New record of lithic blades in Brazil: The Picão site, São Paulo state

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Abstract:

Lithic blades are long and narrow flakes produced from prepared cores which form part of different technological complexes all around the world. In South America, the production and use of blades has been reported in different settings which include early hunter-gatherer occupations of the Pleistocene-Holocene transition, as well as Middle and Late Holocene occupations. Until now, the only reference to blade technology in Brazil comes from the south and corresponds to Early Holocene hunter-gatherer assemblages. This paper presents a second record of lithic blades in Brazil, which includes one fragment and three refitted artifacts manufactured from fine-grained silicified sandstone recovered from a surface site (Picão), which is located in the Dourado Municipality, central São Paulo state. Analysis undertaken on the blades involved the collection of metric data, including longitudinal curvature, and the elaboration of diacritic schemes which consider the direction and order of the observed remnant scars for interpreting the chronological sequence of removals. Results indicate the production of ≥70.5 mm-long, softly curved blades, with evidence of preparation of the point of impact prior to extraction from the core, as well as the presence of unidirectional, parallel scars related to blade production from a single striking platform. These reduction characteristics resemble those encountered in the nearest contexts of southern Brazil and northern Uruguay, although differences also exist. In spite of the lack of chronological data, this new record of blades in central São Paulo state calls for more research into the origins and dispersion of this technology in southeastern South America.

Keywords: lithic blade technology; reduction sequence; diacritic analysis; São Paulo state; southeastern Brazil

1. Introduction

Lithic blade technology constitutes an integral part of different archaeological contexts and periods all around the world, including the Americas. In North America blades are a significant component of various early archaeological complexes and technological traditions. Blades and blade cores are a well-known marker of the Clovis complex or culture (*ca.* 13,125–12,925 cal BP, according to the minimum range of Waters & Stafford 2007: 1123), and they have been intensely studied and characterized (*e.g.,* Beck & Jones 2015; Boldurian

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& Hoffman 2009; Bradley *et al.* 2010: 10-55; Collins 1999; Collins & Lohse 2004; Sain 2012). Some pre-Clovis technological complexes in North America also include blades (Adovasio & Pedler 2004). The obsidian blades produced by pressure flaking in Mesoamerica are perhaps among the most well-known of the continent (see review in Hirth 2012).

In this paper, blades are defined as long and narrow flakes that exhibit specific attributes such as sub-parallel to parallel sides, which are detached from prepared cores intentionally made for that purpose (Bradley *et al.* 2010: 10; Collins 1999; Inizan *et al.* 1995: 73). Considerable variation in blade core preparation, blank production and blade tool uses is recognized around the world (*e.g.*, Bar-Yosef & Kuhn 1999; Boëda 1988).

1.1. Blade technology in South America and Brazil

There are several studies which report blade-making technology in South America, and these comprise different time periods, preparation and production methods and functional uses. Several blades and blade cores have been found in archaeological components ranging from the Late Pleistocene to the Early Holocene, and thus were part of the toolkits of the Paleoindians, or first inhabitants of the sub-continent.

In northern Uruguay, along the frontier with Brazil, blades and a blade core were recognized in component 1 of the Pay Paso 1 site by Suárez (2011a: 127-131, 133-134; 2011b: 367-372) in dated levels *ca.* 10,900–10,630 BP (12,800–12,700 cal BP, according to Suárez 2015:93). Other blades, retouched blades and a blade core were recovered from a further Paleoindian component of this site, dated to between *ca.* 12,000 and 11,400 cal BP (see Suárez 2011a: 141-142, fig. 6.15; 2011b: 371-372; 2015). More recently, Suárez *et al.* (2017 *in press*) reported three blades excavated in the Tigre site, located on the Middle Uruguay river bank, in a *ca.* 11,750–11,090 cal BP-dated stratigraphic unit. To this excavated evidence can be added surface finds in Uruguay (*e.g.*, Hilbert 1991; Suárez 2015: fig.5; Taddei 1980), which include blade tools recovered together with diagnostic Paleoindian artifacts (Nami 2013: 13; Suárez *et al.* 2018).

In southern Argentina, in the Patagonian region, blades and retouched blades were recovered in the Cerro Tres Tetas locality (Santa Cruz plateau) in levels dating back to *ca.* 11,500-10,200 BP (Paunero 2003: 136) and in the Casa del Minero 1 site since at least *ca.* 11,000 BP up to the Late Holocene (*e.g.*, Skarbun *et al.* 2007: 595, fig. 5).

Lithic blades have also been registered in Middle Holocene human occupations in South America. In the northern coast of Peru, at the Paredones site, a blade made of andesite was found in deposit dated to *ca.* 6,775–6,504 cal BP that exhibited microscopic use-wear from the processing of vegetables, as well as starch grains from maize along its edges, in a context with close association with maize cobs (Dillehay & Bonavia 2017: 438, fig. 11.2; Grobman *et al.* 2012).

In Argentina, blade technology for the Middle Holocene period has been recognized in different regions. The arid highland plateau (*puna*) of northwestern Argentina presents blades among its lithic assemblages since at least *ca*. 9,600-8,300 BP (Restifo 2015), although a technology strictly oriented towards the production of blades from prepared cores is only evidenced by the end of the Middle Holocene (Restifo & Hoguin 2012; Restifo 2015).

