

Current Understanding of the Earliest Human Occupations in the Americas: Evaluation of Becerra-Valdivia and Higham (2020)

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Abstract

Various chronologies of the earliest Native American occupations have been proposed with varying levels of empirical support and conceptual rigor, yet none is widely accepted. A recent survey of pre-Clovis dated sites (Becerra-Valdivia and Higham 2020) concludes a pre-Last Glacial Maximum (>26,500-19,000 cal yr BP) entry of humans in the Americas, in part based on recent work at Chiquihuite Cave, Mexico. We evaluate the evidence used to develop this inference. To provide clarity, we present three explicit dispersal models for the earliest human dispersals to the Americas: *Strict Clovis-First* (13,050 cal yr BP), *Paleoindian* (<16,000 cal yr BP), and *Pre-Paleoindian* (>16,000 cal yr BP, encompassing pre-LGM, preferred by Becerra-Valdivia and Higham (2020)), and we summarize the current genetic and archaeological evidence bearing on each. We regard all purported Pre-Paleoindian sites as equivocal and the Strict Clovis-First model to be equally unsupported at present. We conclude that current data strongly support the Paleoindian Dispersal model, with Native American ancestors expanding into the Americas sometime after 16,000 cal yr BP (and perhaps after 14,800 cal yr BP), consistent with well-dated archaeological sites and with genetic data throughout the western hemisphere. Models of the Americas' peopling that incorporate Chiquihuite or other claimed Pre-Paleoindian sites remain unsubstantiated.

1. INTRODUCTION

The initial peopling of the Americas has remained a contentious topic, with strong opinions often coupled with various levels of empirical support. No consensus has emerged, though numerous attempts to develop a general chronology for this process have been published (e.g., Braje et al. 2017a; Goebel et al. 2008; Meltzer 2009; Stanford and Bradley 2012; Sutter 2020; Waters and Stanford 2013; Waters 2019; Waters et al. 2009). There is little disagreement that Clovis and related (probably derived) Fishtail Point complexes represent the first continent-wide cultural manifestation south of the Laurentide and Cordilleran Ice Sheets, though some have argued for earlier Western Stemmed tradition sites localized in the Great Basin and adjacent regions (Beck and Jones 2010, Davis et al. 2020). Pre-Clovis sites are variable in their level of documentation, site integrity, and association of dated materials and cultural activities, but have been generally treated as a single composite group, at least in public perception. The better substantiated (but not universally accepted) pre-Clovis sites post-date 14,800 cal yr BP, e.g., Monte Verde MV II (Dillehay 1997), Paisley Caves (Jenkins et al. 2012), Page-Ladson (Halligan et al. 2016),

Friedkin (Waters et al. 2011), while others purport to extend human occupation of the Americas to 30,000 cal yr BP or even earlier, e.g., Chiquihuite Cave (Ardelean et al. 2020), Pedra Furada (Guidon 2002; Guidon and Delibrias 1986), and Cerutti Mastodon (Holen et al. 2017)).

To synthesize these disparate data, Becerra-Valdivia and Higham (2020) recently developed a chronological model for the earliest human dispersals into the Americas, based on 42 archaeological sites. They rely on recently reported Chiquihuite Cave (Ardelean et al. 2020) and a few other selected sites to infer a pre-Last Glacial Maximum (LGM) entry of humans in North and South America. Because their analysis appeared in *Nature*, it has received widespread attention from the media and public. We evaluate the evidence used to develop this inference and consider additional purported evidence for early occupations from other sites, as well as recent fecal sterol research in Alaska. In order to situate Chiquihuite and other purported early American occupations in a sound epistemological context, we briefly review archaeological arguments and clarify three main colonization models through which to understand the archaeological data.

2. METHODS AND MODELS

2.1 Archaeological argumentation and evidence

Given the ubiquitous problem of equifinality between products of human agency and natural processes, particularly in the context of lithics with no or few flake removals often said to represent pre-Clovis occupations, archaeologists use rigorous minimum criteria to establish human presence. These remain the same as defined by Haynes (1969), including “human [remains], or an assemblage of artifacts that are clearly the work of [humans]... in situ within undisturbed geological deposits in order to clearly demonstrate the primary association of artifacts with stratigraphy... [and] the minimum age of the site must be demonstrated by primary association with fossils of known age or with material suitable for reliable isotopic age dating” (1969:714). In contrast to these reasonable requirements, the following lines of evidence are insufficient: (1) lithics or modified bone for which attributes presumed to result from human manufacture cannot be distinguished from the products of natural agency in the site’s context, (2) ambiguous dating due to unclear association between cultural objects and dated events (including ambiguous stratigraphic context), (3) “sites” with no human-made artifacts, and (4) application of experimental proxies (e.g., fecal sterol analysis) for which controls have yet to be fully established. Natural processes can mimic human agency, including fractured stone and damaged bone, thus necessitating multiple working hypotheses (Chamberlin 1897) to overcome equifinality.

