

DEVELOPMENT OF STONE FLAKE ARTIFACT TECHNOLOGY IN THE EARLY HALF OF HOLOCENE AT LEANG BATTI, SOUTH SULAWESI

PERKEMBANGAN TEKNOLOGI ARTEFAK SERPIH BATU PADA PARUH AWAL HOLOSEN DI LEANG BATTI, SULAWESI SELATAN

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ABSTRAK

Penelitian yang intensif di gua-gua prasejarah Sulawesi Selatan telah menunjukkan kemampuan kognitif penghuni Sulawesi yang mungkin jarang dimiliki populasi lain di Wallacea. Pada paruh awal Holosen kemampuan yang diperlihatkan adalah memodifikasi alat serpih yang dikenal dengan tekno-kompleks Toalean. Namun demikian, gambaran perkembangan teknologi artefak batu pada masa antara sebelum hingga awal perkembangan tekno-kompleks Toalean masih jarang diteliti secara intensif. Situs Leang Batti adalah situs hunian yang dapat mengisi kekosongan informasi melalui studi teknologi artefak serpih. Artefak berjumlah 1376 buah diklasifikasi dan dianalisis pada serpih dengan mengamati dinamika morfometrik dan teknologi tipe alat antara Holosen Awal hingga Tengah. Hasil penelitian menunjukkan bahwa pada Holosen Awal, teknologi yang dominan adalah serpih yang digunakan sebagai alat secara langsung tanpa dimodifikasi. Pada fase Holosen Tengah, ukuran serpih mulai mengalami perubahan karena pengaruh Toalean dengan karakter teknologi serpih yang dimodifikasi mulai masuk dalam konsep dasar sipembuat alat, namun tidak terlalu kuat.

Kata Kunci: Leang Batti; Artefak batu; teknologi; Holosen Awal-Tengah; Toalean

ABSTRACT

Intensive research in prehistoric caves in South Sulawesi has shown the cognitive capability of Sulawesi inhabitants that might not be possessed by other explorers in Wallacea. In the early half Holocene, the ability shown was to modify the shale tool known as the Toalean techno-complex. However, the view of the development of stone artifact technology in the period between before and early development of the Toalean techno-complex is rarely studied intensively. Leang Batti site is the occupation sites that can fill the information gap through the study of flakes artifact technology. 1376 artifacts were classified and analyzed for flakes by observing morphometric dynamics and tool type technology between the Early to Middle Holocene. The results that in the Early Holocene, the dominant technology was large flakes without modification. In the Middle Holocene, the size of the flakes began to change due to the influence of Toalean with the character of the modified flake technology began to enter in the basic concept of making tools, but not too strong.

Keywords: Leang Batti, Stone Artifact; technology; Early-middle Holocene; Toalean

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INTRODUCTION

The evidence of modern human behavior (*Homo sapiens*) in the Wallacea region has now become an interesting issue discussed by world researchers for understanding human evolution and migration to Australia at least between 65 and 50 thousand years ago (Clarkson et al., 2017, 2015; Kealy et al., 2015). There is no doubt that they had maritime capabilities supported by good management to explore the scattered islands in the Wallacea (Bird et al., 2019). However, this knowledge was generally not supported by their cognitive abilities in modifying flake tools. Technology that developed in the Late Pleistocene to Holocene are considered more simple because it is a part of their adaptation system in the insular region with tropical climatic environment (Fuentes et al., 2019; Maloney et al., 2018; Marwick et al., 2016; Roberts et al., 2020).

Sulawesi is one of the largest islands in Wallacea and its position as a transit area played an important role to understanding human cognitive abilities of the Wallacea inhabitants before heading to the Sahulland. Figurative rock paintings of animal and handprints ranging between 40 to 18 thousand years ago are a strong evidence to understanding symbolic art as the identity of their life at that time (Aubert et al., 2014). These images are found scattered in the karst area that spanning widely in the southwestern tip of South Sulawesi, especially in the Maros-Pangkep area. One of the oldest rock images shows an animal hunting scene as an illustration of the socio-economic conditions of the early hunting communities came from 43 thousand years ago at Bulu Sippong Site 4 (Aubert et al., 2019).

Other discoveries related to the art symbols are also shown from the excavation result of Leang Bulu Bettue Site in cultural layer between 26-14 thousand years ago. The find consists of etched ochre, pendant and beads from bone of endemic animal of Sulawesi, as well as two flats of engraved stone interpreted as portable art. Several engraved flakes on cortex were also found at this site (Brumm et al., 2020, 2017; Langley et al., 2020).

On the other hand, the ability to modify small flake tools with high complexity is not seen in their stone artefact technology, as the microlith flake tools developed in the Late Pleistocene of South Asia, such as in India and Sri Lanka (Clarkson et al., 2009); Perera et al., 2011; Wedage et al., 2019) and even in Australia (Clarkson et al., 2018; McDonald et al., 2018; Slack et al., 2004). They were familiar to use flake tools from core reduction without any special treatment (Brumm et al., 2018, 2017; Bulbeck et al., 2004; Glover, 1981). Some of the tools were retouched simply, probably to trim the sharp edges.

The treatment of stone flake was different entering the Holocene. The Sulawesi inhabitant could create more complex technology of small flake tool, while at the same time other islands inhabitant such as the Tron Bon Lei Site in Alor (Maloney et al., 2018; Samper Carro et al., 2016), Site Jeremalai in East Timor (Marwick et al., 2016; O'Connor et al., 2011) and Leang Sarru in Talaud (Ono et al., 2015; Tanudirjo, 2005)), were only produce monotonous and simple flake tool technology. Maros point technology with jagged feature of bifacial retouched and proximal winged has been present in this karst area since 8000 cal. BP (Suryatman et al., 2019). This artefact type is an important part of the Toalean techno-complex tool, may have continued to be used at the end of the Holocene, parallel to the

introduction of backed artifacts technology by the migration of Austronesian speakers arrived in South Sulawesi. Toalean technology is known as a prehistoric culture in South Sulawesi that developed 8000-3500 years ago with a unique techno-complex. One of the technological characteristics is small modified flakes such as Maros points and backed artifacts (Bellwood, 2007, 2013, 2017; Bulbeck et al., 2001; Glover, 1973, 1978; Pasqua & Bulbeck, 1998; Suryatman et al., 2019).

Their skill in modifying flake tools was reversed to their knowledge of symbolic art which culminated in the Late Pleistocene and probably disappeared in the Holocene. There is no evidence of rock art preparation associated to the 8000-7000 cal. BP cultural layer at Leang Jarie, although the rock art from this site are existed since the Late Pleistocene (Hakim et al., 2019; Suryatman et al., 2019). The age of the youngest red images was only 18-17 thousand calBP at the Leang Lompoa Site (Aubert et al., 2014). However, a more in-depth research with a wider data distribution is still needed to prove this matter.

The description of the research result above shows two occupation stages with each different cognitive ability. During the Late Pleistocene, reflection of cognitive ability is rock art production as part of their identity symbol, while in the Holocene the ability is skill of flake tools modification by complex technology. However, the cultural layer between these two stages, namely the end of the Late Pleistocene (Terminal Pleistocene) and the beginning of the Holocene, is unclear and rarely reported. Therefore, the explanation of how the cultural process from before to the early development of the Toalean techno-complex in the prehistoric cave area is still questionable. Research at the Leang Burung 2 Site has produced a terminal Pleistocene chronology, but the exposed cultural layers are difficult to explained because of overlapping with the Late Pleistocene layers (Brumm et al., 2018).

