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The Technological Diversity of Lithic Industries in Eastern South America during the Late Pleistocene-Holocene Transition

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Abstract

Brazilian archaeological literature has insisted for decades upon associating hunter-gatherer sites dated to the Pleistocene–Holocene transition either to the Itaparica tradition, if located in central or northeastern Brazil, or to the Umbu tradition and Humaitá tradition, if located in southern Brazil, Uruguay, or any other adjacent part of Paraguay and Argentina. These associations have been based almost entirely on the presence or absence of *lesmas* and “projectile points,” regardless of their morphological and technological features. In the Uruguayan archaeological literature, three other cultures are recognised: Fell industry, Catalanense industry, and Tigre tradition, all in the Uruguayan region. However, the last 10 years of systematic studies on the lithic assemblages from these sites have shown that Paleoindian societies from Eastern South America are more culturally diverse than expected and that previously defined archaeological cultures present several issues in their definition, suggesting that many of these “traditions” are not valid and should no longer be used. Instead, new lithic industries and archaeological cultures should be defined only when cultural patterns are observable through systematic analyses.

Keywords: Paleoindian, hunter-gatherers, lithic technology, eastern South America, cultural diversity

1. Introduction

When we think about the archaeology of the Pleistocene in the Americas, we can only point to a few sites that are not dated from the very end of that period. This is because the American continent only started to be densely occupied after 13,000 BP, when the Pleistocene was ending. In South America, there are only four places known to this day that present strong evidence that some people settled the continent before 13,000 BP: the Serra da Capivara region, in Northwestern Brazil, which has sites containing simple tools of quartzite pebbles made by direct percussion (choppers), the oldest one being Boqueirão da Pedra Furada, dating around 50,000 BP [1–11]; Monte Verde site, in central Chile, where choppers and flakes are presenting dates older than 33,000 BP [12]; Santa Elina site, in Midwestern Brazil, where retouched limestone flakes and polished pendants made of *Megatherium* sp. (giant sloth) osteoderms were found and dated to around 23,000 BP [13, 14]; and

Taima Taima site in Venezuela, where the El Jobo lithic industry was found dating back to 13,000 BP (or 15,000 cal BP) [15]. It seems that this first phase of human settlement of the Americas is mainly defined by small populations that entered the continent and did not necessarily meet each other. These are just suppositions, since data is still insufficient for a better understanding and discussion of the first phase.

It was only around 13,000 cal BP, during the Pleistocene/Holocene transition, that the continent started to be densely occupied—and this is what we may call the “second phase” of America’s “human settlement.” The first studies of Paleoindians in the Eastern part of South America, which is the focus of this article, emerged in the 1960s with the second generation of academic archaeologists in Brazil. Before them, the only systematic archaeological research in the country was carried out by the *Programa Nacional de Pesquisas Arqueológicas* (a.k.a. PRONAPA), between the 1950s and 1960s [16]. PRONAPA researchers applied the concepts of “phase” and “tradition” which were heavily inspired by the historical-cultural American school. Even after the end of PRONAPA, its theoretical-methodological approach influenced many researchers to classify material culture assemblages into traditions or phases, especially pottery vessels, lithic artefacts, and even rock art, mainly by their size, shape, and decoration, as well as morphological-typological classifications of artefacts and archaeological sites settings. A new “archaeological tradition” would be created for each identified type, and the new assemblages presenting the same types were associated to these “traditions.” Similar types presenting slight regional or chronological differences were associated to subcategories known as “archaeological phases.” This was the first attempt to classify archaeological materials into archaeological cultures. Unfortunately, when Paleoindian research started to be carried out between the 1960s and 1970s, it was not always clear which types could be included in a tradition or phase, due the lack of solid criteria for these definitions. These definition problems affected the classification of Paleoindian cultures in a way that, until the end of the 2010s, archaeological literature defined only five Paleoindian cultures in Eastern South America: the Itaparica tradition, the Umbu or Tigre tradition, the Humaitá tradition, the Catalanense industry, and the Fell industry. But most of these “traditions” have been questioned on the validity of their concepts.

During the 1970s, Brazilian archaeologist Pedro Ignácio Schmitz [17–19] discovered several Paleoindian sites in the Serranópolis region, Midwestern Brazil, dating around 10,700 BP and presenting hundreds of unifacial plan-convex tools. Schmitz gave a name to these tools: *lesmas*. He also defined a new archaeological tradition as a result—the Itaparica tradition—and associated all known sites with *lesmas* to it. In the decades to come, several researchers would associate the presence of *lesmas* to the Itaparica tradition in Northeastern and Midwestern Brazil, even though there was a lot of doubt about the supposed technological homogeneity of these tools [20–27]. Systematical research on comparing *lesmas* from different sites, regions and periods are still scarce to this day, but most authors agree that in most regions where *lesmas* appear, there is a lack of stemmed points or bifacial technology in general. The oldest site known to present *lesmas* is the Lapa do Boquete site [21], in mid-eastern Brazil, dating to $12,070 \pm 317$ BP (15,098–13,289 cal BP).

