Lithic technology and typology from hunter-gatherer sites in Myanmar with special reference to central belt and western fringe of Shan plateau

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Chapter 1
Introduction and structure

1.1 Introduction

Prehistoric hunter-gatherer communities in central belt and western fringe of Shan plateau raise questions related to lithic technology and typology. Both former and recent studies attempt to explore the behavioural pattern of the communities, but they often synthesis the lithic technology as a whole technological trend rather than their own distinctive characters. Subsequently, it often generates the confusion of chopper-chopping too culture in central belt and pebble tool culture in Shan plateau. Thus, the core research question addresses various aspects of lithic technology questioning why the whole lithic technological trend has no uniformity in the basic geographical unit. Following research questions are investigated in this study:

Research question 1: How lithic technology and typology of forager communities in Myanmar have changed over time?

Research question 2: What are the main indicators of the culture?

Research Question 3: How this technology can contribute to what extent in local and regional scale?

1.2 Structure

In terms of above-mentioned features, this summary is organized as a part of the final thesis. It is generally divided into two folds. The first part contains chapter 2 to 5 and the second part includes chapter 6 to 10. Chapter 1 is the introduction of research project and background and it explains the structure of the thesis and how they are organized. Therefore, the first part will begin with chapter 2, narrating research history and development of lithic artefact studies in Myanmar and how they perceived on prehistoric hunter-gatherer communities. It points out the controversial issues dealing with lithic artefacts and how they attempted to overcome them. It also explains the concept of hunter-gatherer or forager communities and their subsistence economy in Myanmar scholarship. Chapter 3 argues geographical definition of lowland and highland with certain characteristics of environmental background, locations of the sites and their associated cultures, exploring these two territorial settings were likely to be main natural inputs or favourable niche for establishing different forager subsistence economy. It intends to speculate the past environmental influence on the culture thorough current background which might have shaped subsistence economy of prehistoric lifeways. Chapter 4 mainly focuses on subsistence pattern of foragers based on the zooarchaeological evidences, which mostly come from rock shelter sites in Shan plateau. It indicates a wide range of fauna from big games to aquatic animals had been exploited for their subsistence. Chapter 5 describes spatial pattern of forager sites and how they are distributed in their particular region. It inspects the dynamic of cultural products in central belt and discusses site preference choice in Shan plateau.

The second part mainly focuses on the analysis of artefacts to understand technology and typology of respective cultures. Therefore, it will begin with chapter 6 briefly reviewing some ecological theories tested and used for lithic assemblages in regional context, especially from neighbouring country Thailand. It also mentions lithic analysis procedure stating basic typology and classification of lithic artefacts, basic variables for the analysis procedure and continues with the explanation of statistical methods which have been conducted in the thesis. Chapter 7 is the study of lithic artefacts from hunter-gatherer sites in central belt. It articulates the concept of cultural-stratigraphy framework, issues and problem of chronology and artefacts. The analysis based on the variable indices of artefact types highlights that how they are different from each other and changes between their specific cultures. It also shows that sub cultural phases are inconsistent with their cultural products and difficult to understand artefacts typological variation and chronological framework. Hence, it argues that only two main cultural system is the most appropriate to show typological variation. Chapter 8 is the study of lithic artefacts from hunter-gatherer sites in Shan plateau. This chapter will explain the lithic artefacts at three hunter-gatherer sites on the western fringe of Shan plateau. It discusses excavations, chronological sequences and cultural products at the sites and signifies how lithic artefacts in this region reflects the common traits between the sites through comparative study of these artefacts among the sites. Chapter 9 is the comparative study of lithic artefacts from central belt and Shan plateau. It mainly carries out on the same typology of artefacts from the site and describe their contribution in local and regional context, describing contrast nature of the areas. Chapter 10 is conclusion and discussion section for the results of the study and future direction. It describes how technological and typological change of prehistoric forager communities in Myanmar through time and verify the characteristics of a specific culture. Also, it discusses the contribution of these cultures in local and regional scale and it articulates which are the main possible demands for future direction of the research.

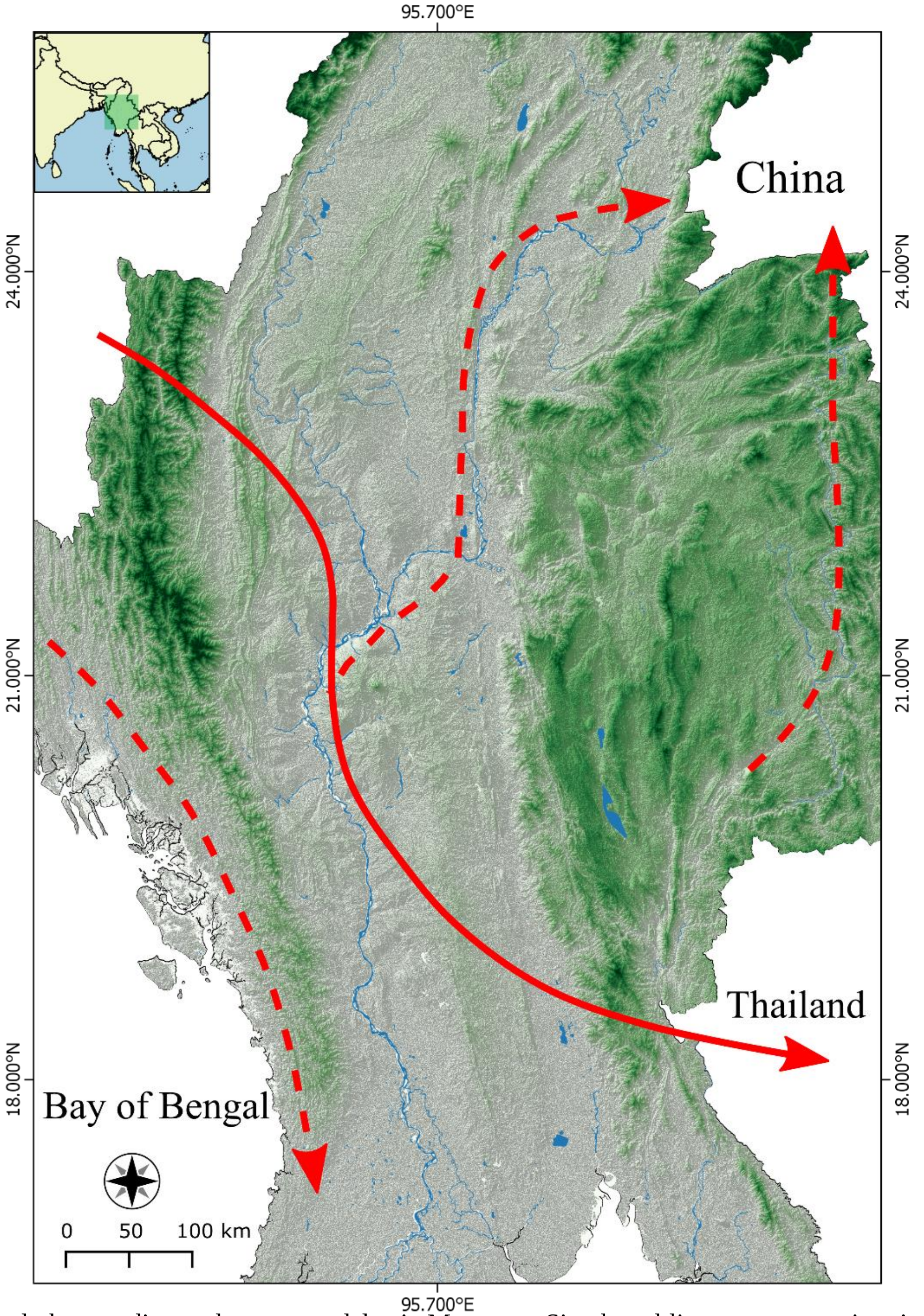
Chapter 2

Previous research projects on hunter-gatherer adaptations in Myanmar

2.1 Introduction

This chapter mainly discusses about previous research works on lithic artefacts in Myanmar, and it presents how lithic artefacts studies have been initiated and how the researchers interpret on the evidences dealing with hunter-gatherer communities. The study of prehistoric hunter-gatherer adaption in Myanmar is interesting and challenging for the archaeologists. It is interesting because the country is located as an intermediate geographical position between Indian sub-continent in the west, mainland Asia in the north, east and west, and insular southeast Asia in the south. Therefore, it is often regarded as one of the possible early human migration routes from inland to island Southeast Asia (1943; Macaulay *et al.* 2005; Field *et al.* 2007; Marwick 2009) and inland human dispersal to East Asia (Li *et al.* 2015) at least from the late Pleistocene, based on geomorphological, palaeontological and archaeological investigations (de Terra *et al.* 1943), genetic and geographical analyses (Macaulay *et al.* 2005; Field *et al.* 2007; Li *et al.* 2015). However, these possible routes differ from each other according to their proposed models (map 2.1). Recent archaeological finds (Win Kyaing 2010a; 2010b; Kyaw Khaing *et al.* 2012; Schaarschmidt *et al.* in press) in Myanmar play pivotal role to reconsider and correlate with prehistoric hunter-gatherer behaviour and movement within the country. Among these archaeological data, lithic artefacts found at the sites can measure subsistence technology and cultural achievement of hunter-gatherer communities in Myanmar.

It is challenging, in addition, because little information about forager communities in the country is known and it is often put aside when archaeologists attempt to summarize the hunter-gatherer subsistence economy and technology in Southeast Asian regional context. Most archaeological projects in the country mainly emphasize on historical archaeology than prehistoric archaeology, as described by Aung Thwin (2001:6-21). Moreover, local archaeological projects and analyses (Hla Gyi Mg Mg *et al.* 1998; Than Tun Aung 2002; Aung Kyaing *et al.* 2005; Win Kyaing 2005; Ye Myat Aung *et al.* 2009; Win Kyaing 2010a; 2010b; Kyaw Khaing *et al.* 2012) are often written in mother tongue and it is also a reason why it cannot reach to international scholars' interest. Hence, several scholars repeatedly cite only the work of Movius and they cannot keep in touch with recent works in the country. For instance, Dennell (2014a:19) even claims as "…*no significant fieldwork has taken place in Myanmar* *since 1938*". It clearly shows there is a gap between local and international scholars to listen to each other. On the other hand, local archaeological projects cannot afford to achieve scientific dates so that relative dating method is usually applied. Although these challenges remain to be cracked down in the future, some research projects have been sporadically conducted to testify early human movement and their activities through the archaeological record.



Map 2. 1 Early human dispersal routes models via Myanmar. Simple red line represents migration route based on archaeological finds while red dashed lines stand for migration route based on genetic study. (Based on de Terra et al. 1943; Macaulay et al. 2005; Marwick 2009 ; Li et al. 2015)

2.2 Previous research works in central belt and Shan plateau

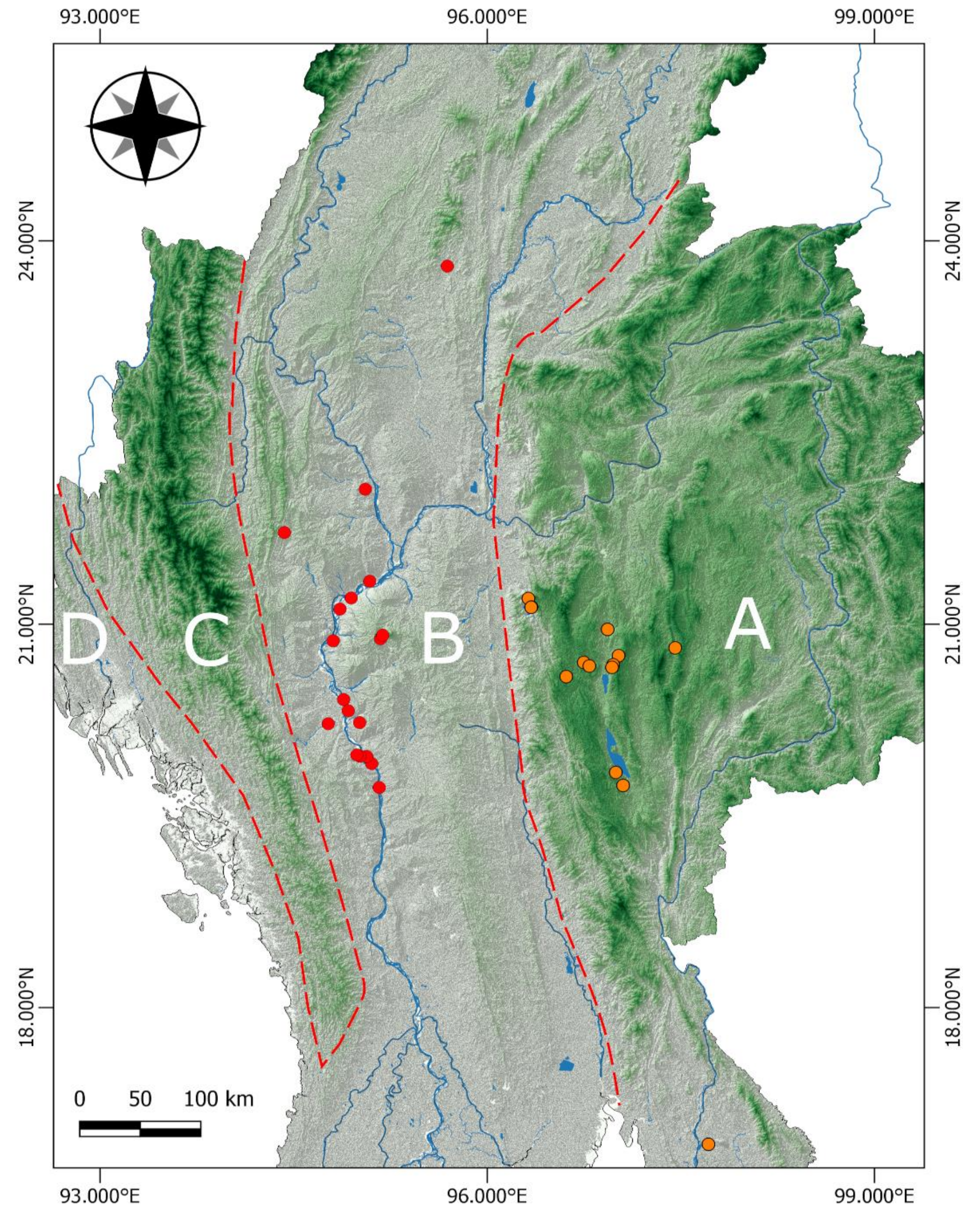
The physiography of Myanmar is generally divided into four main parts, the central belt, the Shan highland, the western mountain belt, and the Arakan coastal strip, and each region has its unique configuration of altitude, geological features, local climatic variations, and forest types (Chhibber 1934:1-2; Huke 1965:4-7) (map 2. 2). Most archaeological investigations have been taken place in the latter two regions although there are some reports on Neolithic cultural traces in the former ones. The intermittent projects for the archaeology of hunter-gatherer communities mainly focusing on these two geographical areas, have been undertaken from the colonial period to recent time. Many lithic artefacts attributed to Palaeolithic revealed by these works can contribute for understanding prehistoric hunter-gatherer economy within the country.

In fact, the terms ကျောက်ခေတ်(*Kyauk-khit*) and ကျောက်လက်နက် (*Kyauk-let-net*), referring to "Stone Age" and "Stone tool", has been appeared in the first Myanmar Encyclopaedia in 1955 (1955:33-34). However, these terms would have been introduced to Myanmar scholarship since early 1900s. From the onwards of 1970s, prehistoric hunter-gatherer subsistence economy was more elaborately discussed in Myanmar academic community. A well-known historian Than Tun (1971:82-100) compactly used the term အစာရှာမုဆိုး (*A-sa-shar mot-soe*), standing for "hunter-gatherers", seemingly directly translated from English to Myanmar and discussed about the subsistence pattern in stone age. He also added the word တံငါ (*Ta ngar*), referring "fisherman", another different subsistence strategy, as a suffix to the former word. These terms were used to mention prehistoric hunter-gatherer foraging activities in Myanmar, but, nowadays, one can clearly see those different economic legacy of prehistoric communities in contemporary hunter-gatherer society of Myanmar. For example, Taron ethnic group in the north still practice as part-time foragers, focusing on subsistence farming while Moken tribe in the south still activate in fishing (Fortier 2014:1016). However, mixed economic pattern had been practiced in the past. Similarly, the anthropologist Sein Htun (1971:366) also used the term အစာရှာဖွေသောစနစ် (*A-sa-shar-phway-thawsa-nit*), which means "foraging strategy", for exploitation to environmental resources at Badahlin cave. These are some theoretical words for prehistoric hunter-gatherer subsistence strategy through the literature accounts. Local archaeologists have begun to take research works on lithic archaeology from about 1969 while international scholars had emphasized their works in the central belt since the end of 1890s.

2.2.1 Central Belt: The birthplace for stone tool research in Myanmar

Former archaeological discoveries and projects, especially from colonial period, have been done in this region, and these works motivated for further studies in the area. Most descriptions about lithic artefacts from Myanmar have been done by the foreign geologists who came to the country in search of oil (Aung-Thwin 2001:7; Aung, Tin Htut 2017:189). When they conducted their field works in central belt, they recognized flaked stones and published their collections in the then academic journals. Among them, Noetling, the German geologists, was the earliest one who described about flaked stones from Myanmar at the end of 19th century (Noetling 1894; 1897b) (figure 2. 1). However, it seemed that his description about associated geological stratum, lower Pliocene (Noetling 1897b), made confusion and uncertainty to accept these flaked stones as cultural products. It became, therefore, a controversial issue among the scholars if these were human workmanship (Swinhoe 1903; Gupta 1923; Mitra 1923; Morris 1935) or not (Oldham 1895; Pascoe 1912).

From the cultural product standpoint, Swinhoe (1903), who conducted a fieldwork at the same spot to search for the flaked stones in 1900 and 1901, believed that these specimens might have belonged to human creation. Similarly, Gupta (Brown 1931:35-36) and Mitra (1923) maintained these flaked stones as artefacts. However, Mitra (1923:94) argued that it is too much exaggerate to convince these stones from either Miocene or Pliocene, but he strongly accepted these stones might have been from earliest Pleistocene. On the other side, Oldham (1895), who also visited to the spot where Noelting collected his specimens, doubted the associated geological strata and flaked stones so that he demanded more evidence to prove the existence of Miocene or Pliocene man in Myanmar. Similarly, Pascoe (1912) claimed that these finds cannot verify for the existence of Miocene or Pliocene man in Myanmar and concluded as Noetling’s hypothesis is impossible. However, Brown admitted that he accepted these flaked stones indicate human workmanship, but he unconvinced these stone are contemporary to Miocene to Pliocene strata, often used as “Red Bed” by geologists, and he accused former authors are too much writing on too little filed experience (Brown 1931:36). Therefore, it can be concluded that most researchers convinced the flaked stones as artefactual evidences, but the associated geological stratum was a main problem for them. However, this controversial problem led to the future archaeological investigation within the country.



Map 2. 2 Physiography of Myanmar based on Chhibber 1934 (Note: A= Shan plateau, B= central belt, C= Arakan mountain range, D= western coastal strip. Red dots represent open air sites while orange dotes represent rock shelter site)

Like above mentioned others, Morris declined to Noetling's hypothesis, but he realized the problem centres on the associated geological layer. Therefore, he (1932; 1935; 1936a; 1936b) tried to establish a robust chronology for the whole material cultural sequences from old stone Age to recent historical period with a set of terraces given in local topographical names. However, Aung *et al* (2015:51-52) claim that his geological terraces are unsuccessful to assign for chronology and the association between artefact types and various taxa are weak for interpretation. Nevertheless, it was the first attempt to define the cultural sequences including stone tool tradition with geological strata.

Figure 2. 1 Ventral and dorsal of a flaked stone collected from Yenangyang by Noetling in 1894. No scale is mentioned in the original figure. (After Noetling 1897)

Since the discovery of Homo *erectus* remains in China (Wang and Sun 2000:19-20) in early 1920s and in Java in 1894 (Bartstra 1983:422), Myanmar has been considered as an important place which can indicate eastward extension from India to China and Java (de Terra *et al.* 1943:267). On the other hand, French archaeologist Colani's work on Hoabinhian culture in northern Vietnam to the late of 1920s (Matthews 1966; Marwick 2007:52) was likely to be also a fact for investigation in Myanmar. From the late 1938 to early 1939, therefore, to test this hypothesis, the American Expedition with the members of archaeologists, geomorphologist and palaeontologist conducted their survey works along the course of Ayeyarwady (formerly spelt as "*Irrawaddy*") river basin and some places, especially cave sites, of southern Shan State. They collected somewhat over 650 stone artefacts and fossils in these two geographical areas, central belt and Shan plateau during their works. Movius designated the name "*Anyathian*" (after colloquial term *Anyatha* for the people from upper Myanmar) for Palaeolithic culture of Myanmar (Movius 1943:341). And "Anyathian" becomes an archaeological lexicon for Myanmar Palaeolithic tradition. He divided Anyathian into two main cultures_ Early Anyathian and Late Anyathian cultures _with sub cultural phase from middle Pleistocene to early Holocene based on associated geological terraces established by de Terra (1943b). Most local archaeologists generally maintain his works and generally accept as reasonable chronological framework for the culture. However, Hutterer (1977) and Dennelle (2014b) claim for uncertainty of geological terraces and lithic artefacts collected as surface finds. Aung (2017:192) highlights the geological terraces used as chronological sequences is still applied in Asia.

With the discovery of over hundred pieces of scrapers and a bifacial tool at Mu valley in 1975, Myint Aung (2012a:3-4) argues that these artefacts reflect a certain technological advance over Anyathian culture and he suggests these tools belonged to late Pleistocene or upper Palaeolithic. In 1995, Ba Maw and his colleagues conducted a field work at Moegyobyin (Ba Maw *et al.* 1998) and revealed about 2000 stone artefacts as surface finds (Than Tun Aung 2002:9) during their field work. According to Ba Maw (1998), it is a single site, reflecting successive technological trend from Palaeolithic to Neolithic via Mesolithic. In 2002, Than Tun Aung (2002) analysed a totality of 2000 lithic artefacts from the sites in lower Chindwin area, following Ba Maw's assumption. Nwe Nwe Moe (2014) reanalysed lithic artefacts and faunal remains from the surface collections in 2014. She also claims (2014:83) that the site has revealed a very long occupational continuity parallel with lithic technological change at the site from late Palaeolithic to Neolithic via Mesolithic. It, however, raises a question since it is difficult to accept technological continuity of lithic culture at the site without detailed explanation of terrace or stratigraphy and associated artefacts at the site. As mentioned above, most works have oriented to central belt and it has been the birthplace for research projects and development of lithic studies.

From the 1970s onward to 2000, archaeological investigations provided momentum for research on stone tool archaeology with projects carried out in the central belt and Shan State (table 2. 1). Among them, three research projects aimed to reinvestigate the Palaeolithic culture of the central belt. Since all Anyathian artefacts, now displayed in the Peabody Museum in the United States of America, had been taken by the American expedition, there was no concrete evidence of Palaeolithic culture in Myanmar except for accounts in the literature. Win Kyaing and his colleagues, therefore, conducted archaeological survey works at Gaungbaung in 2005 and Ayeyarwady valley in 2008 and 2009 respectively. Their works reveal more evidence for Anyathian cultures along the course of Ayeyarwady river and he articulates (Win Kyaing 2010b:33) that Anyathian cultural territory likely to be expanded to the south of central belt.

These works have thrown light on the existence of hunter-gather sites closely located to main water resource, although there are some claims on the authenticity of Anyathian culture.

2.2.2 Shan Plateau: Pebble tool culture

Unlike to central belt, much evidence for subsistence economy of hunter-gatherers come from cave sites in Shan plateau. Since the time of the American expedition, faunal remains likely to be exploited in the past have been exposed in association with the traces of human cultural features at some cave sites in Shan plateau (Movius 1943:389-340). One of the good points of the cave sites is most evidences are found *in situ* with less threat of either human or natural agency for destruction than the open-air sites in central belt. However, construction of modern religious building inside the caves becomes a threat for destruction of cultural features.

There was no prior research work for stone tool culture in Shan plateau before the American expedition undertook a survey. This team realized the cultural traces of prehistoric occupations at such sites as Montawa, Tin Ain, Lu Yoe Taung and Mong Pawn (formerly described as *Möta-wa-ku*, *Tin-Ain*, *Ahyū Taung* and *Möng Pawn*) during their survey (Movius 1943:389-391). Among them, there is a rock shelter in which Movius yielded 10 pieces of flaked stones in association with bones, shells and charcoals from the excavation at that site near Mong Pawn. He conveyed these stones might have been affected by human agency and concluded the site was probably occupied during post-Pleistocene (Movius 1943:391). No more detail description about these flaked stones are mentioned in his work which he mainly emphasized on the artefacts from central belt.

In 1969, a couple of limestone caves, known as Badahlin (formerly known as *Padah-*lin) caves, some 360m distance from each other, were excavated by Aung Thaw and his colleagues. They yielded a great number of stone artefacts and faunal remains along with charcoals and red orcher (Aung Thaw 1971a). Radiometric dates for the cave 1 indicate that the oldest occupation date goes back to some 13400±200 years BP while the youngest one is 1750±81 years BP (Aung Thaw 1971a:133). More detailed discussions have been done in chapter 7. Similarly, recent post-infrared infrared stimulated luminescence (pIRIR) dates offer the earliest human occupation at Badahlin cave 2 back to at least ~30 ka years ago (Schaarschmidt *et al.* in press). The unique feature of cave 1 is the presence of rock art depicting anthropomorphic, zoomorphic and geometric figures (Aung Thaw 1971a). Aung Thaw (1971a:129) claims that one of the excavated finds, red ocher (hematite) might have been used for paintings, but these materials are often recovered in the Hoabinhian sites as powdered and stained on stone tools or human burials (Bellwood 1997; Higham 2013). Although many scholars often consider these paintings as contemporary art of the earliest occupation at the site, there is no direct evidence to prove as simultaneous relationship between cultural remains and rock art.

