fragments. The most abundant taxon was the "cachama" (*Piaractus* sp.), which migrates along rivers and penetrates lakes and flooded areas during the fruiting season of many forest species (when waters are at their peak levels). The piranha (*Pygocentrus* sp.), which can be identified by its teeth, was also present: it generally inhabits flooded grassy areas along river banks ("gramalotes"), lakes and streams throughout the year (Galvis et al., 2006). Other fish remains identified to family level include Cynodontidae, which are carnivorous predators found in rivers and periodically flooded lakes, and Doradidae, which inhabit lakes and slow-moving rivers and are able to resist anoxic conditions; most of its species are omnivorous and nocturnal (Galvis et al., 2006; Toledo-Piza, 2003).

A total of 4930 mammal remains (34%) were identified including incisors, phalanges and long bones. Rodents make up the majority of these fragments, of which the most abundant are the paca (*Cuniculus paca*) and capybara (*Hydrochoerus hydrochaeris*), both of which inhabit *terra firme* forests, ponds and savannas, where they feed on fruits, seeds and tubers (H. et al., 2019). Armadillos of the genus *Dasypus* were identified from remains of bone plates of the shell. These mammals live in diverse ecosystems including tropical humid forest and open savannas. Reptiles are represented by 824 (6%) of the fragments including vertebrae, phalanges and bone plates corresponding to turtles, iguanas, snakes, caiman and crocodiles. These taxa are mostly associated with aquatic environments such as *morichales* (stands of *Mauritia flexuosa*), streams and ancient river beds of the tropical humid forest (Calderón-Espinosa et al., 2019). A small number (N 326, 2%) of faunal remains recovered from the site were identified as bivalves of the family Mycetopodidae. These are characterised by their marked seasonality, being most abundant when the water levels are at their lowest. It is thus an abundant resource that is easy to collect in slow-moving waters (Linares et al., 2018). The only bird remains identified from the study site correspond to a single fragment of a phalange of an egret (family Ardeidae), associated with rapids and wetlands.

The high degree of fragmentation of the bony remains, the presence of small animals and the absence of medium-sized and large mammals like peccaries (Tayassuidae), tapirs (Tapiridae), primates, carnivores

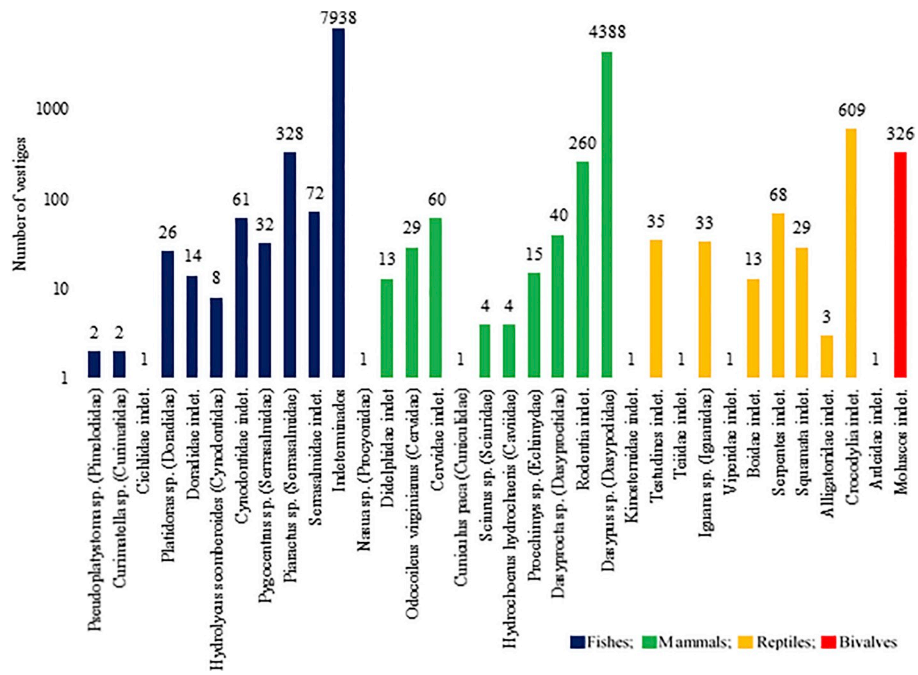
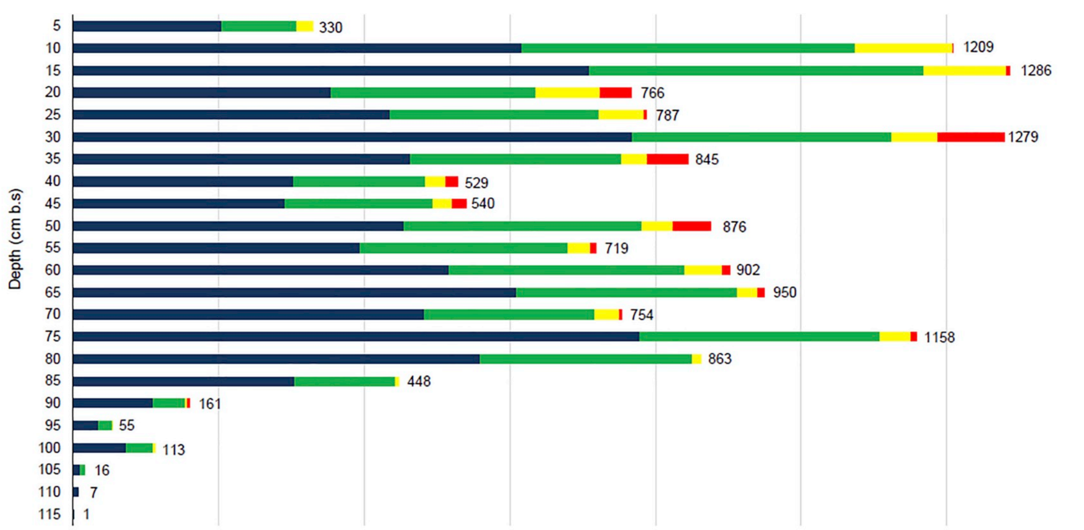


Fig. 10. Number of archaeozoological remains by identified taxa.