Recent archaeological discoveries dating to the terminal Pleistocene and containing unequivocal artifacts with clear historical and technological connections to other established sites have enhanced our understanding of early human adaptations in the Americas (Chatters 2015; Haynes 1969; Haynes 2015). Among these are Swan Point in eastern Beringia, which contains an unequivocal Diuktai component dated 14,200 cal yr BP (Coutouly and Holmes 2018), as well as Page-Ladson (Halligan et al. 2016), Debra L. Friedkin (Waters et al. 2011), and El Fin del Mundo (Sanchez et al. 2014) south of the continental glaciers. The accumulation of Early Paleoindian technology (Clovis, Folsom, etc.) has spurred the development of increasingly complex models of lithic conveyance, subsistence, and mobility (Smallwood and Jennings 2015). These data cohere with each other and with other scientific datasets (e.g., genetics, paleoecology), and, importantly, are consistent with broader literature of hunter-gatherer behaviors derived from anthropology and human behavioral ecology. In contrast, the life cycle of claims for pre-16,000 cal yr BP occupations appears to consist of: (1) discovery and widespread dissemination, (2) criticism and non-responsive retorts, (3) continued absence of any other comparable sites, leading to lack of acceptance within the broader archaeological community, and, for most, 4) disappearance from the record. Assemblages from earlier sites such as Chiquihuite, Pedra Furada, and Topper (see below) generally do not cohere with each other, with any antecedent technologies in northeast Asia, or with later Paleoindian assemblages.

2.2 Models of First Americans dispersal(s)

Given the increasing complexity of genetic and archaeological analyses, particularly in the last 10 years, we believe some equivocation and unclear conceptualization has entered into both sets of literature. Often only two models are directly compared: (1) *Clovis-First paradigm* representing the idea that no humans were present in the Americas south of the glacial margins prior to 13,500 cal yr BP (Miller et al. 2013) or 13,050 cal yr BP (Waters et al. 2020) and (2) an *unnamed alternate paradigm*, where any dataset predating Clovis is taken to refute the Clovis-First paradigm and thus support some vaguely defined and inconsistently applied model, with initial entry perhaps 16,000, 25,000, 30,000, 50,000, or even 130,000 years ago (Braje et al. 2020; Holen et al. 2017). Beyond establishing a chronologically earlier-than-Clovis presence of people, pre-Clovis evidence typically is contextualized with neither earlier Upper Paleolithic archaeological evidence from Eurasia nor with subsequent Clovis or Clovis-contemporary cultural patterns. Instead, pre-Clovis evidence often is described as anomalous, unique, lacking precedent, or is characterized by the *absence* of features exhibited by later, unequivocal archaeological sites (e.g., Ardelean et al. 2020, Dillehay 1997). This is a textbook example of a straw-man fallacy, wherein the idea of Clovis as the first widespread cultural manifestation in the Americas is equated with the idea that all sites must date after 13,050 cal yr BP. In addition, it is a false dichotomy (Clovis short-chronology vs. any purported age), further muddied because the pre-Clovis alternative is poorly defined, and typically not evaluated relative to independent data, such as genetics and paleoecology (e.g., Ardelean et al. 2020; Becerra-Valdivia and Higham 2020). We note that genetic and paleoecological patterning do not bear on establishing the presence/absence of human activity at a site; however, in cases where human agency is not unequivocal, they are relevant. For instance, establishing a 130,000 year old human occupation vs. a 2000 year old occupation in the Americas requires a higher standard of evidence, particularly in the absence of widespread archaeological patterning and lack of support from paleogenetics.

We seek to clarify this issue by providing three models that incorporate specific chronological constraints derived from the consensus emerging in the ancient genetics literature. We term these (1) *Strict Clovis-First Dispersal* (2) *Paleoindian Dispersal*, and (3) *Pre-Paleoindian Dispersal(s)*. We use Paleoindian here to refer to genetically First Americans populations. The term subsumes the earliest widespread cultural traditions in the Americas (such as Clovis, Western Stemmed, and Fishtail Point).

Model 1: Strict Clovis-First Dispersal (post-13,050 cal yr BP). This model, based solely on dating of diagnostic Clovis artifacts, posits that the initial Paleoindian colonization of the Americas south of the icesheets is coterminous with the first widespread archaeological manifestation (West 1996). There is unequivocal presence of eastern Beringian occupations by 14,200 cal yr BP, 700 years earlier than the earliest recognized Clovis occupations (Lanoe and Holmes 2016), and we expect an early period of archaeological invisibility given initial small population sizes (Prasciunas and Surovell 2016). A number of sites pre-dating Clovis *sensu stricto* (between ~15,500-13,050 cal yr BP) have been recognized south of the glacial ice and accepted to varying degrees, including Wally's Beach (Waters et al. 2015), Page-Ladson (Halligan et al. 2016), and Debra L. Friedkin (Waters et al. 2011). For these reasons, we reject this model.

Model 2: Paleoindian Dispersal (after ~16,000). This model is derived from both archaeological evidence and a wide range of independent genetic datasets and appears in some form in an increasing number of syntheses (e.g., Waters 2019 and references below). The genetic group identified as First Americans (FAM) split from East Asian relatives around 26,100-23,900 cal yr BP in East Asia, admixing with Ancient North Eurasians (ANE) until ~20,000 cal yr BP (Moreno-Mayar et al. 2018a, 2018b, Pinotti et al. 2019). The location for this admixture is unknown, but most likely near Lake Baikal in southern Siberia given (1) all known ANE individuals are located in the region (Moreno-Mayar et al. 2018b), (2) the closest relative to FAM, Ust'-Kyakhta, dating to ~14 kya, is also located in the region (Yu et al. 2020), (3) there is unequivocal evidence for human occupations in this region during this time period (Graf and Buvit 2017), and (4) this area contains some of the earliest Diuktai sites, which expand