One of the sites with cultural layer that could be able to fill the current information gaps is Leang Batti, supported by dating data from the excavation of 2018 by the Regional Agency for Archaeological Research in the South Sulawesi (Balai Arkeologi Provinsi Sulawesi Selatan). Hundreds of stone flake artifacts have been found in this cultural layer and technological studies could be able to understand the cultural character in the transition time to a more complex technology. Thus, the research questions posed in this paper are, "How is the stone flake technology at the Leang Batti Site?" and "What are the implications of this technology for the development of the Toalean techno-complex that occurred throughout the region?"

METHOD

The research data used is the excavation result of the Regional Agency for Archaeological Research in the South Sulawesi carried out in 2018. The findings of 1376 stone artifacts were classified as coming from all excavation boxes. Further analysis was carried out by classifying and analyzing flake artifacts based on the material, morphometric, and type of the flake tool. Classification based on technology generally consists of two categories, namely flaked and non-flaked artifacts (Andrefsky, 2005, pp. 11–34). Non-flaked artifacts show no indication of reduction processes but are imported from outside the site (manuport). Some of them can be used as a tool to chip/reduct (Fabricator) and have the trace of usage evidence, such as a hammer stone or the anvil.

The flaked artifacts are classified into three types, namely debitage, flake tool and core. As advised by Hiscock (2002), the debitage need to be classified into several assemblages to quantitatively calculate the minimum number of flakes on the artifacts (Clarkson & Connor, 2013; Hiscock, 2002). Classification of debitage consists of several assemblages, namely Complete flake, flake fragments and debris. The flake fragments are then classified into several sub-assemblages based on the part of the damage, namely transverse proximal, right longitudinal proximal, left longitudinal proximal, distal and medial. In-depth observations on the debitage were carried out in the complete flake category by measuring the length, width, thickness, width of the striking platform, and the thickness of the striking platform. Complete flakes are flakes of reduction that are not damaged and are prepared as a candidate. Therefore, the size of the complete flakes is very important to know the tendency of the tools to be produced.

Flake tools are classified into two sub-assemblages, namely, retouched flakes and unretouched flakes. All flake tools are further analyzed in depth based on technological and morphometric comparisons. Un-retouched flakes are not showing an indication of use-wear on the cutting edge. Therefore, the researchers were assisted by using the dinolite microscope type AM4113T5X. Core stones were also observed in depth by measuring and calculating the maximum length, length of flake removal in the core and reduction pattern. The results of the analysis were then processed and presented using the Microsoft Excel 2016 and R Studio version 3.0.1 to assist the data interpretation and explanation. Statistical analysis will be used to determine the significant differences in comparison of size from each habitation phases. Nonparametric statistical analysis will be used if the data trend is not normally distributed. On the other hand, parametric statistics are used if the trend of the data is normally distributed after tested using the Shapiro-Wilk Test analysis.

RESEARCH RESULTS

Description, Stratigraphy and Cultural Layers

The Leang Batti site is one of the prehistoric caves that have been discovered and researched since 2009. This site was excavated periodically in 2010-2013 and 2018 by the Regional Agency for Archaeological Research in the South Sulawesi Province (Fakhri et al., 2018; Hakim, 2010, 2011a, 2011b, 2012). Administratively, Leang Batti is located in Langi Village, Bontocani District, Bone Regency. It is located at the coordinates of 4°59 '7.1 " (South Latitude) and 120° 1'2.8" (East Longitude) with an altitude of 349 meters above sea level. This site can be reached after 4 to 5 hours of walk from the residential area through gardens, forests and rivers.

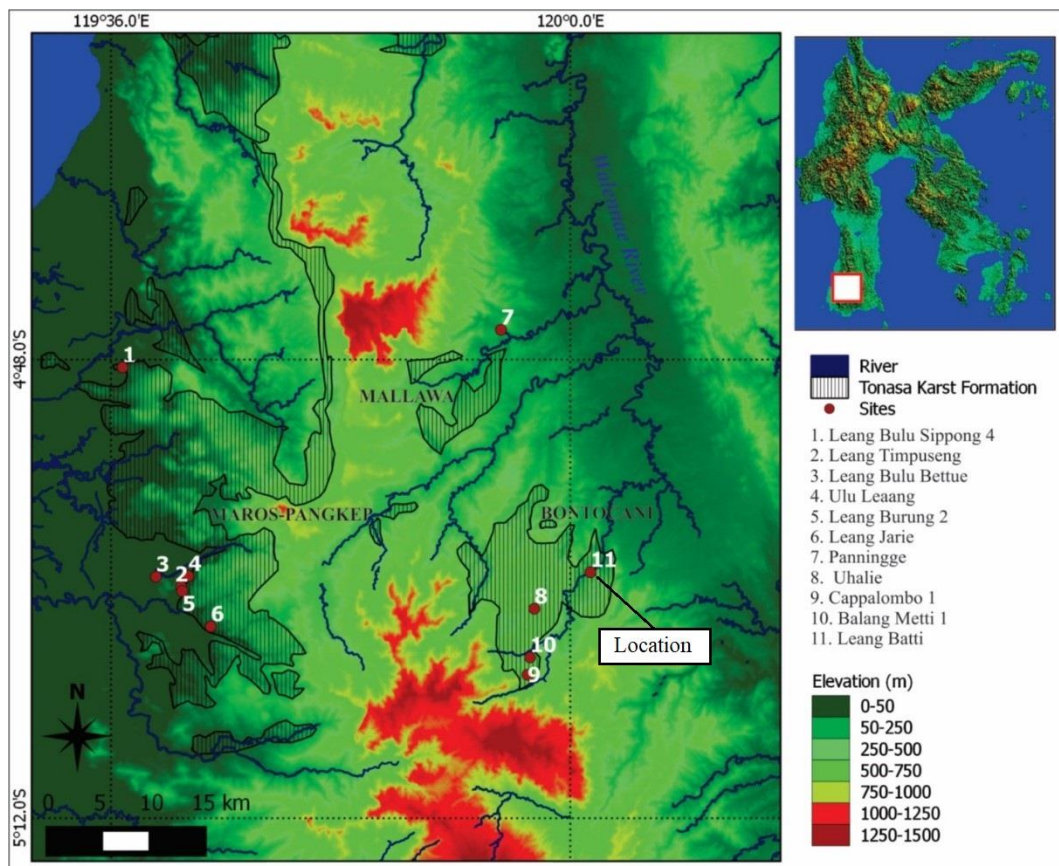


Figure 1. Map of the Location of the Leang Batti Site and Several Other Sites in the Karst Rocks of the Tonasa Formation

(Source: *Geologic map of the Pangkejene and Western part of Watampone Quadrangles, Sulawesi*, 1: 250,000, by Rab Sukamto, 1982; *Geologic Map of the Ujungpandang, Benteng and Sinjai Quadrangles, Sulawesi*, 1: 250,000, by Rab Sukamto and Sam Supriatna, 1982; *Shuttle Radar Topography Mission*, 2014)

Bontocani is a karst area of the Tonasa limestone rock formation in the highlands and separated from the Maros-Pangkep Karst cluster in the lowlands of South Sulawesi (Figure 1). This Karst cluster is also traversed by the Walennae River, an ancient river that became an ancient human settlement landscape since

180 thousand years ago (Alink et al., 2017; Bergh et al., 2015; Suryatman et al., 2016). The site is located only 112 m away from the river, on a cliff with a height of between 28-30m from the ground. The width of the mouth of the cave is 25 to 30 meters, 8 to 12 meters high and 34 to 50 meters deep (Figure 2).

Rock arts can be seen on 9 panels on the roof of the cave, depicting hands which drawn using the spray technique on panels 4, 5, 6, 7, 8 and 9 and depicting animals which drawn using painting techniques on panel 1. Some black depictions are also shown on panel 3. Some of the hand depictions had currently been damaged. The red figurative depictions show the same shape as rock arts from several Late Pleistocene sites in the Maros-Pangkep Region.