From the late of 1990s, local archaeologists attempt to excavate at the limestone caves in Shan plateau. Much evidences for faunal remains associated with stone artefacts have been discovered. Geologist Tin Thein and his colleagues excavated at Buddhawzinaw, Mobye, Waiponla, Myinmahti, Pekon, Lonka Gone in the following years of 1998 (Tin Thein 1997,October,19; 1998; Tin Thein *et al.* 2001; Tin Thein 2011). He discovered several number of stone artefacts in association with faunal remains in these cave sites. Thanks to his works, more information about faunal remains exploited at the karstic region has been realized and these faunal remains are discussed more detail in chapter 4.

Similarly, Hla Gyi Mg Mg and his colleagues explored to some limestone cave sites in 1998 and excavated at Mobye cave (formerly mentioned as "Kyar Taung" which means Mt Tiger in Myanmar language), but they found only two more artefacts and faunal remains found in association at the excavation (Hla Gyi Mg Mg *et al.* 1998:10-11). In 2012, Kyaw Khaing and his colleagues conducted a series of excavation at the cave sites (Kyaw Khaing *et al.* 2012), some were highlighted by Movius in 1943. They discovered a lot of evidence for exploited faunal remains at the sites, but the excavated stone artefacts are relatively scarce in number. In 2016, Marwick and his colleagues excavated at the cave site in Gu Myaung and pIRIR date indicates for earliest occupation at the site might have begun at least ~25 ka years ago (Schaarschmidt *et al.* in press).

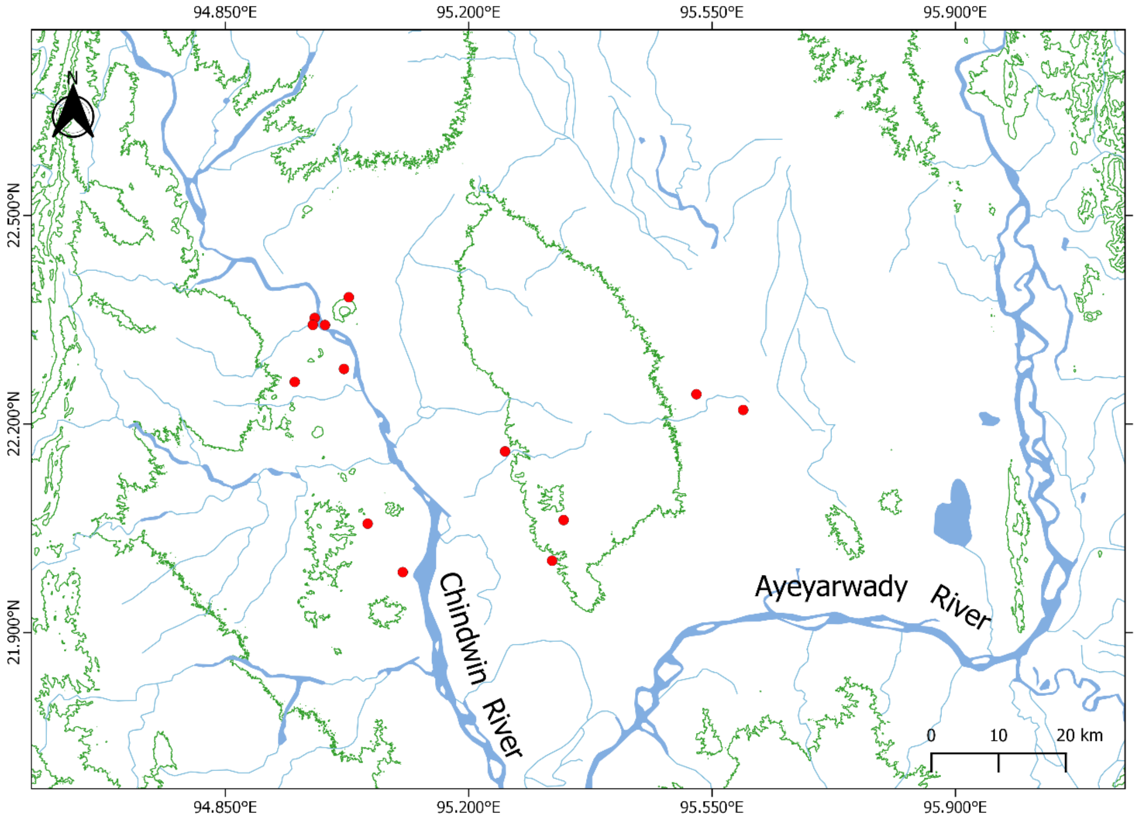
2.3 Methodological development for stone tool analysis in Myanmar

Myanmar has undergone a long term civil war after regaining the independence, and hence prehistoric archaeology is not as priority issue as peace process and security (2001:23). It indirectly effects on the financial support to the development of the discipline and also create insecure situation for conducting archaeological projects in some areas. On the other hand, prehistoric archaeology is not as popular as historical archaeology among the researchers focusing on the past of Myanmar and its antiquities. According to a departmental report (Kyaw Myo Win 2007), only 8 out of 145 archaeological projects between 1903 and 2007 were prehistoric research projects carried out by the then Department of Archaeology, Ministry of Culture, to testify prehistoric hunter-gatherer activities within the country. There were also some research works of geologists and archaeologists from academic institutions as shown in table 2. 1, but they are very fewer in number. Nowadays, lithic studies have been undertaken in momentum, but it is very smaller in quantity. These two facts make clearly why lithic studies in Myanmar are rather backwater when it is compared to those from regional context.

Since the time of Noetling and Morris, the lithic artefacts specimens were classified by their typology and the date was estimated according to their stratigraphic context (Noetling 1894:101; Morris 1935). However, Movius (1943) used typological description with morphological variation for selected tools. His typological scheme and nomenclature still influence on later archaeologists because this method is still widely used in their studies. It is generally based on qualitative description than quantitative data. All lithic artefacts are categorized by typological similarity and, either all or some of them are selected to describe more specifically on morphological variation of each type. Therefore, it is often difficult to realize what kind of raw materials and what kind of lithic artefact types increase or decrease or even influence at a site. Sometimes only ordinal scale such as large, medium and small is used to denote the size of artefacts and it also leads to be problematic to understand how much they are different from each other unless there is no clear description about size measurement. Despite these shortfalls, the advantage of this method is the detailed description of almost every individual lithic artefact and one can easily understand every artefact has what kind of shape they possess. From 2000s onward, some studies started to change to use techno-typological studies. For example, Than Tun Aung (2002) used this method to study the lithic artefacts from the sites in Moegyobyin and Monywa in lower Chindwin area (map 2. 3), but his study is still influenced by classificatory-descriptive method, which was also a prefer method in China as noted by Gao (2000:94-95).

Table 2. 1 show the summary of archaeological projects on prehistoric hunter-gatherer sites in Myanmar (Note: + represents radiometric calibrated dates while * stands for pIRIR dates)

No	**Contributor**	**Site**	**n**	**Associated finds**	**Date**	**Dates**	**Reference**
1	Noetling	Yenangyang	12?	Faunal remains	1894	? Pleistocene	(Noetling 1894:101)
2	Morris	Yenangyaung and its vicinity	27?	-	1932-1936	? Pleistocene	(Morris 1932; 1935:4-7,15-22; 1936b)
3	Movius	Ayeyarwady Valley	650	-	1938-1939	? mid Pleistocene-early Holocene	(Movius 1943:347-378)
4	Aung Thaw	Badahlin	422	Faunal remains, charcoals, red ochre, potsherds, wall painting	1969	13000±200 BP	(Aung Thaw 1969b; 1971a)
5	Myint Aung	Mu valley	>100?	-	1975	? ≥10,000 years bp	(Myint Aung 2012a:1-4)
6	Ba Maw	Moegyobyin and Nwe Gwe	2000?	Faunal remains	1995	? Late Pleistocene	(Ba Maw 1995; Ba Maw *et al.* 1998; Than Tun Aung 2002; Aung Kyaing *et al.* 2005; Nwe Nwe Moe 2014)
7	Tin Thein	Mobye Cave and Buddhawzinaw	?	Faunal remains	1997-1998	? 6000-4000 years bp	(Tin Thein 1997,October,19; 1998; 2011)
8	Hla Gyi Mg Mg	Cave sites in Shan plateau	?	Faunal remains	1998	? Early Neolithic	(Hla Gyi Mg Mg *et al.* 1998)
7	Tin Thein	Waiponla	10?	Faunal remains	2001	? 12,000-6000 years bp	(Tin Thein *et al.* 2001; Tin Thein 2011)
8	Win Kyaing	Pauk	37	-	2005	? upper-Pleistocene	(Win Kyaing 2005; 2010c)
9	Win Kyaing	Ayeyarwady Valley	704	-	2008	? mid-Pleistocene to early Holocene	(Win Kyaing *et al.* 2008; Win Kyaing 2010b)
9	Ye Myat Aung	Badahlin	?	-	2009	-	(Ye Myat Aung *et al.* 2009)
10	Win Kyaing	Ayeyarwady Valley	169	-	2009	? mid-Pleistocene to early Holocene	(Win Kyaing *et al.* 2009:4-5; Win Kyaing 2010a)
11	Kyaw Khaing	Cave Sites in Shan plateau	?	Faunal remains, charcoals	2012	-	(Kyaw Khaing *et al.* 2012)
12	Marwick	Badahlin and Gu Myaung in Shan plateau	?	Faunal remains	2016	~30ka, ~25ka*	(Marwick 2016; Schaarschmidt *et al.* in press)
13	Marwick	Chauk	?	?	2016	?	-



Map 2. 3 Lithic sites in lower Chindwin area (based on Than Tun Aung 2002; Nwe Nwe Moe 2014)

From theoretical perspective, these studies simply try to assign the lithic artefacts under the label of a specific cultural framework such as Palaeolithic or Mesolithic or Neolithic in relation to those from Western classical norms. Sometimes, it leads to a cultural dilemma when a site exposing techno-complex characteristics. It is obvious in the case of artefacts from Badahlin cave 1 when the earliest occupational date goes back to some 13400±200 years BP, while the youngest one is 1750±81 years BP. Other chronological dates fall between 7740±125 BP and 6230±90 BP (Aung Thaw 1971a:133). Several types of artefacts such as potsherds, edged grounded lithic artefacts and simply flaked on either side or both side lithic artefacts. It becomes a controversial issue among the scholars to assign the culture of the site. Aung Thaw (1971a) prefers to use Neolithic culture while Than Tun (1971) designates the site as late Palaeolithic and Myint Aung (2000) denotes Mesolithic as the site cultural features. Therefore, it is better to view as techno-complex or at least late Pleistocene to middle Holocene hunter-gatherer community culture (13,000BP~6200BP) to avoid such dilemma or dogma.

2.4 Conclusion

This chapter discusses about research development of lithic studies in Myanmar and how these works were initiated. And it also presents about the contributions of these studies on early human behavioural pattern and their technological economy of hunter-gatherer communities in the country. There are three parts in lithic studies timeline of Myanmar. The first part deals with the years from 1894 to 1939 in which lithic studies have been initiated and conducted mostly in central belt. The second part belongs to the years from 1969 to 1975 in which prehistoric research works have been conducted not only in mountainous region on the north of central belt but also in Shan plateau. However, there was a huge gap about three decades between those periods, in which prehistoric archaeological investigations were not carried out in both areas. From the late of 1990s to recent, lithic studies have been carried out in continuation and recent excavations can indicate not only artefacts, but also ecofacts exploited by prehistoric hunter-gatherer communities. These works contribute a great amount of information for the forager communities within the country, but they are relatively smaller in number than those from neighbouring countries.

Chapter 3

Environmental setting of hunter-gatherer sites from central belt and western fringe of Shan plateau

3.1 Introduction

As mentioned in chapter 2, most prehistoric hunter-gatherer sites discovered so far fall within the central belt and Shan plateau. These two areas are important to understand how environmental condition affected on the adaptation of hunter-gatherer in the past. Therefore, this chapter mainly generates two different nature of environmental setting in which different prehistoric hunter-gatherer communities existed.

3.2 The environmental setting

3.2.1 Physiography, geology and natural vegetation

Generally, Pleistocene can be regarded as the dawn of the human emergence in the earth history. Therefore, Pleistocene geology and chronology is important for prehistoric archaeologists to reconstruct the stages of early human and their associated culture. Their elevations, environmental setting and basic geological features are totally different, but these areas could have been an attractive favourable niche on their own way. Although there is no direct evidence for environmental conditions of the Pleistocene and early Holocene of the country, the Quaternary environmental background can be partially presumed through geological and geographical studies of scholars such as Chhibber (1934), de Terra (1943b), Davis (1960), Huke (1965) and Bender (1983).

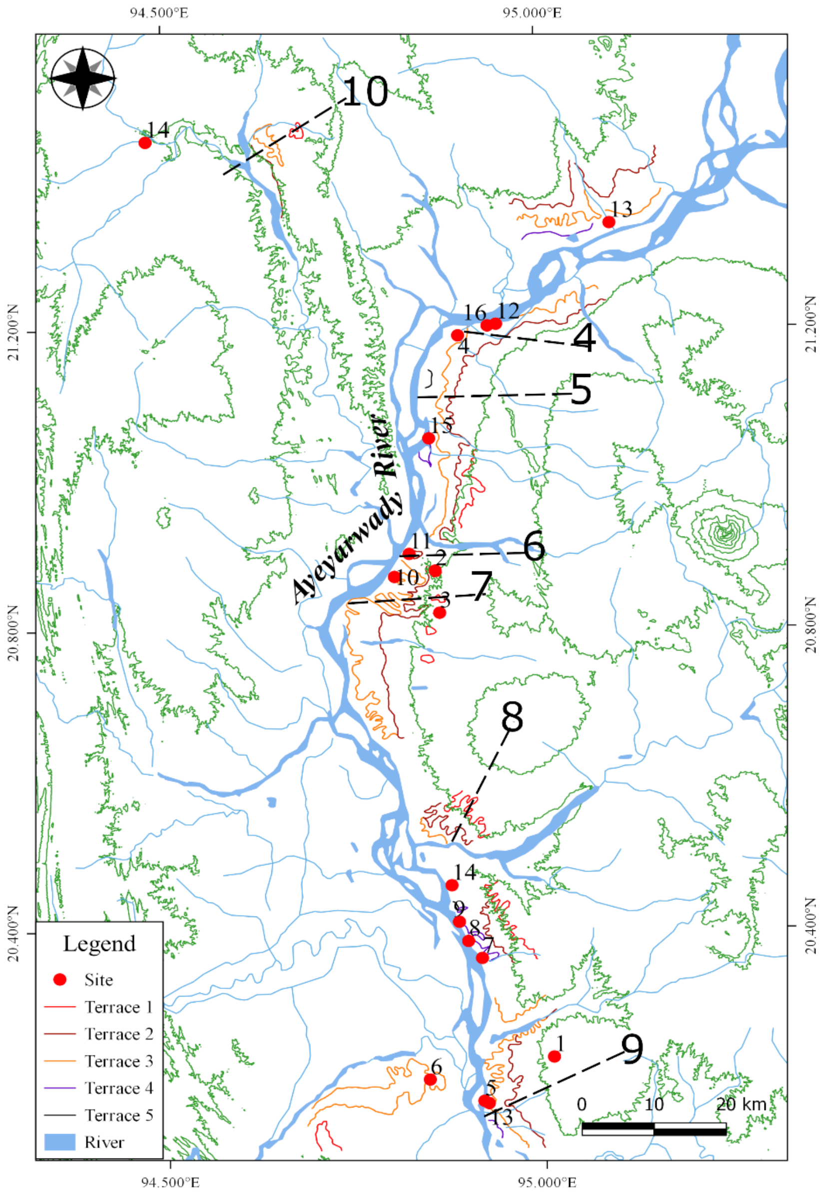
The significant work on Pleistocene geology has been done by Hellmut de Terra between 1938-1939. He was the leader of the American expedition and investigated early human movement in central belt and northern Shan plateau from Pleistocene geological point of view. However, his work on central belt is obvious in Pleistocene geology of Myanmar. He observed several places around Mandalay, but no lithic artefacts were found in association with animal fossils above Pauk and Nyaung U. He was able to document Pleistocene stratigraphy accompanied with lithic artefacts between Magway (formerly spelt as "*Magwe*" in Myanmar), Pauk and Nyaung U (formerly spelt as "*Nyaunu*"). In this area, he investigated the cross section of old Ayeyarwady terraces, especially at seven places (map 3. 1).

3.2.1.1Central belt

Most open air sites discovered so far are the dominant settlement type in central belt, which is an alluvial lowland area, about 1200km in length and 2500km in width. It is surrounded by the Shan highland to the east and the mountainous region to the west and north respectively. The area gradually slopes down to the south and there are some hillocks derived from those mountain and highland areas. Main river system of the country can be found in it while the southern portion, delta area ends up at the sea. Its basic lithology is sandstone, shales, and clays (Chhibber 1934:2). Huke (1965:5-6) explained the area is younger than Shan highland and consolidation of sandstone and shale were formed due to the deposition. When the area is verified with recent geological map of Myanmar (Myanmar Geosciences Society 2014), most hunter-gatherer sites are located on recent alluvial soil belongs to Holocene, and on Miocene-Pliocene geological bed, also known as Irrawaddy group, which is formed due to fluviatile sands and gravels (map 3. 2). Also, Irrawaddian group can be divided into two_ lower Irrawaddian series and upper Irrawaddian series. Usually the former is composed of consolidated sandstones, shales and siltstones containing *Hipparion fauna* and the latter one is composed of conglomeratic sandstones and silts with younger Villafranchian fauna (de Terra 1943a:280; Zin Maung Maung Thein *et al.* 2008:141). Upper Irrawaddian formation is generally considered as middle to upper Pleistocene (de Terra 1943b:287; Bender 1983:99-103).

Bender (1983:102) contends that the entire Irrawaddy group is known for its wealth of silicified wood although fossil palmwoods are rare. A recent lithological study of the region (Licht *et al.* 2014) maintains that the area is an abundance of fossil wood. These two geological studies supports Movius's claim (Movius 1943:349) for the availability of fossil wood as one of the main raw material source in the area for the production of stone tools. Moreover, it seems that silicified tuff, which develops through a process of fossilization from volcanic rock, also used as a raw material source by hunter-gatherer communities (Movius 1943:349).

Generally, the lowland area is about 50 m above sea level and its climatic condition ranges from tropical steppe to semi-arid (Bender 1983:12), receiving less than 1,016 mm precipitation per annum due to the rain shadow of surrounded mountain ranges (Davis 1960:7). Natural vegetation system of the lowland area can be divided into two: various subtypes of dry scrub forests and semi-desert scrub vegetation (Bender 1983:12). According to Davis (1960:4), main Ayeyarwady basic in central belt area is composed of three forest types such as dry forest, dry scrub forest and semi-desert scrub (figure 3. 1). The outer area of middle Ayeyarwady basin is composed of tropical moist forest including its subtypes such as tropical mixed evergreen and deciduous hardwood forest. Geographically, this type of forest area is higher than the core zone. Most open air sites are located in the dry forest type while two open air sites fall within tropical moist forest type (map 3. 3). Nearly all hunter-gatherer sites are located to the main water resource. The outermost area of central belt is covered with deciduous forest in which no sign of prehistoric hunter-gatherer site has been reported yet.



Map 3. 1 Typical Anyathian sites in central belt of Myanmar with their associated old river terraces. Black dash lines show the places where cross-section of stratigraphy was observed by de Terra. (Adapted from de Terra et al. 1943) Anyathian sites: 1. Magway Loc.3; 2. Chinaungma; 3. Sale P.621; 4. Nuang U; 5. Wadaw Chaung; 6. Minbu; 7. Thaphan Chaung; 8. Yon Zeik; 9. Sar Taing; 10. Zee Cho Pin; 11. Chauk; 12. Gabarni; 13. Pakokku; 14. Yenangyaung; 15. Magway; 16. Kyaukku Umin.

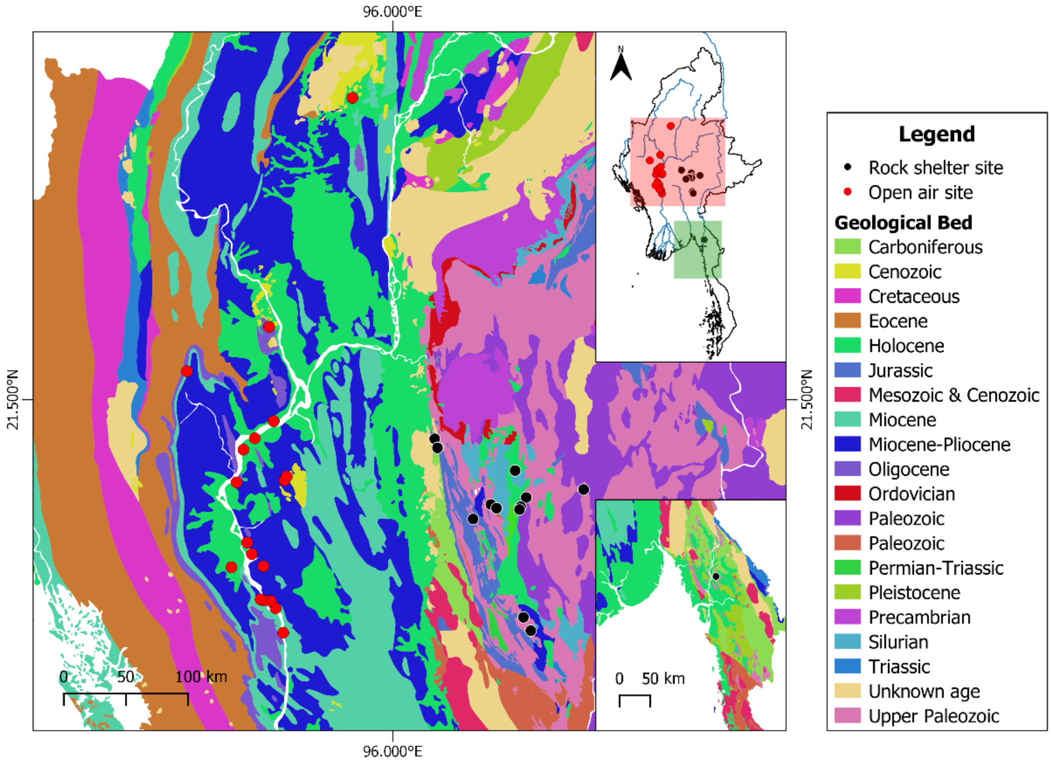
3.1.1.2 Shan plateau

Since higher primate fossils, Peking man and his descendants were found in the fissures and caves connected with karst relief, it was the reason why they choose to investigate in Shan plateau (de Terra 1943b:320). In search for early human occupation, de Terra conducted his fieldwork in northern Shan plateau whereas Movius undertook his survey works in southern Shan plateau. Unfortunately, the stratigraphy de Terra observed the potential places in northern Shan region showed no sign of associated prehistoric occupation, but Movius was able to indicate potential prehistoric hunter-gatherer sites in southern Shan plateau, excavated by later scholars (Tin Thein 2011). Recent genetic study indicates that there was an early human inland dispersal from Myanmar to China in 25~10 kya (Li *et al.* 2015:5-6). The chronology from three hunter-gatherer sites generally give earliest occupations had happened since ~30,000 cal BP, 25,000 cal BP and 13,000 cal BP (Aung Thaw 1971a; Schaarschmidt *et al.* in press) .

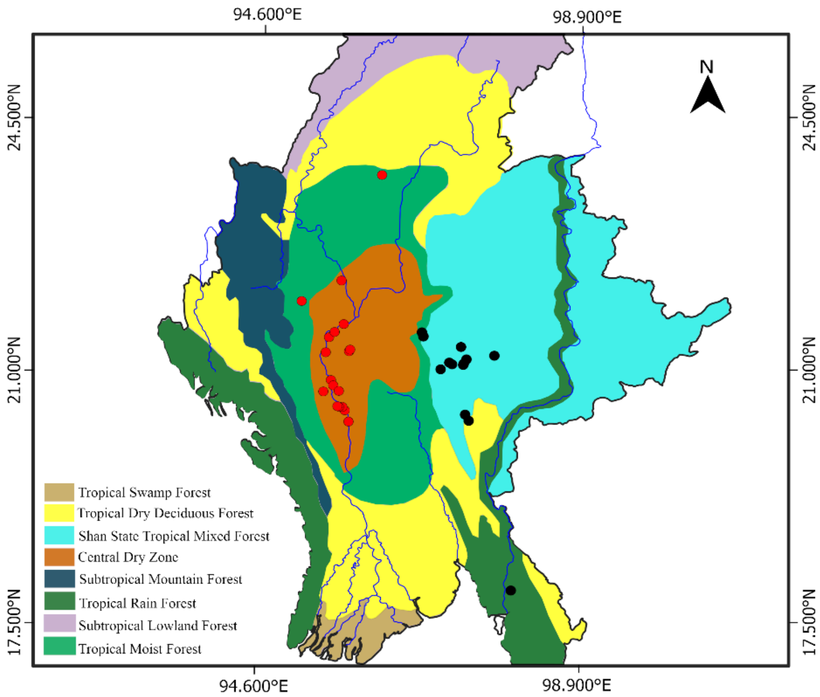
In contrast to central belt area, the settlement type of hunter-gatherer adaptation in Shan plateau is cave or rock shelter sites. It is located to the west of central belt, at least about 1300m above sea level, and the area is about 742.42km in length and 489.74km in width. Geological beds of Shan plateau are different from one area to another. The whole Shan plateau is generally composed of massive deposits of limestone, sandstone, metamorphic rocks, and granite (Huke 1965:4-5). The archaeological record at the rock shelter sites clearly show the exploitation of such kind of pebble for the production of lithic artefacts. However, hunter-gatherer sites from both areas share common use of igneous rocks and quartzite.

The area falls within subtropical monsoon and subtropical mountain climate with an annual precipitation over 1,524 mm. Natural vegetation is tropical upland mixed evergreen and deciduous hardwood forest, but some types of forests, like central belt, grow in the places where rainfall is less. Since Salween river divides the Shan plateau, the area near to the river course is tropical rain forest and inland swamp forest (Davis 1960:7). Almost all hunter-gatherer sites in this region are located on the western fringe of Shan plateau. Unlike to the sites in central belt, these sites are some distance to seasonal streams.