northward into Beringia, represented at the earliest sites in the region around 15-14 kya, Urez-22 in Western Beringia and Swan Point in Alaska (Coutouly et al. 2018; Graf and Buvit 2017; Pitulko et al. 2017). Following this period of admixture, many geneticists have argued for genetic isolation of FAM between ~20,000-16,000 cal yr BP (Raghavan et al. 2014; Tamm et al. 2007). The location of this genetic isolation is unknown, but is unlikely to be Beringia proper given the lack of unequivocal sites in this region during this period and the well-documented presence of humans in Northeast Asia, from southern Siberia to Primor'ye-Sakhalin (Buvit and Terry 2016; Potter et al. 2018). Mitochondrial DNA analyses indicate population expansion and female lineage diversification after 16,000 cal yr BP (15,000-13,000 cal yr BP at 75% confidence interval) (Llamas et al. 2016). yDNA analyses indicate an upper time limit of ~15,300-14,300 cal yr BP (Wei et al. 2018) or 17,700-14,300 cal yr BP (Sun et al. 2021) for human entry to the Americas, and Pinotti et al. (2019) infer a rapid star-like radiation starting at 15,000 cal yr BP.

Autosomal genomic analyses indicate two basal First Americans (FAM) lineages, North Native Americans (NNA, or ANC-B) limited to the far north of North America, and South Native Americans (SNA, or ANC-A) distributed broadly throughout the North and South American continents (Moreno-Mayar et al. 2018b, Posth et al. 2018). *All* late Pleistocene and early Holocene individuals thus far analyzed south of the ice sheets are part of this SNA group (e.g., Anzick, Spirit Cave, Lagoa Santa, Mayahak Cab Pek), and the SNA spread is also characterized as a rapid, star-like radiation throughout the Americas (Moreno-Mayar et al. 2018b, Posth et al. 2018). Splits within SNA lineages date from 14,100 cal yr BP (North and South American SNA) to 12,900 cal yr BP (within South America: Lagoa Santa and modern Karatiana) (Moreno-Mayar et al. 2018b). We note that all of these independent genetic time estimates, mutually independent, all coalesce on post 16,000 cal yr BP expansion of all Native American ancestors and a rapid star-like radiation (i.e., multiple branching within a short period) of the main clade first inhabiting North and South America between 14,100-12,900 cal yr BP.

This model is broadly consistent with the archaeological record of northeast Asia and Beringia. While the extreme western Beringian/North Siberian record does indicate a limited interstadial expansion of a Siberian Middle Upper Paleolithic group by 31,600 cal yr BP, at the Yana site (Sikora et al. 2019), there is a clear depopulation of this area and the rest of north Siberia during the LGM and early deglacial period, from ~27,000-15,000 cal yr BP (Dolukhanov et al. 2002, Kuzmin et al. 2018, Pitulko et al. 2017). The Yana individuals were part of an Ancient North Siberian group related to southern Siberia groups (Ancient North Eurasian) (e.g., Mal'ta, Afontova Gora individuals) but not closely related to Native American ancestors (Sikora et al. 2019). Only two purported human occupation sites dating to the LGM (Yana Downstream Point and ISM-034) have been briefly mentioned in a review paper (Pitulko et al. 2017), but each comprises only a single faunal element interpreted to have been damaged by humans, with no associated artifacts, and can be dismissed as equivocal at best. In contrast, the post-LGM expansion from south to north of the Siberian Late Upper Paleolithic Diuktai Culture after 15,000 cal yr BP is probably associated with Native American ancestors, recorded at the Urez 22 site in western Beringia at 14,600 cal yr BP (Pitulko et al. 2017) and at Swan Point in eastern Beringia at 14,200 cal yr BP (Coutouly and Holmes 2018). We acknowledge that dating based on genomic, mtDNA, and yDNA research are dependent on estimated rates of mutation, and that changing assumptions can alter divergence and admixture dates. However, the coalescence of dates based on numerous lines of independent evidence provides a degree of confidence in estimating the timing of Native American ancestor dispersals into the Americas after ~16,000 cal yr BP.

This independent genetic constraint for initial dispersals into the Americas is consistent with the archaeological record. Most pre-Clovis sites fit with this model, regardless of their empirical support, including Monte Verde II (Dillehay 1997), Page-Ladson (Halligan et al. 2016), Paisley Cave (Jenkins et al. 2012, 2013), Manis (Waters et al. 2011), Schaefer, Hebior (Joyce 2013), Debra L. Friedkin (Waters et al. 2011) and the Firelands Megalonyx (Redmond et al. 2012). Dates for pre-Clovis assemblages at Gault (Collins et al. 2013), Cactus Hill (McAvoy et al. 2000), Meadowcroft (Adovasio 1999), and Parson's Island (Lothrop et al. 2016), may also be assignable to this group once their ages are more securely established.