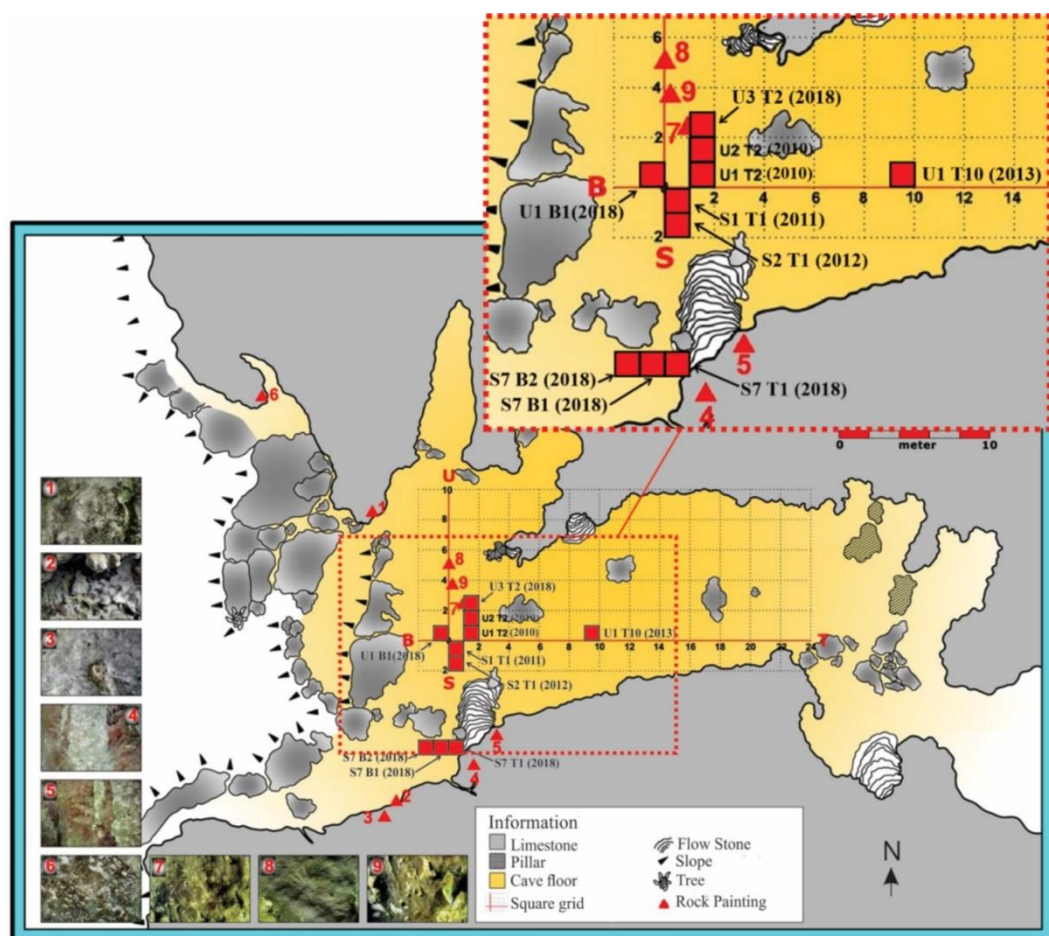


Figure 2. The Excavation Box Grid Plan From 2010 To 2018 At The Leang Batti Site
(Source: Hakim, 2011; Fakhri et al., 2018)

Excavation at the Leang Batti Site have been carried out since 2010 by opening the U1T2 and U2T2 boxes and continued in 2011 by opening S1T1 box. Excavation was again carried out in 2012 by opening the S2T1 box and continued in 2013 by opening the U1T10 box (Figure 2). The archaeological remains which were found consist of stone artifacts, charcoal, and animal bones as food scraps, some of which have been modified as tools. Pottery was also found, but they were relatively from the upper layer, spit 1 and 2 (Hakim, 2011b). The most dominant

types of bone remain are from large mammals, namely anoa (*Bubalus sp.*) and pigs (*Sus*), showing similarities to the types of animal rock arts on cave walls (Saiful & Hakim, 2016). Excavation data for the years of 2010 to 2013 have never been supported by dating results.

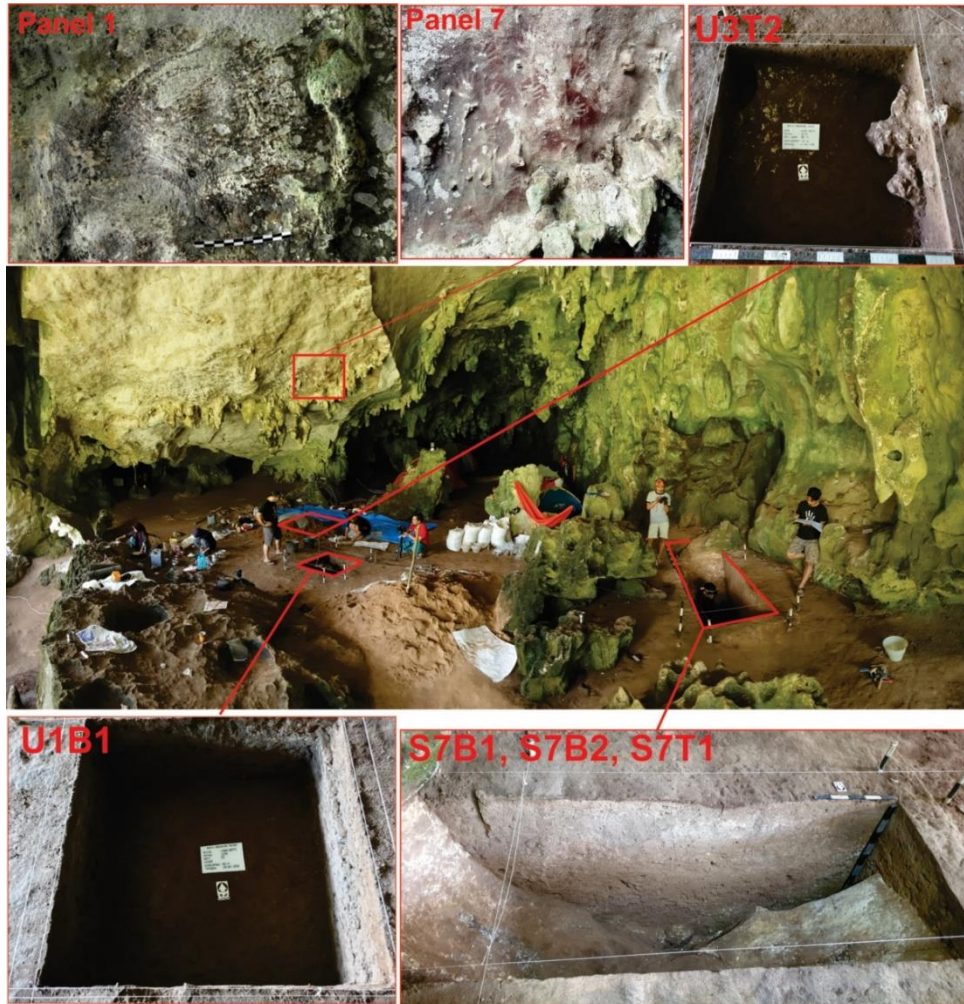


Figure 3. Photos of Site Conditions, Excavation Activities, Rock Arts and Excavation Boxes In 2018.

The rock arts seen in the photo are panel 1, namely animals with painting techniques and panel 7, namely the concentration of hand depictions using spray techniques (Source: Hakim, 2012; Fakhri, et. al., 2018).