Accordingly, these two different ecological orientations provide moderate grounds for speculation about the Quaternary climate and the availability of raw material sources. It is necessary to understand the nature of these two regions where two different stone tool traditions have been found. In the other words, how different habitational patterns arose in response to different varieties of local environment. Therefore, these two main lithic traditions can be summarized as shown in table 3. 1.



Map 3. 2 showing regional geological bed and locations of hunter-gatherer sites (based on Myanmar Geosciences Society 2014)



Map 3. 3 Natural vegetation of Myanmar and locations of hunter-gatherer sites (Adapted from Davis 1960)

Table 3. 1 shows general characteristics of two lithic tradition in Myanmar (asl means above sea level) (Note: the chronology of both region is based on de Terra et al. 1943 and Schaarschmidt et al. 2018)

Topography	Lowland plain (near to main river resource)	Upland karstic region (some distance from water resource)
Elevation	ca. 50m *asl*	ca. ~130m *asl*
Natural vegetation type	Mostly dry zone and tropical moist forest	Shan state tropical mixed forest
Ecofact	Faunal remains (?)	Faunal remains
Site Type	Open air site	Rock shelter site
Typology	Crude and massiveness Lower flake percentage	Multidirectional flaking method, advanced in type and likely to be more effective Higher flake percentrage
Lithic culture	Chopper-chopping tool tradition	Pebble tool culture (Hoabinhian ?)
Dominant artefact type	Chopper, chopping tool, hand adze, scrapers	Unifacial tools, bifacial tools, cores and flakes
Raw material	Fossil wood, silicified tuff, chert, basalt, igneous rock and quartzite	Limestone, granite, sandstone, quatzite, rhyolite, siltstone and igneous rock
Period	Middle Pleistocene~early Holocene(?)	~30 ka

Figure 3. 1 shows the landscape of central plain. The gravel deposit in foreground is regarded as old river terrace and present river can be seen as a white on the upper rigth side in the background (Photo courtsey by Mr Win Kyaing)

Figure 3. 2 shows the landscape of Shan plateau and its surrounding. This photograph was taken from a limestone rock shelter site, known as Gu Myaung.

3.3 Conclusion

This chapter mainly focuses on the main differences of environmental setting of hunter-gatherer sites in central belt and Shan plateua. In turn, the environmental setting migh have been responsible for the emergence of different lithic tradition and hunter-gatherer behavioural pattern in both regions. Seemingly, it might have been also effected on the technology and subsistene pattern of the forager communitites from both region in the past.

Chapter 4

The evidences of faunal exploitation at hunter-gatherer sites in Myanmar

4.1 Introduction

Most archaeological literature dealt with prehistoric hunter-gatherer sites in Myanmar focus on cultural feature, technological achievement and settlement pattern of the site through lithic artefacts, but rarely discuss about subsistence pattern of the sites. In spite of the fact that hunter-gatherer response to their environment mostly rely on the artefacts, the associated ecological remains such as flora and fauna can greatly contribute for reconstructing what kind of environment in which hunter-gatherer communities adapted. This chapter, consequently, explores the faunal remains often discovered at the hunter-gatherer sites from central belt and Shan plateau.

As mentioned in the earlier chapters, lithic artefacts have been discovered since late 1870 to the recent time. Earliest descriptions about lithic artefacts became a controversial issue among the then scholars. The American expedition led by de Terra undertook a significant survey along the course of Ayeyarwady and southern Shan State (de Terra *et al.* 1943). Later archaeologists continue more research projects, and, hence, these projects (Ba Maw 1995; Tin Thein 1997,October,19; 1998; 2000; Tin Thein *et al.* 2001; Tin Thein 2011; Kyaw Khaing *et al.* 2012) in turn reveal several hunter-gatherer sites in both areas. These sites can be listed as follows Tin-Ain, Luyo Taung, Badahlin cave 1, Nwe Gwe Hill, Moegyobyin, Moebyel, Montawa, Mong Pawn, Suzaung Ganaing, Buddhaw Zinaw, Pe Kon, Myin Ma Hti and Loka Kone and Waiponla (see map 4. 1). These sites contribute new information as well as new perspective on hunter-gatherer sites across the country. In the other words, the main research questions of the projects emphasize on artefactual evidences, some scholars were able to document ecofactual evidence as well, despite the limited accessibility of information. Admittedly, hunter-gatherer sites from Shan plateau reflect ecological information than those of central belt because most faunal remains are well preserved in the stratigraphy of rock shelter sites with less disturbance.

4.2 Faunal evidences in hunter-gatherer sires: issues and problems

Dealing with the recovery of faunal remains, in fact, the taxonomic identification works were not able to carry out either during or post excavation because of the limited accessibility of techniques and skills; such event can be clearly occurred in the case of Badahlin cave 1 excavation. However, the excavators have tried to eliminate such weakness in the later excavations so that the taxonomic identification on the faunal remains has begun to undertake. For instance, the excavation at Waiponla cave and others in Shan plateau are good examples for that matter. Nevertheless, there are still some main barriers for the taxonomy of faunal specimens at the archaeological sites, such as experts, techniques and apparatus.

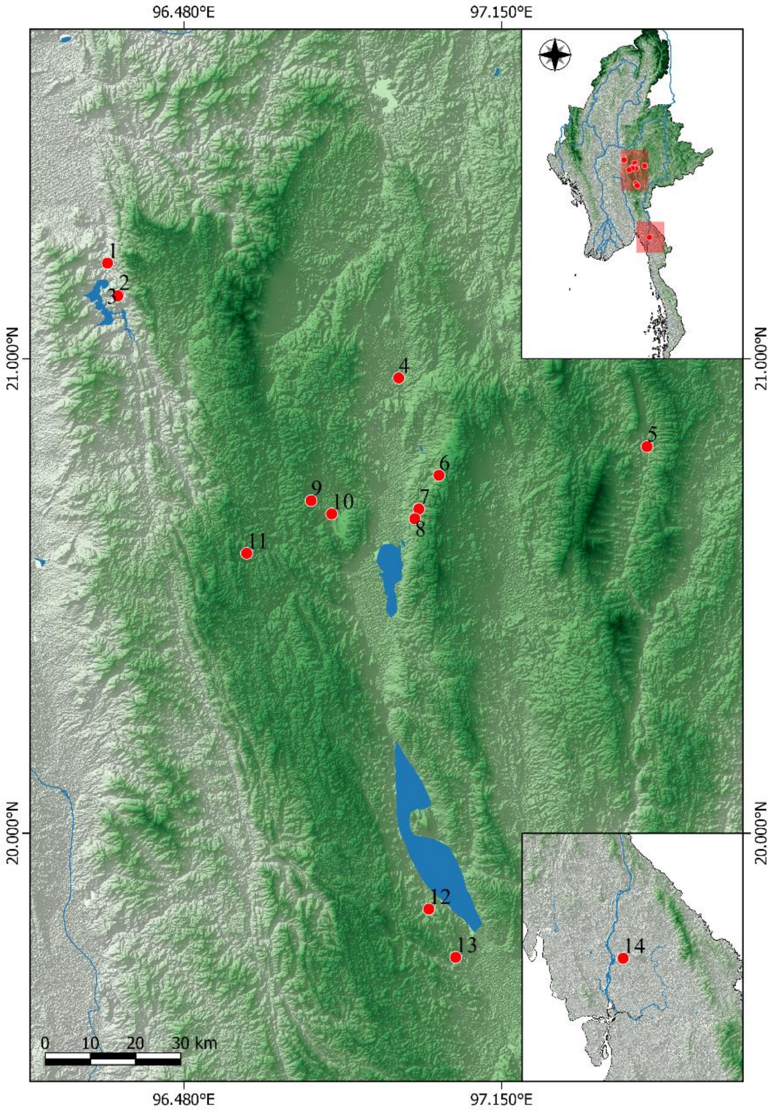
According to the concrete evidences, the ecofacts from the Palaeolithic sites mostly reflect which kinds of fauna were exploited by the hunter-gatherer communities from upland karstic region, although there are some limitations to state what kind of flora had been grown at the site and its vicinity. The discovery of fauna and flora at the archaeological site can contribute for reconstructing the climate and biota at the site in a specific occupational period. Consequently, the limited accessibility of information in the recording of ecofactual evidences is the major issue for reconstructing the environmental condition of the hunter-gatherer sites in Myanmar.

These hunter-gatherer sites in Myanmar can be characterized by two distinct features of settlement types: cave site and open air site. By and large the former one is often a well-preserved place for both artefacts and ecofacts left by the communities from the past while the latter one often suffers the disturbances of human and natural agencies. On the other hand, one of the most threatening issues of the prehistoric cave sites is the construction of religious monuments, which often limits for archaeological investigation (Movius 1943:38-390; Aung Thaw 1971a:127; Tin Thein *et al.* 2001:2; Kyaw Khaing *et al.* 2012). These modern works sometimes lead to unintentional destruction or covers the traces of prehistoric hunter-gatherer communities. Thus, it causes the great loose of the archaeological validity for the artefacts. Similarly, the open air sites are usually damaged in terms of both human and natural activities. Therefore, in spite of the durability of the stone artefacts themselves, the ecofacts directly concerned with them are fragile, perishable and extremely scarce.

4.3 Hunter-gatherer sites and associated faunal remains

4.3.1 Yenangyaung

Fritz Noetling was the very first contributors of lithic archaeology who described about stone artefacts and animal bones from Yenangyaung (known as "Oil Stream" in Myanmar). He (1894:101) claimed that the teeth of a hippopotamus were found along with the artefacts and he (1897a:242-249) contended worn femur of hippopotamus was also discovered at the spot where artefacts were uncovered three years later. He (1897a:248) suggested that the human agency was responsible for being scars on that remain. His descriptions were the debate among the scholars for being natural or artefactual remain of stone artefacts as well as the association of faunal remains (Brown 1931:31-37; Morris 1935:1-39). His discoveries stimulated the scholars for the future works in central belt. Morris (1935:1-4) also attempted to establish the whole sequences of material culture in terms of river terraces, but, it is too weak to construct the relationship between faunal remains and artefacts. The American expedition work (1943) also yielded no typical Anyathain site with associated faunal remains.



Map. 4. 1 showing the cave or rock shelter sites found in association with faunal remains. 1. Gu Myaung; 2. Badahlin 1; 3. Badahlin 2; 4. Luyo Taung; 5. Mong Pawn; 6. Montawa; 7. Suzaung Ganaing; 8. Tin Ain; 9. Buddhaw Zinaw; 10. Lonka Kone; 11. Myin Ma Hti; 12. Pe Kon; 13. Moebyel; 14. Waiponla

4.3.2 Tin-Ain rock shelter

Although no satisfactory data for ecological evidence at hunter-gatherer sites was found in central belt, Movius and his team were able to give an account for faunal remains exploited by hunter-gatherer communities in the past. They uncovered the animal bones through the excavation together with shells scattered in ash and charcoal reflecting the traces of human occupation (Bequaert 1943:431). In spite of the paucity of the artefacts, Movius (1943:390) articulated these bones were burnt and broken showing the nature of human exploitation rather than natural deposition. His statement was strongly recommended by a palaeozoologist Bequaert, the then a member of American expedition, who (1943:395,431) asserted these animal bones are wild species, not domesticated one. Also, he described that the fresh water shells belong to Taia intermedia and Brotia perscutlpta were not present at the site unless they were transported by human activity from the time of post-Pleistocene or perhaps recent age. In addition, Movius (1943:390) collected the faunal remains reflected the species such as hog deer (*Cervus porcinus*), Eld's deer or Thamin (*Rucervus eldii*), Sambar deer (*Rusa unicolor*) and an unidentified species of rhinoceros (*Rhinocerotidae*) at Tin Ain. And he also found the remains of cattle which is difficult to identify domesticated one or wild one or Banting *Bibos sondaicus*. Gorman (1971) convinced these faunal remains were related to the forager activities at Tin Ain. He also highlighted that these species were the similar to those exploited at the cave site in Southeast Asian regional context. In 2012, Kyaw Khiang and his colleagues (2012:11-13) excavated a test pit at the site, but no cultural nor faunal remains were detected since modern religious monuments inside the cave have destroyed the traces of cultural deposits.

4.3.3 Luyo Taung

Luyo Taung (formerly known as Ayū Taung which means "Bone Hill" in Myanmar) was excavated by the American Expedition team in 1937-38. They uncovered that fragmental pieces of bones and teeth of animals in the surface deposit which is 15-18cm in thickness. Most faunal remains are burnt, charcoal pieces and split angular pebbles. Due to highly fragmental condition, it is difficult to identify the cattle whether wild (*Bibos sondaicus*) or domestic (*Bos taurus*). In addition, a few remains of Eld's deer (*Cervus eldi*) were also found (Movius 1943:390). Tin Thein also unearths the site sometime around 1990s and yielded Palaeolithic artefacts and associated faunal remains. He observes that the faunal remains are very fragmented and mixing with cattle and deer species. He commented the dwellers at the site apparently avoided the carnivores than other games because there is no sign of carnivores bones at the site while it was found at Lonka Kone. Therefore, he concluded the site might have been occupied since the transition of Pleistocene/Holocene (Tin Thein 2011:183-185).

4.3.4 Badahlin cave 1

In 1969, a Department of Archaeology team led by Aung Thaw (Aung Thaw 1969a; 1971a) recovered a substantial animal bone assemblage in association with 1600 stone artefacts, a few pieces of charcoal, some fragments of pottery and red ochre in Badahlin cave 1 (known as "Bright Mercury" in Myanmar), Shan State. Prehistoric rock art was also identified on the cave walls (Aung Thaw 1971a:127-129; Taçon *et al.* 2004; Than Tun 2004). Different scholars have associated the cultural remains from Badahlin 1 to the upper Palaeolithic (Than Tun 2004:41-42), Mesolithic (Myint Aung 2000:1-16) and to the Neolithic (Aung Thaw 1971a:123-133). Of the seven radiocarbon dates published by Aung Thaw (1971a:133) the oldest is 13,400±200 BP (R2547/5B) suggesting that at least some of the human occupation probably dates to the Pleistocene-Holocene transition (the youngest age is 1750±81 BP R2547/1). Little systematic zooarchaeological analysis has yet been undertaken on the bone from Badahlin Cave, and Aung Thaw (1971a:129) points out bone fragments and teeth of mammalian animals, land molluscs shells, a skull of probably a deer and a few fragments of tortoise shells are discovered. Mya Muang (1971) has suggested that that the majority of vertebrates were herbivorous artiodactyl species along with some aquatic species (shellfish). In addition, Aung Thaw (1971b:321) describes that the zoologist assumes these faunal remains are wild species, not domestic ones. The anthropologist Sein Tun (1971:366), then a member of the team, also convinces these remains are probably to be wild species. All appear to have been hunted and collected by hunter-gatherers inhabiting the cave since these faunal remains were unearthed in association with cultural remains at the same contexts. Along with Badahlin cave 1, Badahlin cave 2 and Gu Myaung cave were recently excavated by Marwick and his colleagues. Bone fragments, aquatic faunal remains were also discovered (Marwick 2016; Schaarschmidt *et al.* in press). Schaarschmidt *et al.* (in press) conclude that pIRIR dates go back to some ~30 ka and 25 ka for the latter two caves respectively. Excavation report is under prepared so that further results on the analysis of faunal remains are still awaiting. Detail discussion about the evidences are conducted in chapter 7.

4.3.5 Nwe Gwe Hill and Moegyobyin

In 1981, Ba Maw (1995:76) also discovered a fossilized mandible fragment that he identified as Homo erectus in association with wild boar (*Sus sp.*) and dog (*Canis sp.)* remains at Nwe Gwe Hill (known as "Coiled Vine" in Myanmar) in Chaung U Township. According to the taxonomic list, at least 'six classes' of faunal remains were discovered in association with flaked stone artefacts (Ba Maw 1995:76). Ba Maw (1995:74) claimed a date of 200,000 years for these finds, but there has been no absolute dating obtained for the site and no verification of the authenticity of the hominin identification. The possibility of additional Homo erectus remains highlights the research potential of this location, but no additional work has been carried out to date. Ba Maw also collected stone artefacts and animal bones from nearby Moegyobyin (knon as "Thunderbolt Plain"). These faunal remains were studied by Nwe Nwe Moe (2014), who attempted to interpret patterns of human activity and subsistence strategies using taxonomic identification and community composition. The analysis was hindered by the highly fragmented nature of the bone assemblages, but the dominant taxa appear to have been Bovidae and Suidae (Nwe Nwe Moe 2014:54-55). A single specimen exhibited butchery marks, suggesting that people were almost certainly responsible for the accumulation of at least some of the remains. An outstanding problem once again was the difficulty in dating the animal bone assemblages. They were all collected as surface finds and it is possible that they represent a palimpsest that developed over a considerable time period. Therefore, the provenance and association of the faunal remains and lithic artefacts at Nwe Gwe and Moegyobyin sites requires further verification by systematic stratigraphic excavations and chronometric dating.

4.3.6 Moebyel Cave

Moebyel Cave, also known as Kyar Taung ("Mt. Tiger" in Myanmar) cave, has produced a zooarchaeological assemblage in association with stone tool culture including pebbles probably used for raw materials, stone rings and scrapers (Neolithic material culture including polished and ground stone adzes), estimated to be between 6000-4000 years old (Tin Thein 2011:134). Tin Thein excavated the site in 1997 and he (2011:184) argued that the foragers frequenting Moebyel Cave hunted a variety of herbivorous and carnivorous species, including Gaur (*Bibos gaurus*), cattle (*Bibos sondaicus*), Barking deer (*Munjacus munjak*), Eld's deer (*Rucervus eldi*), Sambar deer (*Rusa unicolor*), cats (Felis sp.), gibbons (*Hylobates*), porcupine (*Hystrix*), and wild boar (*Sus scrofa*). Human remains included the molar of a child and two teeth of an adult. In the following year 1998, Hla Gyi Mg Mg and his colleagues also conducted the excavation at the site again (see figure. 4. 1). They also discovered a few species of faunal remains and some lithic artefacts especially stone rings and pebbles (Hla Gyi Mg Mg *et al.* 1998:10). Most faunal species, as shown in table 4. 1, are similar to the results of Tin Thein's analysis. The structure of the captured fauna shows marked differences from that identified at Luyo Taung, and it is possible that this indicates the application of disparate subsistence strategies at the two caves and raises questions about what caused the differential representation of carnivores at Moebyel Cave.

Table 4. 1 showing the species names and quantity of the remains at Moebyel cave (Based on Tin Thein 2011)

Name	Scientific Name	Body Part	Quantity
Cattle	*Bibos sondaicus* (?)	Teeth	9
Sambar deer	*Rusa unicolor*	Teeth	3
Eld's deer	*Rucervus eldi*	Molar	3
		Lower incisor	1
Barking deer	*Munjacus munjak*	Hoof	1
Tiger	*Felis tigris*	Upper palate	1
		Teeth	2
Bear	Not defined	Teeth	1
		Total	21

4.3.7 Motawa and Mong Pawn

Both caves were explored by American expedition in1938 (Movius 1943:389-391), but now modern religious building is built inside the former one in which some fragments of chord-marked potsherds were found. Except for a greenstone chip, no other cultural material remains was yielded. In addition, the last upper molar of a domestic sheep was uncovered at the depth of 25cm. Two species of shells such as *Melanzoides tiuberculata* and *Brotia variabil* were also recovered. Allen, the zoologist commented that these shells are edible so that Movius concluded these shells might have been brought for food by the people (Movius 1943). In 2012, Kyaing Khaing and his colleagues revisited to the cave and undertook an excavation at the site. In contrast to previous work, no satisfactory results except for a lithic artefact and a few potsherds were yielded (Kyaw Khaing *et al.* 2012:19-20). It is possible that modern human activities might have harmed the cultural deposit.

Similarly, a rock shelter near Mong Pawn was excavated by using a small 1m grid, until 75cm in depth. Some cultural remains such as 8 broken pebbles, 2 pieces of quartz, 1 pointed limestone flake, numerous land shells including *Brotia baccata* and *Sulcospira praemordica* and numerous fragments of bones were uncovered. Movius remarked this rock shelter might have been occupied during post-Pleistocene (Movius 1943:391). Both caves reflect the evidences of land shells, probably exploited by the cave habitants while fresh snails were presumably exploited at Tin Ain cave.

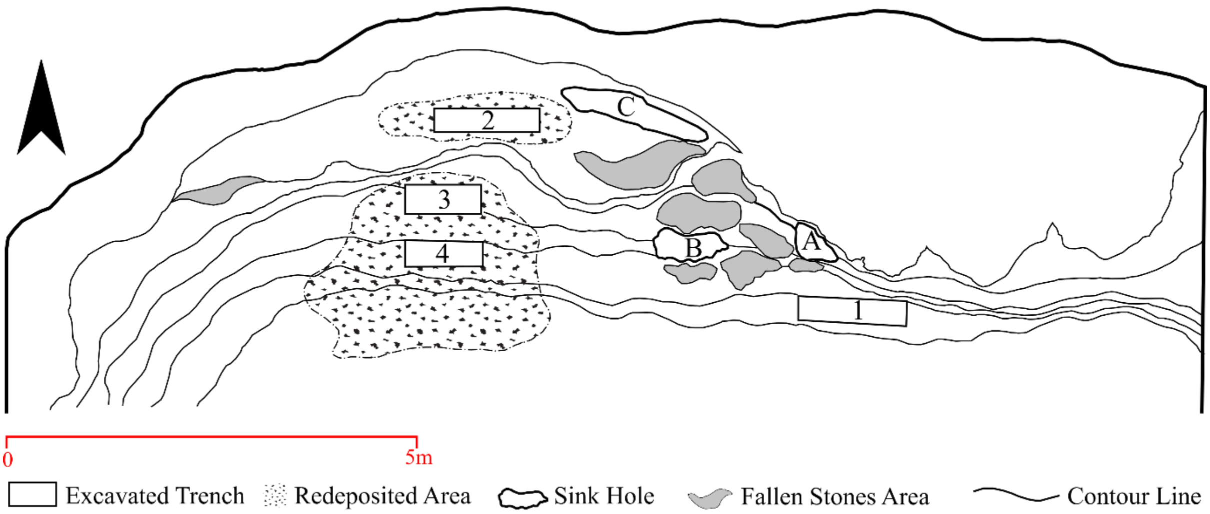


Figure 4. 1 Excavation trenches and plan of Moebyel cave (Adapted and modified from Hla Gyi Mg Mg et al. 1998)

4.3.8 Suzaung Ganaing and Buddhaw Zinaw

Suzaung Ganaing ("Thorny Forest" in Myanmar) cave is closely located to Tin Ain, excavated by Kyaw Khaing and his colleagues in 2012 (see figure 4. 2). Several number of faunal remains including bone fragments, jaw and teeth of unidentified mammalian animals, cattle and deer are found along with a few lithic artefacts in three main stratigraphic layers as shown in figure 4. 3 at the site (Kyaw Khaing *et al.* 2012). Moreover, Kyaw Khaing (2012:14) argues that the site might have been occupied from prehistoric to early historical time since stone beads probably from early urban age. He also admits that the excavation is too limited because two local monks now live at the site. Anyway, the remains are needed to do further analysis and what kind of faunal had been exploited by the occupants.

Buddhaw Zinaw ("Protection Buddha" in Myanmar) has drawn the attention of academic scholars since 1997 when local people frequently reported the discovery of semi-fossilized remains of mammalian species (Tin Thein 2011). Tin Thein (2011:18) claims that the site might have been a good location to choose for occupation since it possesses good ventilation and lighting, no sinkhole but safe to use as a shelter, slightly elevated place and a large pond once closely existed to the site. Therefore, he and his colleagues excavated at the site and they discovered the faunal remains associated with lithic artefacts such as stone rings and pebbles for raw materials. These artefacts were produced from sandstone, siltstone and quartz. Excavated faunal remains contain gaur (*Bibos gaurus*), gaur (?) (*Bibos bantang*), Eld's deer (*Rucervus eldi*), Barking deer (*Munjacus munjak*), Sumatran serow (*Capricornis sumatraensis*) and boar (*Sus scofa*) (Tin Thein 2011). Tin Thein (2011:119) suggests lithic artefacts found at the site are probably from 6000 to 4000 years ago. Kyaw Khaing and his colleagues revisited and excavated at the site in 2012 (see figure 4. 4). They also recovered several number of faunal remains including a fragment of human skull and higher percentage of fragmental pieces of animals remains showing signs of burning and butchering process. It is remarkable that all bone fragments are semi-fossilized. Subsequently, lithic artefacts and several potsherds with or without chord marks. He (2012:18) contends that the foragers occupied at the site might have been moved from Badahlin cave because a hand axe made of schist was found at the site and such kind of raw material is the same with those from Badahlin. However, further evidence is needed to prove a group of hunter-gatherers mobility from Badahlin to Buddhaw Zinaw.

4.3.9 Pe Kone

Like Buddhaw Zinaw, Pe Kon rock shelter came to the forefront of academic worker's interest due to the discovery of lithic artefacts and faunal remains reported by local people. Therefore, Tin Thein and his colleagues surveyed to the site and excavated at the site (see figure 4. 5). They found numerous fragmental pieces of bones and antler remains showing the species of *Bovidae sp.*, *Cervidae sp.* and molluscs with stone rings and pebbles at the first 110cm in depth. However, no cultural materials were found at 120cm and 130cm, but faunal evidences still remain (Tin Thein 2011). Tin Thein (2011:159) maintains that the site might have been a favourable niche for a group of hunter-gatherer in stone age.