	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115
Fishes	62%	51%	55%	46%	55%	60%	55%	57%	54%	52%	55%	57%	64%	64%	67%	65%	68%	69%	64%	65%	63%	100%	100%
Mammals	31%	38%	36%	37%	37%	28%	34%	34%	38%	37%	40%	36%	32%	31%	28%	34%	31%	27%	35%	34%	38%	0%	0%
Reptiles	7%	11%	9%	11%	8%	5%	4%	5%	5%	5%	4%	6%	3%	4%	4%	1%	1%	2%	2%	2%	0%	0%	0%
Bivalves	0%	0%	0%	5%	0%	7%	7%	3%	4%	6%	1%	1%	1%	1%	1%	0%	0%	2%	0%	0%	0%	0%	0%

Fig. 11. Stratigraphic frequency diagram of faunal remains by depth (b.s.) from Grids M-N and A-B.

and birds, suggest that Cerro Azul was a site for processing small animals, and if the ancient occupants did hunt larger animals, these were processed at a different site. The presence of faunal remains throughout the entire temporal sequence of the archaeological site is evidence of continuous management though time of faunal resources associated with mostly aquatic ecosystems. Although no large animals were found, the diversity of small vertebrates and mollusks at the Cerro Azul site indicates that the hunter-gatherers of the Late Pleistocene used a broad range of faunal resources, which in turn suggests that they had to have developed diverse strategies and technologies for hunting and fishing in order to capture such a wide selection of prey across different types of habitat. In broad terms, as shown in Fig. 11 hunting and fishing behaviour displays few changes from the Late Pleistocene occupations to the most recent, with very similar proportions between fish, mammals and reptilians.

5.7. Rock paintings

Thousands of paintings are documented along the SLL rock walls, representing one of the richest rock art sites in South America, along with the nearby Chiribiquete National Park (Castaño Uribe, 2019). During our opportunistic survey of the region, we discovered three new panels of rock art in the coordinates panel 1: 2° 33′ 10,785″ N and 72° 52′ 44,4″ W; panel 2: 2° 33′ 10,8036″ N and −72° 52′ 40,7964″ W; panel 3: 2° 33′ 3,5856″ and 72° 52′ 44,4" W). In this section, we offer some preliminary observations about the SLL rock art related to the theme of the article: the depiction of potential megafauna. The rock art of SLL was drawn using mineral pigments, in particular ochre, which

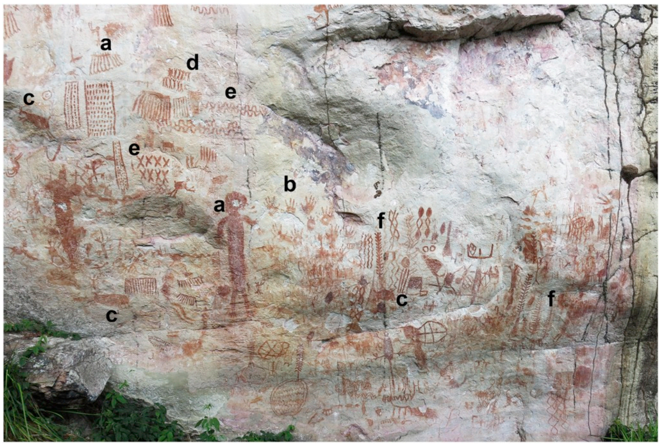


Fig. 12. Example of Cerro Azul rock paintings showing several motifs: a. Anthropomorphic; b. Hands; c. Zoomorphic; d. Geometric; e. Plants.

provides them with their characteristic reddish-terracotta colour. Paintings are usually located on exfoliated 'smooth' walls that are generally protected from the rain. The most abundant motifs depicted in the SLL are anthropomorphic, zoomorphic, and geometric and plant themes (Fig. 12). Many of them depict hunting and ritual scenes, showing humans interacting with plants, forest and savannah animals. Among the most abundant zoomorphic figures are deer, tapirs, alligators, bats, monkeys, turtles, serpents, and porcupines, among many others. Importantly, the rock art depicts what appears to be extinct Ice Age megafauna. Although megafauna images have been suggested for other rock art contexts in Central Brazil (e.g., Prous, 1989) and regions of South America (see Troncoso et al., 2018), to our knowledge, the ones from La Lindosa appear to be the more realistic ones. They include images that appear to resemble giant sloth, mastodon, camelids, horses, and three-toe ungulates with trunks that bear some resemblance to *Xenorhinotherium* or *Macrauchenia*. The overall shape, as well as the large head, thorax and prominent claws, allow us to consider that the animal depicted in Fig. 13a could be a giant sloth. The Fig. 13b drawing, exhibiting a trunk and the characteristic protuberance in the back of the head, reminds us of a mastodon. Fig. 13c with the distinctive small head, long neck, and the characteristic tail of a camelid, in addition, to their overall shape potentially represents a *Palaeolama*. It is markedly distinct to all the deers that are profusely painted in SLL. The horses represented in SLL (Fig. 13d and e) exhibit a large, heavy head characteristic of the American Ice Age horses. Unlike Urbina and Peña (2016), who interpret them as European horses, we tend to favour the hypothesis that these are Pleistocene horses based on their anatomical features as well as the fact that in the majority of indigenous post-Columbian pictographs of Old World horses, they appeared with riders (the aspect that most called the attention and curiosity of Native Americans when they saw horses for the first time) (e.g., Martínez, 2009; Troncoso et al., 2018). In general, Old World horses drawn in post-Columbian times do not exhibit the heavy head associated with Pleistocene horses. Some of the purported megafauna representations are accompanied by an assemblage of human figures of diminutive size in comparison (Fig. 13a) and many of these large animals are on the upper part of the panels. Ochre tablets and exfoliated rocks with red paintings have been recovered from the earliest occupational levels of Cerro Azul indicating that the earliest settlers of the region engaged in rock art. Collectively, all these paintings are likely to represent some of the earliest artistic expressions of native Amazonians, as well as recording their interaction with Ice Age megafauna. More research is needed to provide support to these speculations.

Rock art can be a source of environmental and economic information based on the identification of animals and plants depicted in the paintings (Sepúlveda et al., 2019). The identification of animals can play an essential source of insight about past landscapes and chronology of the paintings (Cobden et al., 2017). In this regard, the representation of Ice Age horses in the SLL provides us with critical chronological and palaeoenvironmental information. The presence of the Ice Age horse would confirm the Late Pleistocene age of the sites and the contemporaneity of humans and now-extinct animals on the landscape. The isotopic study of the diet of 13 extinct Ice Age mega mammal species by de Melo França et al. (2015) shows that horses are the only obligate grazers from the studied animal assemblage. The results of this study suggest that the landscapes around SLL were likely more open, containing savannahs. Upcoming local palaeoecological studies of the region will shed light on this aspect.

