



QUESTIONING THE ANTHROPIC NATURE OF PEDRA FURADA AND THE PIAUÍ SITES

Yan Axel Gómez Coutouly

► To cite this version:

Yan Axel Gómez Coutouly. QUESTIONING THE ANTHROPIC NATURE OF PEDRA FURADA AND THE PIAUÍ SITES. PaleoAmerica, In press, 10.1080/20555563.2021.1943181 . hal-03483162

HAL Id: hal-03483162

<https://hal.science/hal-03483162>

Submitted on 16 Dec 2021

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

QUESTIONING THE ANTHROPIC NATURE OF PEDRA FURADA AND THE PIAUÍ SITES

Yan Axel GÓMEZ COUTOULY

(CNRS, UMR 8096 Archéologie des Amériques, Paris, France; yan.gomez@cnrs.fr)

Abstract

Many archaeologists are still skeptical about a human presence in the Americas during or before the Late Glacial Maximum (LGM), considering that the claim is not yet sustained by hard evidence. Boqueirão da Pedra Furada (Brazil) is one of the most famous pre-LGM claims, but the site has so far been considered ambiguous, and similar concerns have been raised about nearby sites. Nonetheless, for E. Boëda and co-workers, who have been working at these sites, researchers who are still skeptical about the anthropic origin of the assemblages have a psychological barrier and no scientific arguments. Are all skeptics completely blinded by their preconceptions that they cannot see the obvious and unambiguous evidence? To find out, I reviewed the numerous publications of the Piauí sites and the outcome of my analysis is quite simple: the anthropic nature of the LGM/pre-LGM artifacts of the Piauí sites has not been demonstrated.

Keywords

Peopling of the Americas; Late Glacial Maximum; Brazil; Pedra Furada; Geofacts

1. Introduction

1.1. An LGM/pre-LGM human presence in the Americas?

The first colonization of the Americas has always been a hotly debated issue. One of the current discussions is the presence of assemblages (and thus human occupation) in the Americas dating from or before the Late Glacial Maximum (LGM). Many archaeologists are skeptical about the presence of humans in the Americas before the LGM, considering that the claim is not yet sustained by hard evidence. The Boqueirão da Pedra Furada rock-shelter (Brazil) is one of the most famous and published pre-LGM sites from the Americas, but the site has so far been considered very ambiguous because all alleged artifacts are simple cobble tools made on the same raw material cobbles as those naturally falling from the cliff's wall hanging above the site. Other sites dating from (or before) the Late Glacial Maximum are known, but there are relevant concerns about the published pre-LGM assemblages:

- In Eastern Beringia, there is only one site that is currently dated to the LGM: the Bluefish Cave sites in the Canadian Yukon. In the absence of clearly associated lithic artifacts, the claim is based on possible cut marks on just a few bones; but out of 36,000 bones, only 15 would have definitive evidence of butchering, of which 6 have been dated respectively to c. 9000, 12,500, 15,500, 18,500, 21,000, 22,500 and 24,000 cal BP (Bourgeon, Burke, and Higham 2017). Also, the anthropic nature of the marks are questioned by some researchers, including zooarchaeologists (Krasinski and Blong 2020). Moreover, there is a c. 10,000 years hiatus until the first widely accepted site of Swan Point in Alaska (Holmes 2011).
- In Alaska, a recent analysis also shows possible human fecal biomarkers preserved in lake sediments from the Brooks Range (Alaska) dating from the c. 32,000 cal BP (Vachula et al. 2019; Vachula 2020). However, these are no associated archaeological sites, and the reliability of this new technique is not yet known, especially since it is based on the modeling of some not well-established parameters (diet and physiology of the intestines of humans and fauna, estimate of the percentage of different animal species living at the time, etc.).
- In California, the c. 130,000-year-old Cerutti Mastodon site (showing the association of broken mastodon bones with cobbles described as hammerstones) received major media attention a few years back (Holen et al. 2017). However: (1) no knapped tools have been found on this site; (2) most researchers consider that the anthropic nature of the “hammerstones” has not been demonstrated; (3) the site was found in a context of highway construction and there are major concerns about post-depositional disturbances due to highway construction (Haynes 2017; Braje et al. 2017; Ferrell 2019).
- In Mexico, the Chiquihuite Cave has recently been published, extending back c. 30,000 years ago (Ardelean et al. 2020). So far, only one article has been published, and among the illustrated lithics numerous are those that seem compatible with

geofacts¹. Given the poor quality of the raw material (which complicates the technological reading of an artifact) and the karstic environment (favoring the production of geofacts), a more detailed presentation of the assemblage and of the anthropic nature of the tools must be published before the assemblage can be accepted. As it stands, the presence of real tools among this assemblage has not been demonstrated.

- Arroyo Vizcaíno (Uruguay), dating to c. 34,000 cal BP, is a faunal assemblage with possible cut-marks and with one single flake that may have been used to process the bones (Fariña 2015). However, zooarchaeologists have raised questions about the anthropic nature of the marks (Suárez et al. 2014; Borrero 2016).
- The Santa Elina shelter (Brazil) has an assemblage currently dating up to c. 27,000 cal BP (Vilhena Vialou 2011; Vialou et al. 2017; Vilhena Vialou and Vialou 2019), but there are still various concerns with the assemblage and with the dates: (1) purported lithics artifacts all made on limestone (most of them simple flakes) are so far poorly illustrated, which prevents any real assessment by other researchers; (2) although three perforated osteoderms seem to be human-modified, there is no use-wear analysis or even close-up photos of the holes; (3) the various dates (whether the micro-charcoal or wood samples located outside clear combustion features or the directly dated osteoderms) must be considered with caution. It remains entirely conceivable that humans have used fossil osteoderms (Borrero 2016), a practice known at other sites, such as Swan Point (Alaska), where fossil ivory was scavenged and worked, thus providing older dates than the actual occupation of the site (Lanoë and Holmes 2016).
- At Monte Verde I in Chile, dates extending over 30,000 years ago are associated with a dozen of possible human-made lithic implements (used cobbles, flakes, etc.) and with alleged hearths (Dillehay and Collins 1988). However, T.D. Dillehay himself considers nowadays that the data acquired at Monte Verde I are too uncertain and tenuous to confirm their anthropic nature and that it is therefore impossible to support a human presence in Monte Verde around 30,000 years ago (Dillehay et al. 2015; Dillehay, Pino, and Ocampo 2021).

1.2. An ideological debate?

In 2008, a team of researchers led by Eric Boëda, from the Université Paris Ouest Nanterre (Paris, France), started working in the Serra da Capivara National Park, in order to provide new information on the well-known and controversial site of Boqueirão da Pedra Furada and nearby sites. Given that the project aimed to renew the data on this contentious site, one might have expected an open, didactic and transparent debate, with raw data available. Instead, they simply consider that archaeologists who are unconvinced by the evidence are skeptical for ideological reasons, not scientific reasons. According to Eric Boëda and his co-authors, if archaeologists are skeptical about a pre-Late Glacial Maximum occupation of the Americas

¹ 'Geometric pieces' (triangular or square) that appear to be smooth unretouched pebbles; 'cores' without clear removals; many flakes with seemingly flat and smooth lower surfaces; 'bifacial pieces' with weathered appearance and without clear visible negative removals; 'points' with surfaces without negatives and with thick and flat edges, and so on.

and the anthropic origin of the Piauí sites, it is because they represent the “doxa” (Eric Boëda 2014, 1392), they have a “dogmatic rigidity” (Eric Boëda et al. 2016, 287), are ideologists relying on “no scientific data” (E. Boëda et al. 2014, 21) but on observations that have been “dictated, not demonstrated” (E. Boëda et al. 2014, 21) and such archaeologists should “deny technology as a whole for all periods” (Eric Boëda et al. 2013, 447).

Are all skeptics completely blinded by their preconceptions that they cannot see the obvious and unambiguous evidence coming out of these South American LGM/pre-LGM sites? In order to find out, I dove into the publications of the Piauí sites. Why the Piauí sites? Because for the last 40 years there has been extensive research and publications on Boqueirão da Pedra Furada and related sites, thus offering the possibility of a detailed analysis. According to Boëda (2014, 1387), “critics are fed by previous critics” and most researchers never take the time to go back to the original published data. So to take up the challenge and refine my own judgment, I launched a large-scale comparative analysis of the published data in French, English and Portuguese (close to 60 publications, including peer-reviewed articles, book chapters, unpublished master theses and a PhD thesis) concerning the Piauí sites, from the first article announcing the discovery of Boqueirão da Pedra Furada published in *Nature* in 1986 to the most recent research articles of the Boëda team in 2021. These publications include original research from the Guidon-Parenti excavations, from Boëda’s excavations, original work by other researchers, original ethological studies on tool-use by capuchin monkeys, work on taphonomical processes, as well as points of view from outside archaeologists arguing either for or against the anthropic nature of these sites. This is a critical analysis as an external researcher (specializing in Beringian prehistory, not Brazilian archaeology) based on published data only, given that I have not visited the Piauí sites, nor studied their lithic assemblages.

In the following sections, the main concerns archaeologists have with Boqueirão da Pedra Furada and other related sites (Vale da Pedra Furada, Sítio do Meio, Toca da Pena, Toca da Janela da Barra do Antonião, Toca da Tira Peia, etc) will be presented. Indeed, the problems do not only lie in the geological context of the sites, but also with the raw materials, the selection protocol of artifacts (i.e., how archaeologists determine alleged artifacts within the large quantity of natural cobbles in the sediment), the taphonomical analyses of natural cobbles, the use-wear analysis and the anthropic nature of the so-called structures and hearths.

The outcome of my analysis is straightforward: the anthropic nature of the LGM/pre-LGM levels of Pedra Furada and the other Piauí sites has not been demonstrated based on the data presently available in the scientific literature. Many questions remain about Pedra Furada and the Piauí sites that have yet to be addressed. Some of these have been raised for decades but, so far, Boëda and his colleagues have avoided answering these questions. Indeed, they consider –in the introduction of their very first article– that “this very passionate debate is actually little suited for scientific argument” and “it would thus be futile to present arguments” (Eric Boëda et al. 2013, 446). The refuting of the anthropic nature of the Pleistocene artifacts would then be due to the “insurmountable paradigm” (Eric Boëda 2014, 1409). The reason may also rest in the fact that for Eric Boëda and his co-authors, there is no

need to make scientific demonstrations, since they are the specialists and we simply have to trust in their capabilities:

“The training of a technologist, as intensive as the training of any specialist, requires five years or more of university studies to learn the arcane science of fracturing hard rocks, i.e., experimentation. After such a long training, technologists are able to identify the difference between a *geofact* and an *artifact*, just as a paleoanthropologist is able to distinguish between *Sapiens* and Neandertal skulls or a paleontologist between domestic and wild species. I would say, to each its own specialty! We have to trust in the capabilities of specialists in their respective fields” (Eric Boëda et al. 2013, 446).

2. Boqueirão da Pedra Furada: the shelter, the cobbles and the chutes

The Boqueirão da Pedra Furada rock shelter, as well as the other sites discussed here, are located in the state of Piauí in northeastern Brazil, more specifically in the Serra da Capivara National Park. The park has been declared one of UNESCO's World Heritage sites due, among other things, to the abundant rock art. The Boqueirão da Pedra Furada shelter was discovered in 1973 and early archaeological fieldwork focused only on the prehistoric paintings present there. Subsequent excavations took place on a regular basis between 1978 and 1988, at first under the direction of Niède Guidon, and then of Fabio Parenti for the last two years (1987-1988). Overall, over 700 m² meters have been excavated at the site (Guidon and Arnaud 1991), and the history and context of the discovery and excavations are detailed in various publications (Guidon and Delibrias 1986; Guidon and Arnaud 1991; Guidon et al. 1994, 1996; Guidon 1989; Parenti 2001).

Two main sets of archaeological stratigraphic units are under discussion: the lower units and the upper units. The lower units are characterized by the Pedra Furada phases (Pleistocene), divided into three phases (PF1 to PF3, from ca. 50,000 to 12,500 cal BP). The upper units are composed of the Serra Talhada phases (Late Pleistocene/Holocene transition, ca. 12,500 - 6000 cal BP) and the Agreste phase (Holocene, ca. 6000 cal BP). The discussion that follows here focuses on the Pedra Furada phases, the only ones that are challenged by the archaeological community.

At first, the excavations had one objective: to date the prehistoric paintings. It was only after the excavations continued throughout the Pleistocene layers that the archaeologists found artifacts and features they considered human-made or human-modified. When first published (Guidon and Delibrias 1986), the Pleistocene layers with their claimed human occupations were dated to as early as ca. 32,000 years ago. Quite rapidly, even older dates were obtained, extending occupations as far back as 38,000 years ago (Guidon 1989), then 47,000 years ago (Parenti, Mercier, and Valladas 1990). At the time, these dates created major controversy given not only their antiquity, but also because all the associated artifacts were crude-looking

tools made on the local quartz and quartzite cobbles. Soon, researchers began to express concerns (Schmitz 1987; Bednarik 1989; Fagan 1990; Lynch 1990), while some challenged these detractors in return (Bahn, Müller-Beck, and Fagan 1991). Researchers also disapproved of how Guidon used rock paintings at Pedra Furada to legitimize the idea of an early human presence at the site, and how she used the media and newspapers to advance her theories rather than through more traditional scientific media (Carandell Baruzzi 2016). In 1993, researchers were invited to visit the site during a conference; following that conference Meltzer *et al.* (1994) published their article questioning the Pleistocene anthropic occupation of the shelter citing the crude-looking tools, absence of exogenous raw materials, absence of well-defined hearths, presence of nearby chutes of quartz/quartzite cobbles, possibility of charcoal being the result of natural fires, etc. Following that article, the chronology was no longer the issue, the anthropic nature of the artifacts and the associated “features” was and still is (Meltzer, Adovasio, and Dillehay 1994; Prous 1997; Borrero 2016).

The Boqueirão da Pedra Furada rockshelter is located at the foot of a cliff made up of sandstone, quartz and quartzite that constitute the most part of the site’s sediment fill (Figure 1), the same raw materials as those forming all the alleged Pleistocene artifacts and structures. The top of the cliff is about 100 m above the shelter floor (Meltzer, Adovasio, and Dillehay 1994) and the drip-line is located about 19 m from the inside wall (Parenti *et al.* 2018). Moreover, there are still-active natural chutes (i.e. waterfalls eroding part of the cliff) of quartz/quartzite cobbles that regularly fall down the cliff, creating meters-wide cones of natural cobbles on each side of the excavation, some cobbles sometimes ending up in the shelter.