In Argentinean Patagonia, blades and tools made on blade blanks are represented among the lithic assemblages recovered in the Los Toldos locality making up part of the *Casapedrense* industry, which was defined by Menghin (1952) and dated *ca.* 7,260 BP (Cardich *et al.* 1973) (see review in Hermo & Magnin 2012). Blades and blade tools are also recognized in southwestern Patagonia between *ca*. 5,000 and 2,500 (Aschero *et al*. 1993) and in central-northern Patagonia in contexts dating between *ca*. 5,080 and 3,350 BP (Nami & Bellelli 1994). The role of blade technology in Middle Holocene contexts in Patagonia (*ca.*

7,500-3,500 BP) was recently highlighted by Hermo & Magnin (2012; see also Hermo & Lynch 2015), who synthesized and analyzed samples from excavated and surface findings from the Deseado massif. In the same region, microscopic use wear analysis carried out on blades and blade tools (retouched flakes and scrapers) from *ca.* 7,700-3,200 BP stratigraphic units of Maripe Cave, revealed microtraces of cutting and scraping bones and soft animal material as well as traces of scraping hard vegetal material (Lynch & Hermo 2017).

Until now, the only reference to lithic blades in Brazil was reported in the south by Hoeltz *et al*. (2015) and Lourdeau *et al.* (2014; 2017). Working in three different archaeological sites from the Foz do Chapecó region (eastern Santa Catarina and northwestern Rio Grande do Sul states), Lourdeau *et al*. (2014) detected and analyzed a total of 101 blades, with associated dates ranging from *ca*. 8,370 to 6990 BP. More blades were recently reported in excavated units dating back to the Early Holocene in sites from the same region, and five blade cores were reported as surface finds while conducting an archaeological survey (Lourdeau *et al.* 2017).

This paper provides new evidence for lithic blade technology in South America by reporting and characterizing artifacts collected in a survey in the Dourado region, in the geographic center of São Paulo state, southeastern Brazil (see Figure 1).

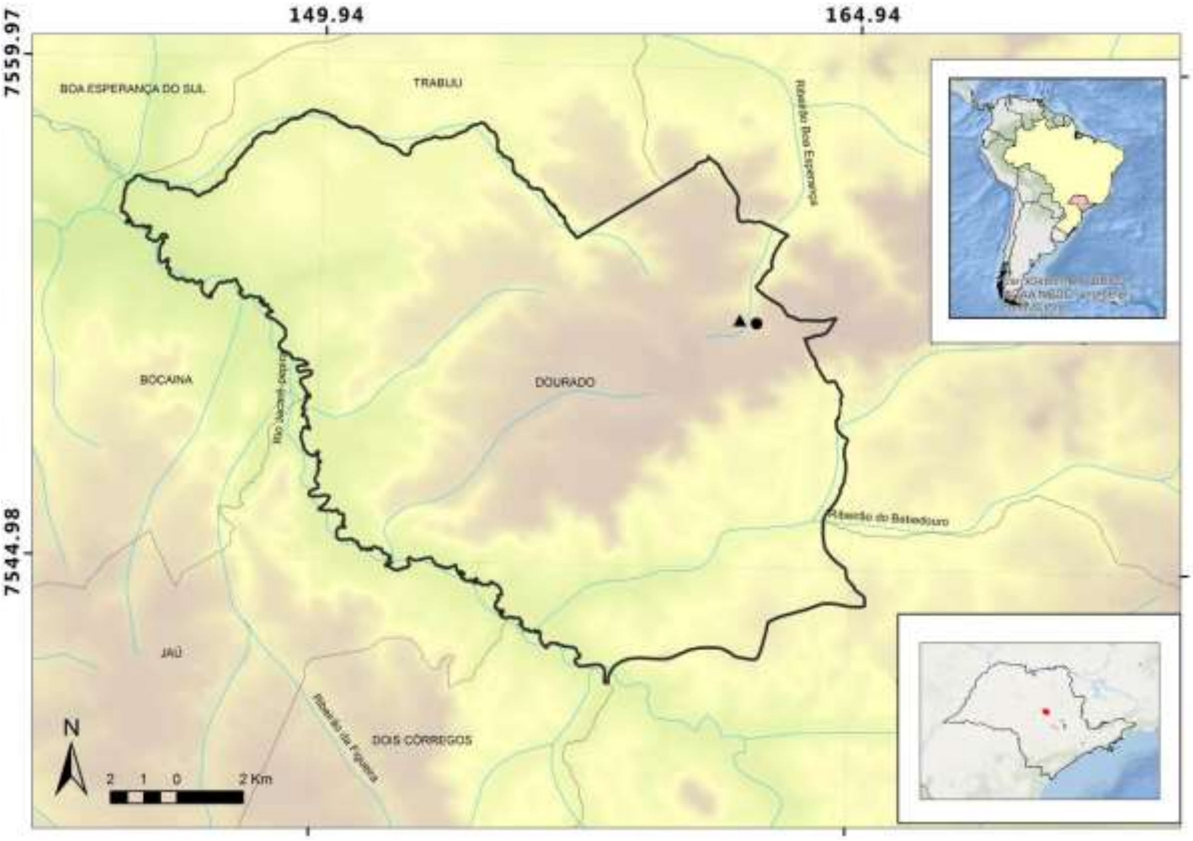

Figure 1. Location of the sites mentioned in the text, within Dourado Municipality, central São Paulo state, southeastern Brazil. Black triangle: Picão site; Black circle: Bastos site. Coordinates are in UTM.