In Brazil, the term *lesma* was initially used as a synonym for *limace*. The term *limace* was first defined by León Henri-Martin [28] but later redefined by François Bordes [29] to refer to unifacial tools that are symmetric, three times wider than they are thick, presenting one pointed extremity (tip), biconvex edges, and uninterrupted retouches all around the artefact. In popular language, *limace* means “slug” in French, while *lesma* also means “slug” in Portuguese, being just a literal translation. However, most recent studies on Paleoindian *lesmas* have made clear that these tools are not that similar to the ones originally defined from the European Mousterian. Instead, *lesmas* present some other patterns, such as the use of a big

flake as a blank, unifacial reduction/*façonnage* (not only retouch), the presence of several active edges, and at least one in one extremity (proximal or distal), plan-convex cross-section, a longer than wider shape, width being bigger or equal to the thickness, and a length that is usually greater than 7 cm. It does not seem to have a more specific standard on general morphology and technology, but this is probably due the lack of research in order to define regional or chronological patterns, especially because the presence of *lesmas* was the only attribute considered to this cultural association. The presence of *lesmas* is only observed in hunter-gatherer groups of Eastern South America, but more studies are necessary in order to better understand cultural patterns before making any cultural affiliations.

The Umbu tradition was supposed to be the opposite of the Itaparica tradition, since there were no *lesmas* associated to it. Instead, many types of “projectile points” were found. Itaparica is located in the Midwestern to Northeastern Brazil, while the Umbu tradition coverage area is only associated to the Southeastern and Southern states of Brazil, Uruguay, and some adjacent areas of Paraguay and Argentina. The concept of the Umbu tradition was created during the 1980s after a series of failed attempts to define “traditions” of stemmed points in Southern Brazil [30]. Those traditions and phase definitions were not clear, and sometimes even contradictory, making it difficult to understand to which tradition or phase new findings should be associated. At the end of the 1980s, all sites presenting stemmed points were aggregated into the Umbu tradition regardless of their morphology and technology. The oldest known site associated to it was supposed to be the Laranjito site [31, 32], in the middle of the Uruguay River, dating to $10,985 \pm 100$ BP (13,035–12,715 cal BP).

In the same area that the Umbu tradition was found, there was a second, contemporary tradition defined based on the presence of large, thick bifaces, some of them boomerang-shaped. This culture was first referred as the AltoParanaense Tradition [33, 34] and later renamed as the Humaitá tradition [35, 36]. However, this tradition was discarded from Brazilian archaeological literature at the end of the 2010s [37], since new findings revealed that typical Umbu and Humaitá tools were now being found in the same contexts. This meant there was only one tradition to associate new Paleoindian findings with stemmed points in southern Brazil and nearby regions.

Many critiques were made of the concept of the Umbu tradition just after a large quantity of assemblages had been aggregated into it [38–43], especially about the fact that the presence of stemmed points was the only attribute used to define it. In fact, until the end of the 2010s, no study was ever made to confirm this supposed cultural homogeneity in assemblages associated to the Umbu tradition. Added to this question, no researcher outside Brazil ever associated stemmed points to the Umbu tradition—even though Uruguay, Paraguay, and Argentina were supposedly part of it. One of the critiques also highlighted that Uruguayan archaeologists were defining the same points that Brazilian archaeologists were calling Umbu tradition to the Tigre tradition [43]. Tigre points were not the only ones found in levels related to the Pleistocene–Holocene transition. In fact, a good chronology for at least three types of stemmed points defined three different lithic industries [44]: Fell industry, Tigre industry, and Pay Paso industry (**Figure 1**).

Since the beginning of the current decade, Brazilian archaeologists also started to verify the validity of this supposed cultural homogeneity in Umbu tradition sites. Studies on geometric morphometry [45–47] and technology [48, 49] on Umbu-associated stemmed points revealed that these artefacts are indeed traditional, since they persist for millennia. However, these studies also revealed that they are heterogeneous in space, since regional cultural patterns revealed the existence of at least three lithic industries in the supposed Umbu tradition coverage area: Rioclarense industry, Tunas industry, and Garivaldinense industry (**Figure 1**).