The similarity of the Serrania de Chiribiquete rock art (Baena et al., 2004; Van der Hammen, 2006) located about 180 km to the south of SLL suggest that both areas were part of a large cultural area sharing many commonalities. Castaño-Uribe and Van der Hammen (2005) who

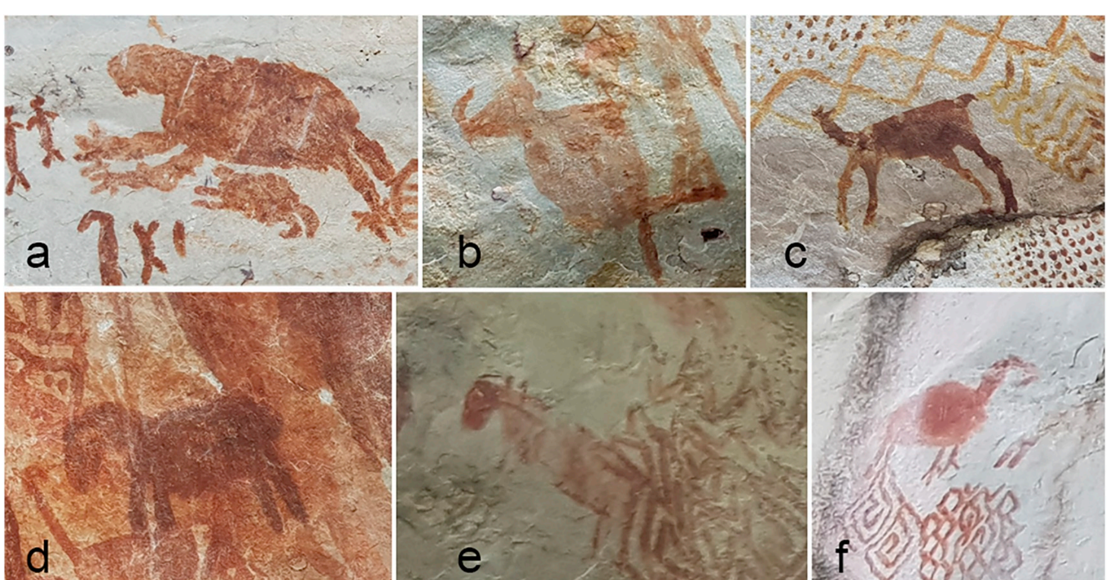


Fig. 13. Potential Ice-Age megafauna displayed in the pictographs of SLL including: a. giant sloth, b. mastodon, c. camelid (*Paleolama*?); d and e. horse; f. long-neck, three-toed ungulate with trunk (*Xenorhinotherium*, *Macrauchenia*?).

carried out a detailed morphological analysis of the Chiribiquete paintings, suggest this Colombian Amazon Tradition is linked to the central Brazilian Planalto, San Francisco and Northeastern traditions. Similarities with the lower Amazon early rock art of Caverna da Pedra Pintada (Davis, 2016) and Grotto of Piläo (Pereira, 2010) also need to be further explored.

6. Discussion

The results presented in this paper from the excavations of three rock shelters in the SLL document the earliest occupation of the Colombian Amazon, starting ~12,600 cal BP. These postdate the earliest occupations on the relatively near Bogota plateau (Tibito and Tequendama) and, coupled with the similarity in lithic assemblage with the Abriense lithics, point to a potential human expansion from the Bogota plateau across the sub-Andean forest, forest-savannah mosaic, and tropical forests during the YD (Aceituno et al., 2013). Across the whole Amazon Basin, the SLL dates are roughly half a millennium later than dated contexts in the Lower Amazon at Caverna da Pedra Pintada, where the first occupation was ~13,100 cal BP (Roosevelt et al., 1996). At present, data do not exist to detail the migratory route of these earlier groups and any potential relationship to early migrants on the Bogota Plateau. Certainly, based on the present radiocarbon dates, the early migrants in Eastern Amazonia do not appear to have passed through the Colombian Amazon, perhaps suggesting a more coastal west to east expansion for the earliest settlers. Future excavations, across the Amazon Basin will hopefully provide data to confirm routes of migration and refine the timing of these movements.

The timing of the entry into SLL, coinciding with the Younger Dryas, raises questions over potential causality. If the early SLL occupation is a result of a migration from the Bogota Plateau during the YD, were the climatic effects of the YD on resources a driver? Climate driven plant resource scarcity, coupled with dwindling megafauna, and likely increasing human populations, could be a push factors that compelled humans to descend the mountains to exploit the diverse resources of SLL. SLL was likely a resource-rich ecotone along the Guayabero River providing abundant edible plants as well as aquatic and terrestrial resources, as evidenced in the archaeobotanical and faunal records. The Guayabero River may also have been used as a route for the communication and expansion of foragers (Roberts, 2019), and the presence of numerous rock shelters would have presented natural, protected camps. The relationship between resources, the YD and human migration remains speculative until robust datasets can be generated.

The absence of local palaeoecological data from SLL prevents us from understanding with accuracy what the landscape was like during the earliest human occupation. As such, we can only provide some suggestions based on the available evidence. The closest pollen record to SLL is the Loma Linda lake (Behling and Hooghiemstra, 2000) that is located 150 km N of SLL, which documents the region as savannah with gallery forest since the early Holocene. Extrapolating from the available palaeoecological records, Piperno and Pearsall (1998) includes the region as well as vast tracts of the Guianas that today are tropical forest as savannah during the Late Pleistocene. This reconstruction scenario needs to be revised based on the fact that recent combined palaeoclimate and palaeoecolgoical data that show that even the driest parts of the Amazon (the heart of the so called 'dry corridor') persisted as forest even during the driest events of the Late Pleistocene (see Bush, 2017).

Phytolith analysis from SLL indicates that these early settlers were consuming tree fruits, including ten different species of palm, *Astrocaryum chambira*, *Attalea maripa*, *A. racemosa*, *Attalea* sp., *Bactris* sp., *Euterpe precatoria*, *Mauritia flexuosa*, *Oenocarpus bataua*, *O. minor*, and *Syagrus orinocensis* along with *Brosimum lactescens* (Moraceae). The evidence suggests that these economic tree and palm species were growing in the vicinity of SLL, indicating that tropical forest elements were present on the local landscape. Last but not least, the potential depiction of megafauna that are obligate grazers (horses) or thrive in open habitats, which is also likely the case of *Palaeolama*, suggest that the landscapes around SLL must have incorporated open spaces.

Our preliminary analysis indicates that the diet of the earliest settlers of the Colombian Amazon, along with the tree and palm fruits mentioned above, included fish and small and medium sized mammals, food items that were most likely available in the resource catchment area of Cerro Azul, Limoncillos and Cerro Montoya. Compared to other early sites in Colombia, the lack of plant processing tools, in particular grinding stones, suggests that roots were not as important as in these other regions (Aceituno and Loaiza, 2018). However, we should take into account the potential use of perishable wooden tools or natural graters for processing roots, such as the ethnographically documented use of *Socratea exorrhiza* spine-roots by some Amazonian groups (Balslev et al., 2008).