1.2. Archaeological and geological setting

The Picão site, where the blades reported here were collected, was detected while conducting a survey in December 2016 that aimed to locate lithic raw material sources used by hunter-gatherers inhabiting the Dourado Municipality area (Figure 1). In the central São Paulo region, long recognized for its diverse lithic assemblages and significance for understanding the peopling of South America (*e.g.*, Araujo 2001a; Beltrão 1974), new research is being conducted based at São Paulo University that has reported (among other finds) evidence of hunter-gatherer occupations between *ca*. 12,640 and 7,650 cal. BP at the Bastos site (Araujo & Correa 2016). The antiquity of the Bastos site posits it as the earliest known Paleoindian site in São Paulo state, where other early sites have also been recently reported (Araujo *et al*. 2017; Santos 2011; Troncoso *et al*. 2016).

The Picão site (central UTM point: 22K 0780795 / 7553549) consists of a surface lithic scatter 0.48 km away from the Bastos site which extends for a maximum of 56.5 m and is located 680 m above sea-level. The site is located in a sugarcane plantation (which characterizes the regional agricultural landscape), with artifacts found within and between the cropped areas, the latter including paths inside the plantation (Figure 2). Artifacts collected add up to 36 specimens, including six flakes, eleven broken flakes, ten flake fragments, two retouched flakes, one broken blade and six blade fragments. The blades and blade fragments were found in the same square meter, suggesting a very good spatial resolution for the site, in spite of the plowing activity (see Araujo 2001b; Lewarch & O´Brien 1981). No cores were detected.

Figure 2. Lithic blade detected on the surface of a path within a sugarcane plantation, Picão site.

The regional landscape is characterized by hills with flat tops composed of Lower Cretaceous basaltic rocks of the Serra Geral Formation and several sandstone packages that are the result of the development of different depositional systems since the Upper Permian-Early Triassic (IPT 1981; Lopes *et al*. 2004). The Picão site is located on an upper slope terrace surrounded by several silicified sandstone outcrops, most of which consist of knappable raw material primary sources which are currently under analysis. All of the artifacts collected in the Picão site, including the blades here analyzed, are manufactured from this rock. No cortex was detected in the blades.

2. Methods

The seven specimens collected in the Picão site, including one broken blade and six blade fragments, add up to four artifacts (one fragment and three refitted). Two analytical procedures were followed, according to a complementary view of conceptual approaches to lithic blade technology. Firstly, metric attributes and indices were recorded. Maximum length, maximum width and maximum thickness were measured with a sliding caliper; weight was measured with a digital scale with 0.1 g precision; edge angle was measured with a digital goniometer. The sum of maximum length, maximum width and maximum thickness was considered, as applied by Bradley *et al*. (2010: 10-55), Collins (1999) and Collins & Lohse (2004: 165-176) for Clovis blades, who used it as a general description of overall size. The ratio of each maximum dimension (length, width and thickness) to the summed dimensions was then calculated (see Table 1), following the same authors. The Index of Curvature, developed by Collins (1999: 86) to record one of the distinctive traits of Clovis blades –their longitudinal curvature–was also measured on complete and refitted blades from Picão (as depicted in Figure 3) considering that the greater the value, the more curved the blade. A maximum curvature point in percentage terms, from the proximal to the distal end of the blade, was also estimated following Boldurian & Hoffman (2009) (Figure 3). These measurements were taken because they provide additional metric data about morphological variation and also because they were applied to blades from neighboring Uruguay (Suárez 2011a, Suárez 2011b).

Table 1. Ratios and indices measured in the blades analyzed from Picão site.

Artifact No.	Length + Width + Thickness (mm)	Length/ Length + Width + Thickness (mm)	Width/ Length + Width + Thickness (mm)	Thickness/ Length + Width + Thickness (mm)	Index of Curvature (ratio)	Maximum curvature point (%)
PCO023[1]	-	-	-	-	2.24	45
PCO024-a[1]	-	-	-	-	-	-
PCO024-b[1]	-	-	-	-	1.33[2]	52[2]
PCO025-a	-	-	-	-	-	-
PCO025-b	154.00[3]	0.60[3]	0.29[3]	0.10[3]	3.93[3]	61[3]
PCO026-a[1]	-	-	-	-	-	-
PCO026-b[1]	-	-	-	-	2.17[4]	46[4]

1. Blade fragment, which inhibited the taking of several measurements
2. Estimated in blade refitted with blade fragments (without platforms) PCO024-a and PCO024-b
3. Estimated in blade refitted with broken blade (with platform) PCO025-a and blade fragment (without platform) PCO025-b
4. Estimated in blade refitted with blade fragments (without platforms) PCO026-a and PCO026-b

Secondly, in order to understand the reduction sequence (or *chaîne opératoire*) by which the blades were produced, a diacritical analysis of each artifact was made according to Dauvois (1976: 194-201). Diacritical analysis considers the direction and order of the observed remnant scars for establishing an interpreted chronological sequence of removals. This method was also used by Lourdeau *et al*. (2014; see also Hoeltz *et al*. 2015) for the analysis of the blades recovered in southern Brazil, allowing for technological comparison with the geographically-closest blades reported until now.