Three chutes are reported nearby the shelter which have been active for at least 60,000 years (Guidon *et al.* 1996), with two of them located literally at both ends of the rock-shelter (and therefore the excavation area): chute C is found on the eastern side, chute B on the western side, and chute A is located farther away (Figures 1 and 7). Australian archaeologist Robert G. Bednarik, who visited the site in the late 1980s (Bednarik 1989), offers the only published (to our knowledge) schematic depiction of the location of the huge deposits of cobbles adjacent to the shelter creating large cones, some dipping towards the excavation area (Figure 1). The chutes include materials such as quartz and quartzite cobbles from the eroding conglomerate layer of the cliff, sometimes brought by violent torrents of water (Guidon and Arnaud 1991). According to Parenti (2001), chutes B and C were active during the Pleistocene, with both contributing to the input of cobbles and playing a role in the sediment formation of the rock-shelter. The excavators argued, however, that cobbles inside the shelter were deposited intentionally and were not the result of fallen and broken cobbles because the shelter was protected by the overhang (where only sand from the sandstone cliff is found). As a result, all cobbles falling naturally were falling outside the drip-line (Guidon and Arnaud 1991) and “could not have fallen directly into the interior of the shelter behind the drip-line” (Guidon *et al.* 1996, 412). However, Parenti (2001, 91) indicated that in some cases, a few cobbles from the chutes could roll or rebound and actually end up inside the shelter. Metzer *et al.* (1994) indicated that the size and asymmetrical nature of the talus from the chutes dipped towards the shelter, thus allowing gravity to carry a percentage of the cobbles inward.

Moreover, they explained that based on the stratigraphic sections, the “alleged artefacts were selected from amidst countless broken cobbles” (Meltzer, Adovasio, and Dillehay 1994, 705). They also consider that some of these may have been transported by water, although the excavators deny that possibility. Based on various published photos of Boqueirão da Pedra Furada, but also from other nearby sites such as Vale da Pedra Furada, the sediments are sometimes filled with multiple natural cobbles and/or natural blocks and slabs (Guidon et al. 1996; Parenti 2001; Eric Boëda et al. 2013, 2014).

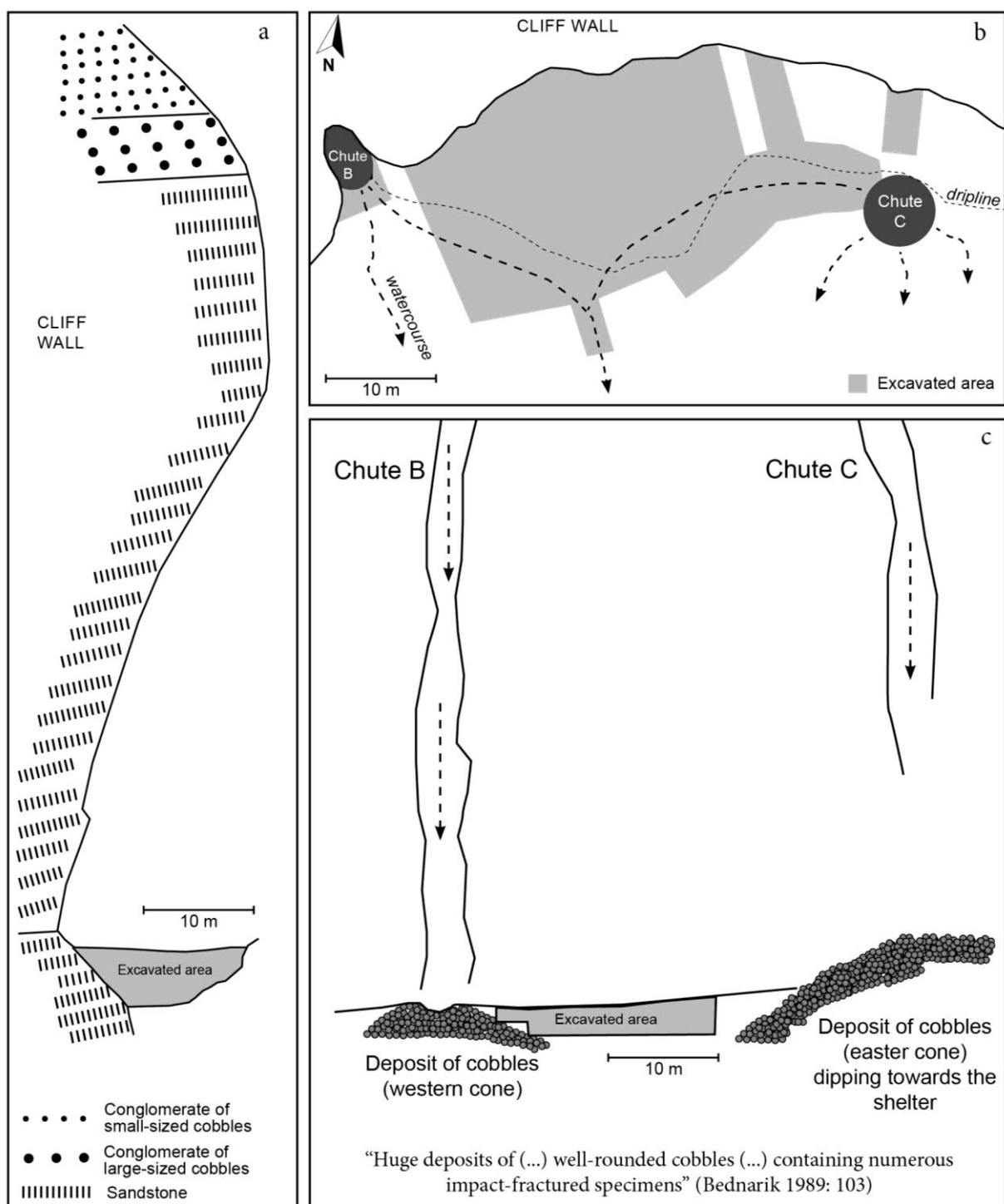


Figure 1. The rock-shelter of Boqueirão da Pedra Furada (profile of the cliff, location of chutes, dripline and cones of accumulated cobbles). a-b) redrawn from Parenti (2001); c) redrawn from Bednarik (1989).

3. The ethological data: monkey business?

In the past few years, ethological studies have documented stone tools use among capuchin monkeys in the Piauí region (Proffitt et al. 2016; Arroyo et al. 2021). Parenti (2001, 43) also describes the direct interaction with monkeys at the very site, given that monkeys would sometimes throw cobbles on the excavators from the top of the cliff. One can only wonder whether 50,000 years of monkeys manipulating cobbles may account for some of the apparently worked cobbles inside the shelter (just a handful of them a century would amount to thousands of cobbles inside the shelter in the present day). Therefore, some researchers (including Parenti in his latest article) have since suggested that the early stone tools from the Piauí could have been made/used by monkeys instead of humans (Fiedel 2017; Parenti et al. 2018). It is indeed a possibility to explore, especially given that some used and (unintentionally) flaked cobbles made by present-day monkeys in the Piauí region (Figure 2) are quite similar to many of the alleged artifacts from this same region. In some cases, cores created by capuchin monkeys sometimes display up to seven flake removals (Figure 2, c). Based on current data, capuchin monkeys of the Piauí region have been using stone tools for different activities for at least three thousand years (Falótico et al. 2019).

Boëda (2013) dismisses the possibility that the Pedra Furada alleged artifacts are the result of monkey behavior, arguing that monkeys do not produce flakes and simply use the cobbles for their mass and not for their cutting edge. However, no one is saying that capuchin monkeys are *intentionally producing flakes and making tools for their cutting edge*, but that they may be *unintentionally producing core-like and flake-like products while using cobbles as hammerstones*. In any case, before asking whether monkeys or humans (*Homo sapiens* or *Homo erectus*) made and used the artifacts, we first need to establish that they are actual artifacts.

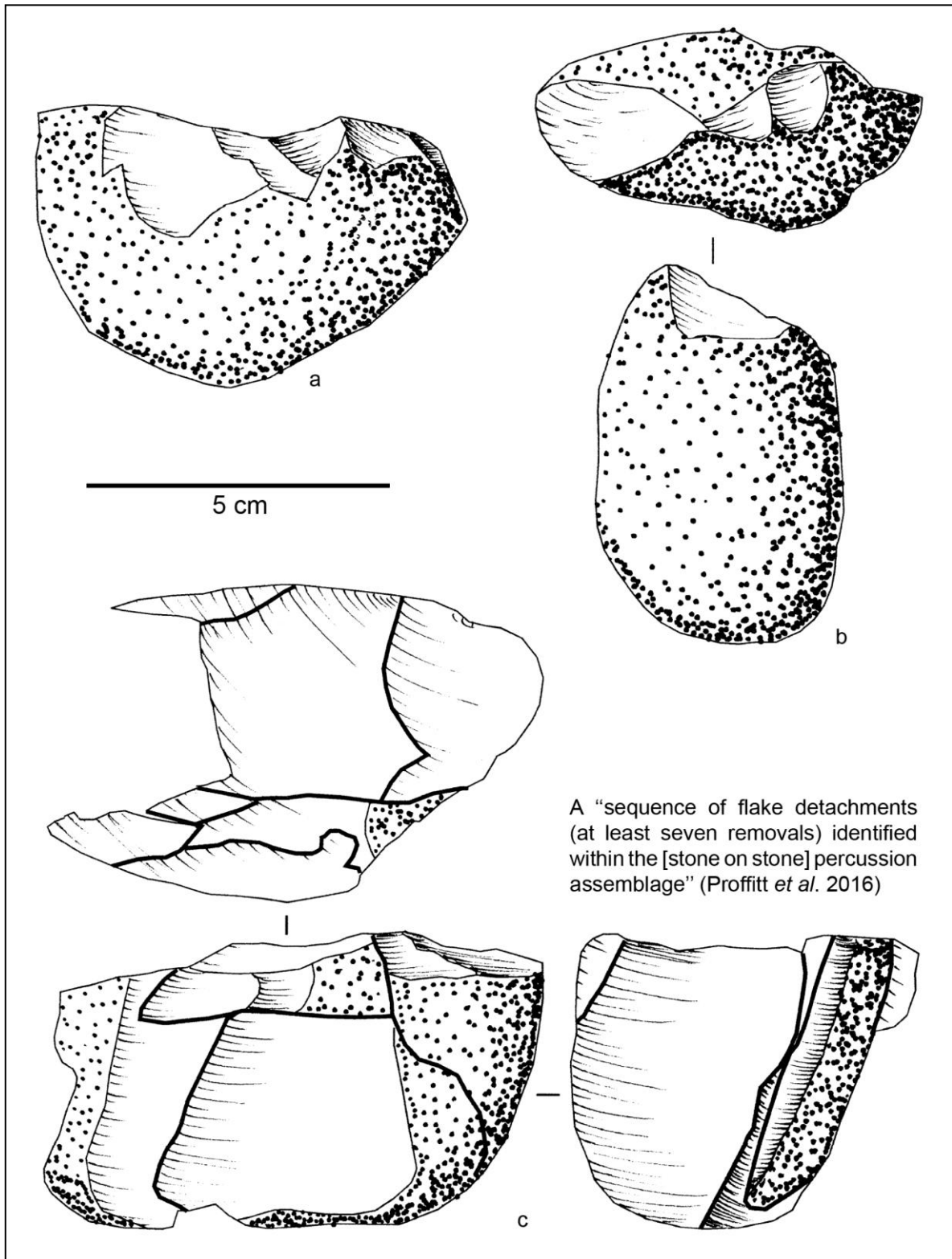


Figure 2. Modern quartz stone tools made by capuchin monkeys in the Piauí region. a, c) adapted from Proffitt *et al.* (2016); b) adapted from Arroyo *et al.* (2021).

4. The absence of flint and chalcedony: it's about the (raw material) economy!

One of the issues that has been discussed for over 35 years is that at Boqueirão da Pedra Furada (and now at the other Piauí sites), the early assemblages are virtually all made of quartz and quartzite cobbles, the same cobbles that naturally fall from the cliffs into the sediment matrix. In rare cases, other raw materials are present, but always raw materials naturally eroding from the cliff. The rare chalcedony pieces found in the Pleistocene levels of Boqueirão da Pedra Furada are considered intrusive (via termite galleries) (Parenti 2001, 93). In sharp contrast, once in the late Pleistocene and Holocene layers (Serra Talhada and Agreste phases), other raw materials appear in most (all?) sites. Among these raw materials, the more common ones are chalcedony and flint (Parenti 2001), sometimes locally available. Flint sources are available just a few kilometers away from Boqueirão da Pedra Furada (Eric Boëda et al. 2014). Boëda *et al.* (2014, 934) downplay the relevance of this question by stating that the local flint is of “poor quality” and is “present in low quantities” during the Holocene. However, these raw materials are of sufficient quality to have been used for a variety of productions during the Serra Talhada phases and are present almost systematically on all of the most recent sites. Indeed, some researchers explain how flint and chalcedony blocks are used in great numbers for the *débitage* of tool blanks during the more recent occupations (Lourdeau 2010, 31). Parenti (2015, 52) also explains that in the Holocene layers of Boqueirão da Pedra Furada, archaeological layers are “full of both agate (...) and chert” and that the absence of exogenous raw material exploitation in the Pleistocene layers is “one of the true unsolved problems”, a sentiment shared by others who consider that “it represents one of the most intriguing archaeological problems in this region” (Aimola et al. 2014, 13). During the Holocene, even hammerstones were sometimes made on exogenous materials (Parenti 2001) at sites full of quartz and quartzite cobbles.

Instead of truly addressing this question, Boëda *et al.* prefer to invoke epistemological explanations, stating that “the Piauí industries have the originality of being produced on quartz! But is this truly a sufficient reason to delete them from the potential record of past humans? Without going into a detailed analysis, we simply cite the fact that in many areas of the world, (...) quartz was always a material of human exploration and use” (Eric Boëda et al. 2016, 288). The issue, of course, has never been *whether humans could use (or have used) quartz*, but rather *why humans in the Pedra Furada area never did use locally available flint and chalcedony during the tens of millennia they occupied the various sites under discussion*. In other words, it has always been a problem of raw material economy *sensu* Catherine Perlès (1980), not of human capabilities. We should add that the presence of exogenous raw materials is often presented as one of the many criteria used to exclude the natural character of an assemblage (Peacock 1991). So far, in almost 40 years of research, after hundreds of excavated square meters at a variety of sites, where tens of Pleistocene structures and/or hearths have been found (cf. *infra*), with hundreds/thousands of Pleistocene prehistoric tools, not one single chip of exogenous raw material has been recovered. Obviously, the lack of exogenous raw materials on a site does not in itself demonstrate the natural character of the assemblage, given that a very local use is always possible. But the recurrence of this aspect on all the sites, coupled with the other hints presented here, is noteworthy.