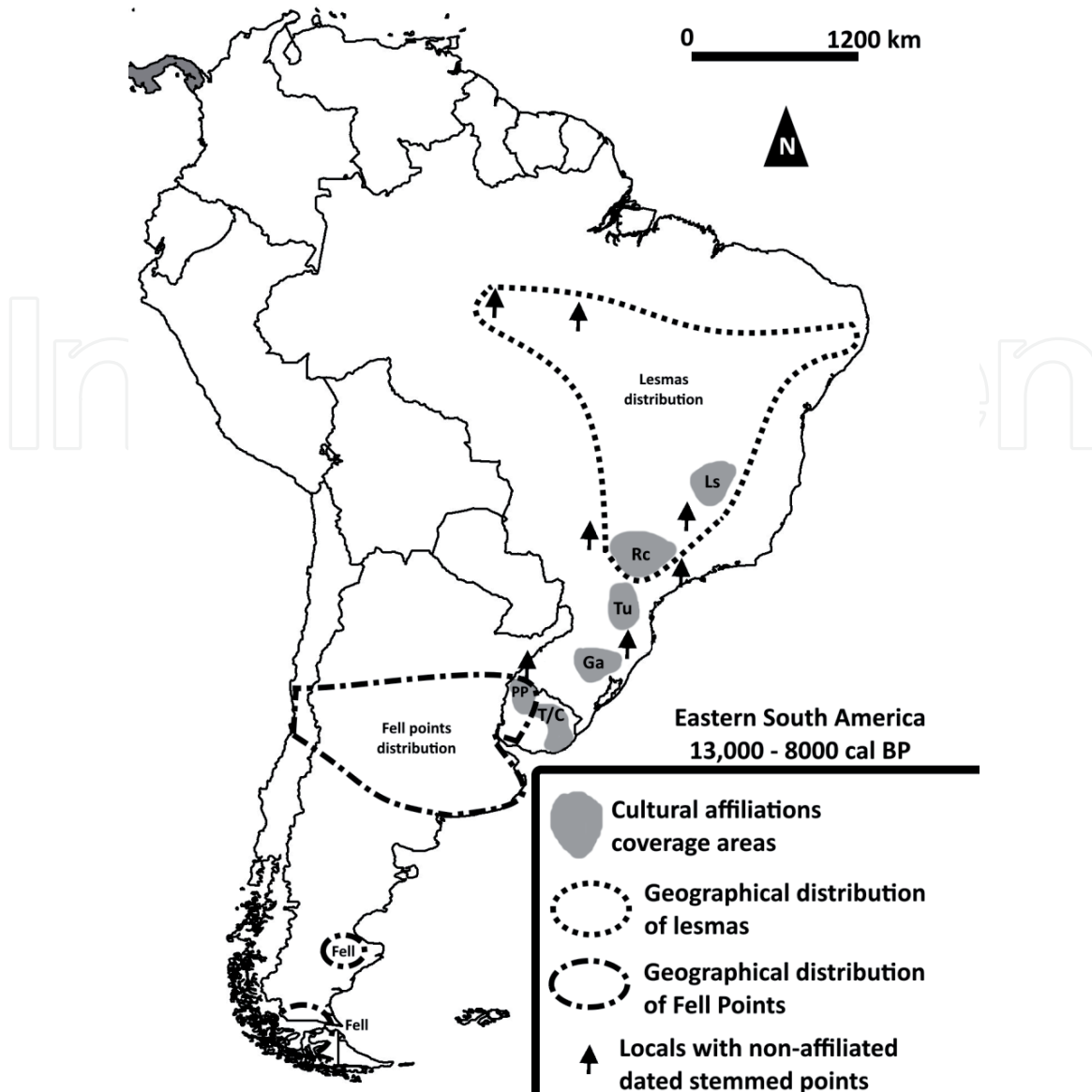


Figure 1.

The distribution of Paleoindian cultures in eastern South America between 13,000 and 8000 cal BP. Ls, Lagoassantense culture. Rc, Rioclarense lithic industry. Tu, tunas lithic industry. Ga, Garivaldinense lithic industry. T/C, Tigre tradition and Catalanense lithic industry coverage areas. PP, pay Paso lithic industry. Sites outside this chronological range were not considered.

The Umbu tradition was declared to be no longer a valid concept [41, 48, 49], and none of these identified industries are related to the previously associated Humaitá tradition. In fact, no studies have ever been made in order to verify if there is any cultural pattern of point types associated to boomerang-shaped bifaces.

2. The fell industry

The Fell industry is named after the first site to present what are now called Fell points (a.k.a. Fishtail points): the Fell Cave site, in southern Patagonia (Chile) [50–53]. Since then, many sites found in the Southern Cone, which extends from the extreme south of Chile and Argentina to the Northern parts of Uruguay, presented Fell points dating back to 11,000 BP (13,000 cal BP) [54–90]. In Eastern South America, specifically Uruguay, the Fell industry disappeared around 10,000 BP (12,000 cal BP) [82], but it is not clear if this is the case for all regions. Blade technology is also observable in some of these sites, even though the cores are not found.