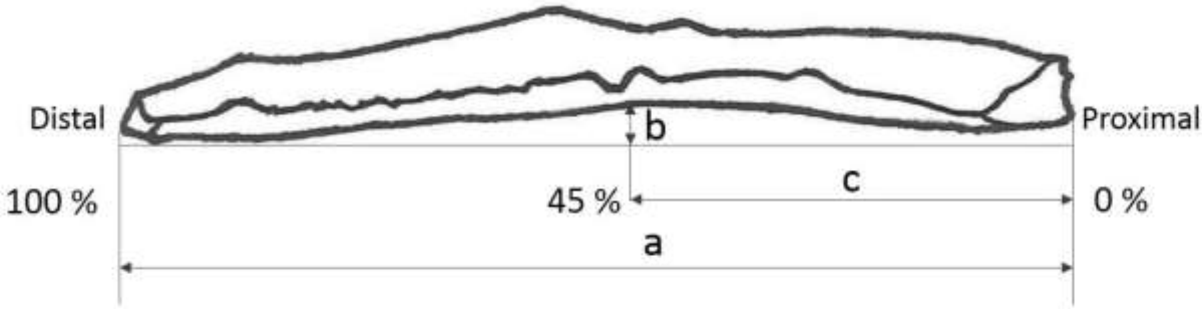

Figure 3. Measures for the calculation of the Index of Curvature (a and b) and the blade maximum curvature point (c). The Index of Curvature is calculated as b/a x 100. The maximum curvature point is a percentage estimated from proximal to distal end. Drawing by Nicolás Batalla, based on Boldurian & Hoffman (2009: fig. 7) and Collins (1999: fig. 7).

3. Blade analysis results

The metric dimensions of the blades are presented in Table 2. The largest specimen in terms of length is the blade resulting from refitting fragments PCO024-a and PCO024-b, which is 112.5 mm-long, although given that the proximal end is missing, the total length is not known (see Figure 4).

Table 2. Metric variables recorded in the blades analyzed from Picão site.

Artifact No.	Length (L) (mm)	Width (W) (mm)	Thickness (T) (mm)	Weight (W) (g)
PCO023[1]	89.00	26.00	10.00	27.20
PCO024-a[1]	67.50	46.00	12.00	42.80
PCO024-b[1]	45.00	42.50	9.00	25.40
PCO025-a[2]	39.00	45.00	16.00	25.80
PCO025-b[1]	54.00	35.50	9.00	22.60
PCO026-a[1]	41.00	22.50	6.50	7.40
PCO026-b[1]	29.50	24.50	7.00	5.90

1. Blade fragment (without platform)
2. Broken blade (with platform)

The highest Index of Curvature value was observed in the blade refitted with blade fragment PCO025-a and broken blade PCO025-b (Table 1). All of the blades are curved to some degree (all values are higher than zero), being that the maximum curvature of the most curved artifact reached beyond the midpoint of the longitudinal profile (Table 1).

To follow up with the technological analysis of the interpreted reduction sequence for the reported artifacts, a general description for each is made and drawings are presented in Figures 4, 5, 6 and 7. The drawings consist of both a conventional technological drawing and a diacritical scheme.