Combining our archaeobotanical analysis with previous work is providing a far greater appreciation of the role of plants in early colonists' diets in the tropics [Mora (2003); Roosevelt et al., 1996; Gnecco, 2003) and elsewhere in SA (e.g., Prous and Fogaça, 1999; Dillehay and Rossen, 2002). Intriguingly, many of the earliest plants consumed by humans in the tropics later become Amazonian hyperdominants (shown in bold below) (Levis et al., 2017; Ter Steege et al., 2013). Palms are predominant in early archaeobotanical records across lowland Amazonia and increasing proportions of palms in vegetation composition is closely associated with humans, with changes beginning when people first appear on the landscape (Morcote-Ríos et al., 2015). Since ~12,600 cal BP, palms have been a major component of contexts at SLL. Archaeobotanical research shows the presence of *Astrocaryum chambira*, *A.* sp., *Attalea racemosa*, *A. maripa*, *Euterpe precatoria*, *Mauritia flexuosa*, *Oenocarpus bataua*, *Syagrus orinocensis*, *Socratea exhorriza*, and *Bactris* sp. since 12, 500 cal BP, in agreement with archaeobotanical data from the Amazon lowland forest at Peña Roja (Mora, 2003). Palm fruits are nutrient rich (oil and proteins), non-poisonous, plant resources that were available for a large part of the year. Palm leaves have been used throughout history for thatching of homes and temporary camp sites, and their fibers are extracted for the fabrication of various implements. The trunks serve as posts or walls in buildings, or for the construction of blowguns, darts, bows and harpoons for hunting and fishing (Galeano and Bernal, 2010).

Evidence from the Lower Amazon ~13,100 cal BP shows consumption of several plants, including: the seeds and fruits of *Hymenaea* (Fabaceae), Brazil nut (*Bertholletia excelsa*, Lecythidaceae), *Sacoglottis guianensis* (Humiriaceae), *Talisia esculenta* (Sapindaceae), *Mouriri apiranga* (Melastomataceae), *Coccoloba pixuna* (Polygonaceae), and Muruci (*Byrsonima crispa*, Malpighiaceae) – all of which continue to be used by indigenous groups today. Archaeobotanical evidence from the sub Andean forest of the Middle Cauca River includes *Dioscorea* sp. and *Calathea* sp. root crops, a variety of *Phaseolus* sp. beans, in addition to *Annona* sp., *Rubus* sp., and avocado, circa 10,000 cal BP (Dickau et al., 2015).

The extent to which early settlers were managing the flora, impacting the establishing tropical forest, is still a matter of controversy. The generation of palaeoecological data will be crucial to shed light on this crucial question. Modern ethnographic and archaeobotanical studies show that hunter-gatherers across the globe do not passively adapt to tropical forests, but are often 'niche-constructors' (e.g, Smith, 2011), modifying their environment through their subsistence activities. Research over the last two decades has highlighted the occupation and use of tropical rainforests by humans, including the manipulation of tree products, management of forest composition, anthropogenic burning, cultivation of edible plants, the detoxification of plants, and the hunting of medium to small-sized arboreal, semi-arboreal, and terrestrial tropical game. Evidence of the human manipulation of forest ecosystems has been documented from SE Asia from at least 50,000–45,000 cal BP (Barker et al., 2017), Melanesia from 45,000 cal BP (Summerhayes et al., 2010), and potentially since least 13,100 cal BP in the Amazon (Roosevelt et al., 1996). The presence of crops, edible and useful plant species in the early archaeobotanical record not only reveal diet and the availability of resources, but also hint at active engagement with plants, plant management and the potential impact on long-term trajectories of vegetation composition and biodiversity. LP/EH archaeobotanical results demonstrate that humans must be considered as an active factor in vegetation succession, especially during periods of broad landscape transition when habitats are establishing. The role of the YD during the initial peopling of the Colombian Amazon, both in terms of a driver for human movement, but also in relation to the climatic impact on the establishing humid tropical vegetation remains to be resolved; however, present data place the timing of the arrival of humans into the Colombian Amazon within the YD, when the cooler, drier climatic conditions resulted in a drop in the Andean tree line, supporting the hypothesis that the human expansion into the Colombian Amazon originated from the Bogota Plateau in response to climate driven changes in resource availability. The Bogota Plateau origin of these early migrants is further supported by lithic assemblages.

The lithic technology of SLL shares features with many of the lithic traditions of South America, both in the highlands and lowlands. Unifacial flakes, with or without retouch, used in cutting, scraping or drilling, are very common in wide regions of South America from the Late Pleistocene onwards (Bueno et al., 2013; Capriles et al., 2019; Constantine, 2013; Dillehay, 2000, 2003; Dillehay et al., 2017; Rademaker et al., 2014; Schmidt, 2004). In Colombia, the artefacts from the SLL are similar to the Abriense class of the Sabana de Bogota; Abriense debitage is an Andean unifacial tradition made by direct percussion using local raw materials. The flakes are retouched and therefore considered in the edge-trimmed tool tradition by Correal (Aceituno and Rojas-Mora, 2015; Correal, 1986). They are also similar to the debitage tools reported at the Peña Roja site (Morcote-Ríos et al., 2014). The unifacial tradition of flakes made by direct percussion is found throughout the Andes, in some cases along with bifacial tools (Middle Porce, Middle Magdalena, Popayan Plateau) (Aceituno et al., 2013; Aceituno and Rojas-Mora, 2015; Gnecco, 2000; López, 1999). The high number of retouched tools and use-wear traces, such as microfracturing on the use edges, together with the presence of animal bones, such as caiman, turtles, snakes, fish and small mammals, including armadillo, capybara and deer, among others, suggests the use of lithics in animal butchery. The retouched edges may indicate processing for all parts of the animal by cutting or scraping soft tissues, fresh hide, bones or muscles. We consider that the small size of tools suggests they may have been inserted into wooden handles. The lack of complex lithic tools in Cerro Azul assemblages may be due to the relatively small size of available quartz and chert nodules, limiting the manufacture of tools that require a high number of removal sequences. Also, the Bamboo hypothesis may apply, which argues that in tropical rainforests, organic tools manufactured from bone and wood are common (Ford, 2017). For example, there are well documented ethnographic uses of pointed wooden spears and arrows in South American groups such as the Ache, Lengua, Orejones, Pumé, Sirionó, Yagua and Yuqui (Waguespack et al., 2009) and the Nukak that still live in the forest of the Guaviare region (Politis, 2007). This may also explain the absence of clear grinding tools or axes in the Cerro Azul assemblage, especially since they are common in other sub-Andean and tropical forest Late Pleistocene and Early Holocene contexts. For example, in Andean regions grinding tools were common inthe Early Holocene (Aceituno and Loaiza, 2018; Aceituno and Rojas-Mora, 2015; Gnecco and Mora, 1997; Groot, 1995; Vecino et al., 2015), and have been documented in the Cordillera Central from the Late Pleistocene (Dickau et al., 2015). Similarly, in the Colombian Amazon at Peña Roja, hand stones, anvils, milling stones, and debitage tools were recovered, dating to the Early Holocene (~8,879–7,609 cal. BP) (Morcote-Ríos et al., 2014). The continued development and integrated analysis of robust paleoecological, archaeobotanical, and material culture datasets will be essential to understand questions of coupled human/plant relationships in the peopling of Amazonia and the establishment of the Amazon rainforest.