Excavation in 2018 was carried out by opening five excavation boxes, namely U3T2, U1B1 and S7B1 S7B2 and S7T1 which are close to each other (Figure 3). The findings were dominated by stone artifacts, while animal bones were few and dominated by small animals, namely rats and bats (Fakhri et al., 2018). There is no indication of findings related to the rock arts drawing activity such as ochre pigment and pigment spray tool from bone, as found in the Late Pleistocene layer at Leang Bulu Bettue (Brumm et al., 2017).

The stratigraphic observations show three layers of culture. The first layer is 1a soil with a fine sand texture, only 5 to 10 cm thick. This layer is visible on all excavation boxes. No other finds apart from pottery are coming from this layer. The second layer is soil layer 2a in the boxes U3T2 and U1B1, and soil 2b in the boxes S7T1, S7B1 and S7B2. Layers 2a and 2b show the same texture of very fine sand but with slightly different colors because it may be affected by soil moisture and light intensity. The S7T1, S7B1 and S7B2 boxes have a drier soil condition than other excavation boxes because they are located on the edge of the cave walls with better light intensity (Figures 3 and 4). Stone artifacts began to emerge abundantly at this layer and there was no more pottery.

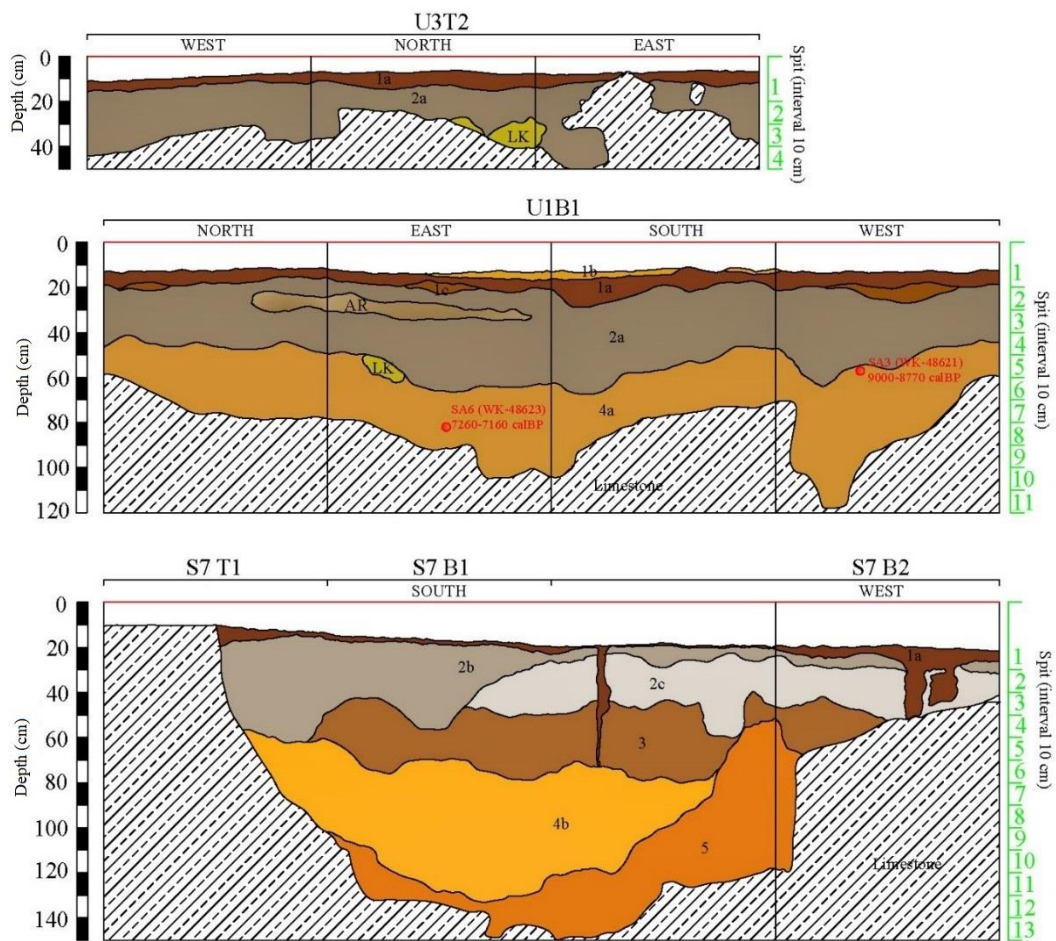


Figure 4. The Stratigraphy of The Excavation Box and The Position Of The 2018 Data Sample At The Leang Batti Site
(Source: Fakhri et. Al., 2018)

The third layer is soil layer 4a in U1B1 and 4b in S7T1, S7B1 and S7B2. Layers 4a and 4b have the same texture, namely loamy sand but with slightly different colors between the two due to humidity conditions. Stone artifacts are still very abundant in this layer. In the S7T1, S7B1 and S7B2 boxes, there are two layers of sterile soil, namely layer 3 with a fine sandy soil texture and layer 5 at the

bottom with a clay texture. Perhaps erosion on the edge of the cave has occurred so that several sterile layers have entered to cover the layers of culture.

The data sample taken for dating purposes were charcoals originating from U1B1 layer 4a (Figures 4 and 5). The two samples were tested in the laboratory of The University of Waikato using OxCal v4.3.2 and Intcal atmospheric curve measurement models (Ramsey, 2017; Reimer et al., 2013). The first sample was Wk-48621 from spit 5 with a depth of 55 cm from the line level, dated as 9000-8770 calBP (95.4%, 7991 ± 20 BP). The second sample was Wk-48623 from spit 8 with a depth of 82 cm, dated as 7260-7160 cal BP (95.4%, 6260 ± 19BP). In S7T1, S7B1 and S7B2 charcoal samples are very difficult to find under intact conditions. One sample of charcoal tested from these boxes with the code Wk-48624 from a depth of 95 cm actually produced a very young age, 1740-1610 calBP (95.4%, 1767 ± 20 BP). This sample is thought to be an intrusion from the layer of pottery, resulting in a younger age. Therefore, the sample dating from the S7B1 box is not used for the purposes of this article.

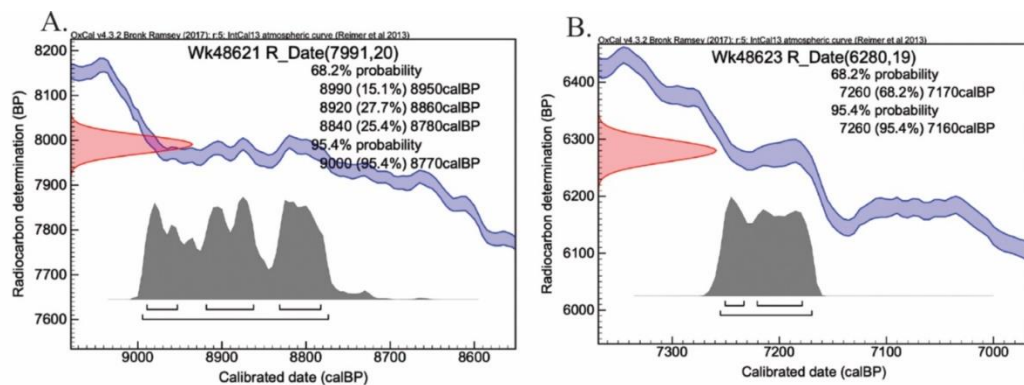


Figure 5. Graph of Calibration Results in Radiocarbon Dating Using Oxcal V4.3.2 and Intcal Measurements Atmospheric Curve.