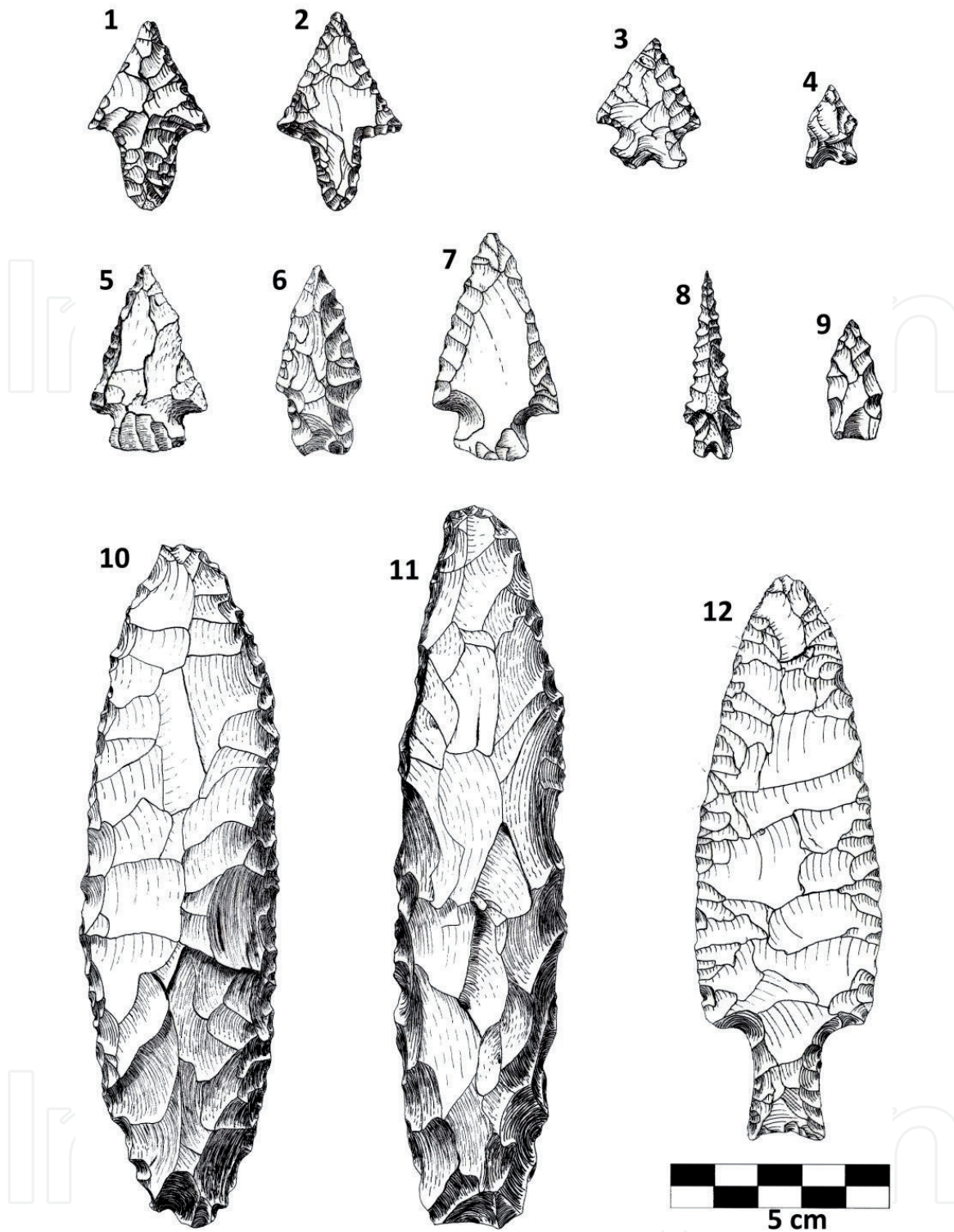


Figure 2.

Examples of formal artefacts affiliated to Paleoindian industries in eastern South America during the Pleistocene–Holocene transition, previously associated to Itaparica or Umbu traditions. (1 and 2) Rioclarense points on flint (Alice Boer site). (3 and 4) Star points on flint (Tunas site). (5–7) Garivaldinense points on silicified sandstone (Garivaldino site). (8) Montenegro point on silicified sandstone (Garivaldino site). (9) Brochier point on agate (Garivaldino site). (10 and 11) Rioclarense lesmas on silicified sandstone (Caetetuba site). (12) un-fluted fell point on flint (unclear context from Mauá municipality, eastern São Paulo state, Brazil). Scale bar is the same for all artefacts in the figure. All drawings by the author.

The Fell point was initially defined only by its shape, but recent studies have been defining it based on more accurate technological aspects [81–86]. The Fell points are defined by the bifacial thinning reduction method by percussion technique followed by the fluting technique—the removal of a long flake from the base—and finished by retouch in order to form convex edges in the body and the typical “fish tail” shape of the stem that is usually ca. 20 mm wide. Miniature

versions of Fell points can also be found in Eastern Argentina (Pampas region) which are basically thin flakes with retouch that imitates the general shape of the traditional Fell point. These miniatures present no bifacial thinning or fluting. The smaller Fell points may also be the result of body reshaping. Whatever the reason is for the smaller versions, they tend not to have well-delineated wings.

Fell points have also been found in other distant parts of South America, like meridional Brazil [87, 88], the equatorial Andes [55], and even the Caribbean sea of Venezuela [71], but they do not have a clear context since they usually constitute surface finds by local habitants. Brazilian Fell points usually differ from those found in other parts of South America because they lack the fluting technique (**Figure 2: 12**).

3. Early lithic industries in Uruguay: Tigre, Catalanense and Pay Paso

The Tigre tradition, the Catalanense industry, and the Pay Paso industry are all found in Uruguay. It is not yet clear yet when these industries appeared and disappeared, since there are some definition problems in the Uruguayan literature.