The abundant rock paintings provide a spectacular line of evidence toward landscape reconstruction and understanding elements of human/environment interaction, from diet to hunting strategy and plant management. Furthermore, the paintings provide insight into social phenomena of SLL inhabitants. The rock paintings were likely a powerful strategy or instrument in the creation of a cultural landscape in the SLL. The relationship between rock paintings, territorial control, ritual practice, and the construction of social networks has been acknowledged by different scholars and is seen as a primary motivation for making the paintings (Krishnendu et al., 2015; Whitley, 2011; Wright, 2014). At Cerro Azul fragments of ochre were recovered from the lower levels, suggesting that paintings were produced from the oldest occupations as an early strategy of creating and defining the cultural landscape. The presence of thousands of rock pictographs in the region supports the hypothesis of social aggregation between the inhabitants or small groups of the SLL (Troncoso et al., 2016).

In summary, these preliminary data are key for future research, such as the origin of first colonisers, the potential existence of megafauna in the region, the settlement pattern and seasonal mobility, the ritual practices, the relation between the sites to the rock paintings; the territory size, the forest management practices, the food procurement strategies and the short and long-distance relationships, for example with Serranía Chiribiquete or other riverine forager groups.

7. Conclusions

The first data obtained in the SLL confirm the early peopling of the northwest Amazon basin during the end of the Ice Age and that at this time this great biome was not a natural barrier for expansion of hunter-gatherers in South America. Radiocarbon dates indicate that the oldest occupations occurred starting around 12,600 years before the present and that the area was occupied throughout the Holocene. As a preliminary hypothesis, we propose an Andean origin for the first humans in the SLL, if we take into account the geographical proximity of the Colombian Andes, radiocarbon dates, similarities in lithic technology and the natural routes (rivers and valleys) connecting the highlands and lowlands. Similarities in rock art between SLL and Chiribiquete suggest the creation of a cultural landscape that involves wider cultural interaction.

Our preliminary results (lithic tools, ecofacts and pictographs) suggest a generalist subsistence strategy, combining hunting and the consumption of tree fruits. Unlike other regions, for the moment we have no evidence of the use of roots or wild crops, although a strategy that involved a degree of forest management does appear likely. A possibility that requires further exploration, is the presence of megafauna in the SLL, with implications for paleoecological dynamics and reconstruction, as well as human subsistence strategies and adaptations. The extensive rock art not only hints at the coeval presence of humans and megafauna in the landscape, but also that megaherbivores were a component of the hunters' diet, an interaction confirmed in contexts from the Bogota Plateau. The timing of the colonisation of Amazonia during the YD presents a compelling context that will be essential to understand the establishment and long-term biodiversity trajectory of Amazonia.

Upcoming excavations in the contexts of the project LASTJOURNEY (ERC_Adv_ ERC_Adv_2018–834514) will bring to light new data to refine these hypotheses.

Acknowledgements

This project was funded by a grant from the Colombian Institute of Anthropology and History (No 199 2017), by the University of Exeter's Exploration Fund (2018) and the ERC project LASTJOURNEY (ERC_Adv_ 834514) and Santo Domingo Centre (SDCELAR) of British Museum. We acknowledge professor Sneider Rojas (UdeA) and the students Valentín Castellanos (UNAL), Andres Durango (UNAL), Mateo

Molina (UdeA) and Benito Venegas (UNAM) who participated in the fieldwork. Thanks to Lauren Raz for help with translation; to Marcela García for editing Figs. 3–5 and 7 and 12; to Ashely Sharpefor guidance in the archaeozoological study. Jeison Chaparro was supported by grant No. 4497 from the Smithsonian Tropical Research Institute. Finally, we also want to extend our thanks to the local residents for their collaboration during both field seasons: to the families of José Noé Rojas (Alex, Norbey and Marcela) and Nelson Castro for their warm hospitality; to our fieldguide "Barbas" and to the Junta de Acción Comunal El Raudal.