5. The natural *versus* cultural identification of artifacts: the unclear (drastic?) selection protocol

One recurring question since Meltzer *et al.*'s publication (1994) concerns the selection protocol of collected artifacts. Simply put: how many natural cobbles are found in the sediment matrix for each alleged human-modified cobble identified by the excavators? The implications of this ambiguity are huge, because if there is almost no selection by the excavators, then the high number of possible tools is likely to be human-made; on the contrary, the more drastic the selection, the higher the probability for these to be geofacts. Since all the 'human-modified' cobbles discovered at Boqueirão da Pedra Furada are found in sediments full of natural cobbles of the same nature, this information is of paramount importance.

For Boqueirão da Pedra Furada, there is little information concerning the artifact selection protocol, but we know that an important selection was operated in the field, and afterwards in the laboratory (Parenti 2001, 148, 150, 155). We know that Parenti considered 595 tools from the Pleistocene to be definitively human-made while “thousands more pebbles are ambiguous, and could be either natural or man-made” (Bahn 1993, 114), but it is unknown how many cobbles or broken cobbles were considered natural and rejected (thousands? tens of thousands? hundreds of thousands?). Years later, to his credit, Parenti recognized some shortcomings during the excavations, including the lack of precise information on “the different criteria adopted when trimming the ‘background noise’, the sedimentary matrix of the archaeological layers” (Parenti, Fontugue, and Guérin 1996, 416). During their more recent excavations, the Boëda team took another approach: at Vale da Pedra Furada, they report that “all the lithic artefacts, knapped or not, were recovered” (Boëda et al. 2014: 930) and that among these, 294 artifacts were considered tools. However, they do not indicate how many natural cobbles were actually recovered overall (1000? 10,000?). In their latest article, they provide a very enlightening figure of a putative “exceptional” artifact photographed *in situ*: the photo shows an isolated artifact completely surrounded by tens or hundreds of seemingly natural cobbles of all sizes (Eric Boëda et al. 2021, fig. 4).

We have, however, more detailed information available on the number of natural cobbles collected from the nearby site of Sítio do Meio (in a similar geological environment) excavated by different teams. This site was first excavated by Guidon from 1978 through 1993 (Guidon and Pessis 1993), then by Pinheiro de Melo in 2000 (Pinheiro de Melo 2007; Aimola et al. 2014) and was finally revisited by Boëda in 2012 (Eric Boëda et al. 2016). The most complete information comes from the older excavations. Sector 2 was the most completely excavated area (272 m²), and out of 10,636 recovered remains, 96 were from the Pleistocene levels, 2522 from the Holocene levels, while 3851 were considered geofacts and 4167 had no stratigraphic position (Aimola et al. 2014). It is not clear how many natural cobbles came from the Pleistocene layers, but there is no doubt that the 96 Pleistocene ‘artifacts’ were identified among thousands of natural lithic remains, especially during the

1978 and 1980 excavations (representing about a third of the total excavated area) because only the lithics considered artifacts were recovered, unlike in the following years when all lithic remains were collected (Aimola et al. 2014) (i.e., 10,636 recovered remains is an absolute minimum, the reality has to be much higher).

During the revisit of the site, the Boëda team opened a 4 m² test excavation where more than 1500 lithic remains were uncovered, including “less than a hundred tools” (Eric Boëda et al. 2016). Of the 38 illustrated tools (Eric Boëda et al. 2013, 2016), undoubtedly the most convincing ones, many are simple with only a few flake scars and no clear evidence of why they were identified as “human-modified” (Figure 3), especially if we keep in mind that “given the micro- or macrocrystalline structure of quartz cobbles, an impact may create several adjacent scars” (Eric Boëda et al. 2014, 3). Therefore, *out of 1500 cobble remains, only 2.5% are illustrated, with most of them not clearly looking as human-modified based on small-scale drawings.*

This raises one of the main problems with these sites: can a fraction of the naturally broken cobbles look human-made? For example, in his Ph.D. thesis, Parenti illustrates several artifacts that do look human-modified, however, there are also many that show incipient cones with multiple impacts indicating they were impacted many times by falling cobbles. In one case, we see, based on Parenti’s drawing, that the artifacts received about 20 to 30 impacts (Figure 4). This artifact had so many previous impacts that Parenti (2001, fig. 67) added a comment explaining that despite the incipient cones from falling cobbles, the artifact was still considered human-modified due to the presence of the three “perfectly bifacial and localized” flake scars. This example is by no means an exception, since many other drawings in Parenti’s thesis show incipient cones on artifacts due to previous impacts, and these are visible also on various photographs of artifacts (Eric Boëda et al. 2014, 2021). In some cases, these incipient cones seem to be located on the flaked surface of the object (as opposed to the cortical part) (Eric Boëda et al. 2021, fig. S8a). Therefore, even after being flaked (intentionally or naturally), these cobbles may have been subjected to impacts.

Of course, cobbles with previous impacts could have been used as blanks for the production of tools or tools could have received blows following their abandonment (falling blocks and natural cobbles). But the presence of so many impacts inevitably raises the question of the natural fracturing of rocks. Therefore, a taphonomical analysis of the natural cobbles is needed to confirm or refute whether cobbles from the natural chutes can mimic the production of the excavated artifacts.

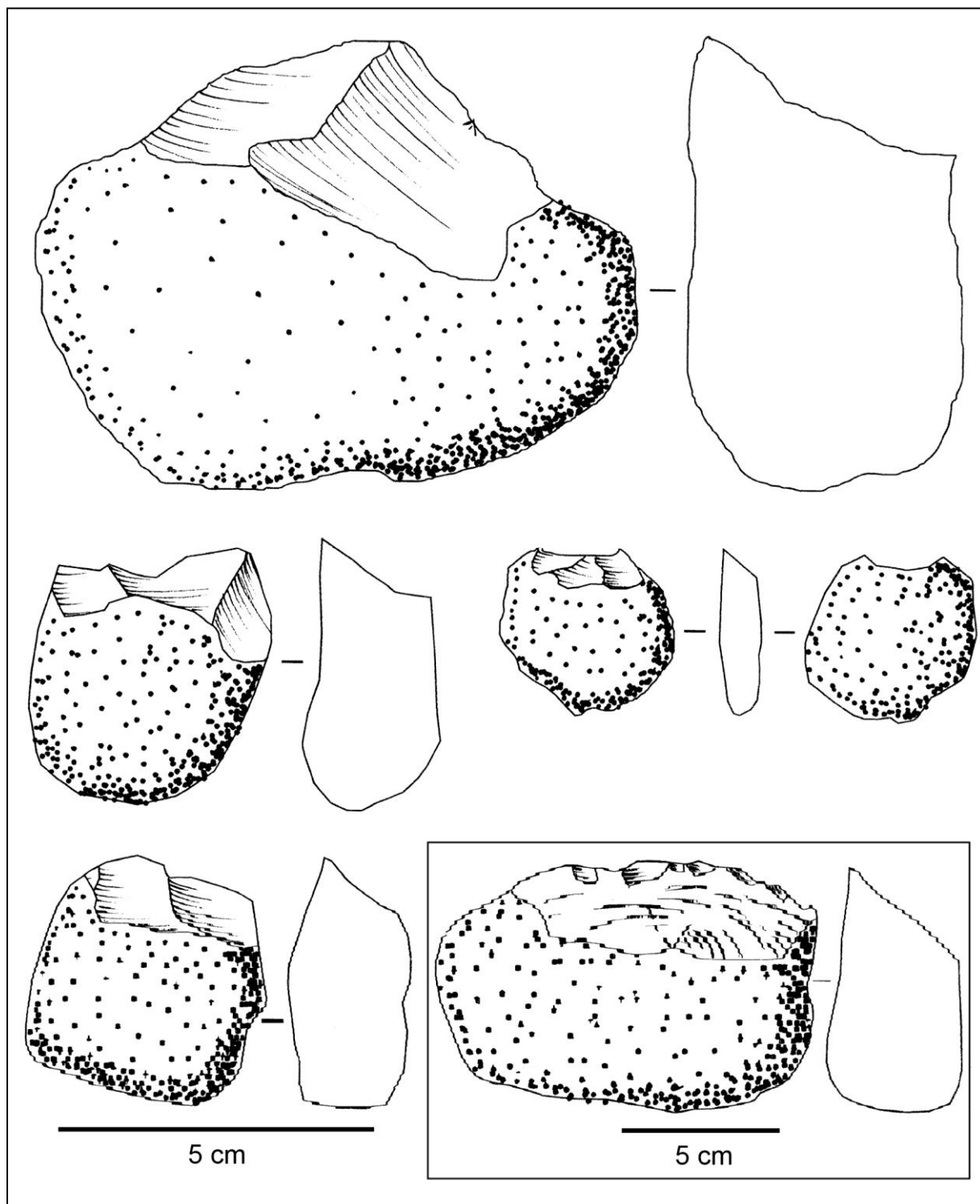


Figure 3. Quartz ‘artifacts’ from Toca do Sítio do Meio. Redrawn from Boëda *et al.* (2016).

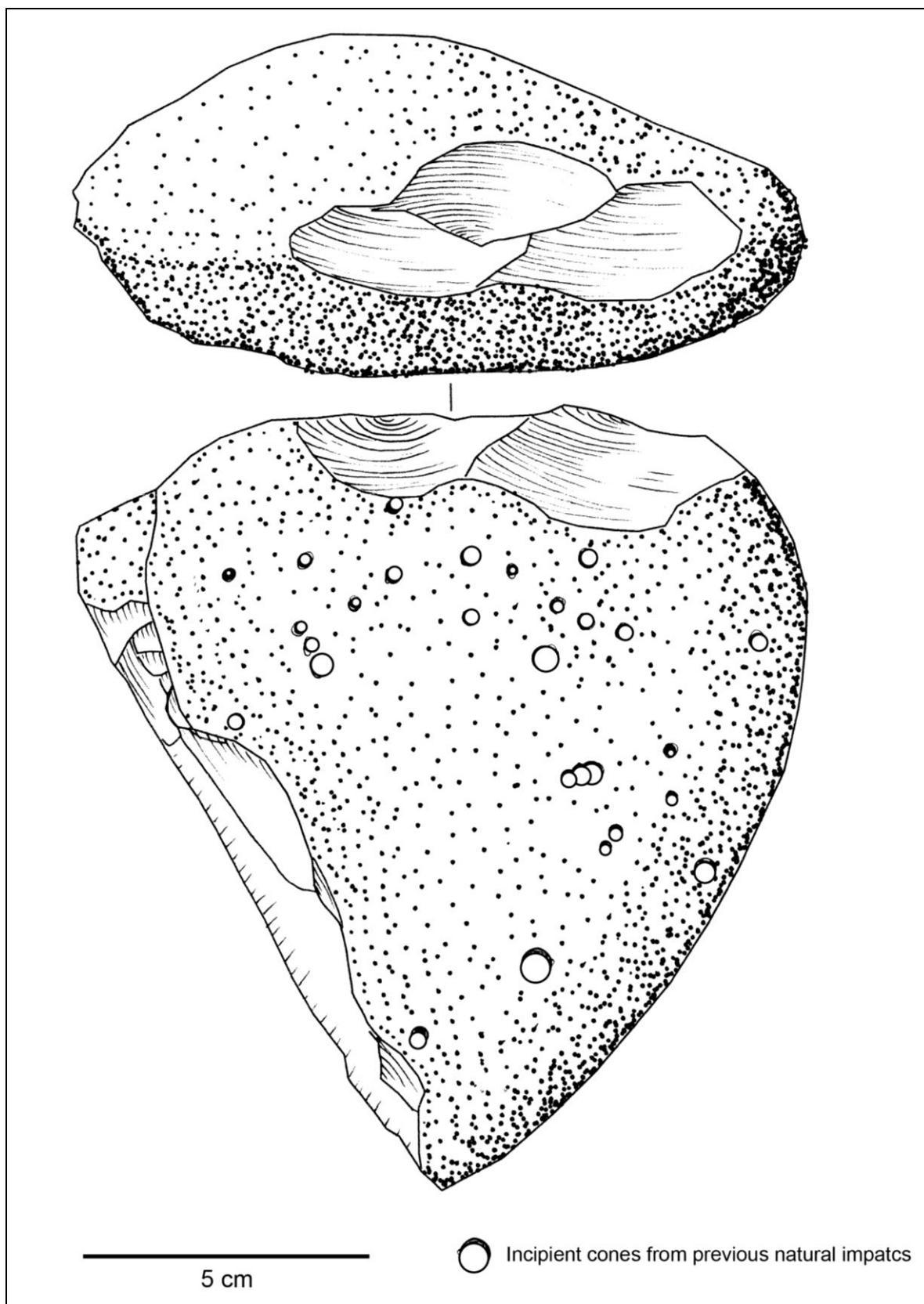


Figure 4. Quartz ‘artifact’ from Boqueirão da Pedra Furada, Pedra Furada phase I. Redrawn from Parenti (2001).

6. The taphonomical analysis: how to create a site with geofacts?

6.1 Parenti's taphonomical analysis (2001)

At the end of his study, Parenti had identified 595 Pleistocene artifacts as definitively human-modified. Since Meltzer *et al.* (1994) raised the issue of the natural cobbles and possible geofacts falling from chutes into the shelter and excavation area, the question of whether natural cobbles in the area could be mistaken for human-made artifacts had to be addressed. In his work, Parenti defends his position by citing an experiment made by Dennell and Hurcombe (1995) who unsuccessfully tried to reproduce similar geofacts by throwing cobbles. However, this experiment was completely biased: the authors threw 100 cobbles only once from a height of 12-15 m, when at Pedra Furada hundreds of thousands of cobbles have fallen down from chutes up to at least 100 m height. The major flaw of this experiment is clear: the authors were not able to break one single cobble, while naturally broken pebbles and flakes are commonly produced by the Pedra Furada chutes (Parenti 2001).

Parenti carried out two taphonomical analyses, selecting 1131 naturally broken cobbles and flakes from the chutes². Then, Parenti compared the taphonomical sample to the 595 Pleistocene artifacts that had been recovered and identified at the site. Given that both taphonomical sets are not described using the same criteria, it is not possible to combine them. However, comparing Parenti's tables allows us to propose the following results:

- The number of flake scars in the taphonomical set is never greater than 3 and rarely exceeds 2, while archaeologically there are artifacts with 5 and more flake scars, including “examples with a high number of flake scars with bulbs” (Parenti 2001, 149).
- The presence of “use-wear retouch” has seldom been observed from chute A (2.4%), while it was much more present in the Pleistocene artifacts (49%).
- The “*angle de chasse*” (the angle between a butt and an upper face, different from the angle between the butt and the lower face) was almost always above 90° in the chute flakes (90%), while it was quite rare in the Pleistocene flakes (17%).