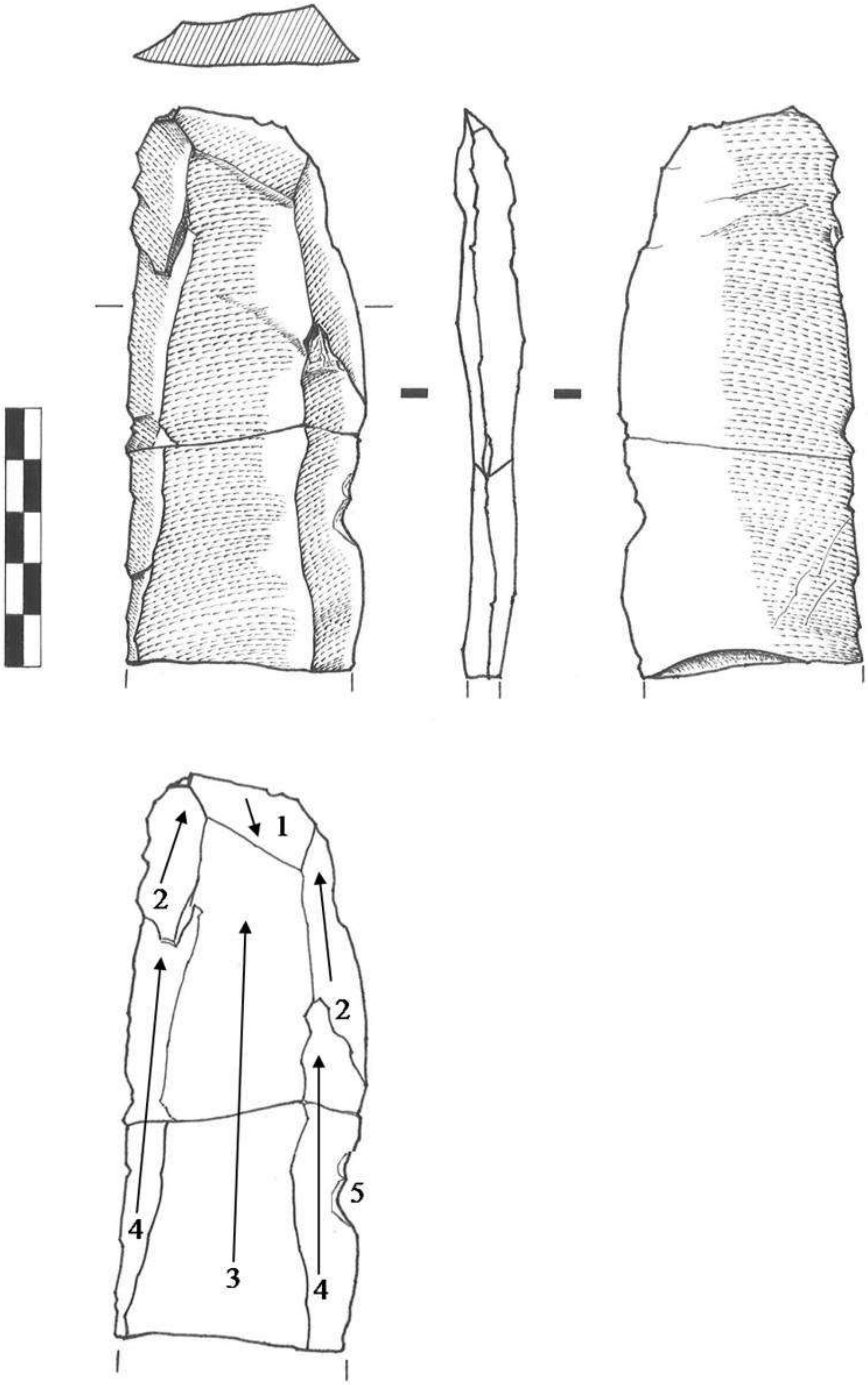

Figure 4. Technological drawing (superior) and diacritic scheme (inferior) of blade resulting from refitting fragments PCO024-a (top fragment) and PCO024-b (bottom fragment). Arrows indicate interpreted direction of the flaking and numbers indicate the order of removal.