Figure A is a sample of Wk-48621 from charcoal yielding a date of 9000-8770 calBP (95.4%, 7991 ± 20 BP). Figure B is a sample of Wk-48623 from charcoal yielding a date of 7260-7160 cal BP (95.4%, 6260 + 19BP) dating (Source: Fakhri et al., 2018)

Based on the description of the stratigraphic and dating, there are two phases of culture that are abundant with artifacts and will further be used in the explanation of this article. The first phase is the **Early Holocene** with an age range between 9000 to 7000 calBP. Their findings are found in layers 4a and 4b. The second layer is the **Middle Holocene**, in layers 2a and 2b with age range between 7000 to 3500 calBP. Although this layer has not been absolute dated, the position of these layer is above the Early Holocene culture. Therefore, an estimate of not more than 7000 calBP is used. The absence of pottery findings from this layer is an indicator of the lowest limit of age not less than 3500 calBP. This limitation is based on data samples from the oldest pottery dating at the Mallawa Site, one of the open neolithic sites close to the Leang Batti Site (Simanjuntak, 2015).

Classification of Stone Artifacts

The total number of artifacts which classified are 1376 stone artifacts (Table 1). Stone artifacts from the Early Holocene period are slightly more in number, around 52.76% (n = 726), while the Middle Holocene is only 47.24% (n = 650). Stone artifacts are dominated by flakes category up to 97.67% (n = 1344) while non-flake artifacts are only 2.33% (n = 32). Flake artifacts in the Early Holocene is around 96.27% (n = 699) while in the Middle Holocene is around 99.23% (n = 645). Non-flake artifacts in the Early Holocene are 3.72% (n = 27); while in the Middle Holocene are only 0.76% (n = 5). Each assemblage did not show significant difference by time. Debitage dominates in both phases with a percentage is over 58%, while complete flake is only 21%. The flake fragment sub-assemblage consisting of Proximal (Left Longitudinal), Proximal (Right Longitudinal), Proximal (Transversal), distal and medial in the two phases also did not show any significant difference. The total of flake fragments from both phases is not over than 6%. The flakes produced did not show a significant difference, less than 2%. However, the retouched tool is higher in the Middle Holocene and vice versa unretouched tool tend to be high in the previous period (Table 1). These data indicate that the intensity of flaking in the two phases does not show a significant difference. A difference is seen in the flake tools, which were more common during the Middle Holocene compared to the Early Holocene.

Table 1. Number and Percentage of Stone Artifact Classification Results from Early and Middle Holocene Phases at Leang Batti Site

Category	Collection	Subcollection	Phase				
			Early Holocene		Middle Holocene		
			Count	%	Count	%	
Flaked Artifacts	Complete flake		159	21.90	137	21.08	
	Core		12	1.65	5	0.77	
	Debris		424	58.40	419	64.46	
	Flake fragment		Proximal (LL)	3	0.41	4	0.62
			Proximal (RL)	4	0.55	4	0.62
			Proximal (T)	47	6.47	38	5.85
			Distal	18	2.48	14	2.15
			Medial	4	0.55	1	0.15
	Flake Tools		Retouched	11	1.52	14	2.15
			Unretouched	17	2.34	9	1.38
Non-Flaked Artifacts	Hammer Stone		4	0.55	1	0.15	
	Manuport		21	2.89	3	0.46	
	Manuport Fragment		2	0.28	1	0.15	
Total			726	100	650	100	

Sumber: Suryatman, et al., 2020

The raw material used for stone artifact was dominated by chert with a percentage of 69.84% (n = 961). Other materials consist of volcanic with a percentage of 28.05% (n = 386), limestone 0.94% (n = 13) and jasper 1.16% (n = 16). The use of material between the Early and Middle Holocene showed a significant difference, especially for the type of flake artifact such as complete flake, core, flake

fragment and debris (Figure 6). Volcanic material tends to be higher in the Early Holocene and decreased in the Middle Holocene. Otherwise, chert material was increased during the Middle Holocene. In addition, the differences can be seen in the use of jasper material, which used in the Middle Holocene but not in the previous period. In contrast, limestone was used in the Early Holocene and not in later times. The difference of raw materials is related to the specific technique of reduction developed during the Middle Holocene era. Flake tools were more dominant in the Middle Holocene, therefore high silica material such as chert and jasper were needed to make tool because easier to shape or modify. Although there is difference of raw material between each phase, the source of these material generally comes from the river. Observations on the cortex of chert and jasper materials show the condition that tend to be thin and rounded. The two materials were should be taken surround the Walennae river, which is not far from the site.

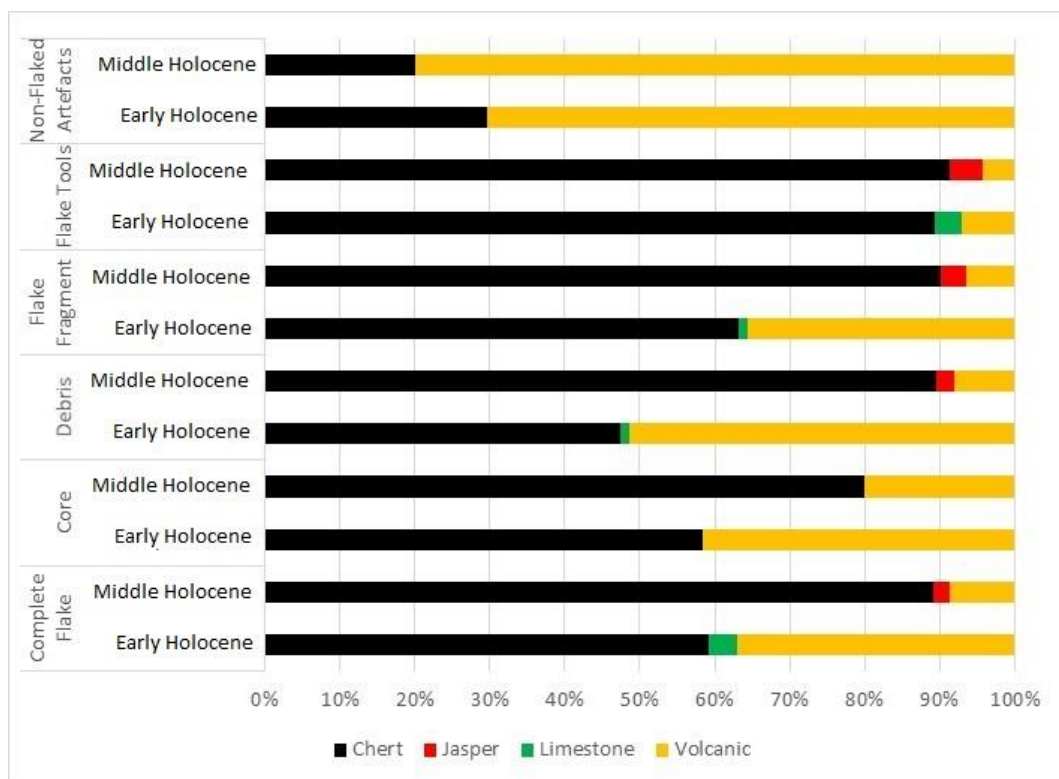


Figure 6. Percentage Diagram of The Comparison of The Artifact Material for Each Assemblage (Complete Flake, Core, Debris, Flake Fragment) and The Category of Non-Flake Artifacts (Source: Suryatman, et al., 2020)

Analysis of Complete Flakes, Flake Tools and Cores

The size tendency of complete flake from the two phases show significant differences based on statistical tests. The length, width and thickness were seen to be smaller during the Middle Holocene compared to the Early Holocene (Figure 7A). Furthermore, the difference also seen in the size of striking platform, which the Middle Holocene shows a smaller size compared to the previous period. These data indicate that the need of smaller flake during the Middle Holocene era and

could be related to their pretention to make smaller flake tools compared to the Early Holocene.