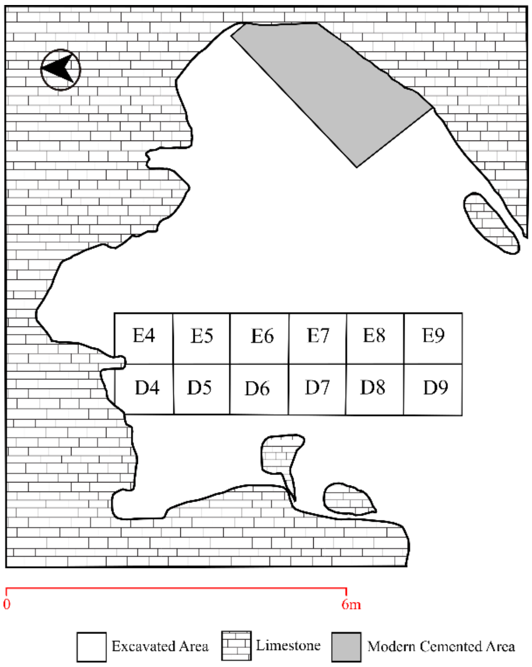


Figure 4. 2 Plan view of excavation at Suzaung Ganaing (Adapted and modified from Kyaw Khaing et al. 2012)

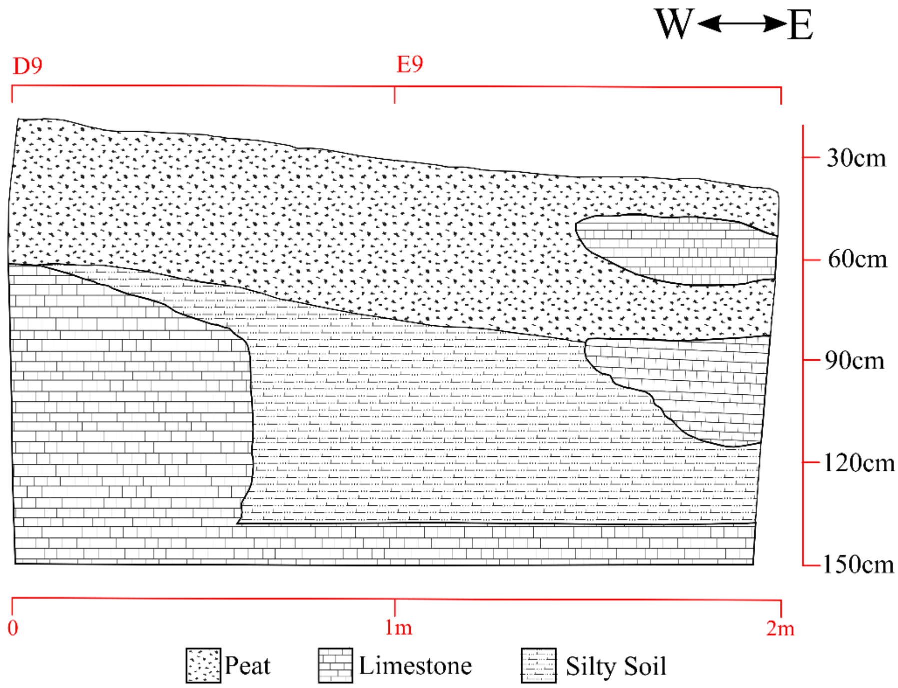


Figure 4. 3 Western soil profile of grid No. D9 and E9 at Suzaung Ganaing (adapted and modified from Kyaw Khaing et al. 2012)

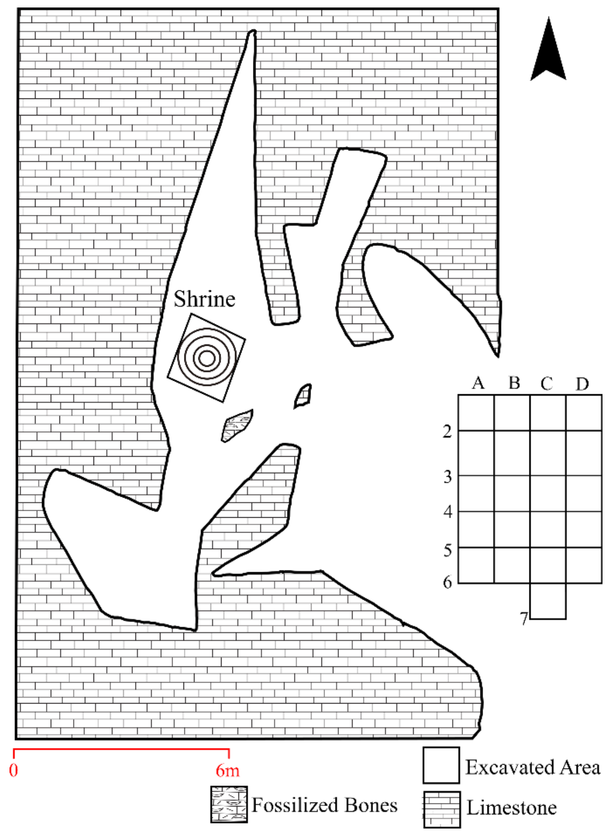


Figure 4. 4 Plan view of Buddhaw Zinaw and excavated grids (Adapted and modified from Kyaw Khaing *et al.* 2012)

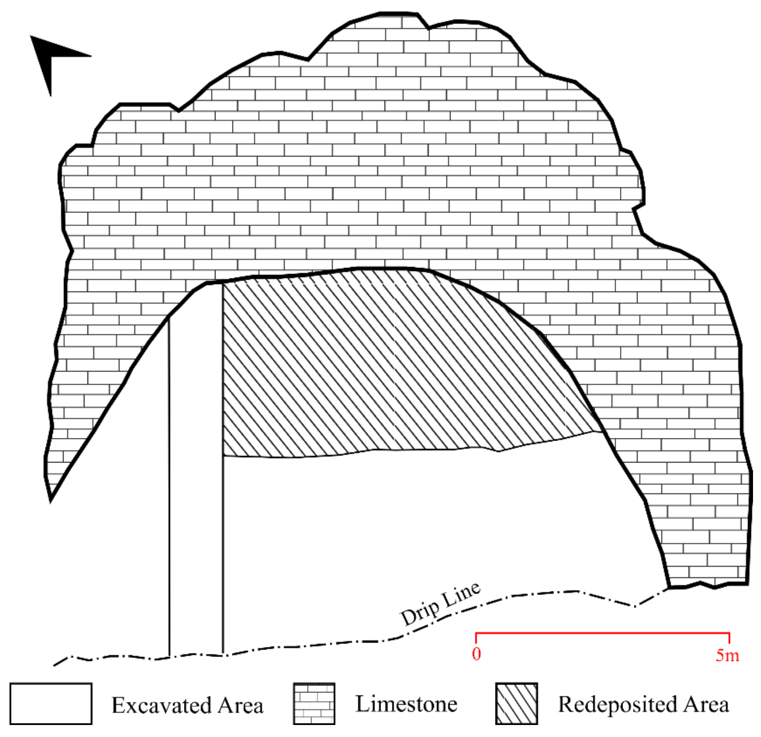


Figure 4. 5 Plan view of excavation at Pe Kone rock shelter (Adapted and modified from Tin Thein 2011)

4.3.10 Myin Ma Hti and Lonka Kone

Much evidences of faunal remains also come from those two rock shelter sites known as Myin Ma Hit and Lonka Kone. The excavation at the former one yielded some lithic artefacts such as stone rings, scrapers and pebbles in association with bone fragments of deer (*Rucervus eldi*), Samber deer (*Rusa unicolor*), cattle (*Bos Taurus*), porcupine (*Hystrix*), rhinoceros (*Rhinoeros sp.*), boar (*Sus scofa*) and human teeth. Furthermore, several number of mollusc shells were also found. The site is suggested that it would belong to 6000 to 4000 years ago (Tin Thein 2011:141-153).

The excavation at Lonka Kone uncovered numerous fragmental pieces of following faunal remains_ cattle (*Bovidae sp.*), *Cervidae sp.*, deer (*Rucervus eldi*) and samber deer (*Rusa unicolor*), hog (Suidae sp.), rhinoceros (*Rhinocerotidae*), feline (*Felis sp*.), turtle (*Chelonia sp*.), monkeys (*Macque sp.*) and even a dog skull. Along with these faunal remains, some cultural remains such as lithic tools, bone tools and sharpen wooden sticks were also found. Tin Thein (2011:168) explains that these materials show good condition of well preservation since peat soil prevents oxygen penetration. He also suggests that site might belong to late Neolithic society. However, no agricultural tools at the site was found and hence his hypothesis should be reconsidered.

4.3.11 Waiponla

Waiponla, a limestone cave in Kayin State, excavated by Tin Thein and his colleagues in 2000, offer a great number of faunal remains, ranging from mammalian games to aquatic animals (Tin Thein *et al.* 2001:99; Tin Thein 2011). They yielded a layer, "cal-tufa bed" in his verbatim, containing faunal remains and lithic artefacts (Tin Thein *et al.* 2001:2). Tin Thein suggests that the faunal remains were deposited by prehistoric occupants who discarding them after they were processed and consumed as food (Tin Thein 2011:100-101). The date of prehistoric human occupation of Waiponla Cave is claimed by Tin Thein *et al*. (2001:5), to be around 12,000 to 6,000 years ago based upon the similarity of stone artefact typology with Badahlin cave 1, which has radiocarbon dates extending back to the terminal Pleistocene (see above, Myint Aung 2000:9). Identified species include barking deer (*Muntiacus muntjak*), Eld's deer (*Rucervus eldi*), Sambar deer (*Rusa unicolor*), Gaur (*Bibos gaurus*), wild boar (*Sus scofa*), fish (*Pisces*) and turtle (*Chelonii/Testudines*) (Tin Thein *et al.* 2001:3-4) , but no quantitative information on the composition of the vertebrate community is available. Due to the quality of the zooarchaeological record from Waiponla the site is considered extremely significant and could produce substantial new information on Southeast Asian foragers, similar to Pleistocene-Holocene cave sites like Ma U'Oi Cave, northern Vietnam and Tham Lod Rock shelter, Thailand (Bacon *et al.* 2004:309-312; Shoocongdej 2006:22-37).

4.4 Information through the faunal remains at hunter-gatherer sites

Although taxonomic identification of faunal remains found at the sites have been conducted, it needs to summarize the species of exploited fauna at hunter-gatherer sites. The faunal remains so far identified can be generally divided into two main groups_ vertebrate and invertebrate. The vertebrate group includes twenty-three species while invertebrate group contains eight species. As shown in figure 4. 6, maximum number of faunal species are found at Lonka Kone and Moebyel than other hunter-gatherer sites, whereas least number of faunal could be identified at Badahlin cave 1. The second largest number of faunal species are found at Myin Ma Hti, Tin Ain, Waiponla and Buddhaw Zinaw. The second least number of identified faunal species are found at Luyoe Taung, Pe Kon, Montawa, Mong Pawn and Moegyobyin. However, recent excavation at Badahlin cave 2 and Gu Myaung still await for the results of identified faunal remains.

Dealing with animal species, the most exploited faunal remains found at the sites are deer (*Rucervus eldi*), boar *(Sus scrofa*) and sambar deer (*Rusa unicolor*) which are 8, 6 and 5 in number respectively. Unidentified *Bovidae sp.* are also found at the sites (see table 4. 2 and table 4. 3). Other mammalian species are less than four in quantity. Molluscs shell are usually found in almost hunter-gatherer sites, some are fresh water species while some are land shells. Most shells remain are easily fragile and usually found into pieces and thus it seems to be difficult for identification. Therefore, the excavators could not give detail account for the shell. Some species are generally considered as gastropod species. These species are strongly suggested that they are closely related with those of early occupational sites in elsewhere of Southeast Asian context (Conrad 2015).

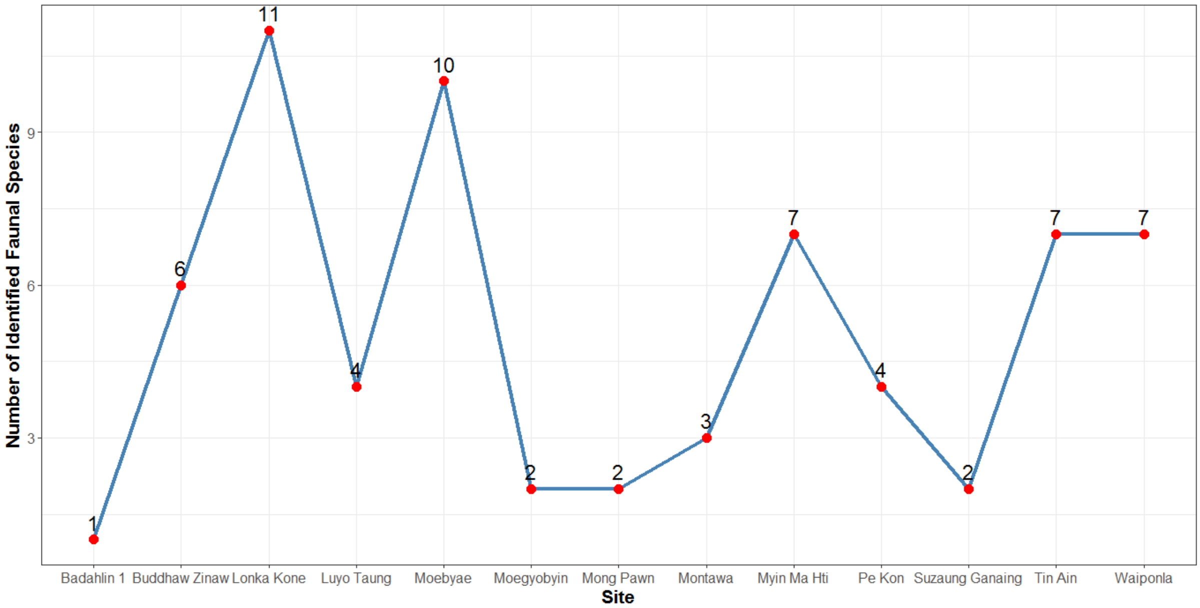


Figure 4. 6 Frequency of faunal species at hunter-gatherer sites in central belt and Shan plateau

As shown in the table. 4. 3, the evidence of faunal exploitation is very scarce in the typical Anyathian sites in the central belt of Ayeyarwady basin because it depends upon the absence of excavation and site formation process. Moreover, it seems the geographical implication also effected at the sites. According to the evidences comes from the excavation, the dominant faunal species mostly exploited in the karstic region are Artiodactyla and Perissodactyla, the terrestrial mammals are dominant. Artiodactyla animal includes Cervidae, Bovidae and Suidae and the traces of Reptilia and Pisces species were also discovered in the karstic sites. Similarly, Suidae and Bovidae might have been exploited in riverine sites such as Moegyobyin for their subsistence economy. It should be noted that the future excavation works will uncover the evidences of fauna exploited at the riverine sites more detail. These above-mentioned species have been applied in the subsistence pattern between middle Pleistocene and Holocene period. The fragmentary pieces of fauna and some burnt in nature show these might have been hunted and exploited.

4.5 Conclusion

In order to reconstruct the human behavioural pattern response to the environment, it is necessary to know the fauna and flora that grown in the specific region of the site. This chapter has presented faunal evidences found at hunter-gatherer sites in central belt and Shan plateau. Depending on the site formation process and disturbances, however, open air sites in Myanmar have too little chance to discover the ecofactual remains without excavation, but yielded evidences from cave sites can contribute the information to reconstruct their subsistence pattern as well as the environment undergone in the past. Yet, no floral evidence has been reported as far, a few faunal remains partially contribute the subsistence pattern of prehistoric hunter-gatherer sites from the late Pleistocene to middle Holocene. On the other hand, recent excavations at Badahlin 2 and Gu Myaung caves have found several numbers of faunal remains associated with lithic artefacts and the results are being awaited. Although there are some challenges in the discovery and recording of ecofactual evidences in Myanmar, a few evidences in hand can partially indicate which biota they have experienced and exploited at hunter-gatherer sites, especially in karstic region.

Table 4. 2 List of identified faunal remains at hunter-gatherer sites (Japanese names are kindly translated by Miss Tomomi Nakagawa)

No	綱	Class	目	Order	科	Family	学名	通称	English Common Name	個体数 (Population)
1	哺乳	Mammalia	霊長	Primate	オナガザル	*Cercopithecidae*	*Macquae*	旧世界ザル	Old World Monkey	1
2					テナガザル	*Hylobatidae*	*Hylobate sp.*	サル	Monkey	1
3			齧歯（ネズミ）	Rodentia	ヤマアラシ	*Hystricidae*	*Hystrix*	ヤマアラシ	Porcupine	2
4			食肉（ネコ）	Carnivora	Carnivore	*Carnivore*	Carnivores	Carnivores	Carnivores	-
5					ネコ	*Felidae*	*Felis tigris*	トラ	Tiger	1
6							*Felis sp.*	ネコ	Cats	1
7					イヌ	*Carnidae*	*Cardinae sp.*	イヌ	Dog	1
8			奇蹄	Perissodactyla	サイ	*Rhinocerotidae*	*Rhinocerotidae sp.*	サイ	Rhinoceros	3
9			偶蹄	Artiodactyla	シカ	*Cervidae*	*Cervidae sp.*	ウシ/バッファロー/ヤギ	Cattle/Buffalo/Goat	2
10							*Muntiacus muntjak*	インドキョン	Indian Muntjac	3
12							*Cervus porcinus*	ブタシカ	Hog deer	1
13							*Rucervus eldi*	ターミンジカ	Eld's deer	8
14							*Rusa unicolor*	サンバー	Sambar deer	5
15					ウシ	*Bovidae*	*Bovidae sp.*	ウシ/バッファロー/ヤギ	Cattle/Buffalo/Goat	4
16							*Bibos gaurus*	インドヤギュウ	Gaur	2
17							*Bibos sondiacus*	ウシ	Cattle	2
18							*Bibos banteng*	バンテン	Banteng	1
19							*Bos Taurus*	ウシ	Cattle	1
20							*Bovine*	ウシ/バッファロー/ヤギ	Cattle/Buffalo/Goat	-
21							*Capricornis sumatraensis*	スマトラカモシカ	Sumatran Serow	1
22					イノシシ	*Suidae*	*Sus scrofa*	イノシシ	Boar	6
23	弁鰓/腹足	Bivalvia/ Gastropoda	弁鰓/腹足	Bivalvia/ Gastropoda	キバウミニナ	*Cerithioidea*	*Melanoides tuberculate*	貝	Shell	1
24					カワニナ	*Pachychilidae*	*Brotia variabilis*	貝	Shell	1
25							*Brotia persculpta*	貝	Shell	1
26					?	*?*	*Pelecypod*	二枚貝	Bivalve	1
27					?	*?*	*Gastropod sp.*	貝	Shell	5
28					?	*?*	*Taia intermedia*	貝	Shell	1
29							*Sulcospira praemordica*	貝	Shell	1
30							*Brotia baccata*	貝	Shell	1
31	爬虫	Testudines	爬虫（カメ？）	Testudines	アオウミガメ	*Chelonidae*	*Chelonia sp.*	カメ	Turtle	3

Table 4. 3 Hunter-gatherer sites and their associated identified faunal remains (Japanese names are kindly translated by Miss Tomomi Nakagawa)

Site	Date	Period		Mammals																						Reptile							Acqu -atic	To tal	Source
			Bibos gaurus (インドヤギュウ)	**Bibos sondiacus (ウシ)**	**Bibos banteng (バンテン)**	**Bovidae sp. (ウシ/バッファロー/**	**Bos taurus (ウシ)**	**Capricornis sumatraensis (スマトラカモシカ)**	**Rucervus eldi (ターミンジカ)**	**Rusa unicolor (サンバー)**	**Cervidae sp. (ウシ/バッファロー/**	**Muntiacus muntjak (インドキョ**	**Ovis aries (羊)**	**Cervus procinus (ブタシカ)**	**Suidae sp. (イノシシ)**	**Sus scrofa (イノシシ)**	**Rhinocerotidae (サイ)**	**Felis tigris (トラ)**	**Felis sp. (ネコ)**	**Canidae sp. (イヌ)**	**Macque sp. (旧世界ザル)**	**Hylobate sp. (サル)**	**Hystrix (ヤマアラシ)**	**Chelonia sp. (カメ)**	**Taia intermedia (貝)**	**Brotia persculpta (貝)**	**Melanoides tuberculate (貝)**	**Brotia variabilis (貝)**	**Gasterpod sp. (貝)**	**Brotia baccata (貝)**	**Sulcospira praemordica (貝)**	**Pelecypod sp. (貝)**	**Pisces sp. (魚種)**		
Badahlinin 1	1969	13,000 cal BP		Unidentified mammalian animals																				√					√					2	Aung Thaw 1971
Bhddhaw Zinaw	1997	6000~ 4000 yrs*	√		√			√	√			√				√																		6	Tin Thein 1997; Tin Thein 2011
Lonka Kone	1990s(?)	Late Neolithic(?)				√			√	√					√	√	√		√	√	√			√					√					11	Tin Thein 2011
Luyo Taung	1939-1940, 1990s(?)	Early Palaeolithic(?)				√			√		√																		√					4	Movius 1943; Tin Thein 2011
Moe Byae	1998	6000~ 4000 yrs*	√	√					√	√		√				√		√	√			√	√											10	Hla Gyi Mg Mg *et al.* 1998; Tin Thein 1998; Tin Thein 2011
Moegyobyin	1995, 2014	>50,000 yrs*				√										√																		2	Ba Maw 1995; Nwe Nwe Moe 2014
Mong Pawn	1939-1940	Post-Pleistocene																												√	√			2	Movius 1943
Montawa	1939-1940, 2012	Neolithic (?)											√														√	√						3	Movius 1943; Kyaw Khaing *et al.* 2012
Myin Ma Hti	2004(?), 2012	6000~ 4000 yrs*					√		√	√						√	√						√						√					7	Tin Thein 2011
Pe Kon	1983	Stone Age				√					√																		√			√		4	Tin Thein 2011
Suzaing Ganaing	2012	Stone Age				√			√		Unidentified mammalian animals																							2	Kyaw Khaing *et al.* 2012
Tin Ain	1939-1940, 2012	Pleistocene ~ Holocene		√					√	√				√			√								√	√								7	Movius 1943; Kyaw Khaing et al. 2012
Waiponla	2000	12,000~ 6000 yrs*	√						√	√		√				√								√									√	7	Tin Thein *et al.* 2000
Total			3	2	1	5	1	1	8	5	2	3	1	1	1	6	3	1	2	1	1	1	2	3	1	1	1	1	5	1	1	1	1	67	

Chapter 5

Spatial distribution pattern of hunter-gatherer sites in central belt and Shan plateau

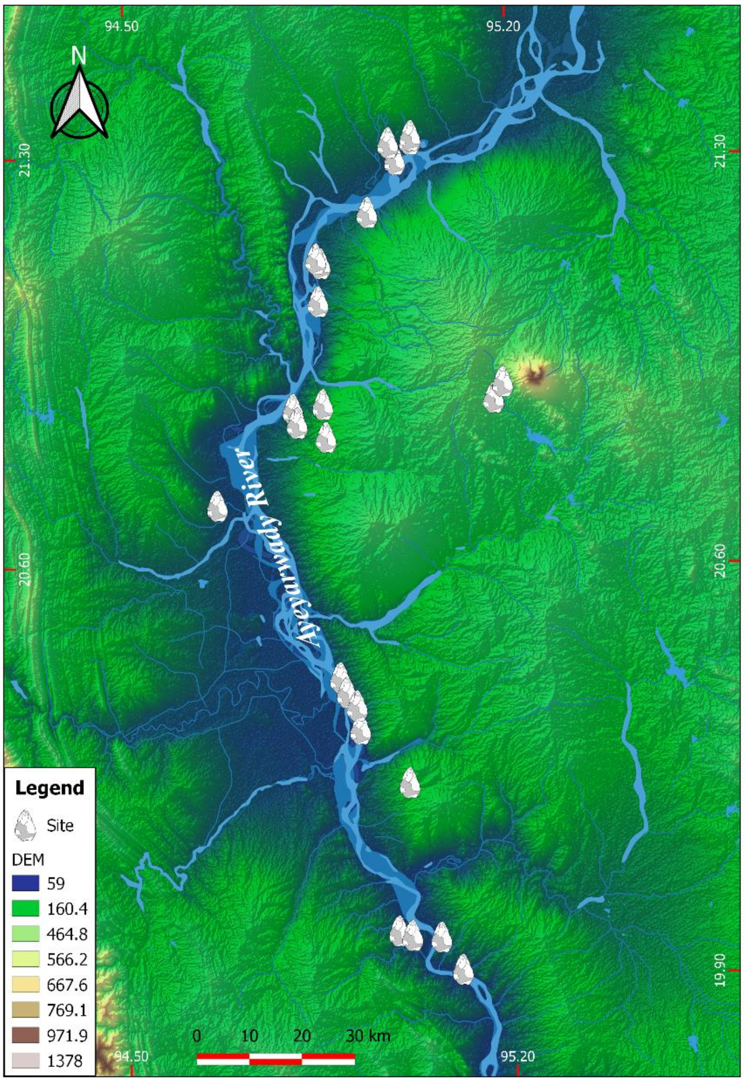
5.1 Introduction

Previous chapter presents the environmental setting of central belt and Shan plateau where prehistoric hunter-gatherer sites are located. It is suggested that current environmental factors partially indicate that both regions probably underwent different environmental background, and, in turn, these factors were the most basic features which stimulated different lithic traditions in the regions. Due to these background conditions, it is interesting to study the spatial distribution pattern of prehistoric hunter-gatherer sites in the country, since, on the other hand, former studies mainly focused on lithic artefacts in the region. Therefore, this chapter intends to present spatial distribution pattern of prehistoric hunter-gatherer sites in central belt and Shan plateau with their different environmental background, although chronological framework for both regions are different. And it will attempt to explore how they distribute in a particular region and to conduct the comparative studies among the sites in both regions.