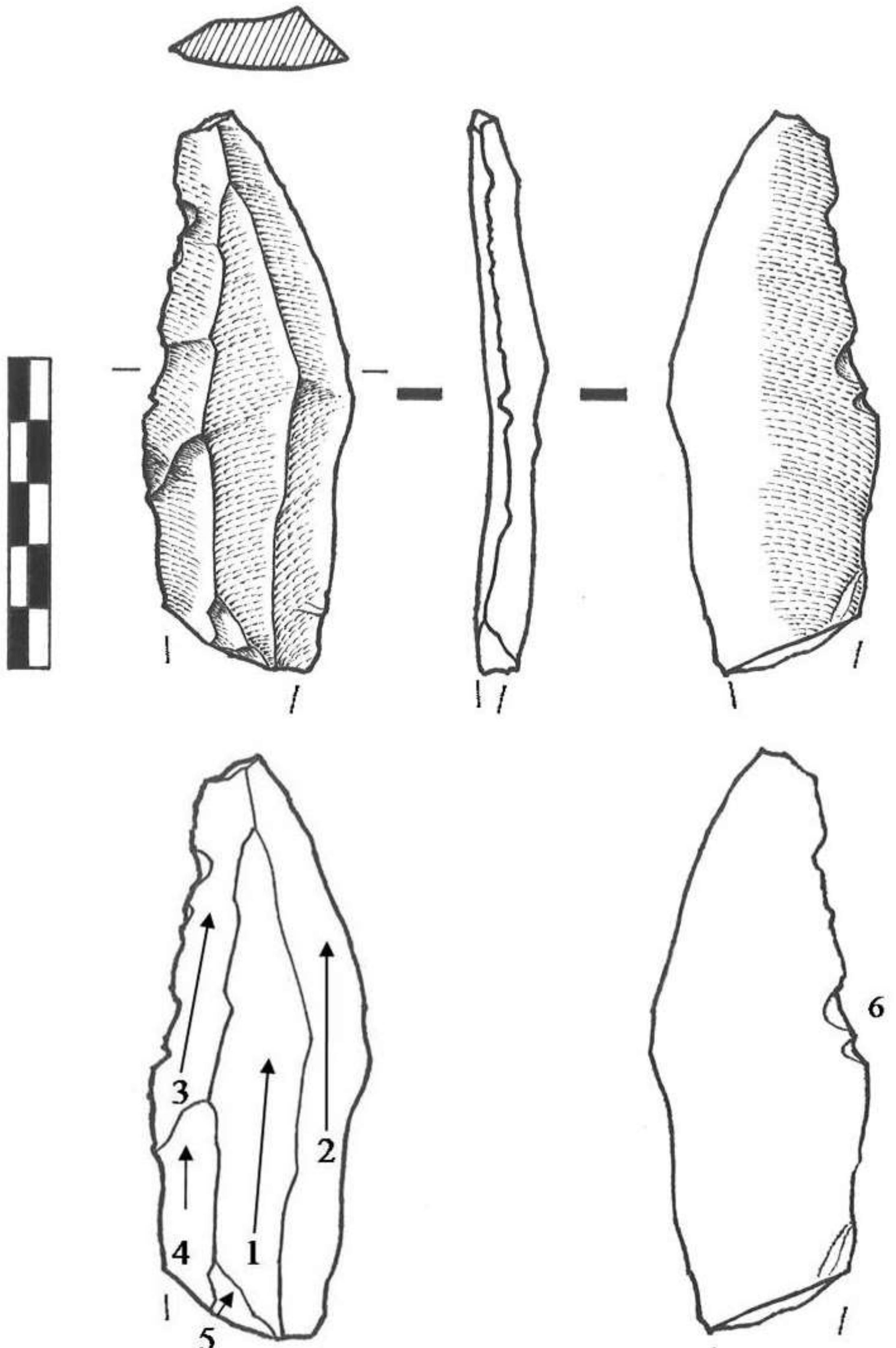

Figure 5. Technological drawing (superior) and diacritic scheme (inferior) of blade PCO023. Arrows indicate interpreted direction of flaking and numbers indicate the order of removal.

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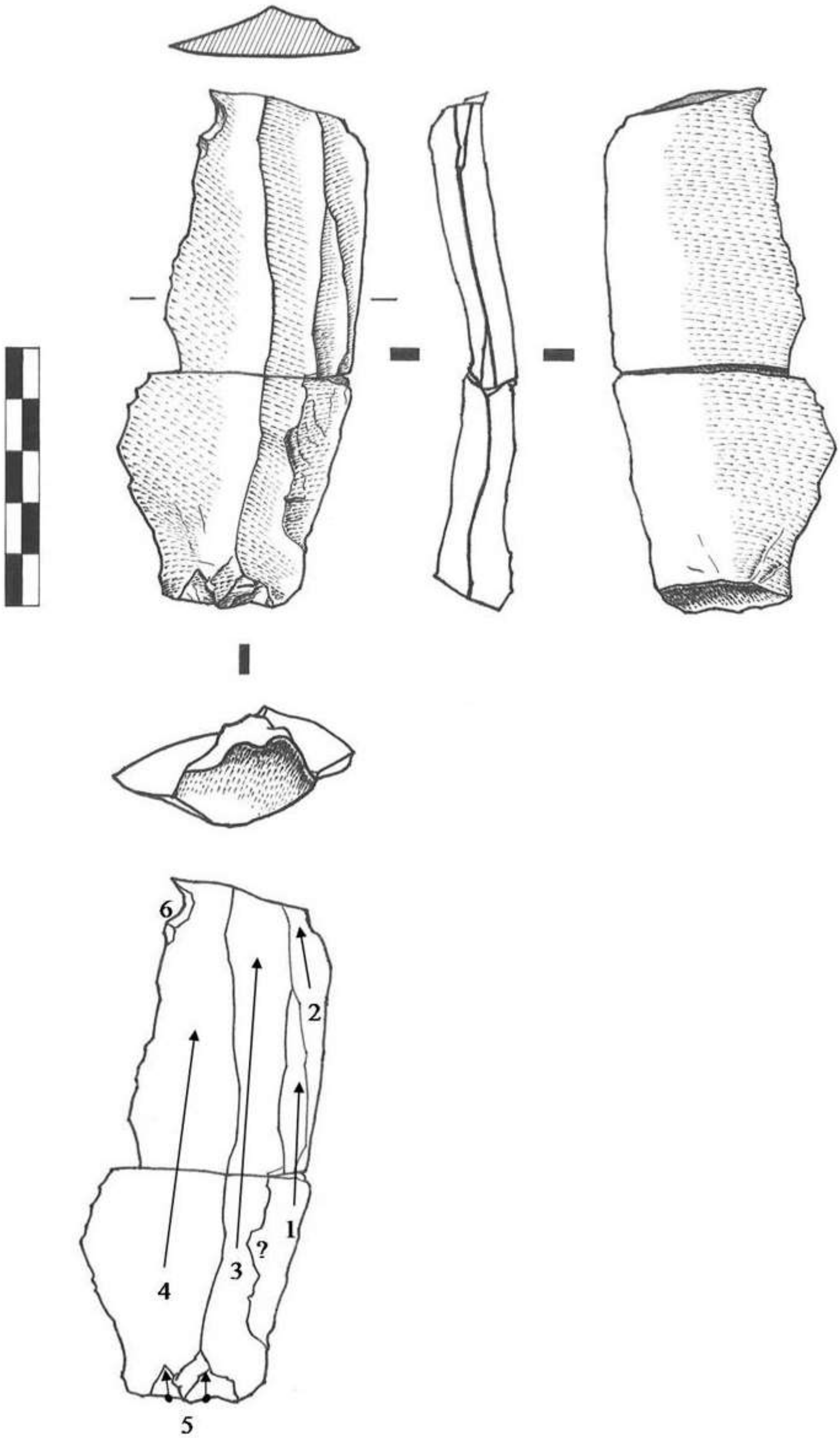

Figure 6. Technological drawing (superior) and diacritic scheme (inferior) of blade refitted with broken blade PCO025-a (bottom fragment) and blade fragment PCO025-b (top fragment). Arrows indicate interpreted direction of the flaking and numbers indicate the order of removal.