These results, also detailed in a recent article (Parenti et al. 2018), could indeed be considered as proof that natural chutes do not mimic man-made tools. It should first be recalled that taphonomical experiments have made it possible to demonstrate how taphonomical processes (falling cobbles, fluvial transportation, etc.) can produce many types of tool-like artifacts such as cores, scrapers, notches and denticulates (Hosfield and Chambers 2016; Borrazzo 2020),

² During the first analysis, Parenti chose 1005 natural artifacts from the chutes B and C. However, this selection included 416 whole (unbroken) cobbles. When trying to analyze how cobbles naturally fracture when falling down the chutes (or when being struck by falling cobbles), it is not necessary to look at whole cobbles. Therefore, Parenti's first analysis was based on comparing 589 broken cobbles or flakes. The second analysis was carried out in order to add new parameters to the taphonomical analysis. This time, 542 broken cobbles and flakes from chute A were analyzed (here again I exclude 444 whole cobbles from the study).

but also that ethological studies show that monkeys can accidentally produce core-like tools with up to seven flake removals (Figure 2, c). However, there is another major caveat to recognize. There are indeed examples in Parenti's thesis on how to involuntarily and artificially produce a human-looking assemblage, and the selection of flakes is a good example. Parenti (2001, 136) explains that previous experimental work by other researchers has quite rightly shown how the angle of the flake is an important criterion to recognize man-made tools. Then, this information is used as the primary criterion for the selection standard for flakes during the Pedra Furada excavation or subsequently in the laboratory (Parenti 2001, 150). Once this selection has been made, it is compared to the natural chutes, and the important difference in the angles from the flakes coming from the excavation and those from the natural chutes is considered proof that those from the excavation were knapped by humans (Parenti 2001, 146, 167).

However, the problem is that the natural sample is a random sample whereas the archaeological sample is based on years of careful selection (any whole or broken cobble in the sediment matrix that does not comply with the established idea of what is human is rejected), and we have already seen that the selection protocol can be quite drastic. In other words, *by years of isolating artifacts with given criteria among thousands of other artifacts considered natural, one can unintentionally obtain a human-looking assemblage*. Other researchers (Duvall and Venner 1979) have already warned against this type of bias, which distorts the comparison between alleged anthropic artifacts and the natural sample. Moreover, the sample of natural flakes is based on only 28 specimens, a sample too small to be representative.

For a viable comparison between the alleged artifacts from the excavation and the naturally broken cobbles, it would be necessary to statistically compare several criteria between comparable samples. Therefore, to balance years of careful isolation of the "best artifacts" in the excavation, one would need to carefully select a few hundred natural broken cobbles that best mimics human-looking tools among tens of thousands of natural cobbles. Or proceed in the opposite manner: compare a random selection of artifacts from the excavation (natural cobbles and fragments included) and then compare them to a random selection from the natural chutes. Only then will we be able to have a real understanding of the difference (or not) between the geofacts from the chutes and the alleged Pleistocene artifacts from the excavation.

6.2. Boëda's taphonomical analysis (2014)

In 2014, Boëda and co-workers, who started working in the Piauí area in order to establish whether the Pedra Furada remains are artifacts or geofacts, provided a new taphonomical analysis: *"Taphonomic analysis was carried out first on material from Boqueirão da Pedra Furada. We were then able to compare these results with the material from Vale da Pedra Furada. [...] Through this comparison a series of 294 objects could be identified by the*

presence of technical traits that showed them to be different from those that taphonomic analysis had demonstrated to be of natural origin" (Eric Boëda et al. 2014, 934).

As a reminder, Parenti's taphonomical analysis was (mainly) based on the number of flake scars with a bulb of percussion. However, this new protocol made by Boëda *et al.* (2014) was quite different, given that their criteria were:

- To "considered the number of impacts [...] and not the number of removal scars";
- To classify the artifacts based on "categories of impact" (perpendicular, parallel, secant, etc.);
- To evaluate "the quality of the impact surfaces" (favourable or unfavourable);
- To examine "the states of the surfaces of removal scars" (patinated or unpatinated).

A more detailed protocol should be good news, but the issue lies not in what the authors show you, but in what they don't. According to the authors, these criteria are applied to a selected sample of about 914 naturally broken cobbles and flakes (i.e., a smaller sample than in Parenti's protocol)³. But most importantly, *the protocol is not applied or compared to the archaeological sample!* That is to say that we do not know the difference between the taphonomical and the archaeological assemblage (differences and ratios concerning the number of impacts, categories of impact, etc.).

Instead, Boëda *et al.* provide a succession of commonplaces on how it should be "for archaeological sites" or "in an archaeological context", or state that "it's hard to imagine that a knapper would use a random flaking surface". The question of course is not what *should happen in an archaeological context*, but what *actually happened at the Piauí sites*. Nowhere in any of the multiple publications produced by Boëda and his colleagues is that information provided (Eric Boëda 2014; Eric Boëda et al. 2013, 2014; E. Boëda et al. 2014; Eric Boëda et al. 2016, 2021; Clemente-Conte, Boëda, and Farias-Gluchy 2017; Griggo et al. 2018; Lahaye et al. 2013, 2015, 2019). Other than the absence of data, this new protocol has other limitations:

- This protocol is based on subjective criteria, such as the "quality of the impact surfaces" (in contradiction with what is advocated in studies seeking to differentiate between natural and anthropic fracturing).
- This protocol prevents any comparisons with the published data from Boqueirão da Pedra Furada site (the most detailed publications of the region), given that the published criteria are completely different.
- There are still no graphical documentation of geofacts to compare to the "archaeological" specimens.

³ They selected 1424 natural artifacts, including 1342 cobbles (38% whole, 62% broken) and 82 flakes. As we already stated for Parenti's protocol, when evaluating natural breakage, whole cobbles are useless: therefore, their total analysis is actually based on c. 832 naturally broken cobbles and 82 flakes.

Despite the critics made to Parenti's taphonomical analysis on the basis that the quantity of analyzed cobbles was too small, at least the results of his protocol are published and can be used for comparison. If Boëda and co-workers seem to recognize the relevance of the taphonomic question, they nevertheless do not detail the results, despite the central role of these questions.

7. Functional analysis at the Piauí sites: a lack of published data

Even though Boëda and co-authors specifically state that they “do not use use-wear analysis to demonstrate the human origin of the artifacts” (Eric Boëda et al. 2013, 447), reading through all of their articles creates the impression that they do. The message is simple: if there is use-wear, it means it was used, therefore the artifacts are human-made. Without being a use-wear specialist, one can point out the absence of published data (thus preventing any use-wear specialist from making a critical evaluation), as well as the methodological caveats. Although most articles briefly mention the presence of use-wear, only two articles focus more specifically on functional studies: Boëda *et al.* (2014) and Clemente-Conte *et al.* (2017).

In the Boëda *et al.* article (2014), there is for the first time a short description of a functional analysis with two use-wear microscopic photos including one artifact from layer C3 (ca. 14,500 to 17,000 cal BP) and one from layer C7 (ca. 20,000 to 24,000 cal BP). The one-page section on functional analysis informs us that “this method [is] based on experimentation” (Eric Boëda et al. 2014, 12), without providing any further information (what experiments? using which raw material? working what raw materials? obtaining which results?). Also missing are any considerations concerning the specific quartz and quartzite varieties of the area, as well as any comments concerning all the possible taphonomic factors that may artificially create various kinds of wear, and how to exclude them from the analysis and not confuse them with the possible functional wear. For example, did natural broken cobbles (in the chutes or the excavated area) undergo use-wear analysis to test whether they show similar taphonomical wear patterns? If they did, we can only regret the absence of published data.

The other article (Clemente-Conte, Boëda, and Farias-Gluchy 2017) not only had the same shortcomings (no data on methods, equipment, experiments, taphonomy, etc.), but it also had what seems to be a circular reasoning. The object of the article was to determine whether observed macroscopic alterations (retouch, etc.) could be attributed to hafting, and therefore whether hafting wear was visible microscopically (Clemente-Conte, Boëda, and Farias-Gluchy 2017, 207–8):

- Based on macroscopic observations (presence of retouch, notches and fractures) the authors suggest the possibility of artifacts being hafted.
- Therefore, if hafted, there is the possibility of microscopic wear still present.
- A short experiment (not-detailed in the article) is conducted, but the generated wear during the experiment did not match the wear observed on the archeological materials.

- The authors conclude that although the experiment failed, artifacts were still most probably hafted: “such traces were not observed on all the [archaeological] artefacts susceptible to having been hafted, and therefore this type of microwear is not always generated”.

Overall, we see that use-wear analyses for the Piauí sites have so far not been published in detail, with very succinct descriptions of the use-wears, without sufficient descriptive contextual data and in some instances with unconvincing circular experimental designs. New use-wear publications on the artifacts from the Piauí sites would be most welcomed where taphonomical factors would be clearly documented and their exclusion as the formative agents of the assemblage would be at the core of the discussion. As described in the present article, what we know so far is that cobbles first accumulated over tens of millennia in the natural sediment matrix in the cliff, then fell down the chutes, were hit again and again by other falling cobbles, some cobbles could have been heated in the ground during bush fires, transported violently during waterfalls and rolled over along waterways; moreover, cobbles were exposed for extended periods of time due to the slow sedimentation rate, in a very windy shelter occupied by various kinds of animals, including monkeys that may have used or thrown from atop the shelter some of the cobbles. The question, as always in use-wear studies, is not *what action can produce this wear*, but *what action can produce this wear that no other natural/taphonomical factor in the study area can produce*. The importance of this taphonomical aspect is highlighted in the recent article on use-wear analysis of tools used by Capuchin monkeys in the Piauí region. The authors clearly indicate that from an archaeological perspective, “merely identifying the characteristics of various percussive activities on a range of stone tools” is not enough and that “future work must develop robust methods of understanding the effect that millennia scale post depositional factors have on ephemeral and fragmented hominins percussive assemblages” (Arroyo et al. 2021, 13).

8. Hearths and stone structures: the limits of interpretation?

Another argument to prove that humans occupied the Boqueirão da Pedra Furada has been the presence of multiple anthropic features, namely hearths and stone structures. Like the artifacts, the ‘structures’ and ‘hearths’ are exclusively made up of the quartz/quartzite cobbles and sandstone eroding from the cliff into the excavated sediment matrix. In itself, humans using the most locally available stones to build hearths makes perfect sense. However, the problem lies, once again, in the criteria used to decide which of the uncovered stone/cobble arrangements are human-modified, in a sediment full of naturally fallen sandstone slabs and quartz pebbles. Parenti used an arbitrary and systematic rule where “any concentration of clasts with at least three contiguous elements, with contiguity established when the distance between clasts was lower than the maximum length of each clast” was considered a structure (Parenti, Fontugue, and Guérin 1996, 418–19). Parenti (2001, 112) also indicates that only the “obvious structures” (“*structures évidentes*”) *sensu* Leroi-Gourhan were taken into account. However, André Leroi-Gourhan’s definition of a structure is an assemblage of entities tied together in a *significant* way (Leroi-Gourhan 1976, 656). Based on Parenti’s drawings (2001), the obvious structures are rare, most being quite questionable.

Parenti documented tens of the so-called anthropic features and hearths in his thesis (which for the most part are illustrated by drawings only), including 88 in the Pedra Furada phases (Figure 5 and 6). As in the case of the identified artifacts, many of the “anthropic features” are identified based on subjective criteria and do not appear to be clearly human-constructed. Many of the structures from the Pedra Furada phases were actually a group of cobbles located near each other. Since the matrix was filled with cobbles and sandstone blocks, one may wonder “how were the features isolated in the field and their boundaries drawn relative to the surrounding matrix and context?” (Meltzer, Adovasio, and Dillehay 1994, 709). This is especially true since the very slow deposition rate means that naturally fallen slabs could have fallen for decades on top of constructed hearths without significant sedimentation, as stated by Parenti (2001). Several points can be used to argue the structures and hearths were just fallen cobbles and blocks resulting in a particular pattern:

1) HEATED COBBLES. Early on, the presence of heated cobbles/pebbles –heated to a temperature estimated to have been at least 200-250°C based on thermoluminescence (TL) measurements– was considered evidence of hearths and human interaction, especially since “the heated pebbles were not scattered on the excavated surface, but were concentrated beside the structures” (Parenti, Mercier, and Valladas 1990, 36). Some hearths were made with only cobbles (Figure 5). Disputing that heated cobbles were due to natural fires, the authors argue that “it could not leave a set of heated [cobbles] next to others that remained unheated”, forgetting that the very next line they discuss the unusual “very slow rate of soil formation at Pedra Furada (an average of 0.1 mm/year)”, where one can easily imagine new cobbles being deposited years after with almost no difference in sedimentation. The relevance of heated cobbles can also be seen in Parenti’s thesis, where the presence of heated cobbles is noted for each structure and used as a discriminating criterion to confirm the presence of hearths (Parenti 2001, 124). However, a later analysis (by the same co-author in charge of the TL in the original paper) confirmed that “the quartz specimens were burnt between 30 and more than 100 ka ago, but they provide no evidence that the heating was related to human activity. (...) TL age of burnt lithics alone cannot prove the human origin of the deposit as temperatures in excess of 500°C can be reached on the ground during high intensity natural fires” (Valladas et al. 2003, 1257–58). A more recent experiment on cobble burning patterns from the site did not provide any evidence of human intervention (Asfora et al. 2014).

2) HEARTHES AND CHARCOAL. In the first publication describing Boqueirão da Pedra Furada (Guidon and Delibrias 1986, 769), the presence of multiple “well-structured hearths at all levels” containing “large quantities of charcoal and ash” was already one of the main arguments for an anthropic occupation of the shelter. These structures were described as made with “cobbles [that] could not have fallen naturally where they were found” and with charcoal “concentrated in the centre of the hearth arrangements”; therefore the forest fire hypothesis was dismissed as “quite impossible” (Guidon and Arnaud 1991, 171, 176), although in his thesis Parenti doesn’t consider the natural fires as quite impossible anymore (Parenti 2001, 114). First of all, based on published figures, it is difficult to agree with the description of the hearths being “well-structured” (Figure 5). Moreover, the report stating that large quantities of

charcoal are concentrated in the center of hearths is quite misleading. Parenti's thesis (2001) provides detailed descriptions of the hearths: within the 49 hearths of the Pedra Furada phases, 21 had no charcoal, 18 had charcoal but with problematic descriptions⁴ and finally only 11 are mentioned as having charcoal inside with no specific problematic comment. Yes, 11 "hearths" may seem like a lot, but again, given that 38 of the 49 hearths are problematic, the remaining 11 may be suspicious as well, especially since they do not look very structured, such as hearths n°20 and 65 (Figure 5).