References

Aceituno, F.J., Loaiza, N., 2018. The origins and early development of plant food production and farming in Colombian tropical forests. J. Anthropol. Archaeol. 49, 161–172.
Aceituno, F.J., Rojas-Mora, S., 2015. Lithic technology studies in Colombia during the late Pleistocene and early Holocene. Chungara, Revista de Antropología Chilena 47, 1–11.
Aceituno, F.J., Loaiza, N., Delgado-Burbano, M.E., Barrientos, G., 2013. The initial human settlement of Northwest South America during the Pleistocene/Holocene transition: synthesis and perspectives. Quat. Int. 301, 23–33.
Andrefsky, W., 2005. Lithics: Macroscopic Approaches to Analysis. Cambridge University Press, Cambridge.
H.,L.-A, Carrillo-Villamizar, J., Díaz-Rodríguez, J., Delgadillo-Ordoñez, N., 2019. Guía de mamíferos de San José del Guaviare. Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Bogotá.
Baena, J., Carrión, E., Blasco, C., 2004. Hallazgos de arte rupestre en la serranía de Chiribiquete, Colombia. Misión arqueológica 1992, Rupestreweb. http://www.rupestreweb.info/chiribiquete.html.
Balslev, H., Grandez, C., Paniagua Zambrana, N.Y., Møller, A.L., Hansen, S.L., 2008. Palmas (Arecaceae) útiles en los alrededores de Iquitos, Amazonía Peruana. Rev. Peru. Biol. 15, 121–132.
Barker, G., Hunt, C., Barton, H., Gosden, C., Jones, S., Lloyd-Smith, L., Farr, L., Nyirí, B., O'Donnell, S., 2017. The 'cultured rainforests' of Borneo. Quat. Int. 448, 44–61.
Barse, W.P., 1990. Preceramic occupations in the Orinoco river valley. Science 250, 1388–1390.
Berg, C.C., 1972. Olmedieae, Brosimeae (Moraceae). Hafner Publishing Company, Victoria.
Boëda, E., Clemente-Conte, I., Fontugne, M., Lahaye, C., Pino, M., Felice, G.D., Guidon, N., Hoeltz, S., Lourdeau, A., Pagli, M., 2014. A new late Pleistocene archaeological sequence in South America: the Vale da Pedra Furada (Piauí, Brazil). Antiquity 88, 927–941.
Borrero, L.A., 2015. Moving: hunter-gatherers and the cultural geography of South America. Quat. Int. 363, 126–133.
Braje, T.J., Dillehay, T.D., Erlandson, J.M., Klein, R.G., Rick, T.C., 2017. Finding the first Americans. Science 358, 592–594.
Bueno, L., Dias, A.S., Steele, J., 2013. The Late Pleistocene/Early Holocene archaeological record in Brazil: a geo-referenced database. Quat. Int. 301, 74–93.
Bush, M.B., 2017. Climate science: the resilience of Amazonian forests. Nature 541, 167.
Bush, M.B., Piperno, D.R., Colinvaux, P.A., De Oliveira, P.E., Krissek, L.A., Miller, M.C., Rowe, W.E., 1992. A 14 300-yr paleoecological profile of a lowland tropical lake in Panama. Ecol. Monogr. 62, 251–275.
Calderón-Espinosa, M.L., Medina-Rangel, G., Jerez, A., Rios-Orjuela, J., López-Perilla, Y., 2019. Anfibios y Reptiles del municipio de San José del Guaviare (Guaviare, Colombia). Universidad Nacional de Colombia, Bogotá.
Capriles, J.M., Lombardo, U., Maley, B., Zuna, C., Veit, H., Kennett, D.J., 2019. Persistent early to middle holocene tropical foraging in southwestern amazonia. Sci. Adv 5, eaav5449.
Cárdenas, D., Politis, G., 2000. Territorio, movilidad, etnobotánica y manejo del bosque de los Nukak orientales. Universidad de los Andes, Bogotá.
Cárdenas, D., Castaño, N., Zubieta, M., Jaramillo, M., 2008. Flora de las formaciones rocosas de la Serranía La Lindosa. Instituto Amazónico de Investigaciones Científicas-Sinchi, Bogotá.
Castaño Uribe, C., 2019. Chiribiquete. La maloka cósmica de los hombres jaguar. Villegas Editores, Bogotá.
Castaño-Uribe, C., Van der Hammen, T., 2005. Visiones y alucinaciones del Cosmos Felino y Chamanístico de Chiribiquete. UASESPNN Ministerio del Medio Ambiente, Fundación Tropenbos-Colombia. Embajada Real de los Países Bajos, Bogotá.
Cavelier, I., Rodríguez, C., Herrera, L., Morcote, G., Mora, S., 1995. No solo de la caza vive el hombre: ocupación del bosque amazónico, Holoceno temprano. In: Cavelier, I., Mora, S. (Eds.), Ambito y ocupaciones tempranas de la América Tropical. Fundación Erigaie, Instituto Colombiano de Antropología, Bogotá, pp. 27–44.
Cobden, R., Clarkson, C., Price, G.J., David, B., Geneste, J.-M., Delannoy, J.-J., Barker, B., Lamb, L., Gunn, R.G., 2017. The identification of extinct megafauna in rock art using geometric morphometrics: a Genyornis newtoni painting in Arnhem Land, northern Australia? J. Archaeol. Sci. 87, 95–107.
Constantine, A., 2013. The early settlement of Continental Ecuador: new evidence from preceramic sites in the Tropical Rain Forest. Quat. Int. 317, 112–117.
Correal, G., 1986. Apuntes sobre el medio ambiente pleistocénico y el hombre prehistórico en Colombia. In: Bryan, A.L. (Ed.), New Evidence for the Pleistocene Peopling of the Americas. Center for the Study of the Early Man, University of Main, Orono, pp. 115–131.
Correal, G., van der Hammen, T., 1977. Investigaciones arqueológicas en los abrigos rocosos del Tequendama: 12.000 años de historia del hombre y su medio ambiente en la altiplanicie de Bogotá Biblioteca Banco Popular, Bogotá.
Correal, G., van der Hammen, T., Piñeres, F., 1990. Guayabero I: un sitio precerámico de la localidad Angosturas II, San Jose del Guaviare. Caldasia 16, 245–254.
Correal Urrego, G., 1981. Evidencias Culturales y Megafauna Pleistocenica en Colombia. Fundacion de Investigaciones Arqueologicas Nacionales, Banco de la República, Litografia Arco, Bogotá.