5.2 Materials and method

The development of landscape archaeology in Myanmar is still in its infancy when it is compared with those in regional context. Although there are a few studies of landscape archaeology concerning with historical urban cities (Thin Kyi 1966; Stargardt 1990; Hudson 2004; San Shwe 2008), there is no archaeological study dealt with spatial distribution pattern of hunter-gatherer sites in Myanmar. Therefore, popular Geographical Information System (GIS) method has been used to know the distribution of prehistoric hunter-gatherer sites. These two main geographical areas for hunter-gatherer sites, as mentioned in chapter 3, are located on the lowland and upland respectively. The area where prehistoric hunter-gatherer sites exist in central belt falls between North latitude 19.7754 to 21.47875 and East longitude 94.2945 to 95.65041 (map 5. 1). Similarly, the area where prehistoric hunter-gatherer sites located in Shan plateau lies between North latitude 19.5445 to 21.4604 and East longitude 95.9362 to 98.1245 (map 5. 2). As a raster dataset, 30 x 30m resolution Digital Terrain Model (DTM) images are mosaiced and generated for spatial data of the hunter-gatherer sites in the areas under the same projection WSG84 (Japan Aerospace Exploration Agency Earth Observation Research Center 2017). GPS locations of these sites are input and calculated with DTM to know their respective elevation and slope values. Moreover, these sites based on geological map of Myanmar

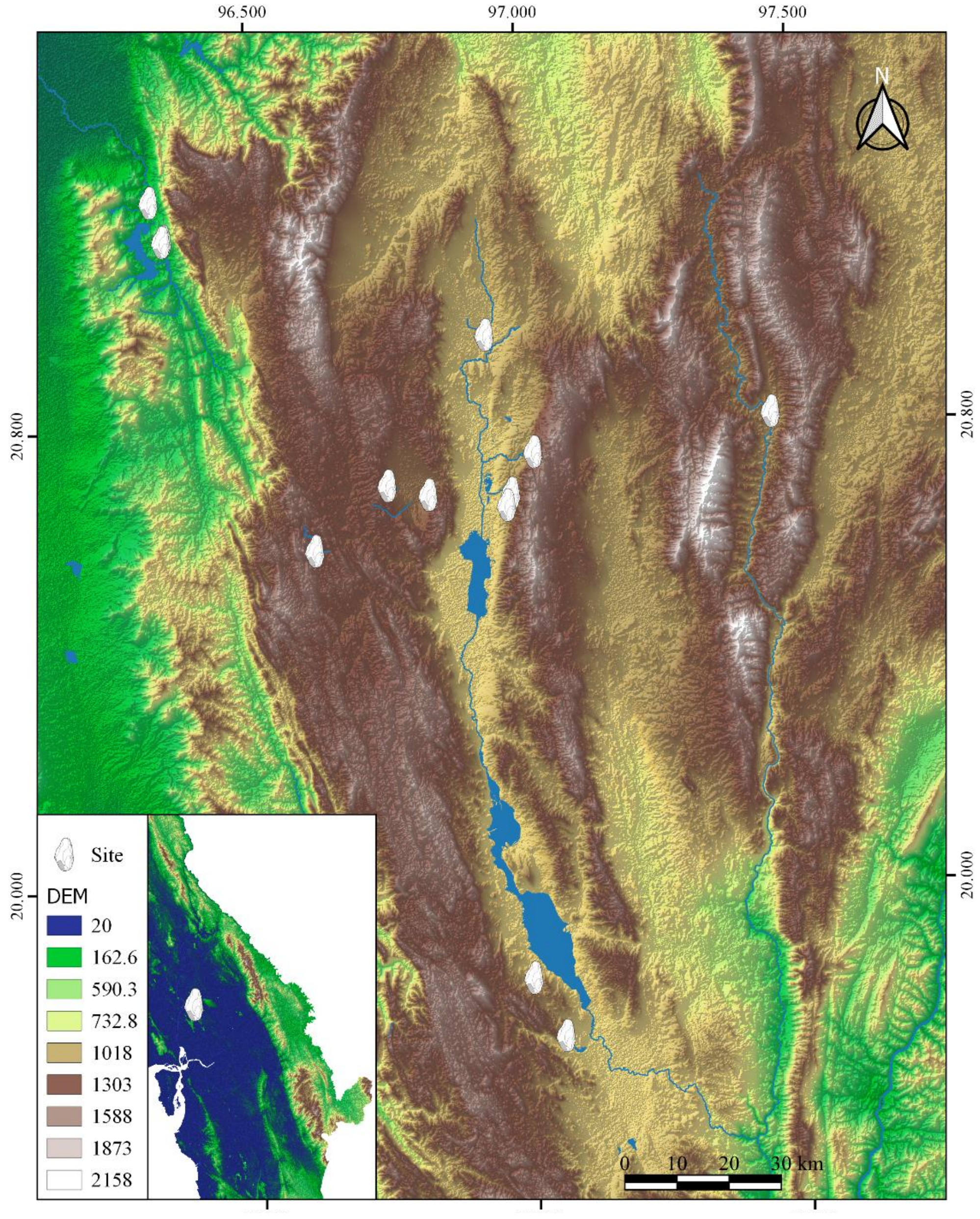
(Myanmar Geosciences Society 2014) are explored for the distribution of pattern of the sites and local geological setting. It is very important to know how they acquire raw materials for the production of lithic artefacts.



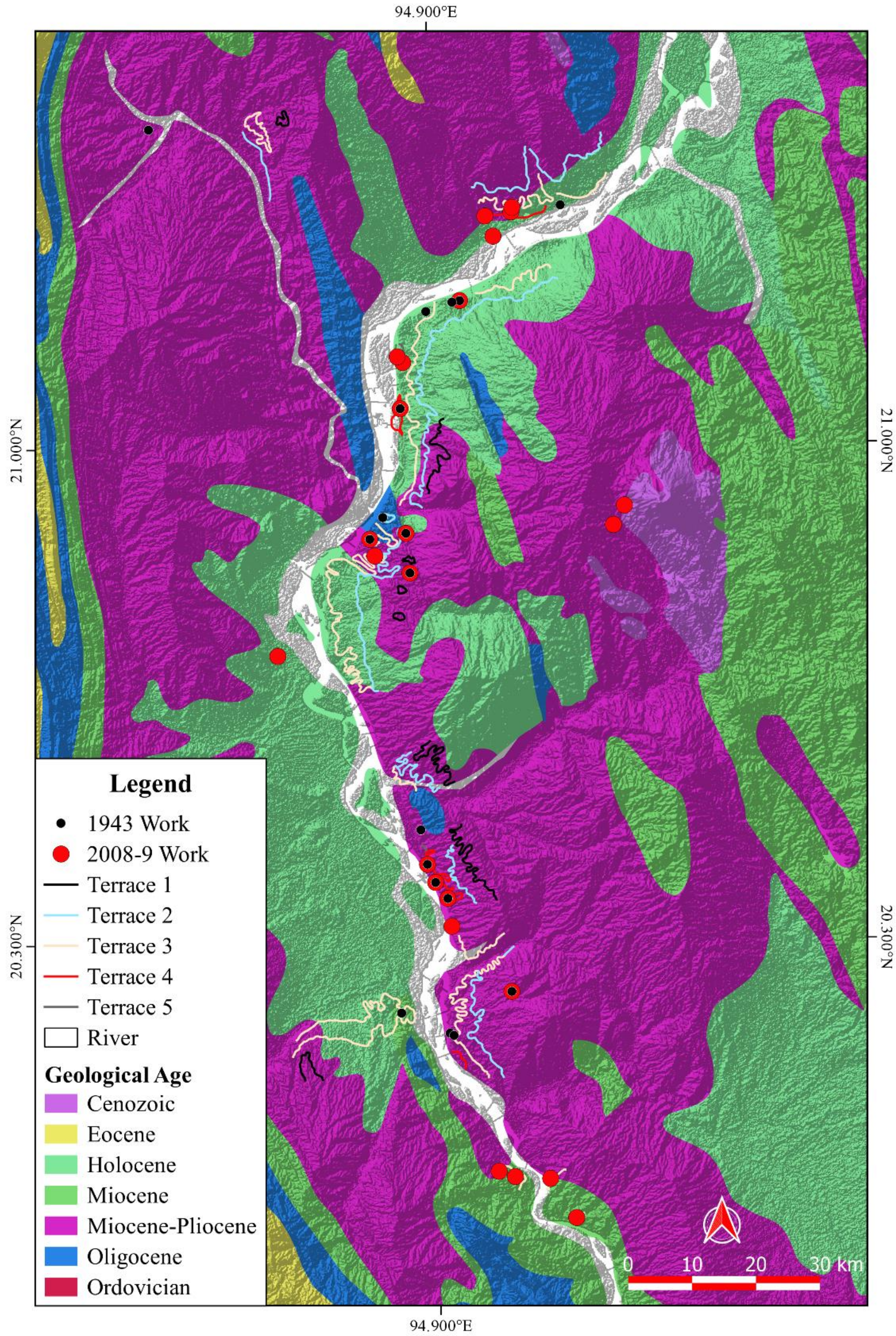
Map 5. 1 Locations of hunter-gatherer sites in central belt

5.3 Results

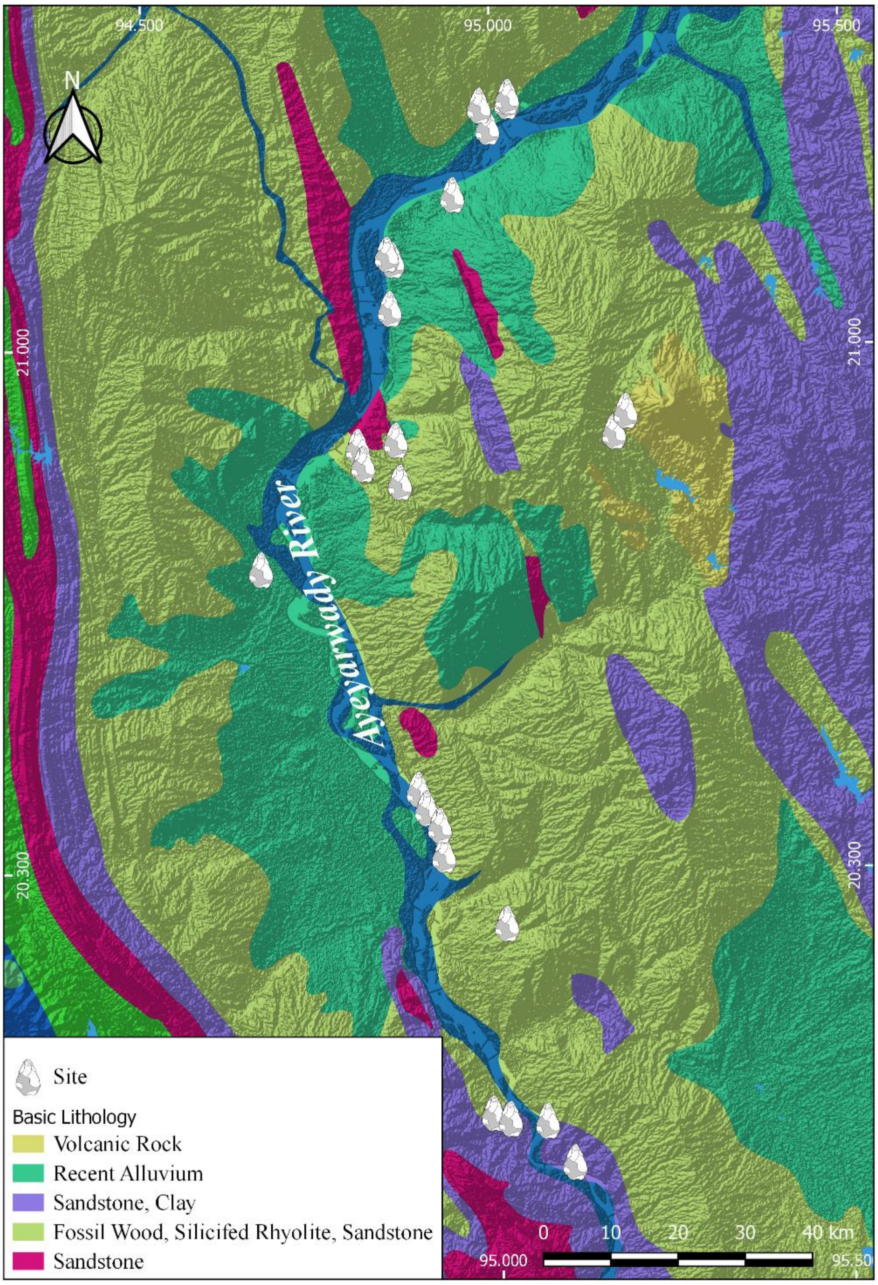
This study includes a totality of 38 hunter-gatherer sites from central belt and Shan plateau. Several scholars are interested in central belt area which exhibits the evidences of prehistoric hunter-gatherer since the late of 1880s. These sites have been revealed by American Expedition in 1937-38 (de Terra *et al.* 1943) and Win Kyaing and his colleagues in 2008-9 (Win Kyaing 2010a; 2010b) (map 5. 3). The chronology of the area is generally assigned to middle Pleistocene to late Holocene (de Terra 1938; Than Tun 1971; Moore 2007; Win Kyaing 2010b). The sites are influenced by crude and massive lithic artefacts mainly made of fossil wood, silicified tuff and quartzite as a character of Anyathian culture. There are 24 hunter-gatherer sites and most of them are closely located to the Ayeyarwady river and 2 sites, about 40km away from the river, are at the foot of Mt. Poppa which was a volcano, while 7 lies on the western bank of the river. The sites on the eastern bank are distributed as clusters along the course of the river whereas some sites on the western bank are sparsely located in very distance.



Map 5. 2 Locations of hunter-gatherer sites from Shan plateau

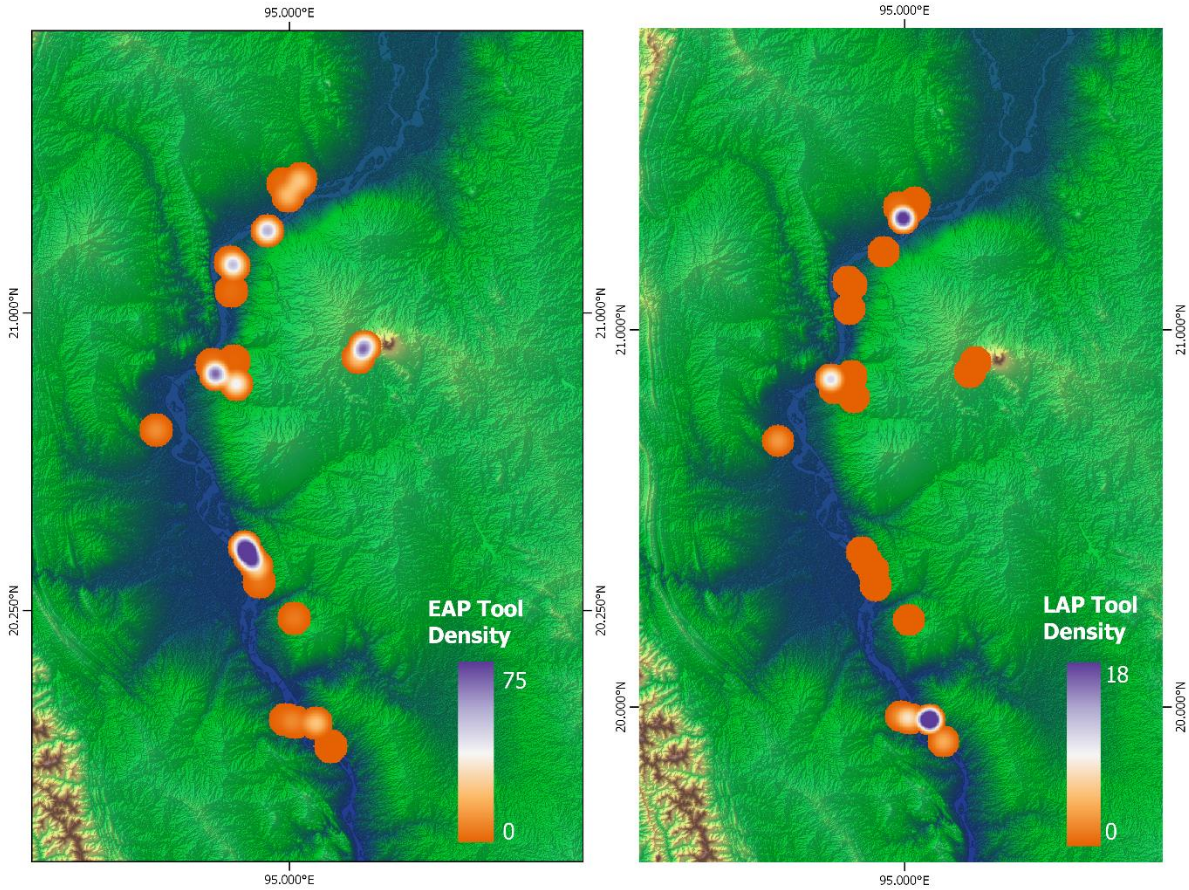


Map 5. 3 Locations of hunter-gatherer sites and geological layers



Map 5. 4 Locations of hunter-gatherer sites and their lithological beds

When the sites are examined with geological settings (map 5. 3 and 5. 4), 11 hunter-gatherer sites are located on the geological layers which is composed of fossil wood, silicified tuff, igneous rocks and rhyolites. Two sites further south take up on sandstone and clay combined geological bed and four sites in the north lies on recent alluvial layer. Similarly, three out of four from the western bank of the river on the north are located on Miocene-Pliocene layer, which is composed of fossil wood, silicified tuff, igneous rocks and rhyolite, and the rest one lies on recent alluvial soil, which is Holocene in geological terminology. The locations of the sites indicate that the hunter-gatherer from these sites could easily accessed to the raw material sources which are closely located to them, and, hence, these raw materials sources seem to be major influence to establish Anyathian cultural horizon.



Map 5. 5 Tool density difference between EAP and LAP phase among the hunter-gatherer sites in central belt

As shown in map 5. 5, regardless of chronological framework, only Early Anyathian Phase (EAP) and Late Anyathian Phase (LAP) tools, based on 2008-2009 fieldwork data, are compared to know the artefact dynamism on this landscape. In general, the hunter-gatherer sites on the eastern bank is more populated than those on western bank of the river. The sites on the north of the river are slightly more populated than those to the south. When the nature of artefact density in EAP is investigated with lithological source as shown in map 5. 4, no remarkable pattern has been recognized because the sites close to raw material and the sites distant to the raw material sources show populated nature of artefacts being near or not to raw material source. However, except for the two sites at the foot of Mt. Poppa, some hunter-gatherer sites closely located to the river have populated artefact density than others. On the other hand, in the case of LAP, some sites near to the river from further north, south and slightly north show noticeable higher artefact density than others. In fact, most of these sites are some distant to main raw material source. Other sites show low artefact density or no sign of artefacts. Therefore, it needs to consider if it was probably the change of foraging strategies of the hunter-gatherer communities between EAP and LAP in the past. Or it can also deal with sampling bias.

In contrast to those from central belt, the geological beds of the sites from Shan plateau are generally different and more diversified. The area covers a total of 14 hunter-gatherer sites, which are 12 cave or rock shelter sites and 2 are the sites located on the hill. The different character of the sites with those from central belt is the discover of faunal remains associated with lithic artefacts (map 5. 6). More detail discussions have been done in the previous chapter. Another common feature of the sites is the utilization of limestone for production of lithic artefacts, which can be easily acquire from smaller rivers or streams. Since the sites lies on different geological bed, the use of raw materials and artefact type are more diversified than those from central belt. The timeframe of the sites can be generally designated from the late of Pleistocene to middle Holocene period (cf. table 2. 1). In the case of the sites from Shan plateau, due to poor information of cultural evidence related to the sites, it is failed to conduct for the analysis of artefact density per site. Dealing with spatial distribution pattern, the hunter-gatherer sites in the north of the region is more populated than those from the south. The orientation from Shan plateau indicates that the hunter-gatherers mostly occupied the cave or rock shelter sites facing to the east than others. The caves orienting to the north and southeast are the least number while others facing to south, southwest and west seem to be moderate choice for their base camp (figure 5. 1). The orientation of hill sites is unknown like those from central belt. However, the choice of occupation at the cave sites might have been under consideration of easily accessible to resources and less risk to the threat on the other hand. If the threat was very serious, the settlers might have left the sites.

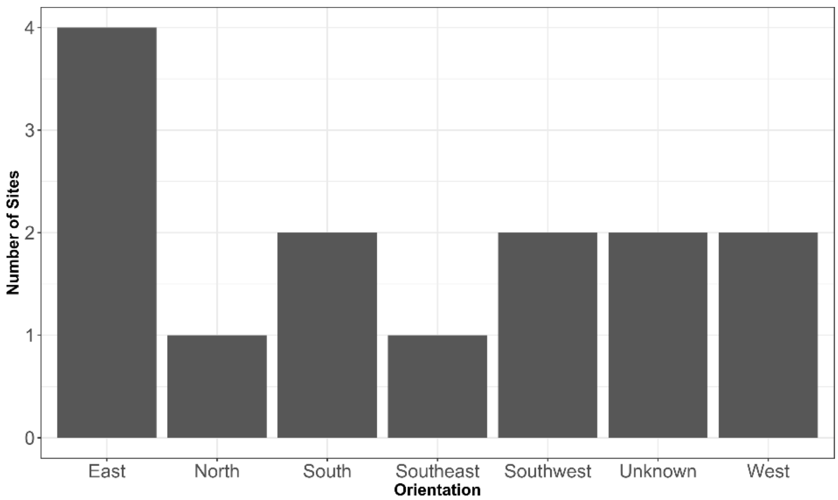


Figure 5. 1 Orientation of the sites from Shan plateau

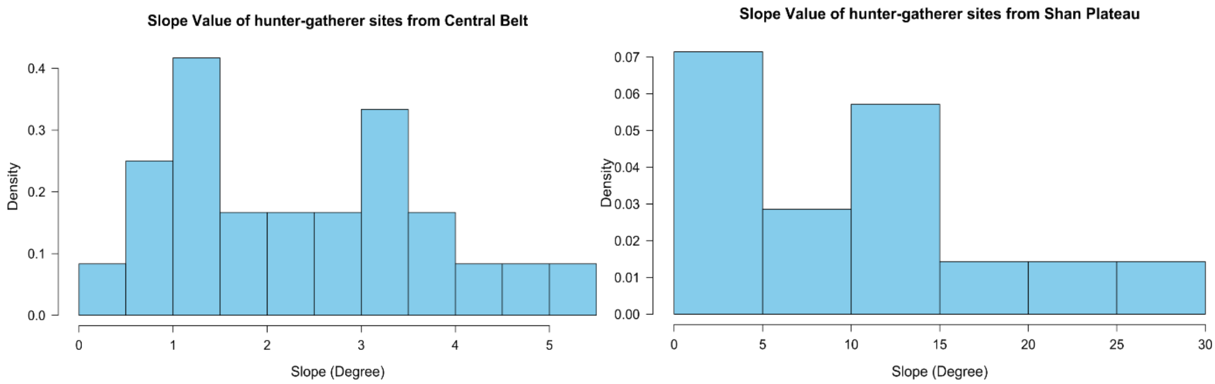
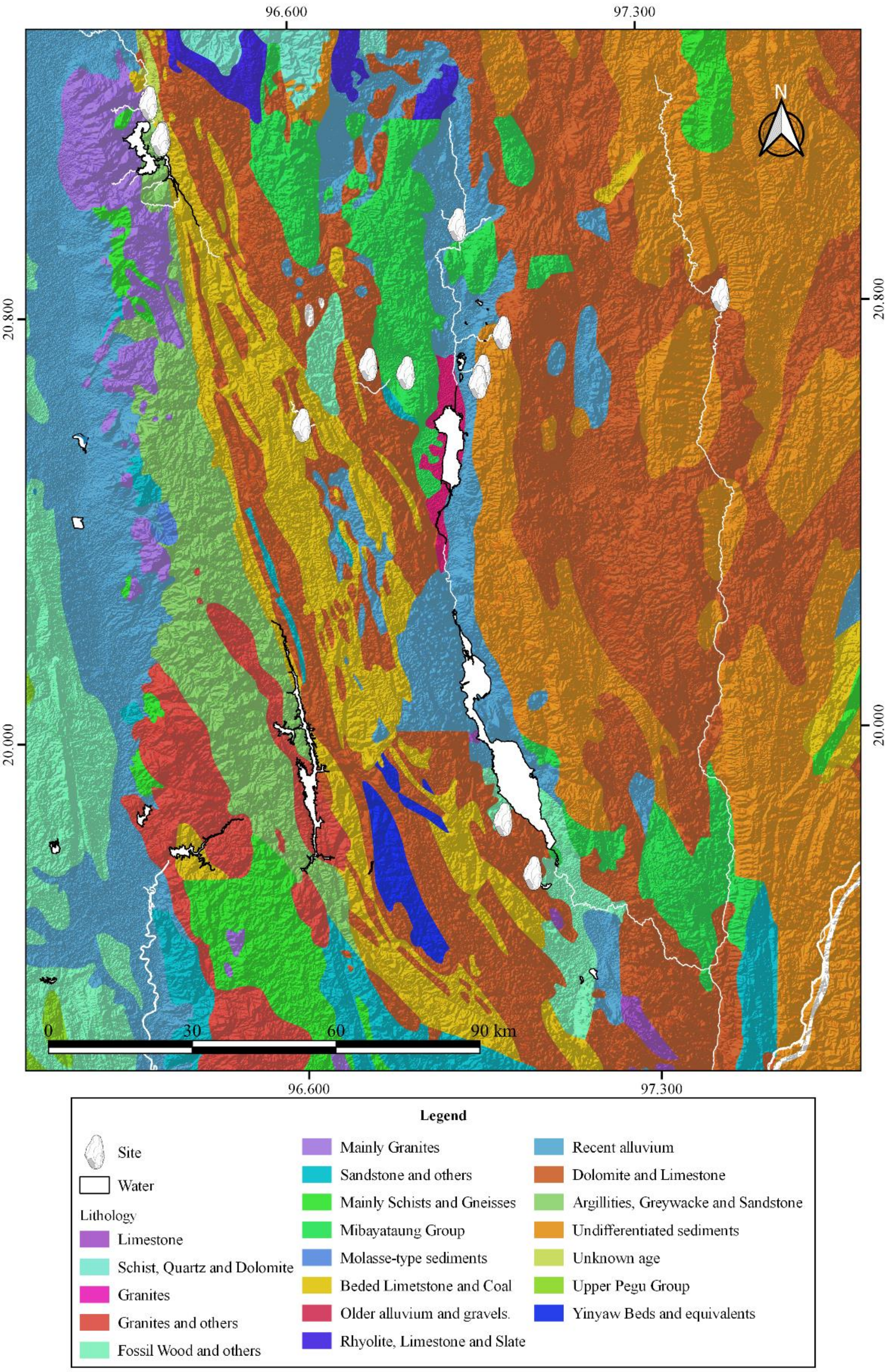