The Tigre tradition got its name due the Tigre River, where the first sites associated to it were found, including the Tigre site, where the oldest date for this tradition was obtained: $10,420 \pm 90$ BP ($12,553$ – $11,841$ cal BP) [42, 43]. Tigre points have never been well-defined and are usually described in the literature as presenting bifacial reduction, a triangular body, and a convex stem [44, 82], regardless of the presence of bifurcated stems in points associated to this same tradition [43]. Some of these features are the same as those found in the Garivaldinense points of Southern Brazil, but the lack of published data on Uruguayan point technology makes it hard to compare and verify if both Garivaldinense and Tigre points are actually the same.

The Catalanense industry is named after the Catalán Chico River, where the first sites associated to it were found, although it extends across other regions of Uruguay [91–97]. Its chronological range would fit between 9000 and 7000 BP ($11,000$ and 8500 cal BP), being defined by the presence of large retouched flakes in the initial period and an increase of discoidal cores and retouched blades in the latest period [43].

The Pay Paso industry comes from the Pay Paso site, the first one to be associated to it, and the oldest date for this industry is 9585 ± 25 BP ($11,081$ – $10,711$ cal BP) [82]. The main artefact related to this industry is the Pay Paso point type, defined as having a triangle body with convex edges, bifurcated stem, and bifacial technology. Bladelets are also found in this industry. Pay Paso industry studies are quite recent, and more research needs to be done in order to better understand its chronological and geographical range.

In sum, more technological studies are still necessary in Uruguayan archaeology in order to better understand these first lithic industries and the possible relationships between them and the other ones found in Brazilian territory.

4. The Rioclarense industry

The Rioclarense industry is named after the region of Rio Claro, in central São Paulo State, where it was first identified by Tom Miller Jr. in the 1960s [98, 99]. Since stemmed points were part of the Rio Claro tradition, it was also aggregated into the Umbu tradition in the early 1990s [35], regardless of the fact that not all its phases presented stemmed points and that *lesmas* were also present in those assemblages.

As mentioned before, recent studies revealed morphological and technological differences between the previously Umbu tradition-associated assemblages. The Rio Claro tradition has now been redefined as the Rioclarense lithic industry due the presence of both *lesmas* and stemmed points of the Rioclarense type in several sites in central São Paulo State dating between the Pleistocene–Holocene transition and mid-Holocene [48, 49], with the Caetetuba site presenting the oldest date—9590 ± 30 BP (11,086–10,712 cal BP)—but previous studies also identified Rioclarense artifacts on the southern Brazilian coast, in the Paranaguá region, after 5000 BP, around the same time when the sambaqui culture started to expand in the region [100].

The Rioclarense point type is defined by a triangle-shaped body with straight edges and wings, an ovalate stem, and two technological types of reduction: (a) bifacial reduction by selective and trespassed flakes removed by percussion (**Figure 2: 2**) and (b) bifacial reduction by parallel flaking by pressure and no retouch, followed by retouch of the active edges (**Figure 2: 1**). By selective we refer to the lack of a systematical diachrony of the flake negatives, and by trespassed we refer to negatives that trespass the middle of the piece in order to make it thinner (in proportion to the width).

The presence of *lesmas* (**Figure 2: 10, 11**) in the Rioclarense industry brings back the discussion on the necessity of studies that compare *lesmas* from sites with good chronologies in order to verify possible technological and morphological patterns in space and time—without just associating them to the supposed Itaparica tradition.

5. The tunas industry

The Tunas industry has never been identified by another name, except by the Umbu tradition [101]—since all stemmed points were directly associated to it since the late 1980s. The name of the industry is related to the Tunas Rock Shelter site, where it was defined [48, 49]. It is found in the Eastern part of Paraná state, Brazil, and presents blade cores, *lesminas*, and star-type points. The oldest site associated to the industry is in fact the Tunas Rock Shelter itself, dating back to 9630 ± 40 BP (11,134–10,744 cal BP). It is still not clear when this industry disappeared, but in the Tunas Rock Shelter site, this industry is only present until 7170 ± 60 BP (8152–7795 cal BP). After that, a totally different lithic technology replaces it [48].

The star point type is defined by the triangle-shaped body with straight or concave active edges, a bifurcated stem, and bifacial reduction by convergent trespassed pressure flaking (**Figure 2: 3, 4**). Blade cores are rare in Brazilian archaeology, but they are present in the Tunas industry, and one of the main types of tools produced by those cores are the *lesminas*—unifacially retouched blades or blade fragments presenting less than 7 cm length with edges that are appropriate as scrapers. This same technology seems to be present in other sites from Eastern Paraná state.

6. The Garivaldinense industry

The Garivaldinense industry was also one of those industries that were masked by the concept of the Umbu tradition. Its name comes from the site where it was first defined: the Garivaldino site, in mid-eastern Rio Grande do Sul State, Brazil. The oldest dates for the industry also come from this site: 9430 ± 360 BP (11,772–9625 cal BP) [48]. It is not clear when this industry disappeared, since the most recent layers of the Garivaldino site itself presents the same material and the same point types since its oldest layers [48, 102]. The most recent layers have not been dated yet, but they are in the same context as some Taquara Tradition

pottery fragments [103], indicating that its occupation lasted at least until the Late Holocene. In technological terms, three point types were identified in this industry: Garivaldinense, Montenegro, and Brochier types. Sites presenting these same types of points can be found in mid-eastern Rio Grande do Sul State.