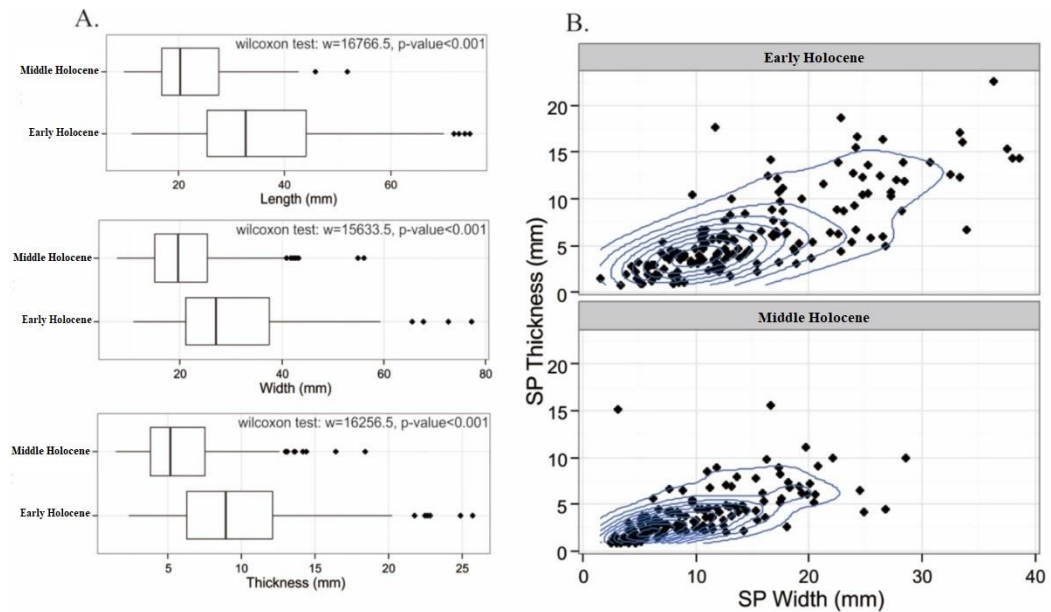


Figure 7. Boxplot Diagram and The Statistical Wilcoxon Test (Nonparametric test) Comparison Of The Length, Width and Thickness Of The Complete Flakes For Each Phase (A). Scatterplot diagram of the width and thickness of the *Striking Platform* flakes for each phase B). (Source: Suryatman, et al., 2020).

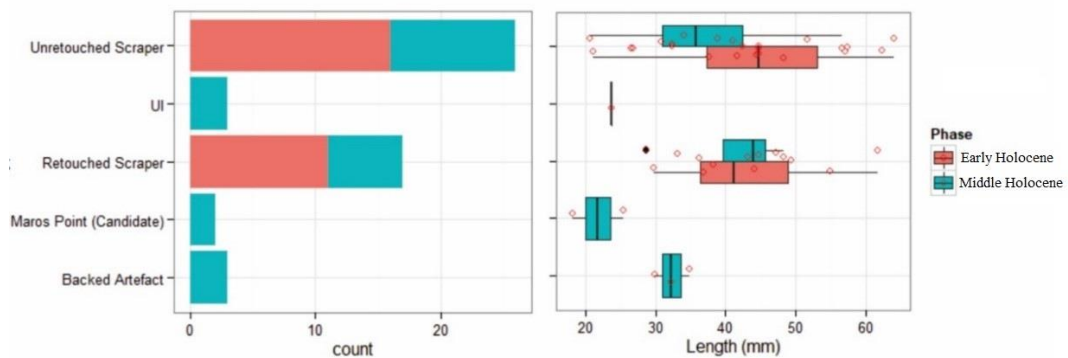


Figure 8. Comparison of The Total Length of The Flake Tool Type in Each Phase of The Leang Batti Site. (Source: Suryatman, et al., 2020).

The type of flake tool during the Early Holocene period was very monotonous, such as only a total of 11 pieces of retouched scraper, while the unretouched were 16 pieces (Figure 8). The striking technique of the scraper is simpler, only freehand direct percussion. This indication on the retouching is a visible scar on the tip of the retouching due to impact. In addition, the intensity of the retouching performed on each artifact was very low. Retouching is only use to trim up the sharpness, not to modify or produces a particular tool. The final tools

produced are tend to be irregular and shows no flake indication from the blade reduction pattern (Figure 9F-K).

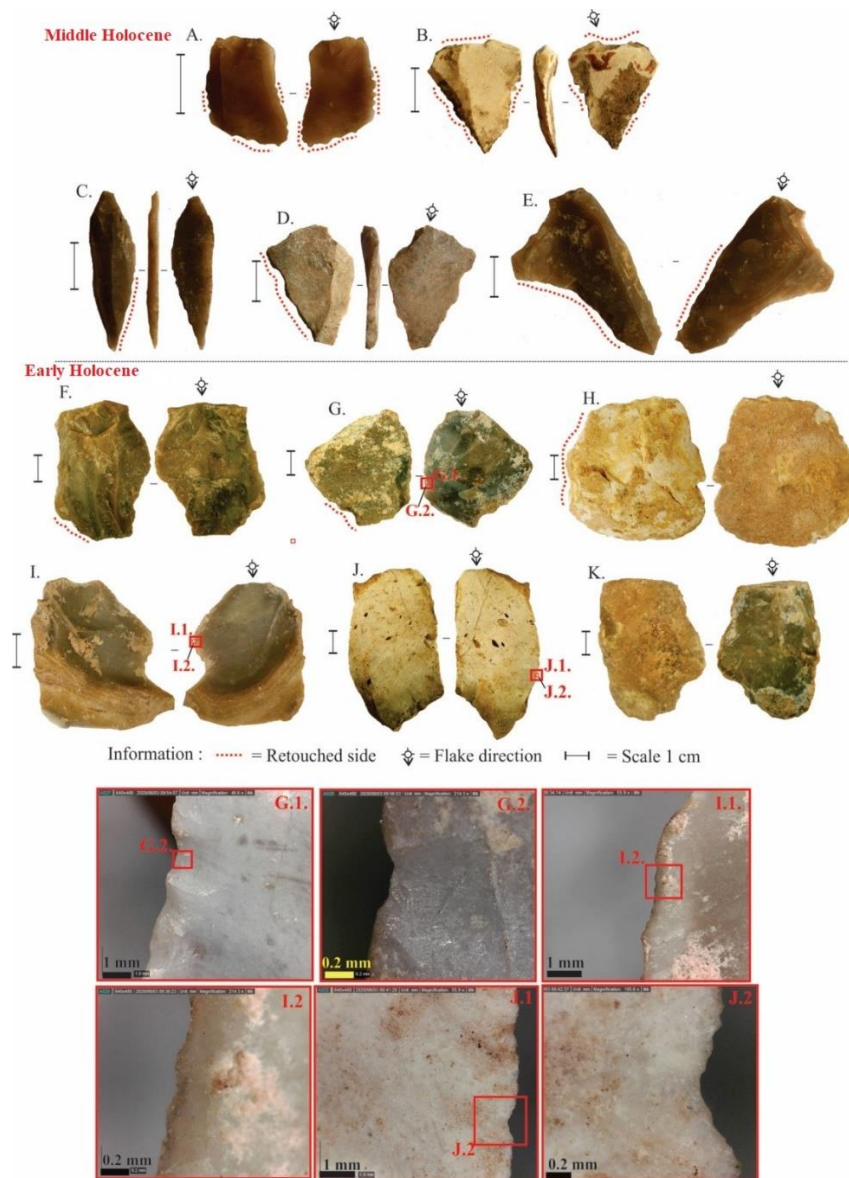


Figure 9. Flake Tools from The Early To Middle Holocene Periods At The Leang Batti Site. The tool type consists of Maros point candidates (A and B), backed flakes (C and D), retouched scrapers (E) from Middle Holocene Phase, Retouched Scraper (F, G and H) and unretouched scrapers from the Early Holocene period (I, J and K) use-wear seen on artifacts G, I and J. Scale 1 cm.