Figure 5. 2 Histogram of slope values from hunter-gatherer sites in central belt and Shan plateau

Table 5. 1 Site characteristics of hunter-gatherer sites from Shan plateau

Site	Elevation(m)	Slope (Degree)	Region	Type	Orientation
Gu Myaung	196	19.2	Shan	Cave	East
Badahlin 1	322	12.7	Shan	Cave	South
Badahlin 2	300	4.7	Shan	Cave	South
Lu Yoe Taung	933	0.8	Shan	Hill	Unknown
Mong Pawn	1064	0.3	Shan	Cave	East
Montawagu	1248	26.6	Shan	Cave	West
Suzaung Ganaing	986	11.3	Shan	Cave	Southwest
Tin Ain	941	9.5	Shan	Cave	West
Buddhaw Zinaw	1220	12.8	Shan	Cave	Southeast
Lonka Kone	1152	3.3	Shan	Hill	Unknown
Myin Ma Hti	1355	12.9	Shan	Cave	North
Pe Kon	986	22.5	Shan	Cave	Southwest
Moebyel	1135	5.3	Shan	Cave	East
Waiponla	130	0.3	Karen	Cave	East



Map 5. 6 Locations of hunter-gatherer sites and their lithological beds

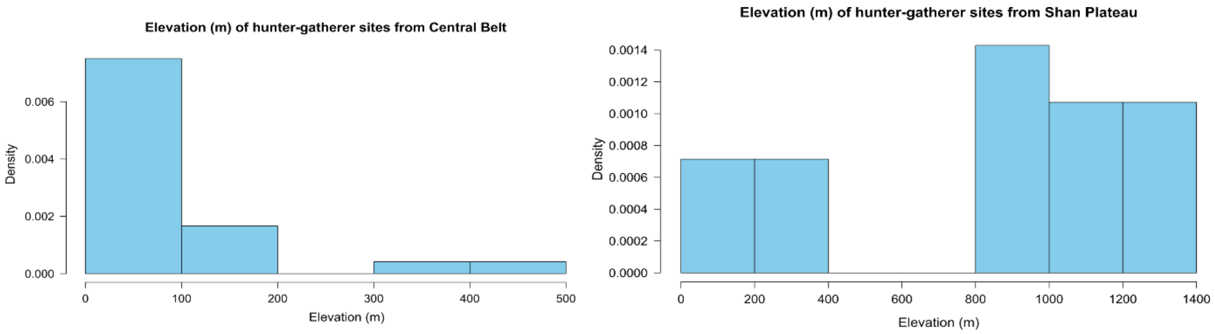


Figure 5. 3 Histogram of elevation from hunter-gatherer site in central belt and Shan plateau

Table 5. 2 Site characteristics of hunter-gatherer sites from central belt

Site	**Elevation (m)**	**Slope (Degree)**	**Region**	**Type**	**Orientation**
Chinaungma	151	3.4	Central Belt	Open-air site	Unknown
Zee Cho Pin	76	2.3	Central Belt	Open-air site	Unknown
Yan Pyay Gone	189	2.8	Central Belt	Open-air site	Unknown
Than Taung Gone	113	3.3	Central Belt	Open-air site	Unknown
Sar Taing	60	4.5	Central Belt	Open-air site	Unknown
Watmasut	55	4.8	Central Belt	Open-air site	Unknown
Yon Zeik	64	3.5	Central Belt	Open-air site	Unknown
Thaphan Chaung	70	3.6	Central Belt	Open-air site	Unknown
Kanthargyi	175	0.8	Central Belt	Open-air site	Unknown
Se Pauk	361	0.2	Central Belt	Open-air site	Unknown
Poppa	417	2.6	Central Belt	Open-air site	Unknown
Setanargyi	70	1.4	Central Belt	Open-air site	Unknown
Kyauk-ku Umin	80	2.1	Central Belt	Open-air site	Unknown
Ywar Thar	67	1.1	Central Belt	Open-air site	Unknown
Lokananda	62	3.7	Central Belt	Open-air site	Unknown
Tin Gat	62	0.8	Central Belt	Open-air site	Unknown
Le Yar	70	1.2	Central Belt	Open-air site	Unknown
Kya Pin	63	1.9	Central Belt	Open-air site	Unknown
Near Army base	98	1.4	Central Belt	Open-air site	Unknown
Near Computer Uni	83	1	Central Belt	Open-air site	Unknown
Kani	64	1.6	Central Belt	Open-air site	Unknown
Minhla	72	1.4	Central Belt	Open-air site	Unknown
Michaungye	76	3.2	Central Belt	Open-air site	Unknown
Gwechaung	86	5.4	Central Belt	Open-air site	Unknown

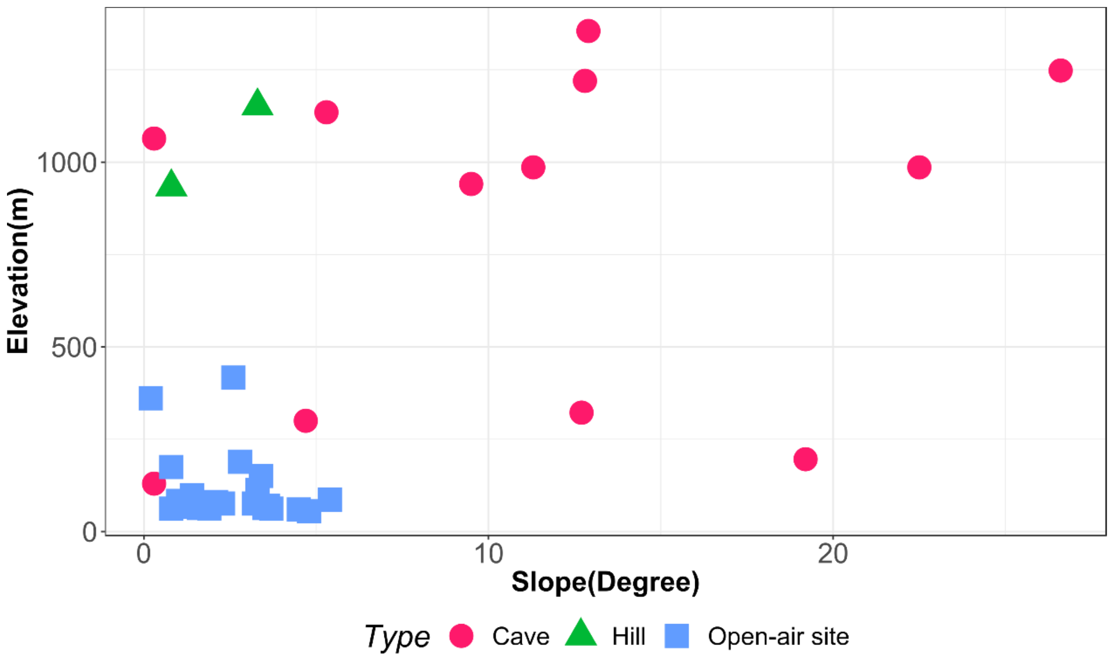


Figure 5. 4 Slope and elevation values of hunter-gatherer sites from central belt and Shan plateau

Due to the results of slope values, it can be divided into three groups: a) low slope group within the range of 0~10 degree, b) mid slope group within the range of 10~20 degree and c) high slope group within the range of 20~30 degree (figure 5. 2, table 5. 1 and table 5. 2) Most of the sites from central belt and some cave sites from Shan plateau belongs to low slope group while other cave sites fall within mid slope and high slope groups in order. Similarly, these sites can be divided into three groups in terms of their respective elevation values (figure 5. 3 and table 5. 2). The first group which elevation value covers less than 100m to 130m can be designated as low elevation sites, including many hunter-gatherer sites from central belt. The second group can be attributed as moderate elevation sites which fall within the range of 130m to 500m. Some sites from central belt and Shan plateau covers in this group. The third group can be assigned as high elevation sites, ranging from 500m to over 1000m. Some hunter-gatherer sites from the Shan plateau fall in this group. Therefore, as shown in figure 5. 4, distinctive feature of hunter-gatherer sites from central belt generally occupied the area within the range of lesser slope and elevation values. In contrast to them, cave and hill sites from Shan Plateau engaged with higher slope degree and higher elevation values.

5.4 Conclusion

This chapter have addressed the spatial distribution pattern of hunter-gatherer sites from central belt and Shan plateau. The sites in central belt reflect clumped distributional nature along the river. Hence, it is obvious that there is a gap between the diffusion of the sites on the south and north of the river. Raw material source seems to be main influence for the distribution of the site, but artefact density of the sites shows that it needs to consider the other factors such as foraging and mobility strategies. In contrast to central belt, hunter-gatherer sites from Shan plateau exhibit the populated nature of the sites in the middle rather than north, south and west. Since the sites are located on more diversified lithological background, utilization of raw materials is more different and diversified. The ratio of slope and elevation shows main difference of the sites from central belt and Shan plateau.

Chapter 6

Optimal foraging models, technological modes and lithic analysis procedure

6.1 Introduction

Previous chapters have addressed former works on lithic artefacts left behind by prehistoric hunter-gatherer communities in Myanmar, different environmental background in which forager communities existed, and spatial distribution pattern of the sites. This chapter contains two parts: first, it will explore technological modes, behavioural ecological models for hunter-gatherer communities which have been tested in the lithic artefacts assemblages of Southeast Asia and the second part is to present the procedure of lithic artefacts analysis conducted in this thesis. It focuses on classification of lithic artefacts and quantifying lithic artefact attributes which come from different nature of lithic dataset. Moreover, it mentions about the statistics methods which have been applied in the analysis for lithic artefacts in Myanmar.

6.2 Optimal foraging theories and technological modes

There is a set of theories regarding with behavioural ecological models of hunter-gatherer communities which have been frequently tested and used by anthropologists and archaeologists. However, it seems that the implication of such theoretical models in forager communities of Southeast Asia are generally fewer in number since the archaeologists working in the area mostly focus on culture history, technological achievements and changes. Two remarkable archaeological studies on theoretical modelling with empirical evidences are chosen to discuss because these works mainly based on archaeological evidences from northwest and western Thailand. Since the country is adjacent to Myanmar and share the same cultural and environmental phenomenon, the modelling theories against archaeological assemblages are very interested to explore and observe. These behavioural ecological theories are namely mobility strategies and a set of optimal foraging theory.

Mobility and settlement pattern of hunter-gatherer communities are formulated by Lee and de Vore in 1968 based on two basic assumptions as follows: hunter-gatherers live in small group and move around a lot. These communities can be characterized by five distinctive features such as a very low level amount of personal property suggesting an egalitarian system, members disperse into smaller forager units, no group maintain exclusive rights for local resource, lack of surplus food, and no group strongly attached to a single food resource (Lee, Richard B. and de Vore 1968:11-12; Rowley-Conwy 2001:39-40). Lee and de Vore's hunter-gatherer community is later termed as "Original Affluent Society" by Rowley-Conwy in 2001. Binford (1980) illustrates the differences between subsistence pattern of hunter-gatherer communities, using the term foragers and collectors. Forager is similar to the characteristics of hunter-gatherer communities defined by Lee and de Vore (Rowley-Conwy 2001). The foragers can be defined by seasonal residential movements among homogeneous resource patch, without practicing storage but pursuing food daily. It is called as residential mobility. On the contrary, the mobility of collectors can be defined by deploy of task group from the base camp for pursuing food resource in heterogeneous environments, food storage practise, establishing field camp near resource for processing raw materials. It is termed as logistical mobility (Binford 1980; figure 6. 1). Shoocongdej (2000) claims that archaeological research for mobility strategies generally focus on the communities from highly seasonal environments of arctic, semi-arctic and temperate zone, but little is known for tropical environments. Therefore, she tested these mobility strategies against the archaeological evidences such as floral and faunal remains and stone artefacts. She (2000) argues that mixed mobility strategy seems to be practised in tropical environments, reflecting residential mobility in wet season and logistical mobility in dry season, but the latter has not yet been archaeologically proved.

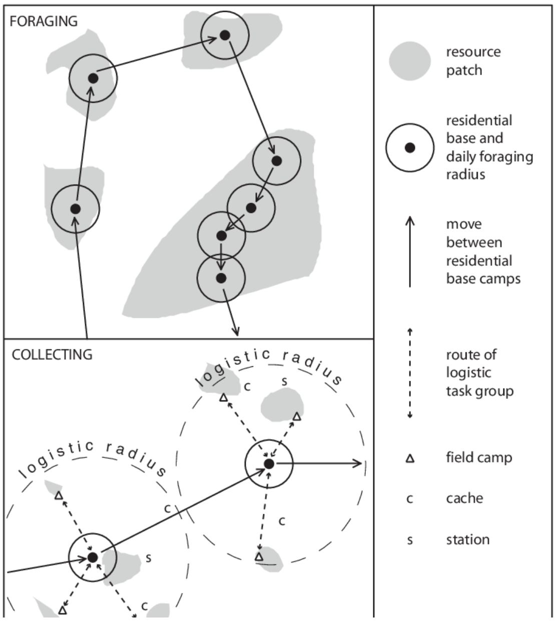


Figure 6. 1 Schematic map showing residential mobility practised by foragers and logistical mobility practised by collectors (After Rowley-Conwy and Piper 2016)

On the other hand, a set of optimal foraging theories such as diet breadth or prey choice, patch choice and time allocation, group formation and optimal group size. Diet breadth or prey choice belongs to the question on which prey or resource should be pursued by foragers. Group formation and optimal group size deal with the impact of group foraging among the hunter-gatherers (Smith 1983). The strengths and weakness of these ecological theories have been widely discussed in the archaeological literature. Marwick tested optimal foraging theories such as central place model, patch choice model and optimal dispersion model with Hoabinhian lithic assemblages from northwest Thailand. Central place model, presented by Orians and Pearson, is to examine the relationships that can exist between usage of resource extent and time for obtaining and transportation of the resource (Marwick 2013). Patch choice model means where the foragers chase prey or resource to obtain maximum return when resources are unequally distributed (MacArthur and Pianca 1966). Optimal dispersion model envisages choosing optimum forager settlement pattern under different environmental condition to reduce round trip travel costs from resource to the base camp. However, he (2008a; 2013) points out that these models are ill-suited to test against the evidences under his study as a single system. On the other hand, to apply these theoretical models for mainland Southeast Asia often undergo with the constraints of the paucity of assemblage data. Therefore, Marwick (2008b:81-85) argues that human behavioural ecological theory is not and instant panacea for understanding lithic assemblages in southeast Asia.

On the other hand, there are some remarkable technological theories dealing with East and Southeast Asia; especially cultural model, biogeographical model and demographic model of technological evolution. The first model was introduced by Movius (1943; 1944; 1948) who studied lithic assemblages from India, China, Myanmar, Malaysia and Indonesia. He (1948:409) defined a line, known as Movius line (Ikawa-Smith 2014), between east and west of Asia, showing absence and presence of hand axe. In the other words, he assigns two territories indicating progressive and stagnant of cultural evolution in the area with western classical system of lithic cultures. It becomes a long-term debate among the archaeologists (Keates 2002; Norton *et al.* 2006; Norton and Bae 2009; Lycett and Bae 2010; Brumm and Moore 2012; Dennell, Robin 2015). Foley and Lahr (1997) present a biogeographical model, which explains hominid distribution in time and space with their associated technology based on famous Clark's technological mode (Clark 1969). This theory also persists model 1 technology (known as chopper-chopping tool industry) from 1.6 to 1.5 myr to 500 kyr, model 1 technology continues in Southeast Asia while neighbouring regions well established mode 2 technology (bifacial or hand axe technology). The demographic model is a model which explains only three lithic technological modes (Clark 1969) and demographic model (Henrich 2004). According to this model (Lycett and Norton 2010), regardless of chronology and regional variant, technological modes and demographic factors such as effective population size, density and social interconnectedness should be testable. However, it seems that this model is too limited since it is mainly valid for only three technological modes and some constraints in practical way, and it is also difficult to test the Southeast Asia assemblages which is characterized by amorphous lithic artefacts and no retouched flakes. Moreover, to the best of the knowledge, this model has not been tested yet for lithic assemblages and social demography for those in other parts of continent due to the limitation mentioned earlier. Therefore, which model should be tested to what extent for Myanmar lithic artefacts becomes interesting and challenging case.

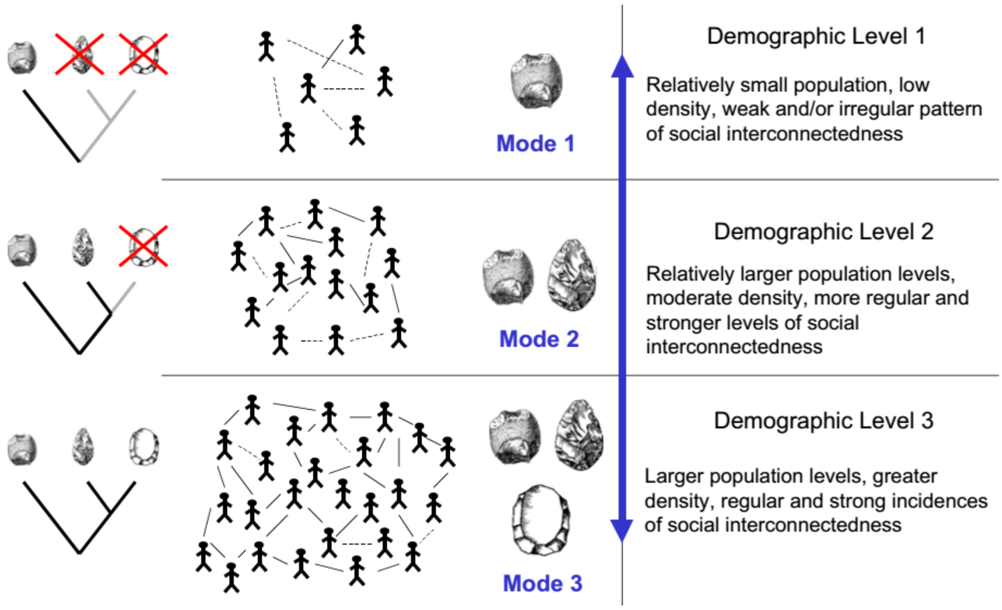


Figure 6. 2 Lithic technological phylogeny and demographic model (After Lycett and Norton 2010)

6.3 Classification

As a second part of the chapter, it will discuss classification and quantifying lithic artefacts from Myanmar. Classification the artefacts is the most basic and important step in archaeology since it can at least indicate similarity and difference between the artefact group. Lyman, O'Brien and Dunnell contended that there are two main reasons for doing classification. The first reason is to structure the observations into a set of groupings and, in turn, grouping observations allows the results to be compared, contrast and explained. The second reason is to provide a set of terminology conventions, usually a set of named groupings or classes (Clarkson and O'Connor 2006:176-177).

The artefacts which have been examined in the study can be mainly classified into two groups: cores and flakes, and the artefact from these two groups are identified into discrete types following their distinctive features. Core tools, for instance, include chopper, chopping tool, hand adze, bifacial tool or hand axe, core, pick and point while flake group mostly contains flakes and chips. Since scrapers are made of both core and flake, therefore, these artefacts are put into both group. Generally, lithic classification procedure conducted in this thesis mainly follows traditional typological scheme commonly practiced in the country, which have been initiated by Movius. Although he (1943) expressed several morphological variation of the artefact types for Myanmar lithic assemblage, this analysis focuses on main artefact types which are described in the followings.

6.3.1 Chopper

Chopper is generally defined as a lithic artefact which has rounded or semi oval or straight cutting edge, as pointed out by Movius (1943:351). Leakey modified his term, based on the artefacts from Africa, as follows: "…*made on cobblestones with rounded cortex forming the butt ends…In the majority, the trimming is bifacial, with multidirectional flaking of the working edges*…" (Jian and Shannon 2000:17). According to Shea (2013:50), a chopper has been flaked from at least 25-75 percent of its circumference and hence it is asymmetrical in profile (one flat and other convex). A unifacial chopper is flaked from one surface while bifacial chopper is formed by the removal of flakes from both side. However, unifacial choppers are mostly found than the bifacial ones, and one of the most influence artefact types in Myanmar, especially at the central belt. In the case of the artefacts from Shan plateau, these artefacts are made of pebbles (Aung Thaw 1971b:313).

6.3.2 Chopping Tool

Generally, a chopping tool can be assigned as a lithic artefact, which has been removed by alternate flaking on both side, with a sinuous edge, generally tabular in shape (Movius 1943:351; 1948:350). The definition of chopping tool type on Myanmar lithic assemblage is generally the same with those from Middle East (Shea 2013:99).

6.3.3 Core

Generally, core is a final stage of the sequence of removals and portraying the last moment of the sequence, regarding as an end or waste product (Inizan *et al.* 1999:59; Andrefsky 2005). In the analysis, these cores can be generally defined as multiplatform core, found in the assemblage of Shan plateau.

6.3.4 Flake and Chip

The data for flake and chip is based on the artefacts from the sites in Shan plateau, but such kind of detached pieces cannot be found in the data from recent collection at central belt. In this analysis, flake is arbitrarily designated to the detached piece which is at least 20mm in length. Some flakes have remarkable sign of edge, but some do not and these flakes show no sign of retouching (Aung Thaw 1971a:127; Marwick 2016). In contrast to the flake, chip is arbitrarily regarded as the detached piece which is less than 20mm in length.

6.3.5 Hand Adze

A hand adze is a core tool which has a straight, slightly rounded or even pointed cutting edge, and it is regarded as a special class of chopper (Movius 1943:351; 1948:350). After examining the artefacts from India, Ghosh (1972) proposed three types of hand adze which are made on pebble, core and flake due to their specific morphology, but fundamental characteristic of hand adze remains the same with Movius's definition. Moreover, he (1972) claimed that hand adze should not be considered as a kind of chopper because it is different from chopper/chopping tool in terms of their form, technique and morphology. Unfortunately, hand adze made on flake are not found in this study.

6.3.6 Pick and Point

Pick and point are generally very fewer in number and larger than other artefact types. Pick is generally characterised by the presence of pointed end to the opposite direction of the butt (Movius 1943). Point is simply assigned to a lithic artefact which has only a pointed end with few flake removals and it is smaller than others.

6.3.7 Scraper

There are two kinds of scrapers which are made of core and flake. Generally, scraper made of core are smaller in size than other artefact types, as pointed out by Movius (1943:351) whereas scraper made of flake has an edge. The former type is usually found in the assemblage of central belt while the latter is often found in the assemblage of Shan plateau. However, retouching on scrapers or flake was not found on the tools from Shan plateau (Aung Thaw 1971a:127; Marwick 2016).

6.4 Quantifying Lithic Artefacts

There is a main reason why archaeologists use statistical method for their analyses. The first reason is that they usually occur a small set of archaeological record which are imperfect and limited data due to funding constraints and time limitation. Consequently, they often try to understand the past with limited data which can be referred as sample and, therefore, they use statistical method for their approach to be explicit, logical and facilitate their evaluation. On the other hand, the main idea is important and statistical methods should be viewed as tool under theory (Todd and Leonard 2011:2). Herbertson (2016:53-54) points out that Beneath and Dibble argue it is virtually impossible to have too rigorous a system of classification after they have experience with core tools, but Read and Russell claim that statistical method can reveal underlying distinctions which cannot available to the naked eye. Read and Russell point out that statistical methods can reveal the peculiarities that cannot seen by visual examination (Herbertson 2016:54). Most lithic studies use statistical methods for modelling and analysing the data for their research designs. There are two main reasons for using statistical methods which have been conducted in the thesis. The first reason is that several scholars have presented their studies of lithic artefacts from Myanmar in descriptive manner that usually lead to the limitation and difficulty to understand how the artefact types are different from each other in practical way and how much size they all have. The second reason is that using only descriptive typology for a specific type of lithic artefacts from different periods or different regions is too limited to compare among them. Therefore, the data for lithic artefacts from central belt and Shan plateau are collected not only in qualitative approach, but also in quantitative approach. There are two statistical methods conducted in the analysis, namely descriptive statistics and inferential statistics.

6.4.1 Descriptive Statistics

Descriptive statistical method is frequently used in several lithic studies to show the basic features of the data and make comparative studies between the datasets. Sample size is referred as a small “n”, representing any observation for a particular class. Main numerical values are described in terms of mean and standard deviation. “Mean” value is calculated by summing the value of each observation and the result is divided by number of observations. Stand deviation is represented as “SD” and it measures the spread of a dataset relative to its mean and it is calculated as the square root of the variance which is the difference from the mean. In the analysis, these expressions are often used to describe for dimensional data of a particular class or an artefact type. It is very clear to understand how much the artefacts are different or similar. These descriptions are often described in the table.

6.4.2 Inferential Statistics

Along with descriptive statistics, inferential statistics such as student *t*-test method, especially two sample *t*-test or two-tailed *t*-test is often conducted for hypothesis testing. This method is often used for comparing a particular artefact type from different sites or regions in the lithic studies (Lycett and Bae 2010; Lee, Hyeong Woo 2017). This study also applies inferential statistical method for comparing artefact type in and between the sites. The aim of this method is to point out the significance of differences between a sample mean and an actual mean. An analyst will set a significance test to avoid rejecting a null hypothesis when it is true.

The underlying idea behind such tests is to identify unlikely results as having a very low probability (Herbertson 2016).

The graphical representations often used in this paper are boxplot, pie chart, bar graph, histogram and scatter plot. Boxplot depicts the distribution of data such as minimum number, first quartile, median number or second quartile, third quartile and maximum number. Some dots in the graph represents outliers. Bar graph is used to show the number of each class and pie chart defines the percentage of a particular class. Along with these graphs, histogram is sometimes used to show the frequency of continuous data. Moreover, scatter plot has been used for the illustration of two variables.