The Garivaldinense point type is defined by its triangle-shaped body with irregular or straight active edges and straight wings, straight or bifurcated stems, and three distinct technological methods of production: (a) bifacial reduction by selective and trespassed percussion or pressure flaking, followed by bifacial retouch by pressure flaking (**Figure 2: 5**); (b) bifacial reduction by convergent non-trespassed percussion or pressure flaking, followed by bifacial retouch by pressure flaking (**Figure 2: 6**); and (c) thin flakes bifacially retouched by pressure (**Figure 2: 7**). Some of these points are clearly recycled and turned into scrapers, with unifacial retouch of the body forming a convex edge.

The Montenegro point type is defined by its triangle blade-shaped bodies with serrated edges, small bifurcate stems, and systematic bifacial parallel reduction forming a vertical central rib in the artefact body. Pressure flaking always starts from the extremities and finishes in the middle of the point (**Figure 2: 8**). This seems to be a logical strategy to avoid leaving the middle of the point thinner than the rest and breaking the point during pressure flaking. The ones with a triangle-shaped, shorter body seem to be broken and reworked, due the diachrony of the body negatives.

The Brochier point type is defined by having no stem and wings, being small, and presenting a tapered or lanceolate shape formed by bifacial or unifacial retouch by pressure flaking. They rarely present reduction, since thin agate flakes are used as blanks most of the time (**Figure 2: 9**).

7. The Lagoassantense culture

The Lagoassantense Paleoindian culture gets its name from the name of the region where it was first defined. The region of Lagoa Santa, in Southeastern Brazil, was a target of archaeological and paleontological studies ever since Danish researcher Peter W. Lund visited the region in the nineteenth century [104]. However, it was only in the 1970s that the region started to be systematically studied by a French-Brazilian program led by Annette Laming-Emperaire [105]. Unfortunately, these studies were suddenly interrupted by the unfortunate case of her death, but they were responsible for the discovery of Lagoa Santa and Luzia—the oldest human skeleton known in the Americas until then. It was only in the 2010s that new systematic research in the area was carried out, led by Walter Neves [106], including interdisciplinary analyses of the material culture, such as fauna [107, 108], human skeletons, and burials [109–111], lithic industry [112–117], micro residues [20, 118, 119], and bone industry [120, 121]. Thanks to this research, specific cultural patterns were identified for the region that persisted from the Pleistocene–Holocene transition until some centuries before the Portuguese conquest. The Lapa do Santo site, for example, that presents the best chronology dates to between $10,490 \pm 50$ BP (12,552–12,057 cal BP) and 790 ± 40 BP (739–571 cal BP).

The Lagoassantense lithic industry was clearly not taken into account by the previously proposed Itaparica-Umbu traditions model, since it does not present *lesmas* or stemmed points in its assemblage. Even though two stemmed points have been found at the Lagoa Santa site [116, 117], they are exceptions within an assemblage dominated by thousands of microliths—lithic tools that are no bigger than 30 mm [99]. These two points have no parallels to any point type defined in