This model also accommodates the fact that Clovis and, presumably the immediate Clovis antecedents are associated with the SNA clade and SNA sublineages. Anzick, a Clovis individual (~12,800 cal yr BP), is a member of an SNA population, as are the later Spirit Cave, Nevada (~10,650 cal yr BP) and all early South American individuals: Los Rieles, Chile (~10,900 cal yr BP); Lagoa Santa, Brazil (~10,400-9800 cal yr BP) Lapa do Santo, Brazil (~9600 cal yr BP); Mayahak Kab Pek, Belize (~9300 cal yr BP) Cuncacacha, Peru (~9000 cal yr BP); Lauricocha, Peru (~8600 cal yr BP); and Saki Tzul, Belize (~7400 cal yr BP) (Moreno-Mayar et al. 2018b, Posth et al. 2018). Given small initial population sizes (Fagundes et al. 2018, Hey 2005), it is likely that the earliest Americans were archaeologically invisible for ~1000 years until the populations expanded to become observable with our current samples (Prasciunas and Surovell 2015). Clovis and related Fishtail complexes are the only (and earliest) continent-wide traditions in the Americas, their distribution and evident rapid expansion, consistent with initial population dispersals. This model can accommodate many historical scenarios and provides no constraints on geographic route(s) of migration. For instance, these data are consistent with Clovis ancestors (SNA) initially expanding into North America after ~14,500 reaching archaeological visibility by 13,050 cal yr BP as the widespread Clovis phenomenon, and expanding into South America carrying Fishtail Point complex technology after 12,900 cal yr BP.

Model 3: Pre-Paleoindian Dispersal(s) (pre 16,000 cal yr BP). This model posits a pre-16,000 cal yr BP occupation of the Americas, and has an unconstrained maximum time limit. The key aspects of this model are that the Americas were first colonized substantially before ~16,000 cal yr BP and, because such a claim conflicts with the genetic record, it must presume that the first arrivals were neither closely related nor ancestral to Native Americans. Here, additional genetic and genomic data from Asia become relevant. Native American ancestors diverged from East Asians between 35,000-25,000 cal yr BP, almost certainly in east Asia, and later admixed with Ancient North Eurasians (ANE) between 24,000-20,000 cal yr BP (Moreno-Mayar et al. 2018a). The only known ANE individuals known from this period (Mal'ta and Afontova Gora) are both located near Lake Baikal in far southern Siberia (Raghavan et al. 2014), indicating the likely location of Native American ancestors during the admixture period. Following this, a period of genetic isolation of Native Americans occurred from 20,000-16,000 cal yr BP (termed the "Beringian standstill," Tamm et al. 2007). The lack of evidence for FAM mtDNA and yDNA lineage diversification and population expansion until after ~16,000 cal yr BP (Llamas et al. 2016; Sun et al. 2021; Wei et al. 2018), coupled with the presence of unadmixed FAM at Ust'-Kyakhta-3 in the Baikal region at 14,000 cal yr BP (Yu et al. 2020), strongly indicates southern Siberia as the location of Native American ancestors between 24,000 and ~16,000 cal yr BP, during the standstill. In addition, it is now evident that Jomon ancestors diverged very early from other East Asians and are not closely related to Native Americans (Gakuhari et al. 2020), refuting proposals for an early coastal migration from northern Japan (Davis et al. 2019, 2020).

Thus, given the presence of lineages ancestral to Native Americans in Asia, thousands of miles southwest of Beringia and the absence of evidence for expansion and lineage diversification substantially before ~16,000 cal yr BP, any human occupation substantially predating this period (if true) may be associated with peoples unrelated to Native American ancestors. An additional issue that must be resolved is the technological discontinuity between Upper Paleolithic Asian industries and purported Pre-Paleoindian American sites, given the lack of evidence for Siberian expansions into Beringia prior to the well-documented Diuktai expansion.

3. REVIEW OF PURPORTED PRE-16,000 CAL YR BP SITES

3.1 Sites used by Becerra-Valdivia and Higham (2020)

A large number of claims of pre-16,000 cal yr BP sites have been made over the past decades, and almost all have been rejected by the scientific community (e.g., El Horno, Tlapacoya, Hueyatlaco

from Mexico; Toca de Esperancea, Brazil, Coats-Hines-Litchey, Tennessee, Brown and Mission Ridge in California, Old Crow, Yukon). At present, only a few have adherents, mostly including sites that have been highly publicized in the popular media. This is exemplified by the model devised by Becerra-Valdivia and Higham (2020), which presents a Bayesian analysis of radiocarbon dates from a selection of early American sites to develop a new model for the peopling of the Americas. Taking a selection of early claims at face value, they conclude that humans were first present in the Americas prior to the LGM (26,500-19,000 cal yr BP) with “more widespread occupation” between 14,700-12,900 cal yr BP (Becerra-Valdivia and Higham 2020:93). We do not take issue with any of the specific modeling methods used, but rather on the data they use to construct their model.

Others have conducted more in-depth and comprehensive analyses, including critical examination of the radiocarbon samples and come to very different conclusions (Goebel et al. 2008, Mulligan and Kitchen 2013, Peros et al. 2009, Prates et al. 2020, Sutter 2020, Waters 2019, Waters and Stafford 2013). The application of chronometric hygiene, as conducted by those authors, is key. Becerra-Valdivia and Higham (2020), in contrast, list each date uncritically, ignoring well-known contextual and other problems. Here, we consider Becerra-Valdivia and Higham’s sampling methods, chronometric hygiene, and the evidence for any pre-16,000 cal yr BP human presence in the Americas.