6.5 Conclusion

This chapter has presented two parts: the first part mainly concerns with some theories such as optimal foraging theories and technological theories which have been tested and should be considered for the archaeological assemblages in southeast Asia. Each model has their limitation or has been limited in accordance with the nature of the data. However, each model deserves to be tested against the assemblages if the data is accessible to all requirements. As a second part, it describes the importance of classification in archaeology and how artefacts are classified in accordance with their typology. Also, it mentions what kind of statistical methods have been used in the analysis and what graphical representations have been applied to illustrate the data. The next two chapters will describe technology and typological analysis of the artefacts from central belt and Shan plateau.

Chapter 7

Technology and typology of stone tools from prehistoric hunter-gatherer sites in central belt

7.1 Introduction

The purpose of this chapter is to discuss about lithic artefacts from central belt with their associated terraces in broaden sense and it also reviews issues and problems of the culture. The later part of this chapter mainly focuses on the attribute analysis of the artefacts. Regarding with hunter-gatherer behavioural pattern in central belt of Myanmar, Anyathian culture stands as a remarkable model, spanning from middle Pleistocene to early Holocene. It is often recognized as one of the earliest lithic traditions in Southeast Asian regional context. As mentioned before, lithic artefacts attributed to Palaeolithic culture has been revealed by the American expedition in 1943, exposing the evidence of prehistoric hunter-gatherer communities in central belt (de Terra *et al.* 1943). They also established a chronology for the culture in terms of associated geological terraces in which lithic tools have been discovered (de Terra *et al.* 1943:343). Several lithic artefacts attributed to Palaeolithic culture were uncovered on the old river terraces of Ayeyarwady in 1937-1938 and 2008-2009 respectively (Movius 1943:347-348; Win Kyaing 2010a; 2010b).

7.2 Pleistocene terraces for Anyathian culture

Before 1950s, Palaeolithic archaeology was usually based upon river system and its terraces to reconstruct the chronology of lithic artefacts and the sites (Dennell, Robin 1990:550; Myint Aung 2012b). The archaeologists, nowadays, have replaced more accurate and advanced scientific dating methods instead of suggesting the date of an artefact or an archaeological site with their associated terraces. Nevertheless, it is still applied in some research projects, but error margin is too wide.

As mentioned above, the American investigated hunter-gatherer sites in central belt and Shan plateau. According to them, they could indicate the forager sites in the former area rather than the latter. The geologist, de Terra (1943b) identified Pleistocene river terraces, especially on the eastern bank, of Ayeyarwady in central belt of Myanmar and assigned them as an important chronological indicator for Myanmar Palaeolithic sites. He (1943b) argued that there are five successive old terraces with their geological formation of Ayeyarwady valley, mainly found between Pauk and Magway. Before Pleistocene terraces begin, upper Irrawaddian formation containing villafranchian fossils exists and it contains thick gravel deposits showing a major pluvial period which remnant relates to terrace 1. Lateritic gravel of Ayeyarwady river is considered as a counterpart of post-Irrawaddian Uru boulder conglomerate. The evidence of long dry interpluvial period can be traced back through extensive degradation and valley cutting due to the river. By removing considerable portion of lateritic gravel from the peneplain, the remnants appear as isolated flat hills (figure 7. 1 and figure 7. 2). These hills can be identified as representing the highest terrace (T1), which is between 85m to 137m above river-level. Then, cutting of river valley continued and it was filled with terrace 2 and 3 deposits. Terrace 2 is mainly composed of a coarse, reddish, irregularly-bedded layer, which is between 55m and 76.2 m above present river-level. Terrace 3 can be defined by extensive and prolonged cemented ferruginous crust or ironstone hardpan, between 27m and 33m above river-level. Terrace 4 varies between 18m and 21m above river-level and it can be defined by the presence of Pagan silt and medium sized red earth about 1m to 2m in thickness at the base. Terrace 5, the lowest one is composed of Singu silt, cross-bedded gravel sand and pink silt. It can be found average 12m in height above present river-level (de Terra 1943b:312-313; Movius 1943:343-344). There are four main types of soil formation connected with terraces. These are lateritic gravels, Nyaung U red earth, Pagan silt and Singu silt. Lateritic gravels layer is usually connected with terrace 1 and it is characterized by a coarse, fluvial, gravelly sand and well-rounded and consisting of schists, quartzites, siltstones, red sandstones and quartz grains of several varieties. Nyaung U red earth is related to terrace 2 and it is composed of brownish red gravelly sand with a certain amount of laterization. Pagan silt relates to terrace 3 and 4, which is a fined fluvial product containing a high content of lime. Singu silt is associated with terrace 5, nearly related to present river deposit (de Terra 1943b:308-310). These soils are usually found in the terraces of Ayeyarwady river, reflecting the nature of climatic condition underwent in the past, especially in Pleistocene period. These terraces and soil formations are defined by Pleistocene chronology as shown in figure 7. 3. Therefore, it can be generally concluded that terrace 1 to terrace 2 belong to middle Pleistocene while terrace 2 to terrace 4 are assigned as late or upper Pleistocene and terrace 5 is attributed as post-Pleistocene or early Holocene.

Regarding with chronological framework (Than Tun 2004:14), therefore, Movius inserted Early Anyathian Phase (EAP) 1 to EAP 2 in middle Pleistocene and EAP 3 to Late Anyathian Phase (LAP) (, #296) 2 fall within upper Pleistocene. Than Tun (2005), consequently, attempt to assign the chronological sequence of cultural phases with the estimated date based on geological formation with some chronological variations. Than Tun denotes that EAP 1 probably belongs to 550,000~330,000 years BP while EAP 2 fall within

330,000~250,000 years BP and EAP 3 was likely to be between 250,000~125,000 years BP. LAP 1 might have been appeared in 125,000~75,000 years BP and LAP 2 would have been in 75,000~10,000 years BP. However, Moore (2007:47-56) suggests that early Anyathian culture in central belt covers within 750,000~25,000 years BP. For late Anyathian cultural horizon, she adds Badahlin and Mu valley as 30,000~12,000 years BP, referring to the geological terraces. On the other hand, recent genetic study by Macaulay *et al.* (2005) indicate that there was a rapid coastal human dispersal from ~65,000 years BP around the Indian Ocean littoral. And another genetic study shows that there was an inland dispersal of early human migration from Myanmar to China round about 25,000~10,000 years BP (Li *et al.* 2015). No scientific dates for the sites and river terraces have been undertaken so that it is difficult to describe how old the sites are. It may be changed when new evidence and scientific dating show more accurate dates.

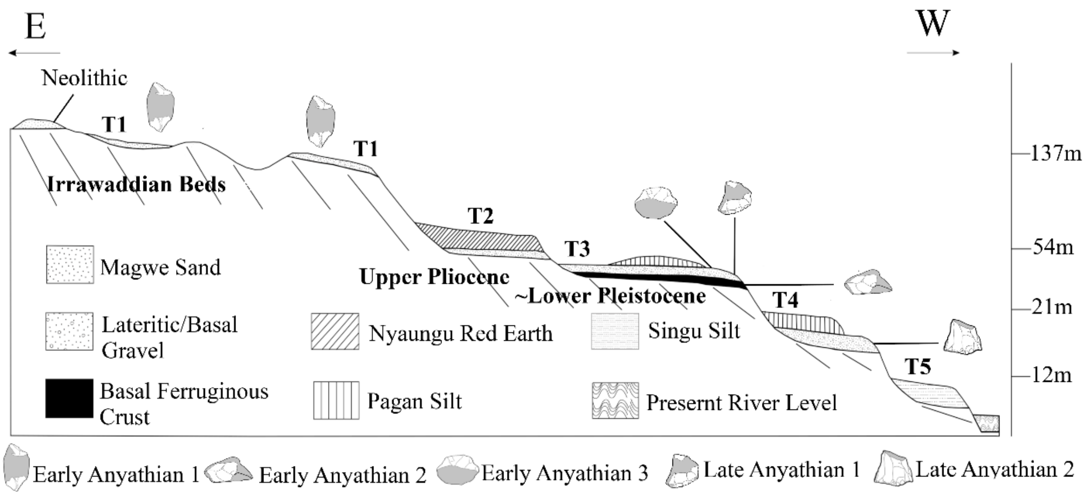


Figure 7. 3 Pleistocene river terraces and associated cultural phases (Adapted from Movius 1943)

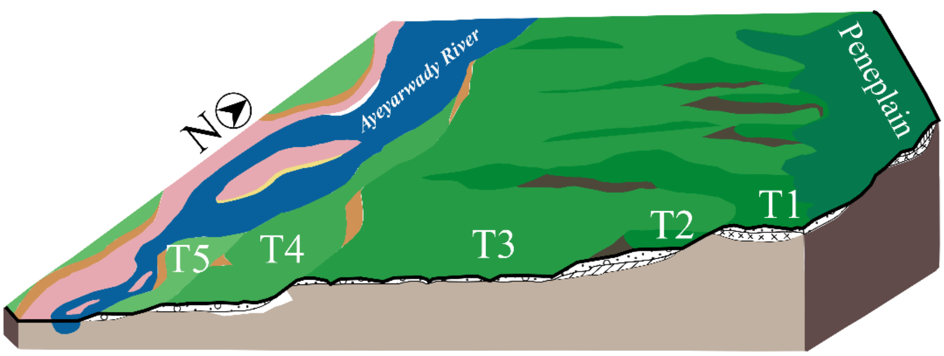


Figure 7. 4 3D view of Pleistocene river terraces near Chauk. No scale in origin. (Adapted and modified from de Terra 1939:110)

7.3 Anyathian culture: nomenclature and typology

Anyathian culture is generally characterized by using fossil wood as raw material source to produce artefacts at hunter-gatherer sites in central belt of Myanmar. The lithic tools associated with these river terraces were collected from the surface and regarded as Palaeolithic tools according to their typology. Movius divided Anyathian culture into two folds_ early and late with successive sub-cultural phases. Early Anyathian culture can be separated into three sub cultural phases such as Early Anyathian culture phase 1, 2 and 3 while Late Anyathian culture is divided into two such as Late Anyathian cultural phase 1 and 2 (figure 7. 4). Early Anyathian cultural phase 1 artefacts are usually found in association with terrace 1 while EAP 2 artefacts were found under terrace 3 and EAP 3 artefacts were found in the terrace 2 context. Similarly, Late Anyathian cultural phase 1 lithic artefacts were uncovered in terrace 3 whereas LAP 2 artefacts were occurred at terrace 4. A totality of 650 lithic artefacts were collected (Movius 1943:346-348), now displayed at Peabody Museum, Harvard University (figure 7. 5).

Movius (1943:351) articulated that the classification of artefacts are based on their form and technique than the function since he assumed these tools were applied in general purposes such as chopping, cutting and scraping. These Anyathian tools are identified into four main categories such as chopper, chopping tool, hand adze and scraper. He explained most choppers are classified as rounded, semi-oval or almost straight cutting edges which have been formed by the removal of flakes on the upper surface of the artefacts only. Chopping tools are produced by alternate flaking with sinuous edges. Hand adze is generally square in shape. It has a straight, slightly rounded or even a pointed cutting edge. Scrapers can be recognized by the size, made on both core and flake. These four main types of artefacts, nevertheless, have their own morphological variations. It seems that, therefore, Movius used polythetic approach for stone tools typology, based on size, shape and flaking technique of the artefacts. His classification scheme is very detail and descriptive for some selected samples, but it is difficult to know how much these tools are different in size for each type and a specific cultural phase in overall series. However, his basic definition for stone tool typology still remains as a standard classification in the archaeological literature of Myanmar.

Movius contended that EAP 1 tools are rather crude and generalized phase of Anyathian culture. It contains fossil wood and silicified tuff series and dominant type is steep-ended hand adze. However, there is no special description for EAP 2 except for the locality, Nyaung U, where the artefacts made of fossil wood only were discovered. In EAP 3 group, chopping tools with alternately flaked edges are most dominant type than others. These artefacts from each phase are assigned as lower Palaeolithic with heavily rolled and weathered character. LAP 1 tools are generally lighter patination and slightly rolled.

Period	Geological Formation	Climate	Archaeology
Post-Pleistocene	Accumulation of Singu silt **T5** Eolian deposits...Magwe sand	**Interpluvial** (Present Condition)	*Neolithic*
Pleistocene – Upper	Deposition of red gravel and sand **T4**	**Pluvial**	*Late Anyathian 2*
	Cutting of main terrace ..**T3**	**Interpluvial**	*Late Anyathian 1*
	Deposition of basal red gravel and overlying Nyaung U red earth **T2**	**Pluvial** Rainfall 2 to 3 times of present in Dry Belt	*Early Anyathian 3*
Pleistocene – Middle	**T2** erosion and a cemented ferrugious crust formation Erosion of lateritic gravel except for isolated remnants **T1**	**Interpluvial** Long dry interval	*Early Anyathian 2*
Unconformity	Deposition of lateritic gravel connected with **T1** and higher slopes of Pegu Yoma ((It is equivalent of the Uru boulder congloerate of northern Myanmar)	**Pluvial**	*Early Anyathian 1*

Figure 7. 5 Anyathian cultural phases and associated geological terraces (After Movius 1943: 345)

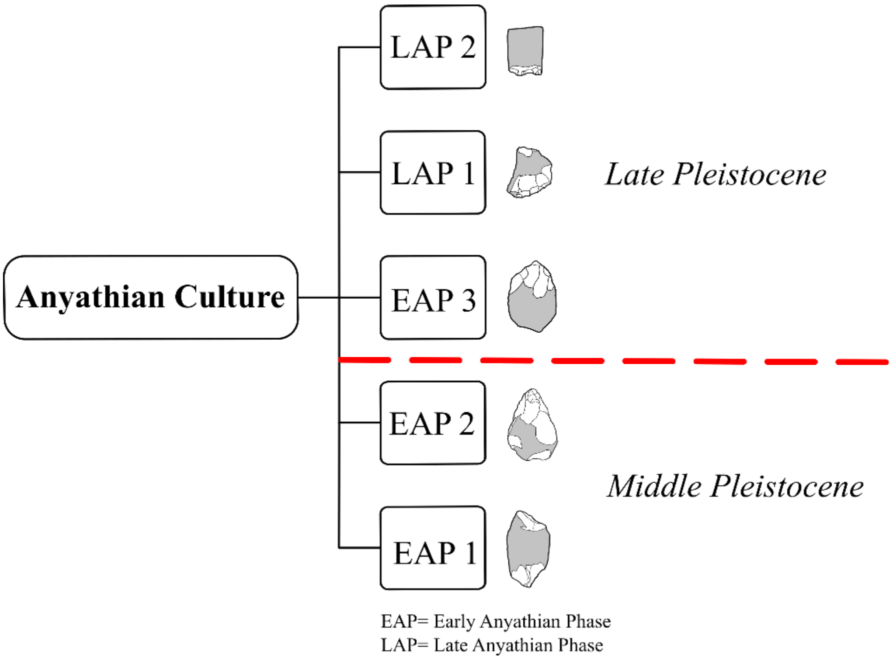


Figure 7. 6 Schematic diagram of Anyathian cultural sequences (Based on Moius 1943)

The most influence artefact type in this group is small, oval, semi-bifacial chopper which is mainly composed of silicified tuff. Unlike to this group, LAP 2 artefacts are influenced by various types of scrapers. These later two sub-cultural phases are regarded as upper

Palaeolithic tools. According to this study, he claimed that there was no hand axe or bifacial tool in Myanmar, defined as a territory in cultural stagnation. His conclusion seems to be an assumption that lithic technological development was evaluated from the point of western classical system (Movius 1943:353-378). Win Kyiang (2010a) argues that these artefact type are dominant in the whole culture, who reinvestigated the sites along the river terraces.

Figure 7. 7 Replicas of Anyathian artefacts collected in 1937-38, now displayed at Department of Archaeology, University of Yangon

6.4 Anyathian dilemma: issues and problems

Since Movius's demarcated line between absence and presence of hand axe or bifacial tools in east and west of the Old World becomes a long-term debate among the scholars, his work in Myanmar turns out to be a subject under the doubtful eyes. Therefore, Anyathian culture has been recently criticized due to uncertainty of terraces and insufficient artefacts to be defined as a culture. Hutterer (1977:44) claims geological terraces associated with Anyathian cultural phases as uncertain and the quantity of EAP 1 to EAP 3 artefacts are not enough to be defined as culture. Moreover, Dennell follows his comment and he (2014b:24-27) also articulates that the terraces are not from middle Pleistocene in age and they are not convincing evidence. These are the result of the local normal faulting along the Sagaing fault, over a hundred kilometres distance from the nearest terrace, which was not then recognized yet. It needs more evidence to prove terrace formations are the effects of the fault's movements. Therefore, he refutes the artefacts collected by Movius as geofacts, especially EAP series.

On the other hand, it seems that these critics are not well informed with other Palaeolithic tools made of silicified tuff and igneous rock, and also recent studies carried out by local archaeologists. Therefore, the term "Palaeolithic" based on typology and the associated geological chronology established through recent studies is generally believed to be convincing. Dealing with de Terra's terraces, it can be verified by using regional geological map of Myanmar whether these terraces are related to Pleistocene or not. According to current geological map, de Terra's terraces are mostly on the Holocene and Miocene-Pliocene layer, and hence his identification of terraces are rather reasonable and acceptable within in this vast landscape. In 2008-2009, Win Kyaing and his colleagues conducted a new survey work along the Ayeyarwady river (map 7. 1). They also rechecked the terraces and collected about 873 artefacts from two successive field works (Win Kyaing 2010a; 2010b). Moreover, these works have yielded several hundreds of Anyathian artefacts from the old terraces of Ayeyarwady river and archaeologists have also noted that these tool collections are largely dominated by four main types of stone artefacts, as mentioned by Movius.

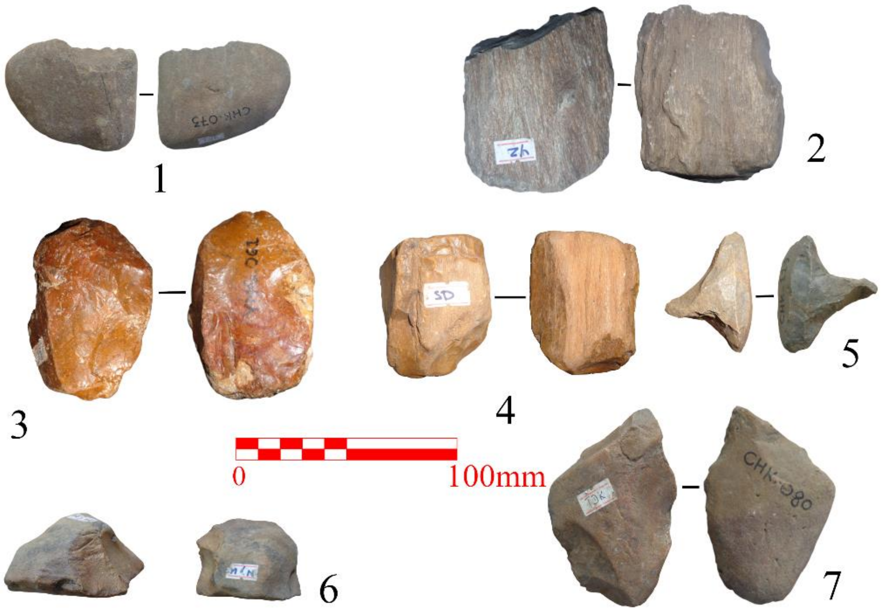


Figure 7. 8 Some Anyathian artefacts from recent field work (1~2 & 6. side scraper, 3. chopping tool, 4. hand adze, 5. point, 7. chopper

7.6 Results

This analysis mainly presents based upon the artefacts (n=104) from 2008-9 field work, but it also describes the available data of 1943 artefacts (n=84) which are now displayed at Peabody Museum (Peabody Museum of Archaeology & Ethnology at Harvard University 2017). Firstly, this study investigate whether the artefacts are appropriate in accordance with sub cultural phases mentioned by Movius (1943) and Win Kyaing (2010a). consideration on evidences in accordance with subcultural phases often lead to inconsistency of cultural demarcation among them when metric indices of cultural phases are compared with each other as shown in figure 7. 7. However, when metric variables are linked to only early and late phases, it clearly indicates that dimensional change of cultural phase as shown in figure 7. 8. Therefore, Anyathian culture should be defined as only early and late Anyathian phases instead of subcultural phases.

The analysis indicates that the most common raw materials are fossil wood and silicified tuff while the others are quartzite and igneous rock. Fossil wood is the most dominant raw material which takes up 53.6% (n=45) and 56.7% (n=59) respectively in group while silicified tuff follows in second position about 42.9% (n=36) and 28.8% (n=30) in both datasets. There is no description about the artefacts made of igneous rock in the former study, but it is 9.6% (n=10) in the recent one. Quartzite is the least number of raw materials which is about 3.6% (n=3) for production of the artefacts while it is 3.8% (n=4) in the latter study. There was no artefact made of flint in Movius' collection, and he (1943:350) claims that there is no true flint in Anyathian artefacts. However, a sample of flint artefact, 1% (n=1) is found in the latter field work (Arkar Aye 2008), it is also noted that such raw material is not as good as those used for artefact production by prehistoric hunter-gatherer communities in other parts of Old World (figure 7. 9). By observing these facts, it is remarkable that prehistoric hunter-gatherers from Anyathian sites mainly relied on the raw materials which are easily available around the Anyathian sites. In the other words, it seems the foragers mainly exploited the nearest raw material source rather than those from the distance. Similarly, the evidences in hand reflect that the foragers might have tried different kind of raw materials to produce artefacts in Early Anyathian tradition, but they mainly relied on the fossil wood than other materials (table 7. 1 and table 7. 2) in Later Anyathian tradition. Unlike to the recent study, silicified tuff might also have been a raw material source for the production of artefacts in the former one. Moreover, a contingency (table 7. 3) is set up to know the interrelationship between artefact type and raw material. The most influence raw materials for the production of chopper type are fossil wood and silicified tuff while hand adze is only made from fossil wood in this study. Another dominant raw material for chopping tool is silicified tuff, followed by fossil wood and igneous rock in order. It should also aware that these pieces of artefacts sample may not encompasses for the whole Anyathian tradition, but it partially exhibits the nature of the tradition. Scrapers are produced from most raw materials, except for flint which is only made for point.

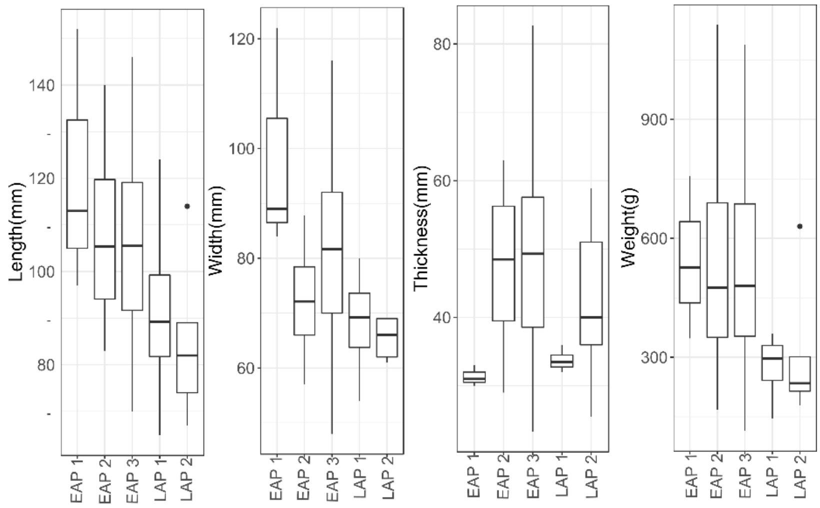


Figure 7. 9 Comparing dimensional measurement of artefacts among the cultural phases shows inconsistency of dimensional change among the phases.

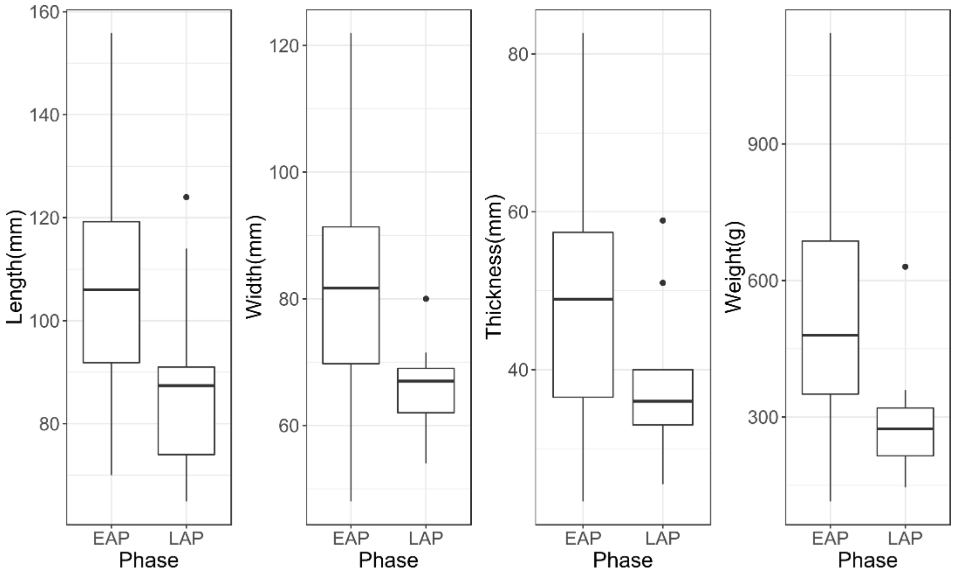


Figure 7. 10 Comparing dimensional measurement of the artefacts only in accordance with early and late phases.