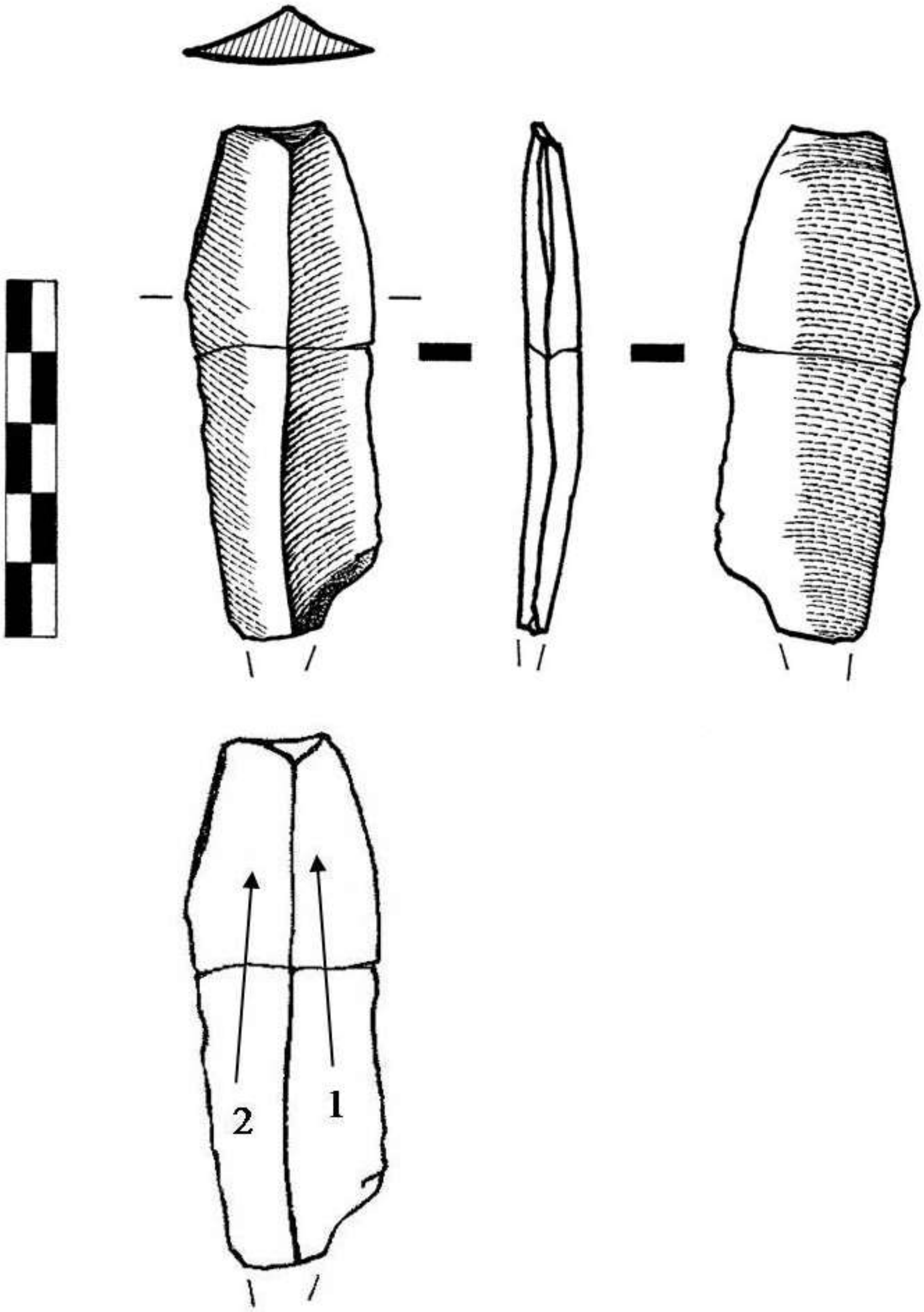

Figure 7. Technological drawing (superior) and diacritic scheme (inferior) of blade resulting from refitting fragments PCO026-a (bottom fragment) and PCO026-b (top fragment). Arrows indicate interpreted direction of the flaking and numbers indicate the order of removal.

The artifact PCO023 (Figure 5) is made on a fine-grained reddish brown (5YR 5/3) silicified sandstone. It presents a diffuse bulb. It is a double-ridged blade fragment in which a first extraction in the central part was followed by 2 sub-parallel removals. These scars correspond to what Lourdeau *et al*. (2014: 193) termed "the production phase", *i.e.*, the obtainment of blades and blade blanks from the core. Two further detachments were made in which the negative of the bulb was preserved, and that would correspond to the preparation of the point of impact prior to the extraction of the blade. Finally, two marginal retouch removals were made on the mid-point of the ventral face, using a striking angle of 55°.

Artifact PCO024 (Figure 4), resulting from refitted fragments PCO024-a (Figure 4, top fragment) and PCO024-b (Figure 4, bottom fragment) is made from a fine-grained dark reddish gray (5YR 4/2) silicified sandstone. It also has two main ridges but seems to exhibit a more complex history. A first extraction is evidenced at the proximal end that is possibly related to the initiation phase of the core (*i.e.*, the preparation of the blade core, see Lourdeau *et al*. 2014: 193-194). Afterwards, two removals were made which partially erased the first extraction scar, possibly related to the production of other blades. The next scar points to the production of a blade in the central part of the artifact, just like in the artifact presented before, that was followed up by two extractions on both sides.