Becerra-Valdivia and Higham’s (2020) selection of sites to include in their analysis appears uncritical and haphazard, and we note that no sampling criteria are reported. Other than the Chiquihuite Cave site published in the same issue of the journal (Ardelean et al. 2020), these authors include only a few pre-16,000 cal yr BP localities: Bluefish Caves, Meadowcroft Rockshelter, and Cactus Hill, which all have contextual and dating issues, and are not widely considered unequivocal evidence of early human occupations (Fiedel 2013, Haynes 2015; Krasinski and Blong 2020). Many other sites (while still equivocal) that may have bearing on the issues are excluded from their review. Of the 42 sites Becerra-Valdivia and Higham assembled, 29 are uncontroversial: 10 Beringian (Berelekh, Broken Mammoth, Dry Creek, Mead, Mesa, Moose Creek, Owl Ridge, Swan Point, Ushki, Walker Road), 13 Clovis (Anzick, Aubrey, Blackwater Draw, Colby, Dent, Domebo, El Fin del Mundo, Jake Bluff, Lange/Ferguson, Lehner, Murray Springs, Shawnee-Minisink, Sheridan Cave), 4 Clovis-coeval (Arlington Springs, Lubbock Lake, Meay Channel I, Wally’s Beach), and two Western Stemmed sites that post-date Clovis (Bonneville Estates, Buhl). Of the remaining 13, 7 date *after* 16,000 cal yr BP (Debra L. Friedkin, Hebior, Lindsay, Manis, Page-Ladson, Paisley Caves, Schaefer). Because these 36 sites collectively post-date 16,000, they are not relevant to supporting the main claims of Becerra-Valdivia and Higham of a pre-LGM occupation of the Americas, and we do not further consider them here. Thus, only 6 sites are presented that correspond to the *Pre-Paleoindian Colonization Model* (Model 3), and only one (Chiquihuite Cave) is claimed to be pre-LGM in age.

We consider those 6 sites here, ordered by age (Table 1); Chiquihuite Cave is addressed in a separate paper (Chatters et al. 2021). We then summarize three generally rejected sites claiming pre-LGM lithic industries that likely reflect naturally occurring geofacts: Calico, Topper, and Pedra Furada. In addition, we consider two other Pre-Paleoindian claims: Cerutti Mastodon and the fecal sterol records from northern Alaska.

Table 1. Pre-16,000 year old sites accepted by Becerra-Valdivia and Higham (2020), ordered by age.

<i>Site</i>	<i>Ages</i> <i>(cal yr BP)</i>	<i>Issues</i>	<i>Supporting</i> <i>references</i>	<i>Critical</i> <i>references</i>
Chiquihuite Cave,	31,100-12,200	Lithic materials are most plausibly inferred to be naturally occurring geofacts.	Ardelean et al. 2020	Chatters et al. 2021

Bluefish Caves, Yukon Territory	~23,600	Marks on bones could be natural, very low percent selected from many thousands of carnivore-deposited bone fragments spanning 10,000 years. The few lithic diagnostics are consistent with post 12,500 cal yr BP Denali complex	Cinq-Mars 1979, Bourgeon et al. 2017, Bourgeon 2018	Haynes 2015, Krasinski and Blong 2020
Meadowcroft, PA	24,300-18,600	Possible date contamination, large standard errors, absence of Pleistocene fauna, possible bioturbation, possible movement of artifacts down through coarse and very coarse fill.	Adovasio et al. 1978, 1983, 1984, 2013, Adovasio 1999; Goldberg and Arpin 1999	Haynes 2015, Fiedel 2013, Haynes 1991, Mead 1980, Kelly 1987, Tankersley and Munson 1992
Cactus Hill, VA	20,600-19,000	Weak association of dates with artifacts. Massive sand with no horizonation, evidence of mixing (Archaic-Clovis). Flecks of charcoal were not of cultural origin.	McAvoy and McAvoy 1997, 2015, McAvoy et al. 2000, Feathers et al. 2006,	Fiedel 2013, Haynes 2015
Gault, TX	26,400-17,400 (24,500-14,500 range of all OSL)	No ¹⁴ C dates, only imprecise OSL with wide range of error. Vertical cracks could have displaced younger materials into older contexts. Morphological overlap between stemmed points and Late Archaic points in region (Darl, Hoxie). Materials in similar contexts at Friedkin, located on the same landform, date later. The deepest pre-Clovis zone was modified by redox (iron reduction/oxidization) due to ground water fluctuation. This could obscure burrows that could mix younger artifacts into older deposits.	Collins et al. 2013, Driese et al. 2013, Williams et al. 2018	Haynes 2015, Morrow et al. 2012
Cooper's Ferry, ID	16,600-13,300	Dates are not clearly associated with artifacts. Pits dug which apparently displaced older, natural charcoal. Other, stylistically similar WST sites date to post-Clovis	Davis et al. 2019, 2020, 2021	Fiedel et al. 2020, Manning 2020