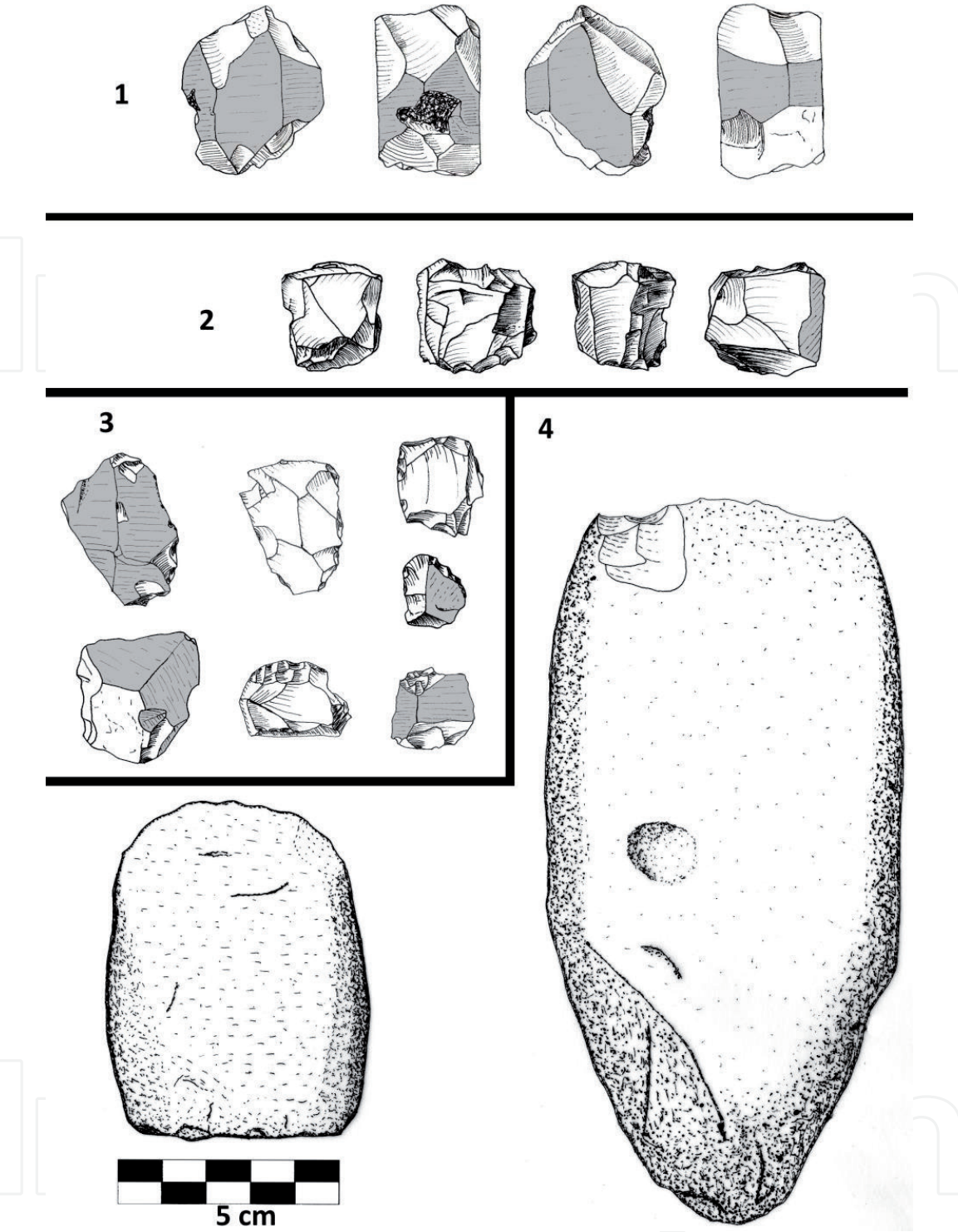


Figure 3.
Typical artefacts of the Lagoassantense industry from the Pleistocene–Holocene transition. All examples are from Lapa do Santo site, except the bigger ground axe blade which is from the Lapa das Boeliras site. (1) Diagonal slicing core on crystal quartz. (2) Opposite-platforms core on crystal quartz. (3) Retouched microliths on crystal quartz. (4) Ground axe blades on igneous rocks. Scale is the same for all artefacts in the figure. All drawings by the author.

South America. They are not bifacially reduced, and they are basically flakes with some retouches that shape the stemmed point. Some other formal artefacts, such as a lesma and a bifacial tool fragment [just the tip], were found in Lagoa Santa region sites but in layers that are not directly related to the Lagoassantense culture occupation [116, 117]. The bifacial artefact could be a preform of any point type, while the lesma was found in the same context as some other non-Lagoassantense flakes and might be related to both Itaparica and Rioclarense industries.

The Lagoassantense lithic industry is defined by the debitage of small crystal quartz flakes (**Figure 3: 3**) using the diagonal slicing core (**Figure 3: 1**) and the opposite platform core methods (**Figure 3: 2**) and by the low production of ground axes [94]. These are the oldest records for ground axe blades in the Americas (**Figure 3: 4**). The lithic industry is also defined by the persistence of making those microliths in the exact same way for at least 8000 years [122], considering that crystal quartz is not a common raw material in the Lagoa Santa region, and other tools (bigger and more complex) could be produced using other types of raw material, like high-quality quartzite, that could be easily found in the area. In this sense, the cultural norm for using small crystals defined the technological limitations of the industry.

8. Paleoindians without cultural association

Even though some lithic industries are finally being defined in technological terms in Eastern South America, many Paleoindian sites are known which have never been the target of systematic technological studies.

We can mention the Paleoindian sites in the Amazon region. The Pedra Pintada cave, for example, presents *lesmas* and bifacial stemmed points in layers dating back to $10,655 \pm 285$ BP (13,090–11,415 cal BP) [123]. The Dona Stella site also presents *lesmas* and bifacial stemmed points, dating back to 9460 ± 50 BP (11,057–10,501 cal BP) [124]. There are at least 12 Paleoindian sites in the Amazon region [124–129] that had never been completely studied in order to verify if there is any technological pattern between them or any other of the mentioned lithic industries. Unfortunately, archaeologists in the Amazon basin are more concerned with pottery industries and early agriculture than the initial occupation of the region.

In the Serra da Canastra region, located between the Rioclarense and Lagoassantense coverage areas, some sites are known that present *lesmas* and stemmed points dating back to $10,290 \pm 35$ BP (12,067–11,775 cal BP) [130]. The Carcará site, in eastern São Paulo state, is another example of a site with stemmed points, dating back to 8870 ± 50 BP (10,158–9692 cal BP) [131] that have never been studied in technological terms.