3) "ORGANIZED" SANDSTONE BLOCKS. Here again, there is no described protocol establishing how or when sandstone blocks were considered as having fallen naturally or as having been intentionally arranged by humans. Thanks to Parenti's iconography we have a drawing for each structure and hearth, and as for the cobble structures, the sandstone structures look quite problematic (Figure 6). Moreover, based on the drawings, it seems that many of the sandstone blocks that are described as the elements of a man-made structure are actually naturally fallen slabs that seem mostly shattered in place (the slabs are fragmented and can be 'refitted'). These shattering episodes cannot be explained by the effects of fire since in most cases it was the unheated slabs that were fragmented. As an example, structure n° 98 (Figure 6) is considered as a stone paving, but the drawing seems to indicate that they were fallen slabs broken *in situ*, as also suggested by the author (Parenti 2001, 73). Indeed, various structures were actually considered as "structures" because it was interpreted they had been used, although the author recognized some were probably naturally fallen slabs (Parenti 2001). Therefore, we do not know how the natural filling was differentiated from the "human-modified" structures, especially since such slabs contribute to the main filling of the site. If these arrangements are really anthropic (which is obviously a possibility), the demonstration still has to be made.

The general sense that stands out is that the natural sediments containing naturally fallen sandstone slabs and quartz cobbles from the cliff were excavated and analyzed by over-interpreting the organization of natural cobbles and blocks. As an example, I will use the definition of two structures which, from my point of view, are good examples of such over-interpretations. Structure n°67 was first considered as a knapping workshop (but there were almost no "artifacts"), it was then considered as a possible floor arrangement for an organic structure such as a tent flap, given that the floor arrangement had the same direction as the most frequent gusts of wind (Parenti 2001, 68). Hearth 65 (Figure 5), the oldest dated hearth of the site, had one single charcoal fragment and numerous heated cobbles: the problem is that the single charcoal fragment was located *outside* of the hearth and that the numerous heated cobbles were also located *outside* the structure; it was interpreted as a hearth that had been intentionally cleaned (Parenti 2001, 124–25).

⁴ By problematic descriptions we mean hearths n° 21, 22, 25, 27, 28, 29, 30, 41, 42, 49 and 52 described in Parenti's work (2001), where the descriptions indicate that charcoal was very rare, that hearths were actually just a charcoal stain with no stone structure, that charcoals were found stratigraphically above the hearth, that the author is not sure whether the hearth and the charcoals are associated, that the hearths had charcoal inside AND outside (therefore not just concentrated inside the feature as stated in some publications), etc.

In his thesis, F. Parenti based part on his hearth descriptions on the work of C. Perlès (1976). But in her article, C. Perlès (1976, 679) also pointed towards the lack of rigor of some studies on combustion structures, not to mention the “hearth” which do not contain ash or charcoal. As he explains in his thesis (Parenti 2001, 81, 114), no anthracological and micromorphological analyses were conducted to assess the anthropic nature of the structures and hearths. Although he states in 2001 that such an analysis is planned, it had yet to be performed in 2015: “a careful taphonomic *caveat* shall be adopted in interpreting these [combustion] features as surely anthropic; (...) only by anthracological, micromorphological and geophysical analysis the core issue of natural *versus* anthropic fires can be asserted” (Parenti 2015, 51).

It is indeed interesting to see that some of the more clearly defined hearths (*i.e.*, pit hearths) are only uncovered during the Holocene, in the Serra Talhada phase (Parenti 2001). I consider pit hearths to be the most obvious, since they result from a clear anthropic gesture (digging of a pit) sometimes coupled with a cobble/slab arrangement and associated with an abundance of fauna, lithic and charcoal remains (Parenti 2001, 50–51). This is not to say that all Holocene alleged structures are anthropic, given that some seem as questionable as the older ones. Moreover, most hearths from the Serra Talhada phases had charcoal, as opposed to those from the older Pedra Furada phases (Parenti 2001, 117)

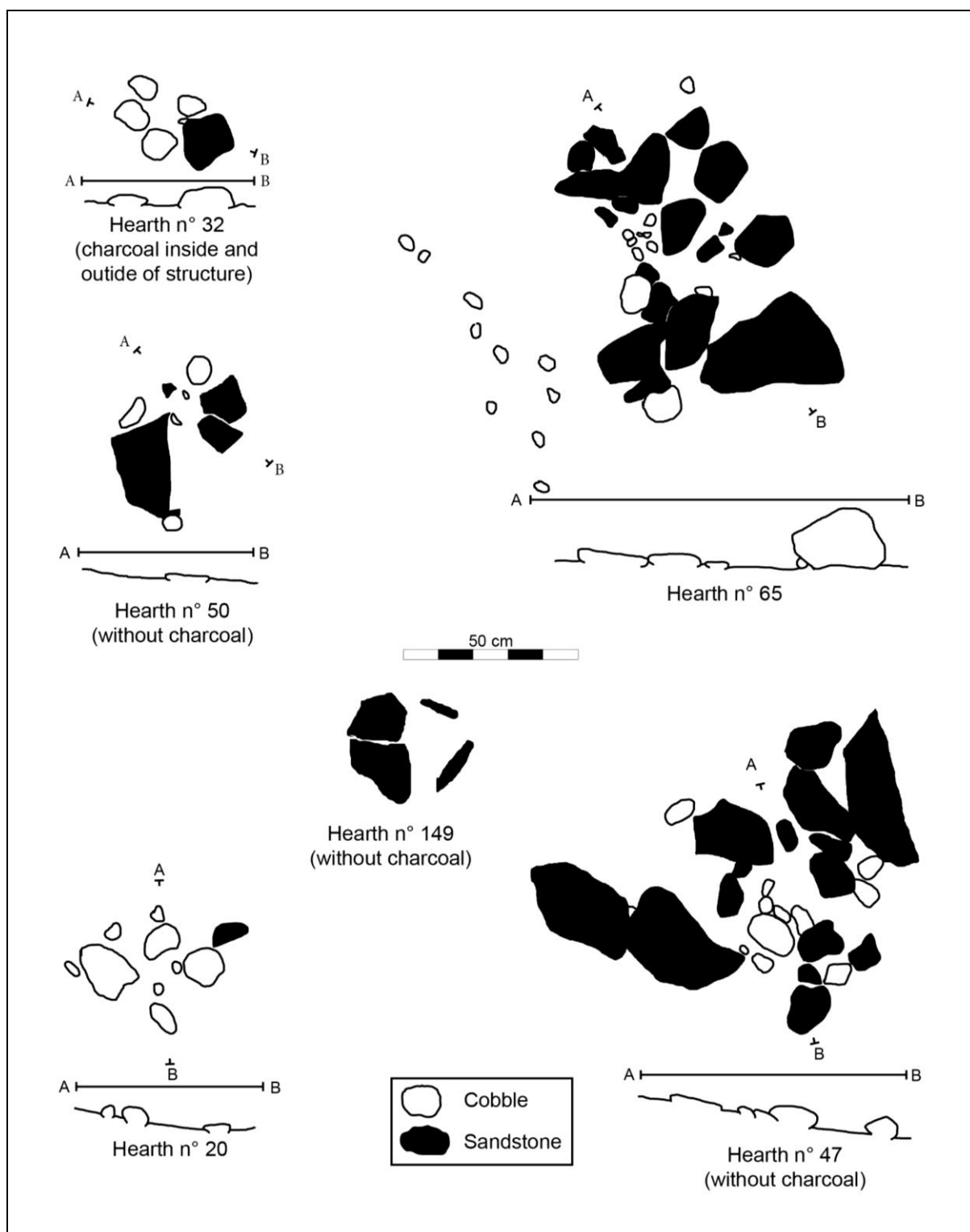


Figure 5. ‘Hearths’ from Boqueirão da Pedra Furada, Pedra Furada phases. Redrawn from Parenti (2001).

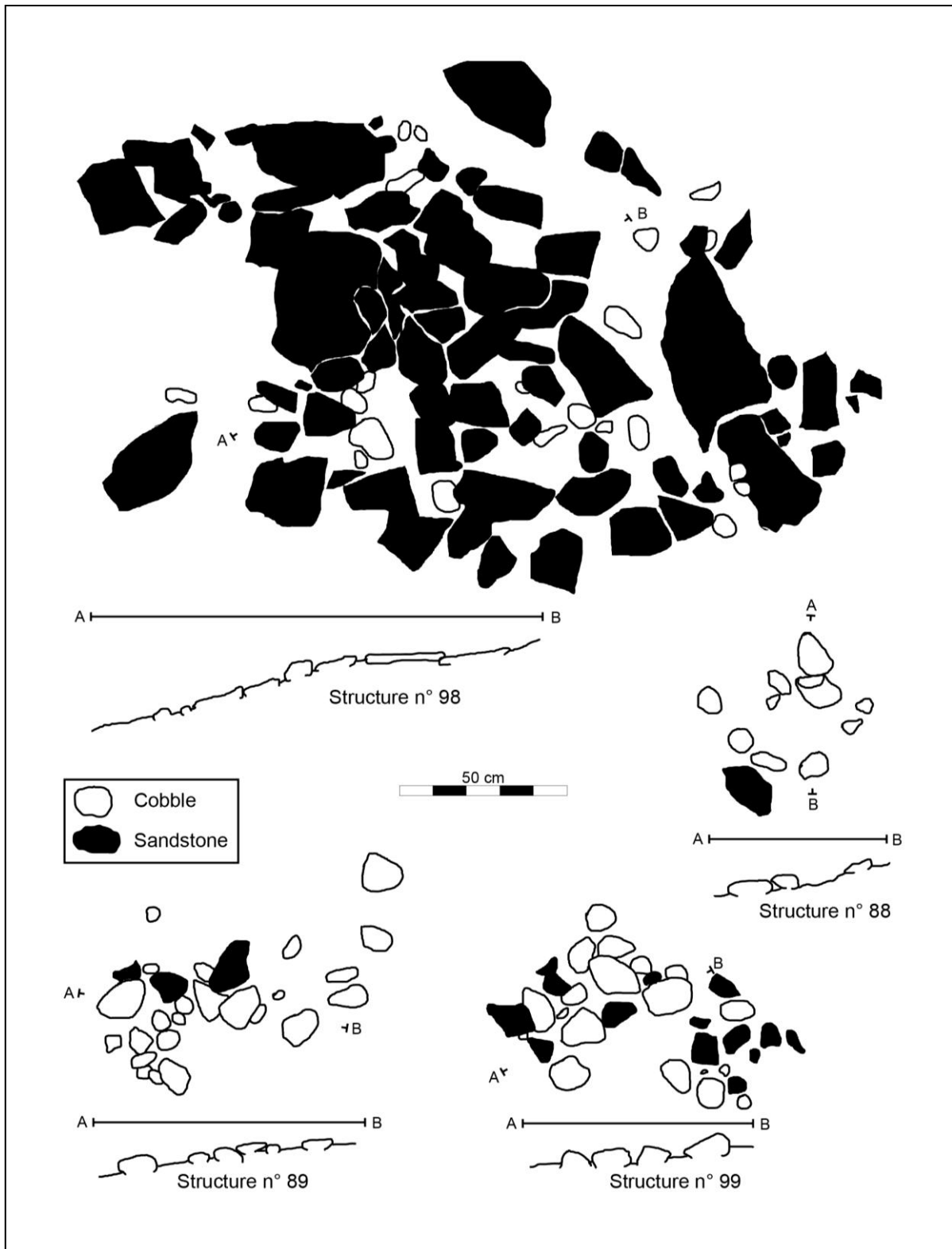


Figure 6. ‘Structures’ from Boqueirão da Pedra Furada, Pedra Furada phases. Redrawn from Parenti (2001).

9. The other Piauí sites: a house of cards?

After the discovery of Boqueirão da Pedra Furada rock-shelter, the challenge has been to find similar Pleistocene sites to confirm an early human presence in the area. The main site known in the area to contain similar industries as Boqueirão da Pedra Furada is Sítio do Meio, but it is located in a similar kind of context (a rock-shelter at the base of the same sandstone cliffs as at Pedra Furada). Although rock-shelters are the most common sites in the area, other types are known, including open-air sites and karstic sites (caves, etc.) (Parenti 2001). Parenti (2001) reports at least 91 open-air sites, 76 including undated presence of hunter-gatherers. In the São Raimundo Nonato area, at least 21 shelters and caves had been found, including three with substantially excavated areas: Toca da Janela da Barra do Antonião, Toca da Cima dos Pilão et Toca do Gordo do Garrincho. None had assemblages extending before the Pleistocene/Holocene transition (Faure, Guérin, and Parenti 1999; Guérin et al. 1999; Parenti 2001, 1996). Some sites (especially caves) had human remains, but none provided evidence of an ancient human presence dating to the LGM or pre-LGM:

- The human remains from Toca da Janela da Barra do Antonião were dated to the Pleistocene/Holocene transition, ca. 12,000 cal BP (Parenti 2001; Parenti et al. 2002).
- Various human teeth and bones were found at Garrincho cave (Peyre et al. 1998; Peyre, Granat, and Guidon 2009; Santos et al. 2003). The teeth were dated through direct ^{14}C AMS around ca. 14,000 cal BP, although the collagen was so insufficient even for AMS dating that the acid wash used for sample pre-treatment was incorporated for the dating (Guidon et al. 2000). The dating of the sediment around the human bones (through TL and OSL) provided two dates, respectively ca. 14,000 cal BP and ca. 24,000 cal BP (Peyre, Granat, and Guidon 2009). Therefore, the dates are very questionable.
- At Toca do Serrote das Moendas, the human remains have not been dated directly. Instead, faunal elements nearby have been dated by electron spin resonance (ESR) to ca. 24-29 thousand years (Kinoshita et al. 2014). But the problem also lies in the association between the fauna and human remains, given that they are in a sediment matrix that could be related to outside elements washing into the cave.
- All known human coprolites from the Piauí area (at least 31 from Boqueirão da Pedra Furada and at least 30 from Sítio do Meio) have been recovered from the Serra Talhada phases (de Miranda Chaves 2000; de Miranda Chaves and Reinhard 2006; Parenti 2001; Aimola et al. 2014).

Similarly, when looking at prehistoric paintings in the Piauí region, there is no indisputable evidence that any of them dated from the Pedra Furada phases. In 2003, a study suggested that paintings from Toca da Bastiana rock-shelter dated to ca. 35,000-40,000 cal BP (Watanabe et al. 2003), based on the thermoluminescence and EPR dating of a single calcite formation on top of the rock art. However, a more recent study analyzed various calcite formations from three sites (including Toca da Bastiana) using both AMS ^{14}C and uranium-series disequilibrium techniques, and the fourteen dates were from the Serra Talhada phase (Pleistocene/Holocene transition and Holocene) (Fontugne et al. 2013). Despite the lack of

evidence, some recent publications are still making a connection between the rock art paintings and the pre-LGM dates (Turnbull 2019).