Two marginal micro-retouch extractions were made at a blow angle of 76° in the dorsal face, below the preserved mid-point of the artifact.

The artifact refitted with broken blade PCO025-a (Figure 6, bottom fragment) and blade fragment PCO025-b (Figure 6, top fragment) is made on a fine-grained reddish brown (5YR 5/3) silicified sandstone. It presents a flat platform (26.00 mm wide x 15.00 mm deep) with evidence of abrasion and a prominent bulb. It exhibits three ridges from the production of previous blades. A first extraction is preserved on the right side, which also shows scars of a small removal of material (Figure 6, question mark in diacritic scheme) possibly caused by weathering or recent damage caused by human activity. A second removal adjacent to the first was made on the right side, which was followed by two other parallel extractions towards the center and left side of the artifact. Small flakes were then detached from the blade platform, possibly as part of the preparation of the point of impact used to extract the blade. Finally, retouch scars are present in the superior left side of the dorsal face, with an angle of 73°.

Artifact PCO026 (Figure 7), resulting from refitted fragments PCO026-a (Figure 7, bottom fragment) and PCO024-b (Figure 7, top fragment) is made from a fine-grained reddish brown (5YR 5/3) silicified sandstone. It exhibits one ridge along the longitudinal center of the blade separating two previous parallel blade extractions (Figure 7, diacritic scheme).

4. Discussion and conclusions

The Picão site in São Paulo state offers a new record of blades in Brazil, with several implications for lithic studies in South America. Firstly, the archaeological periods of blade production in the geographically-closest, dated contexts of southern Brazil (~730 linear km away) and northern Uruguay (~1,280 linear km away) encompass the Late Pleistocene to Early Holocene transition and the Early Holocene (Hoeltz *et al*. 2015; Lourdeau *et al*. 2014; Suárez 2011a, 2011b; Suárez *et al*. 2017 *in press*). Although no dates were yet obtained for the Picão site, some of the dates for lithic assemblages from the neighbouring Bastos site (Araujo & Correa 2016) fall within this same temporal range. Future excavations at Picão should be able to shed light on the chronology of blade production in central São Paulo state.

Secondly, the blades reported here exhibit some similarities and differences with those recovered in southern Brazil and northern Uruguay. In terms of size, the complete blade is 93.0 mm-long, with a fractured artifact that is at least 112.5 mm-long. This makes them within the range of measurements for the southern Brazilian blades (between 30.0 and 149.0 mm-long) (Lourdeau *et al*. 2014: fig. 6) and blade core negatives (60.0 to 100.0 mm-long) (Lourdeau *et al*. 2017: 5-11). The Picão blades, with the exception of refitted fragments PCO026-a and PCO026-b which suggest a blade at least 70.50 mm-long, are slightly longer than those recovered in dated contexts in northern Uruguay, which are between 36.40 and 75.62 mm-long in the Pay Paso 1 site (Suárez 2011a: table 6.4) and up to 50.0 mm long in the

Tigre site (Suárez *et al*. 2017 *in press*: fig. 9). However, blades longer than 113.0 mm were reported from surface scatters in Uruguay (Suárez 2015: fig. 5).

The longitudinal curvature of the Picão site blades (Table 1) is less than that observed among Uruguayan artifacts, which are between 4.20 and 5.00 (Suárez 2011b: table 4). This morphological aspect is possibly a result of holding and rotating the core during knapping (Boldurian & Hoffman 2009: 183), and is thought to have been a procured attribute of Clovis blades and blade tools (average curvature = 9.00) (Bradley *et al*. 2010: 53).

In spite of the absence of cores at the Picão site, some generalizations about blade production can be made that allow comparisons with the two mentioned areas. The initiation of the core by means of centripetal extractions around the flaking surface, common among the southern blades (Lourdeau *et al*. 2014; 2017), could not be detected here, although the potential use of this method cannot be discarded based on the few specimens found at the Picão site. All of the blades present unidirectional parallel scars related to previous blade extractions detached from a single striking platform, which is a characteristic of the blades reported by Lourdeau *et al*. (2014) and is also evidenced in the cores collected in the same area (Lourdeau *et al*. 2017). This production method is also evidenced in the northern Uruguay blades and blade cores (Suárez 2011b: 367-370, fig. 7). The preparation of the striking point prior to blade extraction, recorded by Lourdeau *et al*. (2014) and Suárez (2011a: 128-130), is also present in the Picão artifacts.

Another important similarity resides in the evidence of use via micro-retouch and retouch along the lateral edges of the blades. Lateral working edges were detected among the blades from southern Brazil, with cases of distal retouch being rare (Lourdeau *et al*. 2014: 198), as seems to have been the case in northern Uruguay (Suárez 2011b). The possible uses of the Picão site blades cannot be determined without microscopic use-wear analysis. Diversity rather than uniformity seems to characterize South American blade functions, as indicated by use-wear and starch grain analysis (Dillehay & Bonavia 2017; Grobman *et al*. 2012; Lynch & Hermo 2017).

Finally, the absence of chronological data inhibits further interpretations about cultural relationships and affiliations of the blades under study. As blades were produced in different periods in South America, they are not culturally diagnostic artifacts *per se*. Similarities and differences reported here with blades from nearby contexts have stimulated the need for more research at Picão and other sites that can bring new insights into the origins and circulation of this technology in southeastern South America.

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