The same must be said about the Paleoindian sites located in the middle Uruguay River, close to the Tigre/Catalanense/Pay Paso coverage areas. Even though some technological studies have been carried out in the Laranjito site [32], the technological analysis of the stemmed points in that region has never been done.

The Lagoassantense and the Catalanense industries are proof that not all Paleoindian industries present *lesmas* or stemmed points. Other sites like Bastos, in central São Paulo state and in the Linha Policial 07 site in the upper Uruguay River, do not present these types of formal artefacts. Bastos site dates back to $10,590 \pm 40$ BP (12,645–12,427 cal BP), and its assemblage is mainly defined by the presence of large retouched flakes [132], while the Linha Policial 07 site dates back to 8370 ± 60 BP (9475–9135 cal BP) and is known by the presence of blade debitage [133], specifically the flat-back blade core type, usually found in Clovis sites in North America [134]. In the northeastern region of Brazil, there is the Justino site, for example, that dates back to 8950 ± 70 BP (10,222–9747 cal BP) and presents simple unifacial retouched scrapers [135]. Many sites in Eastern South America are probably being left undated due to the lack of formal artefacts in their assemblages, especially from sites excavated in private archaeology projects. But these sites are just some of the most known examples of Paleoindian industries that could never be included in the Itaparica-Umbu model proposed by Brazilian archaeologists during the second half of the twentieth century.

9. Conclusion

Paleoindian cultures in Eastern South America are finally starting to be studied more in detail due to the systematic research that has been carried out since the beginning of the twenty-first century. It is not yet possible to define archaeological cultures for the earlier Paleoindian period (before 13,000 cal BP) since those sites are rare in the whole American continent. But due the high presence of sites in the late Paleoindian period (after 13,000 cal BP), it is now possible to describe these cultures through systematic research of their lithic technologies. However, it is important to notice that much more research still needs to be carried out in order to have a more complete understanding.

Archaeological evidence in South America does not corroborate the “Clovis First” hypothesis—which assumes that the oldest evidence in Americas are the Clovis Culture artefacts—since many of these cultures arise simultaneously, or even previous to, the Clovis lithic industry [136], considering that the oldest associate Clovis sites date around 11,000 BP (13,000 cal BP) [137]. Few of the Eastern South American Paleoindian assemblages present technological features that are similar to Clovis, except maybe the Fell industry, which presents both blade technology and points made by the bifacial thinning method with fluting. In simple terms, Fell points are Clovis points with a retouched stem, and they are probably related, but it does not necessarily mean that Fell points are derived from Clovis [138]. No other artefact type in Eastern South America presents any similarities to Fell or Clovis points that could indicate any trace of cultural ancestry. In fact, it seems that several cultures emerged independently in South America, with particular, well-defined, attributes. The empirical data in South America is not feasible under the “Clovis First” hypothesis. Not surprisingly, new models are now being discussed, considering multiple migrations, the earliest ones before the Last Glacial Maximum [136].

More research still needs to be done to better delimitate these industries in chronological and geographical terms and to enable verification of cultural ancestry relationships. Regarding the Itaparica tradition, even though recent studies cannot contradict the hypothesis that all sites are culturally homogeneous, few studies have actually been carried out, and the available data are not sufficient to verify if sites with *lesmas* are actually more cultural diverse. The Rioclarense industry is a good example of a lithic industry that presents specific cultural attributes, within which *lesmas* are included. This might be true for other lithic industries in the supposed Itaparica tradition coverage area that are still being obscured under the Itaparica tradition concept, like the new findings (yet to published) found relatively close to Serranópolis region, presenting small *lesmas* and stemmed points with a distinct cultural pattern.

Lithic studies are important for the understanding of ancient societies, since lithics are the best-preserved class of material culture and many methods can be applied in their analysis. Lithics are the class of vestiges that most achieved results on understanding cultural diversity of the first human settlers in the Americas to this day. Other types of vestiges have not presented such potential either due to their preservation issues (the case of organic materials), lack of studies and data (e.g., bone artefacts), or even lack of potential to achieve cultural aspects (e.g., ancient DNA)—even though DNA brings us important data on the understanding of people’s biological dispersal, it does not tell us about cultural history of societies, like cultural origins and diversity, since genes and culture do not necessarily flow together. Studies of other archaeological materials related to the Eastern South American Paleoindian cultures are still necessary in order to understand them in a more complete and accurate way. Many of these sites present rock art, faunal remains, and micro residues that have never been studied until now. The bone

industry is perhaps the category of material culture that most warrants detailed analysis in Eastern South America, since they also enable a technological analysis and are preserved in many Paleoindian sites in Eastern South America [121]. The more archaeologists become concerned with these issues, the more we can understand cultural diversity and the dispersal of the first human societies to colonise the South American continent during the Late Pleistocene. To understand this cultural diversity throughout time and space is the best way to understand the real history of native people, the ancestors of many of us.

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Note

All dates were calibrated using the most appropriate curve for its location (IntCal 13 or SHCal13 calibration curves) [139], with 95.4% probability range.

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