The mission led by Boëda and his team aimed to renew the data on a human presence in the region. Since they have been working in the Piauí area, they not only performed new excavations at the Boqueirão da Pedra Furada rock-shelter, but also have excavated other sites to find traces of additional early occupations at these various locations. Although some of these sites have already been mentioned previously, we provide here a more detailed description site by site. Existing publications describe with more or less detail the sites of Vale da Pedra Furada, Sítio do Meio, Tira Peia, Toca da Pena and Toca da Janela da Barra do Antônio-north. At least two other sites (Livierac and Esperanza) are mentioned (Eric Boëda 2014; Eric Boëda et al. 2016), but remain unpublished.

VALE DA PEDRA FURADA.

The main site that has been published is Vale da Pedra Furada (Eric Boëda et al. 2013; E. Boëda et al. 2014; Eric Boëda et al. 2014, 2021; Lahaye et al. 2015). Discovered by Gisele Felice in 1998, it has been excavated over a surface of 60 m² (20 m² since 2011). The site contains 8 levels (C1 to C8) dating up to 24,000 cal BP for C7 (although C8, stratigraphically below, has not yet been dated and could thus be older). As for Boqueirão da Pedra Furada, all artifacts are quartz and cobble ‘tools’. The site has been described by the authors as an open-air site nearby Boqueirão da Pedra Furada, usually in contrast to Boqueirão da Pedra Furada that was located at the base of the cliff; the understated implication being that Vale da Pedra Furada was devoid of the natural disturbances linked to falling cobbles. In fact, the site is described in one instance as having virtually no disturbances and located on a stream bank (E. Boëda et al. 2014, 15–23). Although various articles discussing this site were published by the Boëda team in 2013, 2014 and 2015, it is a reply by Parenti (2015) that enabled us to really understand the nature of Vale da Pedra Furada. Parenti’s description and maps (2015) of Vale da Pedra Furada show that it would be actually only 65 to 70 m from the main shelter of Boqueirão da Pedra Furada (Figure 7), simply a locus of that site (not a new open-air site), directly impacted by the runoff of the main excavation and fully affected by the intermittent water courses eroding the entire deposit of the shelter (thus not on a stream bank). As a result, the sedimentary source of both sites is strictly of the same origin (i.e. pebble and cobble conglomerates eroding from the cliff) and the site cannot be described as without disturbances. In summary, Parenti (2015, 49) recommends researchers to be “still more cautious” in their analysis of alleged artifacts from Vale da Pedra Furada than for the Boqueirão da Pedra Furada. This information is indeed perceptible in the most recent publication on Vale da Pedra Furada, since for the first time we see photos documenting the major disturbances created by collapsed blocks from the local cliff and how close the cliff walls are on the background of the excavation (Eric Boëda et al. 2021). When a site is close enough to a cliff to have blocks falling on top, it might be time to stop considering it as an “open-air” site. In any case, a large taphonomical analysis should be launched given the problematic context of the site (on the immediate periphery of collapsed blocks from the cliff) and of the archaeological layers (sediments of quartz and quartzite blocks, boulders, cobbles and pebbles in a dominant matrix of sand and silt), as described in this latest publication.

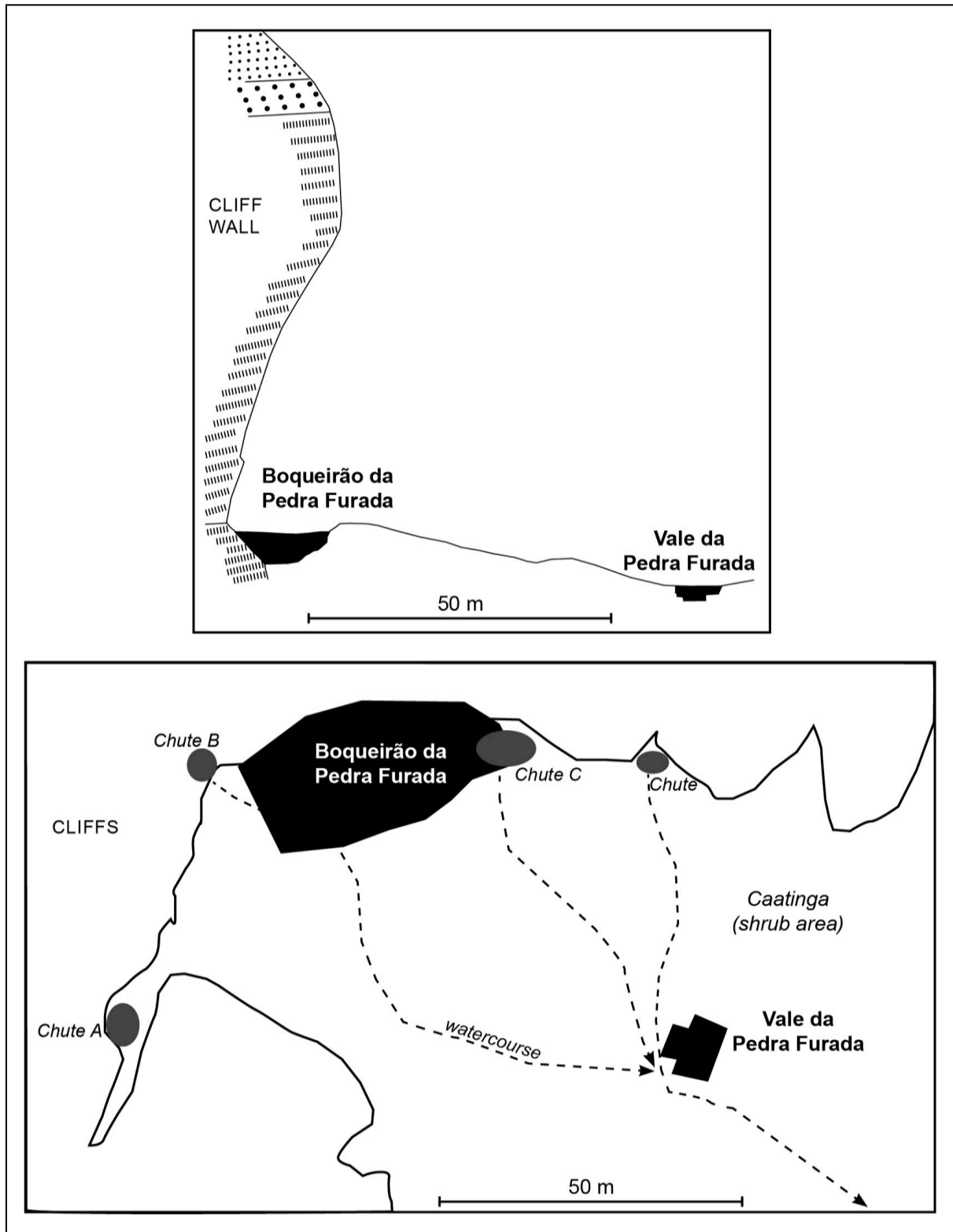


Figure 7. Boqueirão da Pedra Furada and Vale da Pedra Furada: two sectors of a same site. Profile and map redrawn from Parenti (2015).

SÍTIO DO MEIO.

This rock-shelter is located along the same sandstone cliffs as Boqueirão da Pedra Furada, less than 2 km away. The site has been extensively excavated by Guidon and then Pinheiro de Melo over hundreds of square meters (Aimola et al. 2014; Guidon and Pessis 1993). More recently, Boëda and colleagues (Eric Boëda et al. 2016) excavated a new 4 m² test-excavation with the objective of confirming whether the site had an early occupation with real artifacts (since the context and disturbances are similar to that of the Pedra Furada site). The new published dates extend the occupation back to ca. 29,000 cal BP. As already discussed in the selection protocol section, Boëda and co-authors reported fewer than a hundred artifacts (all made of quartz and quartzite), found amidst thousands of natural cobbles that fill the sediment from the eroding elements of the cliff. In terms of structures, Pinheiro de Melo (2007) only reported one possible hearth from the Pleistocene levels. Boëda and co-authors described an additional structure formed of two orthogonally oriented blocks (Eric Boëda et al. 2013), interpreted as the result of a human intervention. However, the published photos of the feature are unconvincing. In their latest publication on the site they indicate that micromorphological analyses are in progress therefore they cannot confirm the anthropic nature of the structure so no interpretations are possible (Eric Boëda et al. 2016). It should be recalled that in 2013, this putative feature was modestly described as a “spectacular” “mega-structure” or “suprastructure” that “cannot be attributed to natural deposition” and that “may be evidence for the first human spatial organization in our study region” (Eric Boëda et al. 2013, 458–59).

TOCA DA TIRA PEIA.

This rock-shelter, excavated over 25 m², is not located along the sandstone cliffs as the previous two sites, but in the calcareous massif of Antero. There are so far 5 identified components, dated through OSL: C4 (ca. 4000 cal BP), C6 (ca. 17,000 cal BP), C7a (ca. 22,000 cal BP), C8 (undated) and C9 (undated) (Lahaye et al. 2013; E. Boëda et al. 2014). The authors assert that “lithic artifacts were found to be numerous in the C6 and C7 layers” (Lahaye et al. 2013, 2846), which can be seen as an overstatement since 57 artifacts were recovered in C6 and only 6 in C7. The overall assemblage is composed of 113 artifacts, including 35 tools and 12 cores. Unfortunately, only 7 artifacts (6 tools and 1 core) from layers C6 to C8 are repeatedly illustrated at a reduced scale in the three publications on the site (Lahaye et al. 2013; Eric Boëda et al. 2013; E. Boëda et al. 2014). It is also unfortunate that although 12 cores are identified, only one is illustrated and not at full scale. Given the importance of the site for the authors (“an exemplary case study”), numerous full-size illustrations (photos and drawings) of the assemblage would be useful and necessary. The publications also lack the needed detailed geological context of the site (the cliff, the sediments, the environment, etc.), as well as a proper geomorphological analysis. The authors specify that “the top of the cliff has no deposits whatsoever” (Eric Boëda et al. 2013, 452), therefore implying the artifacts (all made on quartz and quartzite) do not come from the eroding cliff. It is unclear however whether natural quartz and quartzite cobbles were present in the sediment and whether a selection protocol was used for the recovery of artifacts.

TOCA DA JANELA DA BARRA DO ANTONIÃO.

This site was excavated in the 1980s over 750 m² to a maximum depth of 8 m (Parenti, Mercier, and Valladas 1990; Guerin et al. 1999; Parenti et al. 1999). During these excavations, close to 2000 artifacts were found made of quartz, quartzite and chert, including core tools, retouched tools, and flakes. These artifacts were all assigned to the Holocene Serra Talhada phase (Parenti, Mercier, and Valladas 1990; Parenti et al. 1999). One nearly complete human skeleton was discovered and dated to ca. 10,000 cal BP (Parenti, Mercier, and Valladas 1990; Peyre, Granat, and Guidon 2009). Boëda conducted additional site surveys about 200 m away from the first excavations, opening 8 m² to a depth of 1 m (Lahaye et al. 2019, 224). The publication about the renewed effort at the site has so far focused on chronology, with dates that go back to at least ca. 20,000 cal BP, without any discussions or illustrations on the archaeology and associated artifacts. Here is an excerpt of the article quoting *in extenso* the only published archaeological information: “an older archaeological horizon (C4a) (...) yielded lithic artefacts, manuports and megafauna. An archaeological level (C5a) (...) contained tools and artefacts. Finally, the lowermost archaeological level (C6a) (...) produced chopper-like pebble tools and bone fragments” (Lahaye et al. 2019, 224).

TOCA DA PENA.

This site is a rock-shelter and a cave excavated between 2008 and 2014. Lithic artifacts have been uncovered in close association with faunal elements, although the lithics have not been described and published, unlike the faunal data. Although at first the site was compared to the old levels of Boqueirão da Pedra Furada based on typological grounds (Eric Boëda 2014, 19), new 14C dates of bone remains place the occupation during the Pleistocene/Holocene transition, around 12,000-11,000 cal BP (Eric Boëda 2014; Griggo et al. 2018). Therefore, this site is outside the scope of the present discussion on potential human presence during or before the LGM.

LIVIERAC.

There is no published information on this site. All that has been published are a couple of maps with an approximate location (Eric Boëda et al. 2016; Dycus 2018). The site seems to be located in close proximity (tens of meters?) from Vale da Pedra Furada, and might be simply another sector of the same site.

ESPERANZA.

There is no published information on this site.

This brief synthesis on the other sites of the Piauí region shows the recurrent lack of contextual data and the absence for most assemblages of quality drawings and photographs of the artifacts (or even absence of illustrated artifacts in some cases). It is for example very problematic that it was Parenti's article that explained how Vale da Pedra Furada was geologically connected to Boqueirão da Pedra Furada or that publications on supposed early sites such as Toca da Janela da Barra do Antonião provide no information or evidence whatsoever on the archaeology and the artifacts. Ironically, the article on Toca da Janela da Barra do Antonião is entitled “Another Site, Same Old Song”. Indeed, I could not agree more

with this sentiment. *Another site, same old song: still no artifacts, still no data, still no context, still no demonstrative evidence.*

10. Conclusion

Throughout this article, my goal has been to show that, far from skepticism based on ideological grounds with no scientific basis, major scientific issues remain with the Piauí sites. We can only hope that future publications will provide more explicit data in order to sustain claims of LGM and pre-LGM human settlement in Brazil: a description of the immediate environment and possible sources of natural disturbance; better photographic documentation of the natural filling of the sediments; geoarchaeological and geomorphological studies; large-scale, detailed and illustrated taphonomic analyses of the natural cobbles fallen from the cliffs; explicit selection protocols; well-documented use-wear studies. Future publications should also illustrate – with full-scale drawings and photos – more of the alleged artifacts, together with some of the geofacts. With the advent of modern photography and online accessible materials, artifacts need to be clearly illustrated, avoiding reduced-scale figures, so a real assessment can be made by other lithic technologists. When photographs are published, it sometimes gives a different sense of the reality of the artifacts because an illustrator can exaggerate some flake scars or render them more fresh than they are, as expressed by other researchers (Gillespie, Tupakka, and Cluney 2004, 631; Fiedel 2017, 6).

The final outcome of this analysis, based on the analysis of the numerous published data, is that it is difficult to support a human presence in this region during or before the Last Glacial Maximum. However, the published data seem to convincingly establish a human presence at these sites starting with the Serra Talhada phases (Pleistocene/Holocene transition). Is it because the chronology is then acceptable and fits our colonization model? The data discussed in this article shows that this skepticism is linked to the available and published archaeological data:

- To date, no taphonomical study has been published to exclude the presence of geofacts in the assemblages from the older Pedra Furada phases;
- Ethological data show how Capuchin monkeys have been using and making simple stone tools for at least a few millennia;
- During the Serra Talhada phases, we see the appearance of unambiguous tools, exogenous raw materials, pit hearths, rock art, human remains and human coprolites;
- Current paleogenetic data support a peopling of the Americas (excluding Beringia) starting around 20,000 years ago, showing that these ancient sites are therefore not only problematic based on archaeological data.