Chiquihuite Cave, Mexico (Ardelean et al. 2020) formed a major part of the pre-16,000 record in Becerra-Valdivia and Higham 2020. Lithics were recovered from deposits with associated ages ranging from 33,150 to 12,200 cal yr BP (Ardelean et al. 2020). Chatters et al. 2021 comprehensively evaluates the claims of anthropogenic origin of the lithics reported from the cave site. We summarize the results here. The recovery of purported lithic materials in the geomorphic setting of debris flows of fractured limestone on steep slopes within a cave strongly suggests the possibility of natural fracture. The Chiquihuite assemblage is dominated by predominantly cortical spalls with unpatterned scalar, hinge, step and lunate fractures, and random flake scars that generally do not overlap. Secondary retouch is rare and

unpatterned, with no evidence of systematically produced flakes or bifacial retouch. All of the geochemically tested “artifacts” cluster with non-artifactual rock from onsite debris flows or from the cave walls/ceiling. No non-local raw material is present, although high quality toolstone is available nearby. The materials are randomly distributed through the sediments, with higher amounts associated with layers of debris flow or rockfall. No hearths or activity areas were encountered, and fauna from the cave are typical cave residents, carnivorans and their prey, rather than high ranked fauna typically hunted by Paleoindians. There was also no change in material culture through 20,000 years, nor any indication of idea interchange with known Paleoindian groups through 1200 years of temporal overlap, both of which are inconsistent with the well-known modern human technological behaviors. Chatters et al. (2021) conclude the most plausible hypothesis, supported by multiple lines of evidence, is that the materials result from natural processes.

Bluefish Caves, Yukon Territory (Cinq-Mars 1979), has recently appeared in the popular press with reports of new findings. Bourgeon et al. (2017) radiocarbon dated six bones hypothesized to exhibit human-produced cut-marks to 23,560 cal yr BP (and 22,580, 21,250, 17,890, 15,300, and 12,390 cal yr BP). These few specimens were selected from a total assemblage of 36,000 bones (0.0002%) that the authors themselves note derived mainly from carnivore accumulation. An argument was made that cuts were in locations typical for butchering, but reported cut frequencies and distributions belie this (e.g., 20 close-spaced cuts would not be needed to remove a tongue). These bones were not collected in clear association with human-manufactured lithics, and no detailed stratigraphic analysis establishes such a necessary connection. None of the dated Cave 1 specimens have any stratigraphic provenience (i.e., we do not know where they were found) and the two dated Cave 2 specimens have ambiguous provenience (“south debris” and “loess 142 cmbs” (52: 238)). However, all of the material appears to derive from a heavily cryoturbated layer including angular clasts of roof fall. Only about 100 lithics were recovered, and assuming 6 components based on non-overlapping radiocarbon ages, this works out to about 17 items per occupation spanning over 10,000 years. In any case, there is reason to doubt whether any of the lithic artifacts are contemporary with any of the episodes of bone modification. They all appear to represent a lithic industry, including Campus-type wedge shaped microblade cores, that is most closely related to the Denali Complex (American Paleoarctic tradition), common in the region during the early Holocene, postdating 12,500 cal yr BP (Clark 2001). Bourgeon (2018) and Bourgeon et al. (2017) have convincingly shown that the damaged bones *could* have been modified by humans, but they have not demonstrated that the marks could *not* have resulted from cryoturbation, bioturbation or other post-depositional damage, and whether the few lithics are associated with the dated bones. A critique of Bluefish Caves material has recently been published (Krasinski and Blong 2020) making similar points.

The next oldest sites, **Meadowcroft, Pennsylvania** and **Cactus Hill, Virginia** both contain definitively human-made artifacts found underlying early Paleoindian (Adovasio et al. 1978, 1983, 1984) or Clovis occupations (McAvoy and McAvoy 1997, 2015), but they have different problems (Table 1). Meadowcroft has been criticized on multiple counts, including possible radiocarbon contamination (Fiedel 2013, Haynes 2015, Haynes 1991, Mead 1980, Kelly 1987, Tankersley and Munson 1992, though this criticism has been contested: Adovasio 1999, Adovasio et al. 2013). At Cactus Hill, the association between the dated charcoal flecks and the material culture in an unstratified sand deposit is unclear (Fiedel 2013, Haynes 2015). The ages of these Pre-Clovis horizons could lie within the age range of the *Paleoindian Colonization model* (Model 2). The evidence for the early dating of these two sites remains generally unconvincing to archaeologists (Wheat 2012).

Gault Site, Texas, contains unequivocal stone tools and debitage below Clovis layers but researchers have no radiocarbon dates or dates directly associated with cultural materials (e.g., hearths, organic tools) (Collins et al. 2013). Multiple optically stimulated luminescence (OSL) dates yield a wide possible temporal range (at 2 σ): 24,500-14,500 ya (Collins et al. 2013). The younger end of this age range falls within the *Paleoindian Colonization model*. In fact, at the nearby Debra L. Friedkin site, located on the same chert source and with a similar geomorphic setting, Waters et al. (2011) obtained a

much larger set of OSL dates and were thus able to statistically narrow the age range for that occupation to between 15,500 and 14,000 years ago. This is likely also the age range for Gault.

Cooper's Ferry, Idaho, is the final early site considered by Becerra-Valdivia and Higham (2020). New stratigraphic dates from Cooper's Ferry have been recently reported from inside and outside several pit features (Davis et al. 2019, 2020), but the evidence remains inconclusive. A recent critique suggests the oldest demonstrated occupation, marked by Lind Coulee points, dates to ~11,500 cal yr BP, although ambiguous evidence *may* indicate an earlier occupation at 14,600-14,100 cal yr BP (Fiedel et al. 2020). Vertical movement of dated charcoal and bone samples in the LU3 stratum (including those from pit fill already in secondary context) through bioturbation and anthropogenic disturbance is obvious from date 'outliers.' The pits from which some of the oldest dates derive are excavated from above or the top of LU3 which indicates that these pit samples are residual and hence, not indicative of the age of the pits themselves. *In situ* dates from the surface of LU3 and from pits dug into it are ~11,500 cal yr BP, consistent with other Western Stemmed tradition sites, and likely date the occupation. Davis et al. (2021) have held to their interpretation, but without providing any new evidence to counteract the criticism.