Davis, C.S., 2016. Solar-aligned pictographs at the paleoindian site of painel do pilão along the lower Amazon river at monte alegre, Brazil. PloS One 11, e0167692.
de Melo França, L., de Asevedo, L., Dantas, M.A.T., Bocchiglieri, A., dos Santos Avilla, L., Lopes, R.P., da Silva, J.L.L., 2015. Review of feeding ecology data of Late Pleistocene mammalian herbivores from South America and discussions on niche differentiation. Earth Sci. Rev. 140, 158–165.
Delgado, M., Aceituno, F.J., Barrientos, G., 2015. 14C data and the early colonization of northwest South America: a critical assessment. Quat. Int. 363, 55–64.
Dickau, R., Aceituno, F.J., Loaiza, N., López, C., Cano, M., Herrera, L., Restrepo, C., Ranere, A.J., 2015. Radiocarbon chronology of terminal pleistocene to middle holocene human occupation in the middle Cauca Valley, Colombia. Quat. Int. 363, 43–54.
Dillehay, T.D., 2000. The Settlement of the Americas: A New Prehistory. Basic Books, New York.
Dillehay, T.D., 2003. Las culturas del Pleistoceno tardío en Suramérica. Maguaré 17, 15–45.
Dillehay, T.D., Rossen, J., 2002. Plant food and its implications for the peopling of the New World: a view from South America. In: Jablonski, N.G. (Ed.), The First Americans: the Pleistocene Colonization of the New World. University of California Press, Berkeley, pp. 237–253.
Dillehay, T.D., Calderón, G.A., Politis, G., de Moraes Coutinho, M.d.C., 1992. Earliest hunters and gatherers of South America. J. World PreHistory 6, 145–204.
Dillehay, T.D., Goodbred, S., Pino, M., Sánchez, V.F.V., Tham, T.R., Adovasio, J., Collins, M.B., Netherly, P.J., Hastorf, C.A., Chiou, K.L., 2017. Simple technologies and diverse food strategies of the late pleistocene and early holocene at huaca prieta, coastal Peru. Sci. Adv. 3, e1602778.
Ford, A., 2017. Late Pleistocene lithic technology in the Ivane valley: a view from the rainforest. Quaternary International 448, 31–43.
Galeano, G., Bernal, R., 2010. Palmas de Colombia: Guía de campo. Bogotá, Instituto de Ciencias Naturales-Universidad Nacional de Colombia.
Galvis, G.J., Mojica, S., Duque, C., Castellanos, P., Sánchez-Duarte, M., al, A.e., 2006. Peces del medio Amazonas. Región de Leticia. Conservation International, Bogotá.
Gnecco, C., 2000. Ocupación temprana de bosques tropicales de montaña. Universidad del Cauca, Popayán.
Gnecco, 2003. Against Ecological Reductionism: Late Pleistocene Hunter-Gatherers in the Tropical Forests of Northern South America. Quaternary International 109–110, 13–21.
Gnecco, C., Mora, S., 1997. Late pleistocene/early holocene tropical forest occupations at San Isidro and Pena Roja, Colombia. Antiquity 71, 683–690.
Groot, M., 1995. Checua: un aporte para el conocimiento del precerámico de la sabana de Bogotá In: Cavelier, I., Mora, S. (Eds.), Ambito y ocupaciones tempranas de la América Tropical. Fundación Erigaie, Instituto Colombiano de Antropología, Bogotá, pp. 45–58.
Groot, M., Bogotá, R., Lourens, L., Hooghiemstra, H., Vriend, M., Berrio, J., Tuenter, E., Plicht, J., Geel, B.v., Ziegler, M., 2011. Ultra-high resolution pollen record from the northern Andes reveals rapid shifts in montane climates within the last two glacial cycles. Clim. Past 7, 299–316.
Gruhn, R., Bryan, A.L., 1984. The record of Pleistocene megafaunal extinction at Taima-Taima, northern Venezuela. In: Martin, P.S., Klein, R.G. (Eds.), Quaternary Extinctions. A Prehistoric Revolution University of Arizona Press, Tucson, pp. 128–137.
Iriarte, J., 2007. New perspectives on plant domestication and the development of agriculture in the New World. Rethink. Agri: Archaeolo. Ethnoarchaeol. Perspec 51, 167.
Islebe, G.A., Hooghiemstra, H., Van der Borg, K., 1995. A cooling event during the younger Dryas chron in Costa Rica. Palaeogeogr. Palaeoclimatol. Palaeoecol. 117, 73–80.
Kress, J., Betancur, J., Echeverri, B., 1999. Heliconias. Llamaradas de la Selva Colombiana. Guía de Campo. Cristina Uribe Editores, Bogotá.
Krishnendu, P., Banerjee, A., Makal, A., 2015. Relations between rock art and ritual practice: a case study from eastern India. Archaeol. Res. Asia 3, 34–48.
Levis, C., Costa, F.R., Bongers, F., Peña-Claros, M., Clement, C.R., Junqueira, A.B., Neves, E.G., Tamanaha, E.K., Figueiredo, F.O., Salomão, R.P., 2017. Persistent effects of pre-Columbian plant domestication on Amazonian forest composition. Science 355, 925–931.
Linares, E., Lasso, C., Vera-Ardila, M., Morales-Betancourt, M., 2018. Moluscos dulceacuícolas de Colombia. Instituto de Investigación de Recursos Biológicos Alexander von Humboldt., Bogotá.
López, C., 1999. Ocupaciones Tempranas en las Tierras Bajas Tropicales del Valle Medio del Río Magdalena: Sitio 05-Yon-002 Yondó-Antioquia. Fundación de Investigaciones Arqueológicas Nacionales, Banco de la República, Bogotá.
Martínez, J.L., 2009. Registros andinos al margen de la escritura: el arte rupestre colonial. Boletín del Museo Chileno de Arte Precolombino 14, 9–35.
Mora, S., 2003. Early Inhabitants of the Amazonian Tropical Rain Forest: a Study of Humans and Environmental Dynamics. University of Pittsburgh Latin American Archaeology Reports No. 3, Pittsburgh.
Mora, S., Gnecco, C., 2003. Archaeological hunter-gatherers in tropical ainforests: a View from Colombia. In: J.,M (Ed.), Under the Canopy: the Archaeology of Tropical Rainforests. Rutgers University Press, New Brunswick, pp. 271–290.