(Source: Suryatman, et al., 2020).

Types of flake tools recovered during the Middle Holocene were more varied than the Early Holocene. Some of them showed the characteristics of the Toalean techno-complex. The type of tools consisted of Maros point and backed artifact (Figure 9 AD). Two Maros points show unfinished work process and identified as a candidate. The indication of the Maros point is easy to be observed

with a bifacial retouched process on both lateral sides and prepared as a jagged shape. One of them has been retouched on the proximal side to prepare the base, but the work has not been completed on the proximal base. Three backed artifacts were found indicating the work process by two directions retouched (bidirectional) using bipolar technique to produce steep slope angles closed to 90 degrees (Hiscock, 2006; Maloney & O'Connor, 2014; Suryatman et al., 2017). Toalean tools show a trend toward smaller sizes, between 10 and 35 mm.

Other tools type found in the Middle Holocene layer are including 6 retouched scrapers and 10 unretouched scrapers. The size trend in the two phases did not show a significant difference. However, especially for the unretouched scrapers, it was slightly smaller in the Middle Holocene era (Figure 8). Three tools that were recovered could not be identified and to be generated as Unidentified / UI because they were found in damaged condition. Damage may occur during the working process, especially when used more complex equipment such as in Toalean culture. So, it can be concluded that the flake tools in the Middle Holocene period tended to be smaller due to the influence of the Toalean techno-complex, although not significant. The concept of the flake tool also has an impact on the tendency of the complete flake size to be smaller during the Middle Holocene.

The core stone from two occupation periods show several reduction patterns for flakes production, namely unidirectional (6 pieces), bifacial (3 pieces), bifacial and radial (2 pieces) and random (6 pieces). The reduction patterns that existed during the Early Holocene period were generally still found in the later period (Figure 10A). Core with bifacial patterns during the Early Holocene period showed a larger size compared to other cores. The cores with random reductional patterns show a tendency of smaller size compared to other cores and can be found in both occupation periods. The cores with random reductional pattern begin to reduce in size and become harder to grip.

One of the bifacial and radial cores is similar to Chopping Tools technology, the core tool that are found mainly in the open sites of Walennae Cabbenge valley (Alink et al., 2017; Suryatman et al., 2016). The core comes from the Early Holocene layer using pebblestone. Core with similar technology have been reported in Leang Burung 2 Cave, dated to more than 50,000 calBP, and overlap to the Late Pleistocene layer (Brumm et al., 2018). It is still difficult to interpret if there is a cultural connection between the early human inhabitants of the Walennae valley and Leang Batti.

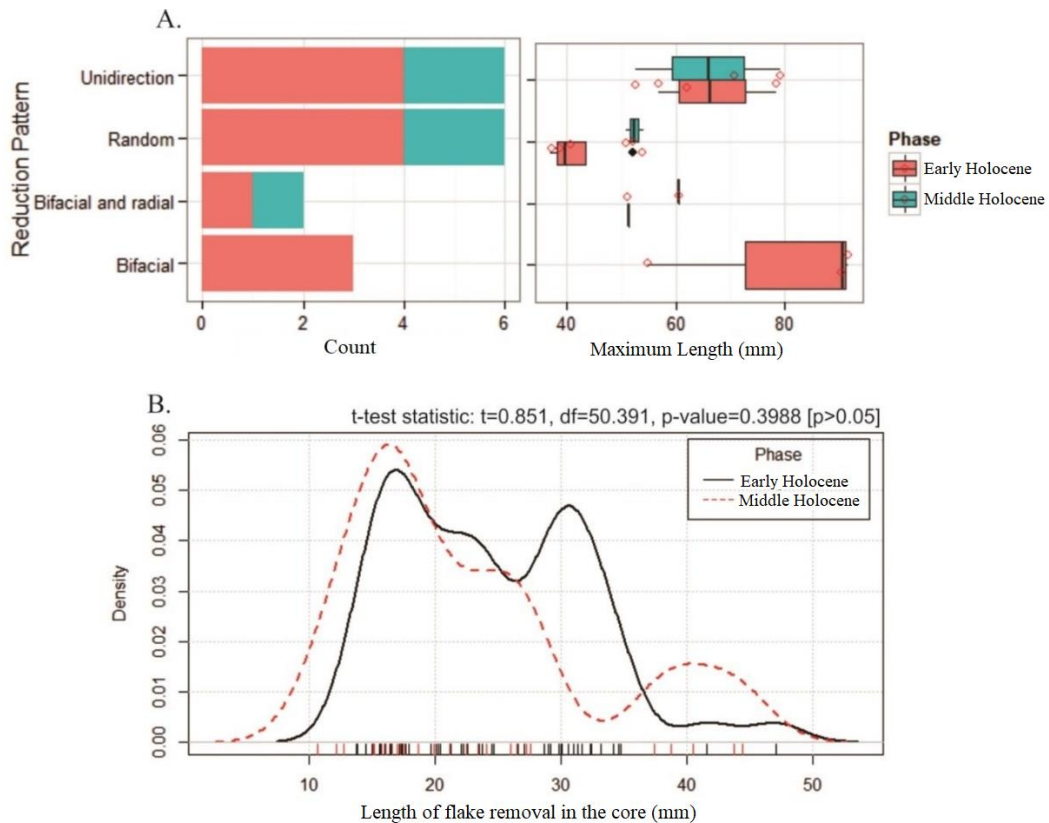


Figure 10. Bar Chart and Box Plot Comparison of The Number and Size Of The Maximum Length of The Stone Core of The Two Phases of Occupancy
 (A) Diagram of Density estimate and statistical test using the sample method *t-test* (*Parametric Test*) comparing the tendency of the length of flakes release on the core stone in the two residential phases at the Leang Batti Site (B).
 (Source: Suryatman, et al., 2020)

The core that differs between the two occupation phases is core which extracted from large flakes (Figures 11D and E), found in the Middle Holocene period but not found in the previous phase. The core usually uses the remains of larger flakes and then reduced to produce smaller flakes. Perhaps there was a need of smaller tools so that they use some larger flakes for retouched by bifacial reduction pattern.

Another difference between the two periods is also presented by the tendency of the length of flake removal in the core, which is slightly smaller during the Middle Holocene compared to the Early Holocene (Figure 10B). This reduction is related to the need for small tools that increase in the later period. However, the difference is not significant based on statistical tests, because the influence of the Toalean techno-complex was not too strong. They still used long scrapers even the influence of Toalean technology has started in the Middle Holocene.