In sum, all purported pre-16,000 cal yr BP sites used by Becerra-Valdivia and Higham (2020) to develop their peopling model have unresolved problems of association with human agency and/or dating. The primary conclusions of their model are thus called into question.

3.2 Additional evidence of pre 16,000 year old occupations

We also consider three proposed sites that can be constructively compared with the sites used by Becerra-Valdivia and Higham (2020) in their model. Each was widely publicized, but all are now almost universally rejected by the archaeological community: Calico, Topper, and Pedra Furada, along with recent fecal sterol studies in Alaska.

In 1964, flaked cobbles and apparent waste flakes were found on the alluvial plain at the foot of the **Calico Hills** of eastern California. Louis Leakey, visiting the site and familiar with the Oldowan lithic industries of East Africa identified these objects as human made, the products of a New World Lower Paleolithic, with dating estimates ranging from 80,000-50,000 years old (Leakey et al. 1968). A closer inspection of the context of these finds, an alluvial peneplain where high-energy flash floods typically smash cobbles and boulders against one another, demonstrated that they were the product of natural processes (Haynes 1969, 1973). The most anthropogenic-looking objects had been chosen as artifacts from the millions of stone clasts. The site is no longer taken seriously by the professional archaeological community.

The **Topper Site, South Carolina**, is a chert quarrying and processing locality verifiably occupied from Clovis times on (Anderson et al. 2016, Goodyear 2005, Smallwood 2010). A meter below the Clovis layer, excavators began finding shattered chert cobbles (from broken bedrock outcrops at the site) among which they saw flake-like forms, angular fragments, and "broken cobbles without negative bulbs of force and exhibiting frequent hinge terminations" (Haynes 2015). Dating placed the upper part of the deposit between 20,000 and 16,000 cal yr BP, but with a possible deeper "hearth" at >50,000 cal yr BP (Goodyear 2005). Volunteers working at the site bagged all screen residue and sent it to the lab, where artifact-like objects were isolated. The fractured chert could have resulted from freeze-thaw, stream transport, or some other natural mechanism (Waters et al. 2009). Moreover, the purported pre-Clovis deposits are only found downhill from the chert outcrop, and no pre-Clovis artifacts have been identified in deposits uphill from the outcrop (Miller 2010, Sain 2015, Smallwood 2010). Consequently, the reason there is no apparent change in this material over as much as 35,000 years, and why none of it bears any resemblance to Paleoindian cultures or Asian Upper Paleolithic industries, is because it is likely a natural accumulation of re-deposited chert. The Pre-Clovis materials at Topper have yet to be peer reviewed, but the claim is unconvincing to most archaeologists (Wheat 2012).

At **Pedra Furada, Brazil**, excavators working beneath extensive rock-art panels found a Holocene-age occupation (Serra Telhada phase), including unquestionable artifacts made from non-local stone, underlain by a sparse assemblage of flaked cobbles and minimally modified cobble flakes, which they named the Pedra Furada phase (Guidon and Delibrias 1986, Guidon 2002). Charcoal deposits, some associated with groups of roof fall blocks in this lower unit, were interpreted to be hearths and dated between 37,000 and 21,000 cal yr BP. Again, as at Topper and Chiquihuite Cave, there is no change evident in the purported technology over that span of 16,000 years. Archaeologists invited to visit the site were not convinced, noting that the reported tools all had random, short, thick flake removals, and they concluded the cobbles were derived from a conglomerate stratum 30 meters above in the overhanging cliff (Meltzer et al. 1994). Rocks falling from this cliff had struck previously fallen rocks, producing the fractures. Items most closely resembling artifacts were selected from the thousands of possible clasts. As with Bluefish Caves, an effort has been made more recently to separate the presumably human-modified objects from those produced by natural processes. Proponents have acknowledged that tool-using capuchin monkeys could be responsible for at least some of the artifacts (Falotico et al. 2019, Parenti et al. 2018). Additional putatively early sites have been identified in the vicinity (e.g. Boeda et al. 2014), but all share the problem of equifinality with natural processes (Borrero 2016). Collectively the assemblages from Calico, Topper, and Pedra Furada are generally dissimilar both from each other, and from all unequivocal early Paleoindian complexes.

The **Cerutti Mastodon, California**, purported to be a 130,000 year old human occupation in the Americas, was reported in *Nature*, and this claim was widely disseminated in public media (Holen et al. 2017). We find it understandable, however, that Becerra-Valdivia and Higham (2020) do not even mention this site in their review of the most plausible pre-Clovis sites in North America. The Cerutti Mastodon paper follows in a long tradition of purported sites based on interpretation of bone fracturing (joining McMinnville, OR, Lamb Spring, Selby and Dutton, CO, La Sena, Jensen and Shaffert, NB, Lovewell, KS, to name a few), none of which are considered valid today. In such situations, stone tools are absent and human agency is inferred from conchoidally and spiral fractured bones. The Cerutti claim would place hominins in the Americas before modern *Homo sapiens* migrated out of Africa (Rito et al. 2019) and was roundly criticized in the academic literature. Some (Braje et al. 2017b) questioned the absence of chipped stone in an area with plentiful deposits of good lithic material; others attributed the association of cobbles and bone fragments to the use of heavy equipment at the site (Haynes 2017, Ferrell 2019).