Morcote-Ríos, G., 2017. Recorrido en el tiempo: 12000 años de ocupación de la Amazonia. Universidad y Territorio. Universidad Nacional de Colombia, Bogota, pp. 68–93.
Morcote-Ríos, G., Cabrera, G., Mahecha, D., Franky, C., I.,C, 1998. Las palmas entre los grupos cazadores recolectores de la Amazonía colombiana. Caldasia 20, 57–74.
Morcote-Ríos, G., Aceituno, F.J., León Sicard, T., 2014. Recolectores del Holoceno Temprano en la Floresta Amazónica Colombiana. In: Rostain, S. (Ed.), Antes de Orellana. Actas del 3er Encuentro Internacional de Arqueología Amazónica, pp. 39–50 Quito.
Morcote-Ríos, G., Giraldo-Canas, D., Raz, L., 2015. Ilustrated Catalogue of Contemporary Phytoliths for Archaeology and Archaeobotany. I. Amazonian Grasses of Colombia. Universidad Nacional de Colombia, Bogota.
Muttillo, B., Lembo, G., Rufo, E., Peretto, C., Lleras Pérez, R., 2017. Revisiting the oldest known lithic assemblages of Colombia: a review of data from el Abra and tibitó (cundiboyacense plateau, eastern Cordillera, Colombia). J. Archaeol. Sci.: Rep 13, 455–465.
Peplinsky, J., Pitman, N., Vriesendorp, C., Alvira Reyes, D., Ravikumar, A., del Campo, A., Stotz, D.F., et al., 2018. Colombia: La Lindosa, Capricho, Cerritos: Rapid Biological and Social Inventories Report 29 (Rapid Biological and Social Inventories Informe/ Report). Field Museum Of Natural History, Chicago.
Pereira, E., 2010. Arte rupestre e cultura material na Amazônia brasileira. In: Pereira, E., Guapindaia, V. (Eds.), Arqueologia Amazônica 1. Museu Paraense Emilio Goeldi, Belem, pp. 261–283.
Piperno, D.R., 2006. Phytoliths: A Comprehensive Guide for Archaeologists and Paleoecologists. AltaMira Press, San Diego.
Piperno, D.R., 2011. The origins of plant cultivation and domestication in the New World tropics. Curr. Anthropol. 52, S453–S470.
Piperno, D.R., Pearsall, D.M., 1998. The Origins of Agriculture in the Lowland Neotropics. Academic Press, San Diego.
Politis, G., 2007. Nukak: Ethnoarchaeology of an Amazonian People. Left Coast Press, Walnut Creek.
Prous, A., 1989. L'Art Rupestre du Brasil Central. Les Dossiers d'Archaeologie, Dijon.
Prous, A., Fogaça, E., 1999. Archaeology of the pleistocene-holocene boundary in Brazil. Quat. Int. 53, 21–41.
Rademaker, K., Hodgins, G., Moore, K., Zarrillo, S., Miller, C., Bromley, G.R., Leach, P., Reid, D.A., Álvarez, W.Y., Sandweiss, D.H., 2014. Paleoindian settlement of the high-altitude Peruvian Andes. Science 346, 466–469.
Ranere, A.J., Cooke, R.G., 2002. Late glacial and early holocene occupation of central American tropical forests. In: Mercader, J. (Ed.), Under the Canopy: the Archaeology of Tropical Rainforests. Rutgers University Press, London, pp. 219–248.
Ranere, A., López, C.E., 2007. Cultural diversity in late pleistocene/early holocene populations in northwest south America and lower Central America. int. J. South. Am. Archaeol. 1, 25–31.
Reimer, P.J., Bard, E., Bayliss, A., Beck, J.W., Blackwell, P.G., Ramsey, C.B., Buck, C.E., Cheng, H., Edwards, R.L., Friedrich, M., 2013. IntCal13 and Marine13 radiocarbon age calibration curves 0–50,000 years cal BP. Radiocarbon 55, 1869–1887.
Riris, P., Oliver, J.R., Mendieta, N.L., 2018. Missing the point: re-evaluating the earliest lithic technology in the Middle Orinoco. 5. Royal Society Open Science, pp. 180690.
Roberts, P., 2019. Tropical Forests in Prehistory, History, and Modernity. Oxford University Press, Oxford.
Roberts, P., Hunt, C., Arroyo-Kalin, M., Evans, D., Boivin, N., 2017. The deep human prehistory of global tropical forests and its relevance for modern conservation. Nat. Plants. 3, 17093.
Roosevelt, A.C., 2017. Interpreting long-term human-environment Interaction in amazonia. In: Amstrong-Fumero, F., Gutierrez, J.H. (Eds.), Legacies of Space and Intangible Heritage: Archaeology, Ethnohistory, and the Politics of Cultural Continuity in the Americas. University of Colorado Press, Boulder, pp. 209–238.
Roosevelt, A.C., Lima da Costa, M., Lopes Machado, C., Michab, M., Mercier, N., Valladas, H., Feathers, J., Barnett, W., Imazio da Silveira, M., Henderson, A., 1996. Paleoindian cave dwellers in the Amazon: the peopling of the Americas. Science 272, 373–384.
Sánchez, M., 1997. Catálogo preliminar comentado de la flora del Medio Caquetá. Estudios en la Amazonía colombiana. Vol. 12. Tropenbos, Bogotá.
Schmidt, A., 2004. Diversificar para poblar. El contexto arqueológico brasileño en la transición Pleistoceno-Holoceno. Complutum 15, 249–263.
Sepúlveda, M., Saintenoy, T., Cornejo, L., Dudognon, C., Espinoza, F., Guerrero-Bueno, Z., Cerrillo-Cuenca, E., 2019. Rock art painting and territoriality in the precordillera of northernmost Chile (South-Central Andes). Archeological and spatial approaches to the Naturalistic Tradition. Quat. Int. 503, 254–263.
Smith, B.D., 2011. General patterns of niche construction and the management of 'wild'plant and animal resources by small-scale pre-industrial societies. Phil. Trans. Roy. Soc.B 366, 836–848.
Summerhayes, G.R., Leavesley, M., Fairbairn, A., Mandui, H., Field, J., Ford, A., Fullagar, R., 2010. Human adaptation and plant use in highland New Guinea 49,000 to 44,000 years ago. Science 330, 78–81.
Ter Steege, H., Pitman, N.C., Sabatier, D., Baraloto, C., Salomão, R.P., Guevara, J.E., Phillips, O.L., Castilho, C.V., Magnusson, W.E., Molino, J.-F., 2013. Hyperdominance in the Amazonian tree flora. Science 342, 1243092.
Toledo-Piza, M., 2003. Cynodontidae (cynodotids). In: Reis, R.E., Kullander, S.O., Ferraris, J., C.J (Eds.), Checklist of the Freshwater Fishes of South and Central America. EDIPUCRS, Porto Alegre, pp. 234–237.
Troncoso, A., Moya, F., Basile, M., 2016. Rock art and social networks among hunter gatherers of north-central Chile. J. Anthropol. Archaeol. 42, 154–168.
Troncoso, A., Armstrong, F., Basile, M., 2018. Researching rock art in central and south America. In: David, B., McNiven, I.J. (Eds.), The Oxford Handbook of the Archaeology and Anthropology of Rock Art. Oxford University Press, Oxford, pp. 282–314.
Urbina, F., Peña, J., 2016. Perros de guerra, caballos, vacunos y otros temas en el arte rupestre de la serranía de La Lindosa (río Guayabero, Guaviare, Colombia): una conversación. Ensayos: Historia y Teoría del Arte 20, 7–37.
Van der Hammen, T., 2006. Bases para una prehistoria ecológica amazónica y el caso Chiribiquete. In: Morcote-Rios, G., S.,M, Frankly, C. (Eds.), Pueblos y paisajes antiguos de la selva amazónica. Universidad Nacional de Colombia-Taraxacum, Bogotá, pp. 19–28.
Van der Hammen, T., Correal, G., 2001. Mastodontes en un humedal Pleistocénico en el valle del Magdalena (Colombia) con evidencias de la presencia del hombre en el pleniglacial. Boletín de Arqueología 16, 4–36.
Van Der Hammen, T., Hooghiemstra, H., 1995. The el Abra stadial, a Younger Dryas equivalent in Colombia. Quat. Sci. Rev. 14, 841–851.
Vecino, G.S., Marín, C.A.M., Salas, L.V.C., 2015. Alteration of tropical forest vegetation from the Pleistocene–Holocene transition and plant cultivation from the end of early Holocene through Middle Holocene in Northwest Colombia. Quat. Int. 363, 28–42.
Vialou, D., Benabdelhadi, M., Feathers, J., Fontugne, M., Vialou, A.V., 2017. Peopling south America's centre: the late pleistocene site of santa elina. Antiquity 91, 865–884.
Waguespack, N.M., Surovell, T.A., Denoyer, A., Dallow, A., Savage, A., Hyneman, J., Tapster, D., 2009. Making a point: wood-versus stone-tipped projectiles. Antiquity 83, 786–800.
Whitley, D.S., 2011. Rock art, religion and ritual. In: Insoll, T. (Ed.), Oxford Handbook of the Archaeology of Ritual and Religion. Oxford University Press, Oxford, pp. 307–326.
Wright, A.M., 2014. Religion on the Rocks: Hohokam Rock Art, Ritual Practice and Social Transformation. University of Utah Press, Tucson.