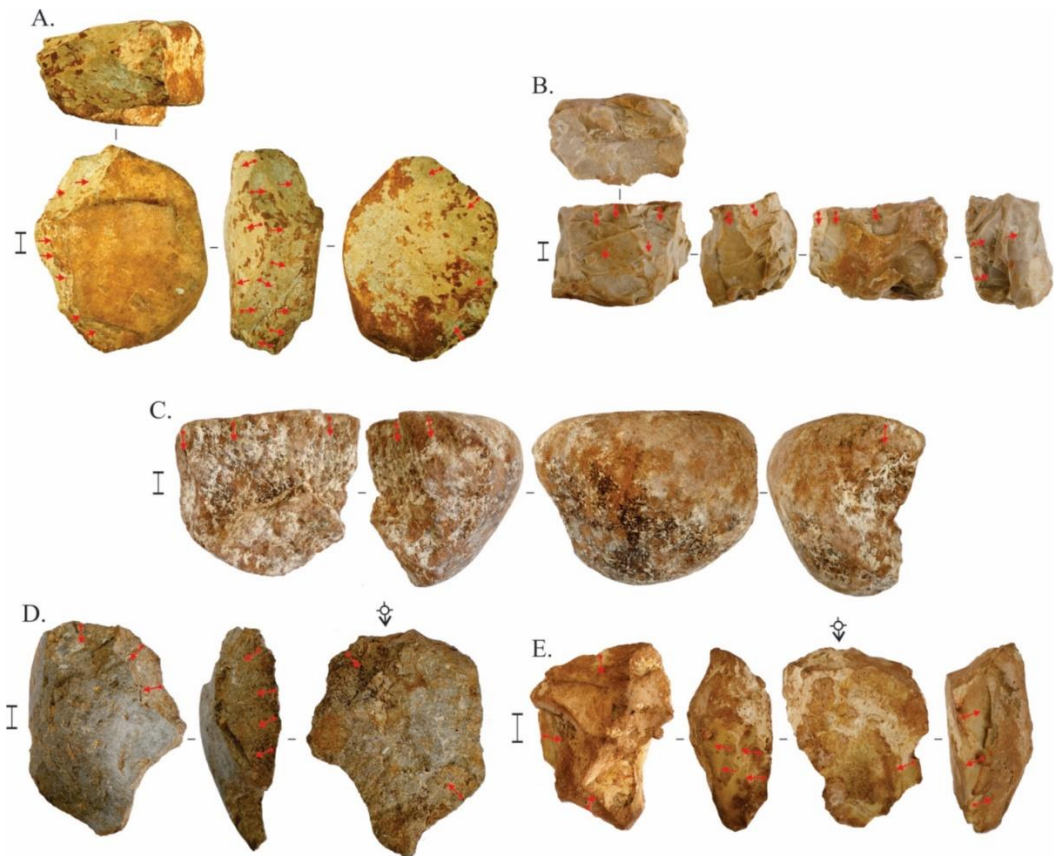


Figure 11. Volcanic Cores with Bifacial and Radial Reduction technique, similar to the Chopping Tool Technology from the Early Holocene occupation period
 (A). The core of unidirectional reduction pattern using chert material from Early Holocene dwellings
 (B). The core pattern using a unidirectional reduction of volcanic material of the Middle Holocene layer (B). The core stone is extracted from a larger flake using volcanic materials (D) and chert (E) from the Middle Holocene phase. Scale 1 cm.
 (Source: Suryatman, et al., 2020).

DISCUSSIONS

The Leang Batti site is one of the caves sites in the highland of the Bontocani Region which has some variation of rock painting, besides Leang Uhalie. However, until now there are no dating results analyzed specifically from the Bontocani region. The current dating data of rock art is only from the Maros-Pangkep region, because there are no 'popcorn' or calcite material sample attached to the painting in the Bontocani region for dating analysis as applied in the Maros-Pangkep region. However, if we compare the form dimensions of both animals and hand stencils, the figurative images of Leang Batti are not much different from other red painting that have been widely dated in Maros-Pangkep region.

Based on spatial context, the site location is still in the same karst formation to the Maros-Pangkep region and it is still possible to be in the same cultural landscape, even there are differences elevation (Pasaribu & Permana, 2017; Saiful & Burhan, 2017). Therefore, the Bontocani sites region may also have been

inhabited by prehistoric people who have the same rock art tradition as the Maros-Pangkep region.

Current excavation data from Leang Batti do not show any evidence of the Late Pleistocene occupation layer, as found at the Maros Pangkep region. Excavation findings obtained from the Holocene strata also show no archaeological evidence associated with art symbols, such as found from the Late Pleistocene layer at the Leang Bulu Bettue Site (see Brumm et al., 2017). The cultural layer in the context of the rock art from Leang Batti may never be recovered because it might be eroded, or perhaps there is any hidden cultural layer which not yet found, covered by boulders of rock from the collapse.

Technological knowledge that seems to be retained from the Late Pleistocene to the Early Holocene is the use of flake tools which tend to be large with reduced by the Direct Percussion technique, as well as its comparison with similar findings from the Leang Burung 2 (Brumm et al., 2018; Glover, 1981). These flakes have not been modified, some of them have only been retouched possibly for the purpose of tidying the sharp edges. However, there are some technological differences from the Late Pleistocene which were not found at the Leang Batti Site, namely the bipolar technique for reducing core that was also reported from the Leang Burung 2 Site. The differences may occur because of the use of different material sources at each site. Some knowledge to reduce core stone could be leaved because the conditions of the available source materials are imposible to be applied in certain sites. For example, volcanic rocks from rivers that are widely used in Leang Batti are certainly not appropriate to reduce by bipolar techniques. Macroblade flakes were not found in Leang Batti, but it should be noted that Macroblade of Leang Burung 2 is also questionable, since there is no clear evidence of blade core, so the flakes identified as the macroblade could be produced incidentally by the reduction intensity of a large core.

Entering the Middle Holocene period, lithic flake artifact technology began to change. Total flake artifacts analyzed were 97.67% (n = 1344) while non-flake artifacts were only 2.33% (n = 32) (see also Table 1). Therefore, the flakes artifact is a representation of the development of stone artifact technology that occurred in this site. Beside the flake tools, debitage is an important part to study flake technology because it is a part of the basic concept (mental template) in the preparation of the lithic tool. However, not all of them have strong attributes to indicate this matter, because some of them may be released to chance and damage due to transformation during the deposition process (Hiscock, 2002). Therefore, debitage need to be classified firstly and further morphometrically analyzed in the sub-category complete flake because it is representing to the prepared flake as the tool candidate (Andrefsky, 2005, pp. 82-112).

The analysis result shows that the lithic materials which previously varied were changed by chert in the Middle Holocene. The size of flakes from the core reduction were also getting smaller. These changes occurred due to the Toalean techno-complex began to influence into the basic concept of the maker. The technology of small flake tools and high modifiability knowledge seems to force the Leang Batti inhabitant to uses chert material for preparing smaller flakes. However, this influence does not too strong affected, because the number of Toalean tools is very rare and tends to fail during the reduction process. Leang

Batti inhabitant might difficult to adopt the new technology, especially when modifying their flake technology. Therefore, they kept their previous technology in order to survive in the middle of other communities that introduced the Toalean cultural techno-complex.

The evidence of the oldest Maros point technology between 8000-7000 calBP has been reported at the Leang Jarie Site, one of the lowland site of South Sulawesi (Suryatman et al., 2019). Thus, the Leang Batti inhabitants in the highland still retained their previous technological knowledge, when the lowlands inhabitant started to innovate in the making of more complex flake tools. This wave of knowledge was extending to the highlands area around the Middle Holocene. The stone artifacts at the Cappalombo 1 Site is the evidence of Toalean's technological which has exist in the Bontocani highlands at least around 6500 calBP. Moreover, this culture continues to the intensive technology of backed artifacts after 3500 years ago (Suryatman, et al., Article in press; Suryatman et al., 2017). Thus, the Leang Batti inhabitants might be survive and be trapped in the middle of the Toalean culture, and their impact also received by the Leang Batti inhabitant.

CONCLUSIONS

The results showed that the lithic technology at the Leang Batti Site consisted of two different occupation phases. The first phase is the Early Holocene period estimated between 9000 and 7000 years ago. The technology is dominated by large flakes and used directly as a tool without modification. Some flakes are also simply retouched, probably just to trim up the sharpening edge. This technology may come from the knowledge of their ancestors before the Toalean techno-complex developed throughout the region.

The second phase is the Middle Holocene period which is estimated between 7000 and 3500 years ago. The flake artifact began to change as Toalean's techno-complex influence which difused as the basic concept of the artefact maker. Chert materials were increasingly dominating and small flakes with more complex technology were starting to be produced increasingly because of the requirement for small tools. However, Toalean's influence was not too effected because they might not be ready to accept the changes of flake tool technology, which were even more difficult. The Leang Batti inhabitant retained the previous technology to live between the other communities that applied earlier the Toalean cultural techno-complex.

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