With the mounting evidence of taphonomical disturbances present at the sites and the ethological studies showing monkey tool use in the Piauí region, researchers can no longer ignore these data. It has been over three decades since the first publication of Boqueirão da Pedra Furada (1986), over two decades since Parenti's thesis on the site (1993) and over one decade since Boëda and co-workers started working in the Piauí area (2008). During all this

time, answers to the main archaeological dilemmas (taphonomical analysis, etc.) have not been addressed or published with hard data.

All the critical comments made here concerning the Pedra Furada and the other Piauí sites are also valid for any other site in any other context. Artifacts and their context of discovery must be well documented, especially when dealing with doubtful artifacts (crude-looking stones, probable hammerstones, possibly butchered bones, etc.). Of course, nothing can compare to first-hand analysis of stones, bones, sediments or any other materials. And it is understandably one of the recurring arguments of the defenders of such claims: the vast majority of researchers doubting the published data have not themselves studied the actual materials first-hand for years, as have the publishing team. Although absolutely true, this argument is still a concern. If publications do not provide the necessary data to support their claims, and if they do not convince the readers outside of the publishing team/school of thought, we are at a methodological dead-end. As expressed by Luis Alberto Borrero (2016, 6), “there is no better specialist than the one who can sustain his/her claims on the basis of arguments or data (...). What is needed is clear evidence that can be shared, analyzed, and interpreted”.

Acknowledgements

I would like to thank Claire Alix, Véronique Darras, Jacques Pelegrin, Colas Guéret, Angela K. Gore and Caroline M. Renard for their multiple corrections, suggestions and discussions on previous drafts of the manuscript. I would also like to thank the four anonymous reviewers for providing constructive criticism.

Author biography

Yan Axel Gómez Coutouly is a permanent researcher at the CNRS (French National Center for Scientific Research) at the laboratory “Archaeology of the Americas” (UMR 8096). His research focuses on lithic technology among late Pleistocene and early Holocene societies in Beringia, during the initial stages of the peopling process of the Americas. Since 2013, he has been directing the French archaeological mission in Alaska (mafAK) funded by the French Ministry of Foreign Affairs (MEAE), the French Polar Institute (IPEV) and the CNRS.

Bibliography

- Aimola, Giulia, Camila Andrade, Leidiana Mota, and Fabio Parenti. 2014. "Final Pleistocene and Early Holocene at Sítio Do Meio, Piauí, Brazil: Stratigraphy and Comparison with Pedra Furada." *Journal of Lithic Studies* 1 (2): 5–24. doi:10.2218/jls.v1i2.1125.
- Ardelean, Ciprian F., Lorena Becerra-Valdivia, Mikkel Winther Pedersen, Jean-Luc Schwenninger, Charles G. Oviatt, Juan I. Macías-Quintero, Joaquín Arroyo-Cabrales, et al. 2020. "Evidence of Human Occupation in Mexico around the Last Glacial Maximum." *Nature* 584 (7819). Nature Publishing Group: 87–92. doi:https://doi.org/10.1038/s41586-020-2509-0.
- Arroyo, Adrián, Tiago Falótico, Aitor Burguet-Coca, Isabel Expósito, Patrick Quinn, and Tomos Proffitt. 2021. "Use-Wear and Residue Analysis of Pounding Tools Used by Wild Capuchin Monkeys (*Sapajus libidinosus*) from Serra Da Capivara (Piauí, Brazil)." *Journal of Archaeological Science: Reports* 35: 1–19. doi:10.1016/j.jasrep.2020.102690.
- Asfora, Viviane K., Pedro L. Guzzo, Anne-Marie Pessis, Vinicius SM Barros, Shigueo Watanabe, and Helen J. Houry. 2014. "Characterization of the Burning Conditions of Archaeological Pebbles Using the Thermal Sensitization of the 110° C TL Peak of Quartz." *Radiation Measurements* 71. Elsevier: 485–89. doi:10.1016/j.radmeas.2014.04.022.
- Bahn, Paul G. 1993. "50,000-Year-Old Americans of Pedra Furada." *Nature* 362 (6416). Nature Publishing Group: 114–15.
- Bahn, Paul G., Hansjürgen Müller-Beck, and Brian Fagan. 1991. "Concerned Readers." *Archaeology* 44 (2). Nature Publishing Group: 10–11.
- Bednarik, Robert G. 1989. "On the Pleistocene Settlement of South America." *Antiquity* 63 (238). Cambridge University Press: 101–11.
- Boëda, E., G. Felice Daltrini, M. Fontugne, S. Hoeltz, A. Lourdeau, C. Lahaye, M. Pagli, and S. Viana. 2014. "Les Industries Pléistocènes Du Piauí. Nouvelles Données, as Indústrias Pleistocênicas Do Piauí Novos Dados." In *Peuplement de l'Amérique Du Sud: L'apport de La Technologie Lithique. Povoamento Na América Di Sul: A Contribuição Da Tecnologia Litica. Poblacion de America Del Sur: La Contribucion de La Technologica Litica*, edited by Maria Farias and Antoine Lourdeau, @rchéo-éditions.com, 14–63.
- Boëda, Eric. 2013. *Techno-Logique & Technologie: Une Paléo-Histoire Des Objects Lithiques Tranchants*. Paris: @rchéo-éditions.
- . 2014. "Les Premiers Peuplements Préhistoriques En Amérique Du Sud. Rupture de Paradigme Mission Archéologique Française Du Piauí, Brésil." *Comptes Rendus Des Séances de l'Académie Des Inscriptions et Belles-Lettres* 158 (4). Persée-Portail des revues scientifiques en SHS: 1383–1432. doi:https://doi.org/10.3406/crai.2014.95411.
- Boëda, Eric, Ignacio Clemente-Conte, Michel Fontugne, Christelle Lahaye, Mario Pino, Gisele Daltrini Felice, Niede Guidon, et al. 2014. "A New Late Pleistocene Archaeological Sequence in South America: The Vale Da Pedra Furada (Piauí, Brazil)." *Antiquity* 88 (341). Cambridge University Press: 927–41. doi:http://antiquity.ac.uk/ant/088/ant0880927.
- Boëda, Eric, Antoine Lourdeau, Christelle Lahaye, Gisele Daltrini Felice, Sibeli Viana, Ignacio Clemente-Conte, Mario Pino, et al. 2013. "The Late-Pleistocene Industries of Piauí, Brazil: New Data." In *Paleoamerican Odyssey*, edited by Kelly E. Graf, Caroline V. Ketron, and Michael R. Waters, Texas A&M, 445–65. College Station: Texas A & M University.
- Boëda, Eric, Marcos Ramos, Antonio Pérez, Christine Hatté, Christelle Lahaye, Mario Pino, David Hérison, et al. 2021. "24.0 Kyr Cal BP Stone Artefact from Vale Da Pedra Furada, Piauí, Brazil: Techno-Functional Analysis." *PLoS ONE* 16 (3). Public Library of Science San Francisco, CA USA: e0247965. doi:10.1371/journal.pone.0247965.
- Boëda, Eric, Roxane Rocca, Amélie Da Costa, Michel Fontugne, Christine Hatté, Ignacio Clemente-Conte, Janaina C. Santos, et al. 2016. "New Data on a Pleistocene Archaeological Sequence in

- South America: Toca Do Sítio Do Meio, Piauí, Brazil." *PaleoAmerica* 2 (4). Taylor & Francis: 286–302. doi:http://dx.doi.org/10.1080/20555563.2016.1237828.
- Borrazzo, Karen. 2020. "Expanding the Scope of Actualistic Taphonomy in Archaeological Research." In *Actualistic Taphonomy in South America*, edited by Sergio Martínez, Alexandra Rojas, and Fernanda Cabrera, 221–42. Topics in Geobiology 48. Uruguay: Springer.
- Borrero, Luis Alberto. 2016. "Ambiguity and Debates on the Early Peopling of South America." *PaleoAmerica* 2 (1). Taylor & Francis: 11–21. doi:http://dx.doi.org/10.1080/20555563.2015.1136498.
- Bourgeon, Lauriane, Ariane Burke, and Thomas Higham. 2017. "Earliest Human Presence in North America Dated to the Last Glacial Maximum: New Radiocarbon Dates from Bluefish Caves, Canada." *PLoS ONE* 12 (1). Public Library of Science San Francisco, CA USA: e0169486. doi:https://doi.org/10.1371/journal.pone.0169486.
- Braje, Todd J., Tom D. Dillehay, Jon M. Erlandson, Scott M. Fitzpatrick, Donald K. Grayson, Vance T. Holliday, Robert L. Kelly, Richard G. Klein, David J. Meltzer, and Torben C. Rick. 2017. "Were Hominins in California ~130,000 Years Ago?" *PaleoAmerica* 3 (3): 200–202. doi:https://doi.org/10.1080/20555563.2017.1348091.
- Carandell Baruzzi, Miquel. 2016. "The First American Scoop: The Pedra Furada Controversy in Newspapers." *Centaurus* 58: 239–56. doi:doi:10.1111/1600-0498.12120.
- Clemente-Conte, Ignacio, Eric Boëda, and María Farias-Gluchy. 2017. "Macro-and Micro-Traces of Hafting on Quartz Tools from Pleistocene Sites in the Sierra de Capivara in Piauí (Brazil)." *Quaternary International* 427. Elsevier: 206–10. doi:http://dx.doi.org/10.1016/j.quaint.2015.12.015.
- Dennell, Robin, and Linda Hurcombe. 1995. "Comment on Pedra Furada." *Antiquity* 69 (264). Cambridge University Press: 604–604.
- Dillehay, Tom D., and Michael B. Collins. 1988. "Early Cultural Evidence from Monte Verde in Chile." *Nature* 332 (6160). Nature Publishing Group: 150–52. doi:10.1038/332150a0.
- Dillehay, Tom D., Carlos Ocampo, José Saavedra, Andre Oliveira Sawakuchi, Rodrigo M. Vega, Mario Pino, Michael B. Collins, et al. 2015. "New Archaeological Evidence for an Early Human Presence at Monte Verde, Chile." *PloS One* 10 (11). Public Library of Science San Francisco, CA USA: e0141923. doi:10.1371/journal.pone.0141923.
- Dillehay, Tom D., Mario Pino, and Carlos Ocampo. 2021. "Comments on Archaeological Remains at the Monte Verde Site Complex, Chile." *PaleoAmerica* 7 (1). Taylor & Francis: 8–13. doi:10.1080/20555563.2020.1762399.
- Duvall, James G., and William T. Verner. 1979. "A Statistical Analysis of the Lithics from the Calico Site (SBCM 1500A), California." *Journal of Field Archaeology* 6 (4). Taylor & Francis: 455–62.
- Dycus, Kathy. 2018. "Brazil: Leafing through Prehistory." *Mammoth Trumpet* 33 (1): 8–12.
- Fagan, Brian. 1990. "Tracking the First Americans." *Archaeology* 43 (6). Nature Publishing Group: 14–20.
- Falótico, Tiago, Tomos Proffitt, Eduardo B. Ottoni, Richard A. Staff, and Michael Haslam. 2019. "Three Thousand Years of Wild Capuchin Stone Tool Use." *Nature Ecology & Evolution* 3 (7). Nature Publishing Group: 1034–38.
- Fariña, Richard A. 2015. "Bone Surface Modifications, Reasonable Certainty, and Human Antiquity in the Americas: The Case of the Arroyo Del Vizcaíno Site." *American Antiquity* 80 (1). JSTOR: 193–200. doi:10.7183/0002-7316.79.4.193.
- Faure, Martine, Claude Guérin, and Fabio Parenti. 1999. "Découverte d'une Mégafaune Holocène à La Toca Do Serrote Do Artur (Aire Archéologique de São Raimundo Nonato, Piauí, Brésil)." *Comptes Rendus de l'Académie Des Sciences-Series IIA-Earth and Planetary Science* 329 (6). Elsevier: 443–48.
- Ferrell, Patrick M. 2019. "The Cerutti Mastodon Site Reinterpreted with Reference to Freeway Construction Plans and Methods." *PaleoAmerica* 5 (1). Taylor & Francis: 1–7. doi:10.1080/20555563.2019.1589663.

- Fiedel, Stuart J. 2017. "Did Monkeys Make the Pre-Clovis Pebble Tools of Northeastern Brazil?" *PaleoAmerica* 3 (1). Taylor & Francis: 6–12. doi:<http://dx.doi.org/10.1080/20555563.2016.1273000>.
- Fontugne, Michel, Qingfeng Shao, Norbert Frank, François Thil, Niède Guidon, and Eric Boëda. 2013. "Cross-Dating (Th/U-14C) of Calcite Covering Prehistoric Paintings at Serra Da Capivara National Park, Piauí, Brazil." *Radiocarbon* 55 (2–3): 1191–98. doi:[10.1017/S0033822200048104](https://doi.org/10.1017/S0033822200048104).
- Gillespie, Jason David, Susan Tupakka, and Christine Cluney. 2004. "Distinguishing between Naturally and Culturally Flaked Cobbles: A Test Case from Alberta, Canada." *Geoarchaeology: An International Journal* 19 (7). Wiley Online Library: 615–33. doi:[10.1002/gea.20015](https://doi.org/10.1002/gea.20015).
- Griggo, Christophe, Iderlan De Souza, Éric Boëda, Michel Fontugne, Christine Hatté, Antoine Lourdeau, and Niède Guidon. 2018. "La Faune Du Pléistocène Supérieur-Holocène Ancien de La Toca Da Pena (Piauí, Brésil)-Étude Paléontologique." *Quaternaire* 29 (3): 205–16. doi:[10.4000/quaternaire.10082](https://doi.org/10.4000/quaternaire.10082).
- Guerin, Claude, Martine Faure, Paulo R. Simões, Marguerite Hugueney, and Cécile Mourer-Chauvire. 1999. "Toca Da Janela Da Barra Do Antonião, São Raimundo Nonato, PI. Rica Fauna Pleistocênica e Registro Da Pré-História Brasileira." *Sítios Geológicos e Paleontológicos Do Brasil* 69. DNPM/CPRM Brasília: 131–37.
- Guidon, Niède. 1989. "On Stratigraphy and Chronology at Pedra Furada." *Current Anthropology* 30 (5): 641–42.
- Guidon, Niède, and B. Arnaud. 1991. "The Chronology of the New World: Two Faces of One Reality." *World Archaeology* 23 (2). Taylor & Francis: 167–78. doi:[10.1080/00438243.1991.9980169](https://doi.org/10.1080/00438243.1991.9980169).
- Guidon, Niède, and Gabriel Delibrias. 1986. "Carbon-14 Dates Point to Man in the Americas 32,000 Years Ago." *Nature* 321 (6072). Nature Publishing Group: 769–71.
- Guidon, Niède, Fabio Parenti, Maria de Fatima Da Luz, Claude Guérin, and Martine Faure. 1994. "Le plus Ancien Peuplement de l'Amérique: Le Paléolithique Du Nordeste Brésilien." *Bulletin de La Société Préhistorique Française* 91 (4–5). Société préhistorique française: 246–50. doi:<https://doi.org/10.3406/bspf.1994.9732>.
- Guidon, Niède, A. M. Pessis, Fabio Parenti, Michel Fontugue, and Claude Guérin. 1996. "Nature and Age of the Deposits in Pedra Furada, Brazil: Reply to Meltzer, Adovasio & Dillehay." *Antiquity* 70. Antiquity Publications: 408–21.
- Guidon, Niède, and Anne-Marie Pessis. 1993. "Recent Discoveries on the Holocenic Levels of Sitio Do Meio Rock-Shelter, Piauí Brasil." *CLIO - Série Arqueologica* 9: 69–76.
- Guidon, Niède, E Peyre, Evelyne, Claude Guérin, and Yves Coppens. 2000. "Resultados Da Datação de Dentes Humanos Da Toca Do Garrincho, Piauí-Brasil." *Clio Arqueológica* 14: 75–86.
- Haynes, Gary. 2017. "The Cerutti Mastodon." *PaleoAmerica* 3 (3). Taylor & Francis: 196–99. doi:<https://doi.org/10.1080/20555563.2017.1330103>.
- Holen, Steven R., Thomas A. Deméré, Daniel C. Fisher, Richard Fullagar, James B. Paces, George T. Jefferson, Jared M. Beeton, et al. 2017. "A 130,000-Year-Old Archaeological Site in Southern California, USA." *Nature* 544 (7651). Nature Publishing Group: 479–83. doi:[doi:10.1038/nature22065](https://doi.org/10.1038/nature22065).
- Holmes, Charles E. 2011. "The Beringian and Transitional Periods in Alaska: Technology of the East Beringian Tradition as Viewed from Swan Point." In *From the Yenisei to the Yukon: Interpreting Lithic Assemblage Variability in Late Pleistocene/Early Holocene Beringia*, edited by Ted Goebel and Ian Buvit, 179–91. College Station: Texas A&M University Press.
- Hosfield, R. T., and J. C. Chambers. 2016. "Flake Modifications during Fluvial Transportation: Three Cautionary Tales." *Lithics*, no. 24: 57–65.
- Kinoshita, Angela, Anne R. Skinner, Niède Guidon, Elaine Ignacio, Gisele Daltrini Felice, Cristiane de A. Buco, Sonia Tatum, Marcio Yee, Ana Maria Graciano Figueiredo, and Oswaldo Baffa. 2014. "Dating Human Occupation at Toca Do Serrote Das Moendas, São Raimundo Nonato, Piauí-Brasil by Electron Spin Resonance and Optically Stimulated Luminescence." *Journal of Human Evolution* 77: 187–95. doi:<https://doi.org/10.1016/j.jhevol.2014.09.006>.