Fecal Sterols, Alaska. A continuous 34,000 cal yr BP human occupation has recently been claimed for northern Alaska on the basis of fecal sterols in sediments from two lakes. Vachula et al. (2019, 2020) found the highest levels of coprostanols during the LGM at both lakes with negligible presence throughout the Holocene in one of the lakes. They assume that coprostanols are a direct proxy for human presence, and thus claim intensive human occupation from >32,000 to 17,000 cal yr BP. However, controlled studies establishing the correlation of specific organic molecules with humans and other animals have not been done. Fecal sterols have been used to distinguish carnivore, omnivore, and herbivore feces, but Vachula did not consider whether this record could be attributed to other omnivores (e.g. black bear, brown bear), or carnivores (e.g., wolves, foxes, wolverines and other mustelids, eagles, hawks). A recent study with more controls (Harrault et al. 2019) could not fully distinguish canids (dogs) from humans, and coprostanols had wide overlap between the two (Harrault et al. 2019:fig. 1). The only omnivores that study considered were humans, pigs, and dogs, and no carnivores were included. More reliable proxies refute Vachula et al's claims: the many radiocarbon dated assemblages in eastern Beringia clearly show onset of occupation after 14,200 cal yr BP with large population increases after 4000 cal yr BP (with the expansion of Arctic Small Tool tradition peoples) and after 2000 cal yr BP, when Ipiutak and other populations reached their highest prehistoric levels (Potter et al. 2017, Tremayne 2015). These patterns noticeably contradict Vachula et al's (2019) pattern of high LGM and negligible Holocene human populations. For these reasons, we find these claims by Vachula et al. (2019, 2020) to be

premature and their studies inadequately controlled, and thus, they do not provide meaningful data on the colonization of the Americas.

None of the sites cited by Becerra-Valdivia and Higham (2020) or included in the above discussion provide unequivocal support for pre-16,000 cal yr BP occupation of the Americas. Based on numerous well-dated sites with undisputed human-made artifacts, the unequivocal archaeological record of North America postdates 16,000 cal yr BP, consistent with the *Paleoindian Colonization Model*, which, as noted, is in basic agreement with a wide variety of unilineal genetic and autosomal genomic data (e.g., lineage diversification, effective population expansion, star-like radiation, split times among lineages) (Llamas et al. 2016, Moreno-Mayar et al. 2018a, 2018b, Sikora et al. 2019, Wei et al. 2018).

4. CONCLUSIONS

We evaluated the 42 sites considered by Becerra-Valdivia and Higham (2020) in inferring an early occupation of humans in the Americas, beginning prior to the LGM (26,500-19,000 cal yr BP) with a second pulse after 16,000-15,000 cal yr BP. Of these 42 sites, the majority are uncontroversial sites that are Clovis-age or later, and all but 6 sites post-date 16,000 cal yr BP. The remaining 6 sites (Chiquihuite Cave, Bluefish Caves, Meadowcroft, Cactus Hill, Gault, and Cooper's Ferry) all have unresolved issues with unequivocal human agency or direct association between dated materials and cultural occupations. Based on the unequivocal sites considered by Becerra-Valdivia and Higham (2020) we agree with their inference of early human occupation between 14,700-12,900 cal yr BP, consistent with other chronologies (e.g., Goebel et al. 2008, Mulligan and Kitchen 2013, Potter et al. 2017; Prates et al. 2020).

Extraordinary claims of Ardelean et al. (2020) and Bourgeon et al. (2017) of pre-LGM occupations must also imply that these humans were genetically unrelated to Native Americans. These latter have a clear genetic history that entails divergence from East Asians and admixing with Ancient North Eurasians several thousand miles away in Asia between ~26,000-20,000 cal yr BP (Moreno-Mayar et al. 2018a), when the alleged ancient humans were already long-ensconced at Chiquihuite, Bluefish Caves, and other purported early sites. If Becerra-Valdivia and Higham's (2020) interpretations of pre-LGM occupations were correct, they would call into question the coherent and converging pattern of human colonization of the Americas derived through decades of research across multiple disciplines – archaeology, genetics, geology, and paleoecology. The likelihood that all these lines of evidence are wrong appears vanishingly small. It seems implausible that a modern human population that survived for 20,000 years went extinct after at least a millennium of overlap with early Paleoindian populations but yet left no trace in any of the later groups whose DNA has been sampled. At present, we conclude that the limited evidence garnered to support pre-LGM occupations (e.g., Chiquihuite Cave, Bluefish Cave, fecal sterols) is insufficient to establish a Pre-LGM human presence in the Americas.

Of the three explicit, synthetic colonization models presented above, the *Strict Clovis-First Dispersal Model* (13,050 cal yr BP) can be rejected due to the presence of unequivocal sites earlier than 13,050 cal yr BP. The *Pre-Paleoindian Dispersal Model* (before ~16,000 cal yr BP) has also not met its burden of proof, and sites like Chiquihuite Cave and Bluefish Caves do not provide compelling evidence to support it. The *Paleoindian Dispersal Model* (after ~16,000 cal yr BP), which posits a sparse population ancestral to Clovis Paleoindians during an exploration phase (Haynes 2015, Prasciunas and Surovell 2015), remains the most plausible, supported by independent evidence from genetics, paleoecology, and the archaeological record.

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