- Krasinski, Kathryn E., and John C. Blong. 2020. "Unresolved Questions about Site Formation, Provenience, and the Impact of Natural Processes on Bone at the Bluefish Caves, Yukon Territory." *Arctic Anthropology* 57 (1). University of Wisconsin Press: 1–21. doi:10.3368/aa.57.1.1.
- Lahaye, Christelle, Guillaume Guérin, Eric Boëda, Michel Fontugne, Christine Hatté, Marine Frouin, Ignacio Clemente-Conte, et al. 2015. "New Insights into a Late-Pleistocene Human Occupation in America: The Vale Da Pedra Furada Complete Chronological Study." *Quaternary Geochronology* 30. Elsevier: 445–51. doi:http://dx.doi.org/10.1016/j.quageo.2015.03.009.
- Lahaye, Christelle, Guillaume Guérin, Maria Gluchy, Christine Hatté, Michel Fontugne, Ignacio Clemente-Conte, Janaina C. Santos, et al. 2019. "Another Site, Same Old Song: The Pleistocene-Holocene Archaeological Sequence of Toca Da Janela Da Barra Do Antônio-North, Piauí, Brazil." *Quaternary Geochronology* 49. Elsevier: 223–29. doi:https://doi.org/10.1016/j.quageo.2018.03.006.
- Lahaye, Christelle, Marion Hernandez, Eric Boëda, Gisele D. Felice, Niède Guidon, Sirlei Hoeltz, Antoine Lourdeau, et al. 2013. "Human Occupation in South America by 20,000 BC: The Toca Da Tira Peia Site, Piauí, Brazil." *Journal of Archaeological Science* 40 (6). Elsevier: 2840–47. doi:http://dx.doi.org/10.1016/j.jas.2013.02.019.
- Lanoë, François B., and Charles E. Holmes. 2016. "Animals as Raw Material in Beringia: Insights from the Site of Swan Point CZ4B, Alaska." *American Antiquity* 81 (4): 682–96. doi:10.7183/0002-7316.81.4.682.
- Leroi-Gourhan, André. 1976. "Les Structures d'habitat Au Paléolithique Supérieur." In *Les Civilisations Paléolithiques et Mésolithiques de La France*, CNRS, 656–63. Paris: Centre national de la recherche scientifique.
- Lourdeau, Antoine. 2010. "Le Technocomplexe Itaparica: Définition Techno-Fonctionnelle Des Industries à Pièces Façonnées Unifaciellement à Une Face Plane Dans Le Centre et Le Nord-Est Du Brésil Pendant La Transition Pléistocène-Holocène et l'Holocène Ancien." Thèse de Doctorat, Nanterre: Université Paris Ouest Nanterre La Défense.
- Lynch, Thomas F. 1990. "Glacial-Age Man in South America? A Critical Review." *American Antiquity* 55 (1). JSTOR: 12–36.
- Meltzer, David J., James M. Adovasio, and Tom D. Dillehay. 1994. "On a Pleistocene Human Occupation at Pedra Furada, Brazil." *Antiquity* 68 (261). Cambridge University Press: 695–714.
- Miranda Chaves, Sérgio Augusto de. 2000. "Estudo Palinológico de Coprólitos Pré-Históricos Holocenos Coletados Na Toca Do Boqueirão Do Sítio Da Pedra Furada: Contribuições Paleoetnológicas, Paleoclimáticas e Paleoambientais Para a Região Sudeste Do Piauí-Brasil." *Revista Do Museu de Arqueologia e Etnologia*, no. 10: 103–20.
- Miranda Chaves, Sérgio Augusto de, and Karl J. Reinhard. 2006. "Critical Analysis of Coprolite Evidence of Medicinal Plant Use, Piauí, Brazil." *Palaeogeography, Palaeoclimatology, Palaeoecology* 237 (1). Elsevier: 110–18. doi:10.1016/j.palaeo.2005.11.031.
- Parenti, Fabio. 1996. "Estratigrafia Do Caldeirão Do Rodriguez, São Raimundo Nonato, Piauí." *CLIO - Série Arqueologica* 11: 119–35.
- . 2001. *Le Gisement Quaternaire de Pedra Furada (Piauí, Brésil): Stratigraphie, Chronologie, Évolution Culturelle*. Editions Recherche sur les Civilisations. Paris.
- . 2015. "Old and New on the Same Site: Putting Vale Da Pedra Furada into a Wider Context. A Comment to Lahaye et al. 2015." *Quaternary Geochronology* 30. Elsevier: 48–53. doi:http://dx.doi.org/10.1016/j.quageo.2015.06.008.
- Parenti, Fabio, Alan Cannell, Evelynne Debar, Martine Faure, and Mercedes Okumura. 2018. "Genesis and Taphonomy of the Archaeological Layers of Pedra Furada Rock-Shelter, Brazil." *Quaternaire* 29 (3): 255–69. doi:10.4000/quaternaire.10313.

- Parenti, Fabio, Martine Faure, Fátima Da Luz, and Claude Guérin. 2002. "Pleistocene Faunas and Lithic Industries in the Antônio Rockshelter (Coronel José Dias, Piauí, Brazil): Studying Their Association." *Current Research in the Pleistocene* 19: 89–91.
- Parenti, Fabio, Michel Fontugne, Niède Guidon, Claude Guérin, Martine Faure, and Evelyne Debard. 1999. "Chronostratigraphie Des Gisements Archéologiques et Paléontologiques de São Raimundo Nonato (Piauí, Brésil): Contribution a La Connaissance Du Peuplement Pléistocène de l'Amérique." *Mémoires de La Société Préhistorique Française* 26: 327–32.
- Parenti, Fabio, Michel Fontugue, and Claude Guérin. 1996. "Pedra Furada in Brazil and Its 'Presumed' Evidence: Limitations and Potential of the Available Data." *Antiquity* 70 (268). Cambridge University Press: 416–21.
- Parenti, Fabio, Norbert Mercier, and Hélène Valladas. 1990. "The Oldest Hearths of Pedra Furada, Brasil: Thermoluminescence Analysis of Heated Stones." *Current Research in the Pleistocene* 7: 36–38.
- Peacock, Evan. 1991. "Distinguishing between Artifacts and Geofacts: A Test Case from Eastern England." *Journal of Field Archaeology* 18 (3). Taylor & Francis: 345–61.
- Perlès, Catherine. 1976. "Le Feu." In *Les Civilisations Paléolithiques et Mésolithiques de La France*, CNRS, 679–83. Paris: Centre national de la recherche scientifique.
- . 1980. "Économie de La Matière Première et Économie Du Débitage: Deux Exemples Grecs." In *Préhistoire et Technologie Lithique, Journées Du 11-12-13 Mai 1979*, edited by Jacques Tixier. Valbonne: Centre de Recherches Archéologiques du CNRS.
- Peyre, Evelyne, Jean Granat, and Niède Guidon. 2009. "Dents et Crânes Humains Fossiles Du Garrincho (Brésil) et Peuplements Anciens de l'Amérique." *Actes Société Française d'histoire de l'art Dentaire* 14: 32–37.
- Peyre, Evelyne, Claude Guérin, Niède Guidon, and Yves Coppens. 1998. "Des Restes Humains Pléistocènes Dans La Grotte Du Garrincho, Piauí, Brésil." *Comptes Rendus de l'Académie Des Sciences de La Terre et Des Planètes* 327 (5). Elsevier: 355–60.
- Pinheiro de Melo, Patricia. 2007. "A Transição Do Pleistoceno Ao Holoceno No Parque Nacional Serra Da Capivara - Piauí - Brasil : Uma Contribuição Ao Estudo Sobre a Antiguidade Da Presença Humana No Sudeste Do Piau." PhD Thesis, Recife: Universidade Federal de Pernambuco.
- Proffitt, Tomos, Lydia V. Luncz, Tiago Falótico, Eduardo B. Ottoni, Ignacio de la Torre, and Michael Haslam. 2016. "Wild Monkeys Flake Stone Tools." *Nature* 539 (7627). Nature Publishing Group: 85–88. doi:10.1038/nature20112.
- Prous, André. 1997. "O Povoamento Da América Visto Do Brasil: Uma Perspectiva Crítica." *Revista USP*, no. 34: 8–21.
- Santos, Guaciara M., Michael I. Bird, Fabio Parenti, Leslei K. Fifield, Niède Guidon, and Paul A. Hausladen. 2003. "A Revised Chronology of the Lowest Occupation Layer of Pedra Furada Rock Shelter, Piauí, Brazil: The Pleistocene Peopling of the Americas." *Quaternary Science Reviews* 22 (21–22). Elsevier: 2303–10. doi:10.1016/S0277-3791(03)00205-1.
- Schmitz, Pedro Ignacio. 1987. "Prehistoric Hunters and Gatherers of Brazil." *Journal of World Prehistory* 1 (1). Springer: 53–126.
- Suárez, Rafael, Luis A. Borrero, Karen Borrazzo, Martín Ubilla, Sergio Martínez, and Daniel Perea. 2014. "Archaeological Evidences Are Still Missing: A Comment on Fariña et al. Arroyo Del Vizcaíno Site, Uruguay." *Proceedings of the Royal Society B: Biological Sciences* 281 (1795). The Royal Society: 20140449. doi:10.1098/rspb.2014.0449.
- Turnbull, David. 2019. "Territorializing/Decolonizing South American Prehistory: Pedra Furada and the Cerutti Mastodon." *Tapuya: Latin American Science, Technology and Society* 2 (1). Taylor & Francis: 127–48. doi:10.1080/25729861.2019.1647759.
- Vachula, Richard S. 2020. "Alaskan Lake Sediment Records and Their Implications for the Beringian Standstill Hypothesis." *PaleoAmerica* 6 (4). Taylor & Francis: 303–7. doi:10.1080/20555563.2020.1818171.
- Vachula, Richard S., Yongsong Huang, William M. Longo, Sylvia G. Dee, William C. Daniels, and James M. Russell. 2019. "Evidence of Ice Age Humans in Eastern Beringia Suggests Early Migration

- to North America." *Quaternary Science Reviews* 205. Elsevier: 35–44. doi:10.1016/j.quascirev.2018.12.003.
- Valladas, Hélène, Norbert Mercier, Mostafa Michab, Jean Louis Joron, Jean Louis Reyss, and Niède Guidon. 2003. "TL Age-Estimates of Burnt Quartz Pebbles from the Toca Do Boqueirão Da Pedra Furada (Piauí, Northeastern Brazil)." *Quaternary Science Reviews* 22 (10–13). Elsevier: 1257–63. doi:10.1016/S0277-3791(03)00029-5.
- Vialou, Denis, Mohammed Benabdelhadi, James Feathers, Michel Fontugne, and Agueda Vilhena Vialou. 2017. "Peopling South America's Centre: The Late Pleistocene Site of Santa Elina." *Antiquity* 91 (358). Cambridge University Press: 865–84. doi:10.15184/aqy.2017.101.
- Vilhena Vialou, Agueda. 2011. "Occupations Humaines et Faune Éteinte Du Pléistocène Au Centre de l'Amérique Du Sud: L'abri Rupestre Santa Elina, Mato Grosso, Brésil." In *Peuplements et Préhistoire En Amériques*, edited by Denis Vialou, CTHS, 193–208. Paris.
- Vilhena Vialou, Agueda, and Denis Vialou. 2019. "Manifestações Simbólicas Em Santa Elina, Mato Grosso, Brasil: Representações Rupestres, Objetos e Adornos Desde o Pleistoceno Ao Holoceno Recente." *Boletim Do Museu Paraense Emílio Goeldi. Ciências Humanas* 14 (2). SciELO Brasil: 343–66. doi:10.1590/1981.81222019000200006.
- Watanabe, Shiguo, Walter Elias Faria Ayta, Henrique Hamaguchi, Niède Guidon, Eliany S. La Salvia, Silvia Maranca, and Oswaldo Baffa Filho. 2003. "Some Evidence of a Date of First Humans to Arrive in Brazil." *Journal of Archaeological Science* 30 (3). Elsevier: 351–54. doi:10.1006/jasc.2002.0846.