Table 7. 1 Frequency table of lithic raw materials by Phase (early and late) in 1943 data

Raw Material	Phase		Total	Percent		Total Percent
	Early	Late		Early	Late	
Fossil Wood	33	12	45	39.29	14.29	53.57
Silicified Tuff	33	3	36	39.29	3.57	42.86
Quartzite	3	0	3	3.57	0	3.57
Total	69	15	84	82.15	17.86	100

Table 7. 2 Frequency table of lithic raw materials by Phase (early and late) from 2008-9 data

Raw Material	**Phase**		**Total**	**Percent**		**Total Percent**
	Early	Late		Early	Late	
Fossil Wood	50	9	59	48.08	8.65	56.73
Silicified Tuff	30	0	30	28.85	0	28.85
Igneous Rock	10	0	10	9.62	0	9.62
Quartzite	4	0	4	3.85	0	3.85
Flint	1	0	1	0.96	0	0.96
Total	95	9	104	91.35	8.65	100

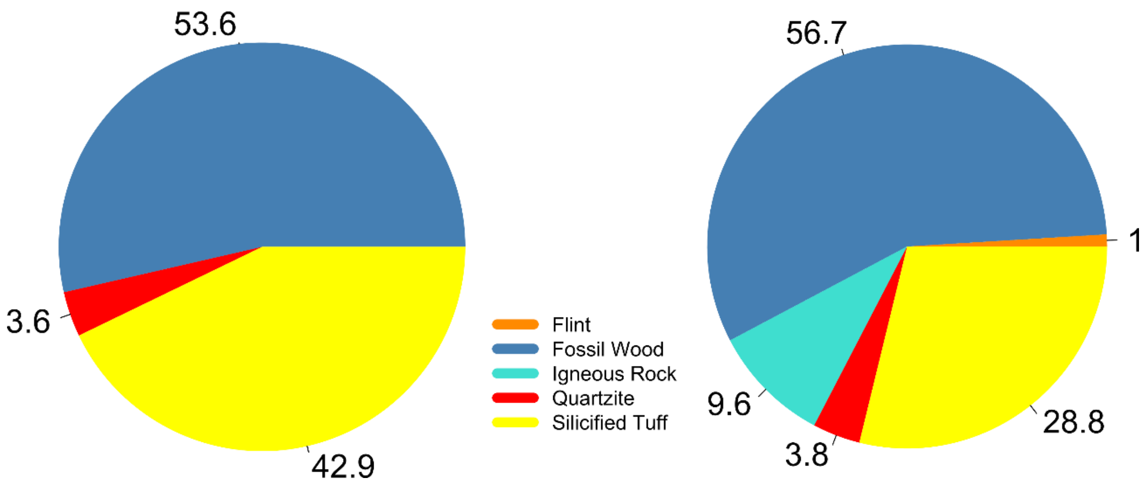


Figure 7. 11 Pie chart showing raw material percentage in both data (left to right: 1943 dataset and 2008-9 dataset)

Dealing with lithic artefacts typology, the most common type of artefacts are chopper, chopping tools, hand adze and scrapers. The rest ones such as core, flake, pick and point are not as many as the former. The largest number of artefacts in 1943 data is hand adze (n=35) and chopper (n=16), chopping (n=10) and scraper (n=10) stand in order. These artefacts are at least 10 in quantity while the rest ones are no more than 7 in number. Pick and point are the least number in the whole group, which are only one in respective group. However, it is different from the current data study.

Table 7. 3 Frequency table of lithic artefact types by raw materials

Type	**Raw Material**					**Total**
	Flint	Fossil Wood	Igneous Rock	Quartzite	Silicified Tuff	
Chopper	0	23	1	1	10	35
Chopping Tool	0	7	6	0	15	28
Hand Adze	0	28	0	0	0	28
Scraper	0	1	3	3	3	10
Pick	0	0	0	0	2	2
Point	1	0	0	0	0	1
Total	1	59	10	4	30	104

The most influence artefact type is chopping tool which is 35 in number. Chopper and hand adze, however, are the same quantity which is 28 for each type. The fourth largest group is scraper type in this analysis which is 10 in number while pick and point are the least number of artefact type which are 2 and 1 in quantity respectively, no more than 3 in the samples (figure 7. 10). According to both datasets, these four main types of artefacts are the most dominant others.

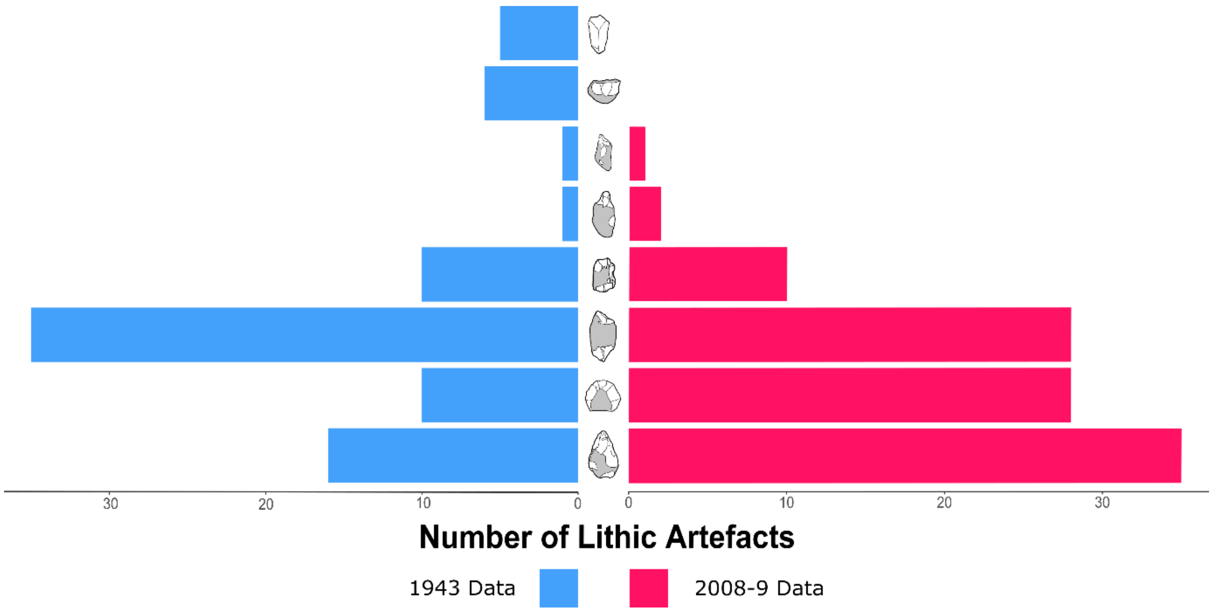


Figure 7. 12 Artefact type frequency in 1943 and 2008-9 data (bottom to top: chopper, chopping tool, hand adze, scraper, pick, point, core and flake)

Table 7. 4 Frequency table of lithic artefact type by cultural phases

Type	Phase		Total	Percent		Percent
	Early	Late		Early	Late	
Chopper	30	5	35	28.85	4.81	33.65
Chopping Tool	28	0	28	26.92	0	26.92
Hand Adze	25	3	28	24.04	2.88	26.92
Scraper	9	1	10	8.65	0.96	1.92
Pick	2	0	2	1.92	0	1.92
Point	1	0	1	0.96	0	0.66
Total	95	9	104	91.35	8.65	100

As shown in table 7. 4, the demography of artefact type can be observed for early and later phases. Chopper is the largest group in both phases which is 30 (28.85%) and 5 (4.81%) in number respectively. In contrast to this, chopping tool, about 28 (26.92%) is the second largest in early phase, although it does not appear again in the later one. Hand adze is the third influence type in the whole tradition which is 25 (24.48%) and 3 (2.88%) in number for each phase. Scrapers are the least dominate artefact type in relation to the former ones which is 9 (8.65%) and 1 (0.96%) for early and late Anyathian culture. Also, the rest ones are pick and point which are the least artefact type in the whole cultural sequence which is 2 (1.92%) and 1 (0.96) in quantity. Therefore, it also shows that utilization of chopper, hand adze and scraper would continue until late Anyathian phase. However, chopping tool which is the largest one in size does not appear again in the later phase and it raises a question that this artefact type was no longer to use in later or it transformed into another artefact types such as chopper or hand adze or scrapers which are smaller in size.

Table 7. 5 Statistic data of lithic artefact types. (L= length, W= width and T= thickness)

Type	**n**	**Length(mm)**		**Width(mm)**		**Thickness(mm)**		**Weight(g)**		**W/L**	**T/W**	**T/L**
		Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**			
Chopper	35	102.6	17.56	83.92	15.18	48.1	10.1	511.95	189.94	0.82	0.6	0.48
Chopping Tool	28	112.71	19.77	90.33	15.31	60	11.74	669.1	275.64	0.82	0.68	0.54
Hand Adze	28	105.41	20.32	68.28	12.23	38.74	10.25	406.82	198.83	0.65	0.58	0.4
Scraper	10	90.35	12.86	72.1	10.54	35.88	8.9	274.11	89.46	0.81	0.51	0.41
Pick	2	135.78	28.46	91.52	14.1	56.63	17.1	772.1	526.2	0.7	0.64	0.42
Point	1	72.5	-	60	-	36	-	157.4	-	0.83	0.6	0.5
Total	104											

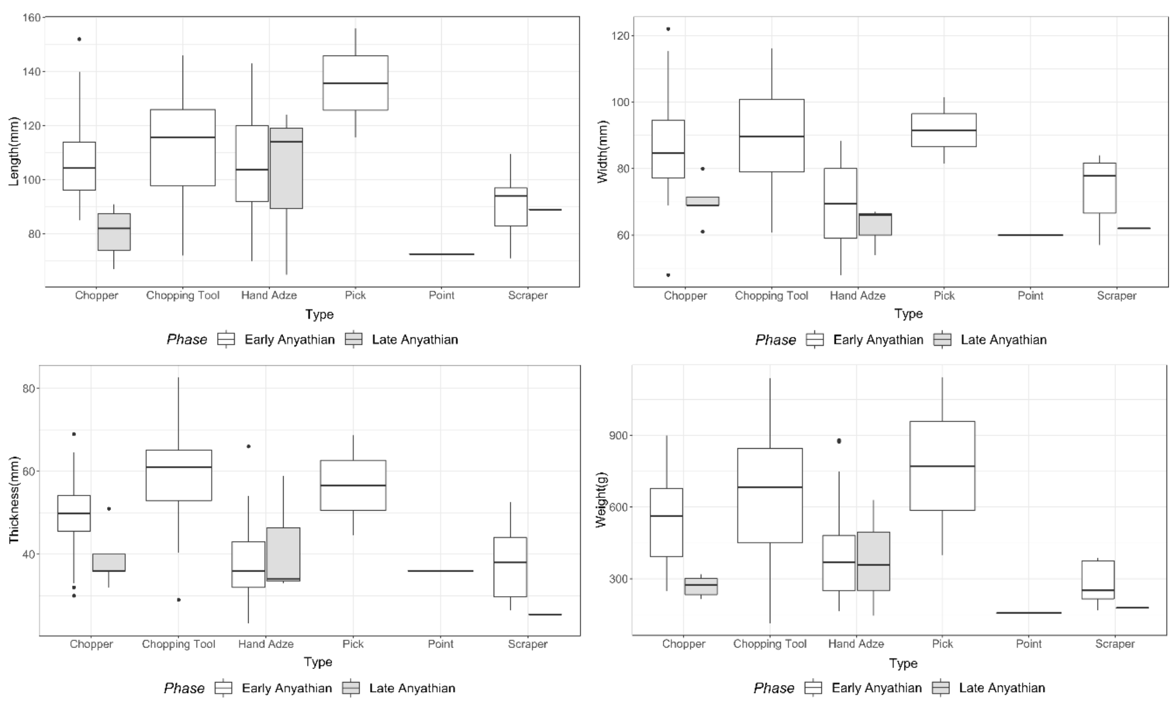


Figure 7. 13 Comparison of artefact types by cultural phases.

In the former study, Movius (1943) expressed the artefacts typology by using descriptive-classificatory method for selected items which is very informative for morphological variations of a particular artefact type, but it remains as an issue which makes difficult to understand the size of a specific artefact type and how much they are different from each other. Therefore, this study examines the artefact types based on their dimensional accounts to know what extent of a particular artefact type possesses and how it can be defined from each other. According to dimensional account as shown in table 7. 5, largest artefact type in Anyathian can be generally defined as pick, seemingly to be less effective in function than others. In the case of chopping tool, it is the second largest artefact type, followed by chopper and hand adze in order. There is no notable length value between chopper (102.6mm) and hand adze (105.41mm), but the former one is larger in width and thickness and so as in weight. When scrapers are compared with hand adzes, these artefacts are larger in width and smaller in other dimensional variables. There is only a point artefact which is the smallest in all values. In weight variable, chopping tool (669.1g), chopper (551.95g), hand adze (406.82g) and scraper (274.11g) stand in order after pick (772.1g). Moreover, ratios between width and length (W/L), thickness and width (T/W) and thickness and length (T/L) by of lithic artefacts are mentioned to know how much they are different from each other. However, the further right columns indicate that there is no remarkable difference of ratios among the artefacts.

Additionally, as shown in figure 7. 11, artefact types are compared in accordance with their respective cultural phase. It shows that the geometric indices of metric variables in chopper from early and late Anyathian phases are quite different. However, in the case of hand adze, length and width variables are not different while thickness and weight variables in later phase are slightly larger than early phase. Except length, other variables are quite different between early and late Anyathian cultural phase.

Table 7. 6 *t*-test results for the mean values for choppers and hand adzes. Values inside the boxes shows they are statistically different.

Type	**Phase**	**n**	**Length**			**Width**			**Thickness**		
			T	**df**	***p* (two-tail)**	***t***	**df**	***p* (two-tail)**	***t***	**df**	***p* (two-tail)**
Chopper	EAP:LAP	30:5	4.968	8	0.001105	3.936	12	0.001966	2.8537	7	0.02578
Hand Adze	EAP:LAP	25:3	0.26643	2	0.813	1.366	4	0.2494	0.4148	2	0.7149
	Total	55:8									

Also, two tailed *t*- test is performed to know the artefacts between two cultural phases are statistically different or not. Due to sampling bias, however, other artefacts such as chopping tool, scrapers, pick and point cannot be compared (cf table 7. 4), only chopper and hand adze type can be done. The null-hypothesis is that the mean values of the samples among the phases are not statistically different. If two-tailed *p* value is less than 0.005, null hypothesis is rejected, and two data sets are statistically different. As shown in table 7. 6, metric dimension of choppers between early and late phases are statistically significantly different while hand adzes show mean values are not statistically significantly different. Hence, it is generally assumed that hand adzes from early and later phases are generally similar while choppers among the phases are different.

7.7 Conclusion

This chapter has addressed the nature of lithic artefacts from hunter-gatherer sites in central belt, especially known as Anyathian culture. It seems that some critics on the culture are not well informed with recent field works in Myanmar. Former studies attempt to reconstruct the culture with relative chronological schemes, but it still lacks of scientific dates. Most lithic artefacts in central belt are still consistence with the characteristics defined by Movius, especially raw material acquisition and artefact typology. However, the analysis argues that Anyathian culture should be viewed into only two phases instead of dividing with sub-cultural phases. Concerning with the acquisition of raw materials, the evidence in hand shows that raw materials diversity is only found in early phase, not in later and so as in the former evidence. It still remains as a question for the acquisition of raw materials why prehistoric hunter-gatherers in the area only depend on fossil wood and silicified tuff in early and later phases while other materials were only used in early phase. Early and late Anyathian cultural artefacts are totally different from each other since the former ones are larger in all dimensional account than the latter ones. Typologically, four main types of artefacts are dominant in the whole culture, but some artefacts such as chopping tool, point and pick are not found in later phase. Both pick and chopping tool are largest in all aspects, and hence it is probably that these larger tools might have not been used in later phase and it seems to be replaced with more effective and portable artefact types.

Chapter 8

Technology and typology of stone tools from prehistoric hunter-gatherer sites in western fringe of Shan plateau

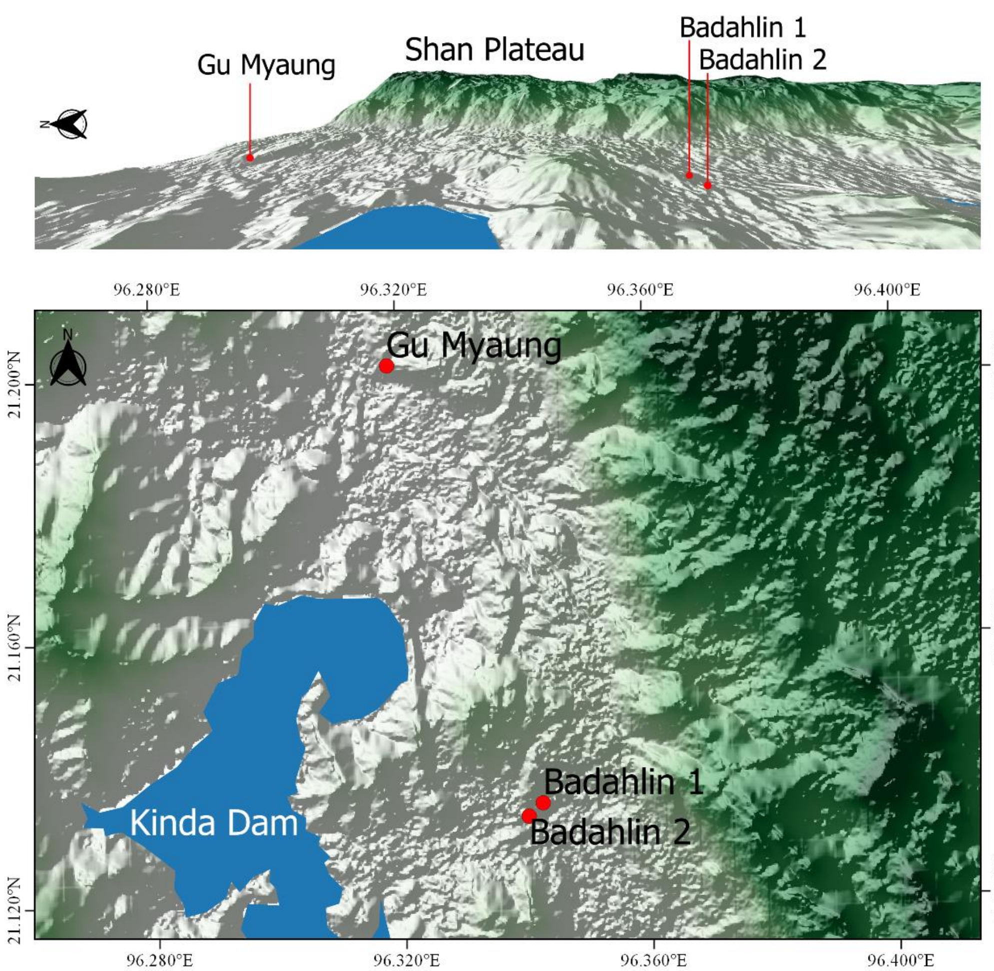
8.1 Introduction

Previous chapter discussed about lithic technological and typological analysis from hunter-gatherer sites in central belt. This chapter aims to present about lithic artefacts from hunter-gatherer sites in Shan plateau, especially from Badahlin cave 1, Badahlin cave 2 and Gu Myaung.

Evidences on hunter-gatherer adaptation in upper Pleistocene and early Holocene come from recent excavations at the cave or rock shelter sites, located on the western fringe of Shan plateau. A totality of fourteen cave or rock shelter sites have been so far excavated by several scholars, including Movius (1943:389-391), Aung Thaw (1971a), Tin Thein (2011), Hla Gyi Mg Mg *et al.* (1998), Kyaw Khaing (2012) and Marwick (2016). Unlike those from central belt, these sites are located on the periphery of Shan plateau and they can provide much information to better understanding on subsistence pattern and different lithic tradition of hunter-gatherer communities in upland karstic region from late Pleistocene to early Holocene. Most of the excavated sites are lack of scientific dates, but the artefacts are often compared with those from Badahlin cave 1 to suggest their timeframe. Therefore, the error margin is too wide to reliable, but it cannot be deniable that these were the materials left by the hunter-gatherer communities since those are found *in situ* at the excavations. Badahlin cave 1 (BDL1) (Aung Thaw 1971a), hence, was the first scientific dated stone age site and it plays an important role to know the hunter-gatherer communities' behaviour of Myanmar stone age sites. Similarly, recent excavations at Badahlin cave 2 (BDL2) and Gu Myaung (GUMY) (Marwick 2016) offer more fresh information with absolute dates on how early hunter-gatherer communities responded to their environment and what kind of cultural level they achieved in the late Pleistocene and early Holocene. The author also had a chance to join recent excavations at Badahlin cave 2 and Gu Myaung in 2016, led by Marwick. (More information about those sites are being prepared by Marwick.) Consequently, lithic artefacts from these three sites are selected to study to know the culture level of forager communities in upland karstic region. Lithic artefacts from these sites, in fact, can decisive even if lithic technology in Myanmar was "progressive" or "stagnant".

8.2 Badahlin cave 1: excavation, stratigraphy and chronology

The site lies some 360m distance from Badahlin cave 2 to the southwest, and both are limestone caves, probably 230~350 million years in geological age (Pe Maung Than 1971:353). These two cave sites are slightly elevated terrain than the surrounding area, located on the western fringe of Shan plateau (map 8. 1). Badahlin cave 1 also possesses some kind of rock art such as paintings (Aung Thaw 1971a:129-130) and cupules (Taçon *et al.* 2004:138-139), assumed as contemporary with earliest occupation at the site (Aung Thaw, 1971:127; Myint Aung, 2000:10-11; Than Tun, 2004:41), although there is no concrete evidence to relate rock art and other cultural materials yielded from the excavation. The site was excavated by Aung Thaw and his colleagues in 1969 for the first time, and Ye Myat Aung and his team (2009) also conducted an excavation at the site in 2009.



Map 8. 1 Locations of Badahlin cave 1, Badahlin cave 2 and Gu Myaung and 3D view of the landscape at the top

The site itself is divided into two parts_ one in the east and another in the west_ by a natural partition wall in the middle of the cave (figure 8. 2, figure 8. 3 and figure 8. 4). Main trenches were laid down in each part, and some smaller grids were also arranged in the eastern cave floor. In the excavation, they revealed four stratigraphic layers in the trench 1A in which topmost soil is nearly 40cm in depth, composed of brown and slightly calcareous soil. A piece of charcoal sample indicates the date going back to some 1750±81 BP. The second layer is between 13.9cm and 57.9cm in which the soils is highly calcareous and brown and light grey in colour. There is also a 16cm thick lime residual layer in the middle of layer 2. Third layer contains very fine-grained shale soil or clay in medium grey colour which is between 57.9cm and 80.7cm in depth and about 23cm in thickness. Two radiocarbon dates for the layer are 6750±125BP and 11250±200BP. The last one is natural soil, very calcareous and yellowish brown in colour which is about 105.1cm below the surface (Aung Thaw 1971a:127 and 133) (table 8. 1 and figure 8. 5). A radiocarbon date from charcoal sample in layer 3 at trench 2 indicates there was an occupation 7740±125 BP. Similarly, two radiocarbon dates from bone samples in layer 4 at trench 2 show that there might have been at least two occupations between 6230±90 BP and 13400±200 BP. Similarly, trench 1B was also laid to the west of the cave, but only charcoal samples from second layer was taken for radiocarbon date, indicating an occupation about 6570±125 BP. It is the same date with third layer in trench 1 at cave 1A. Therefore, these radiocarbon dates suggest that at least a group of hunter-gatherer community might have occupied at the cave before 13400±200 BP, the oldest one in the site chronology (Aung Thaw 1971a:127-133). In addition, three different radiocarbon dates such as 7740±125 BP, 6570±125BP and 6230±90 BP, indicate that the site was still occupied in middle Holocene. Subsequently, lithic artefacts from Badahlin should be regarded as the behavioural pattern of hunter-gatherer community from the late Pleistocene to middle Holocene.

Figure 8. 1 Badahlin cave 1 from the eastern point of view. There are two chambers inside the cave, demarcated by a limestone wall. It is now covered with a barbed wire fence to protect the rock art.

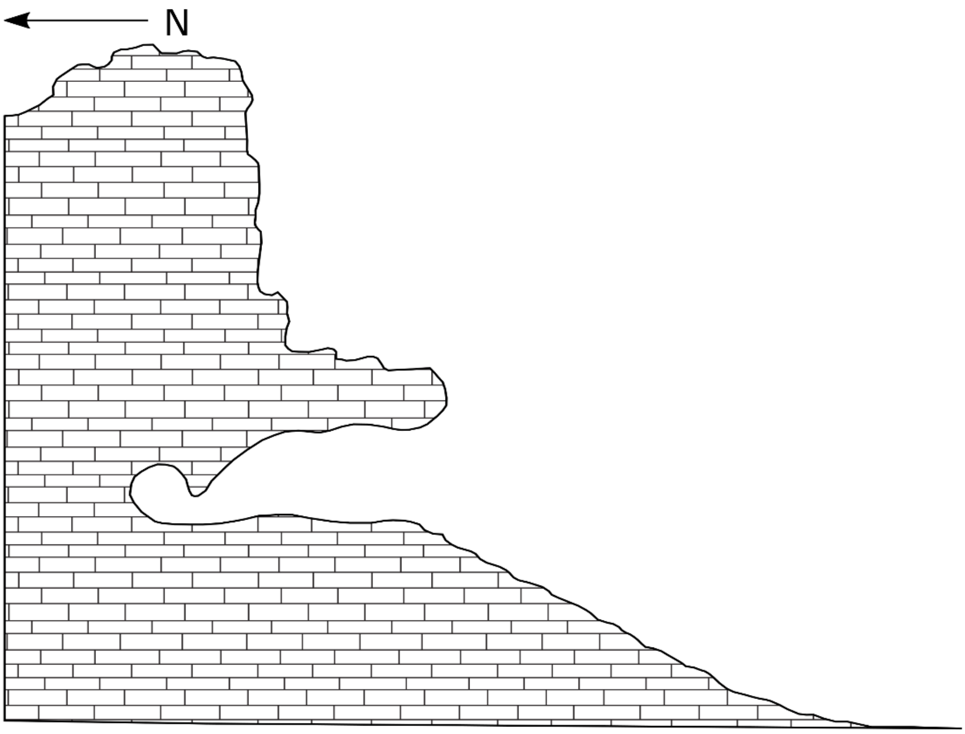


Figure *8*. 2 The section view of Badahlin cave 1 from the west. No scale is mentioned in the original figure. (After Aung Thaw 1971)

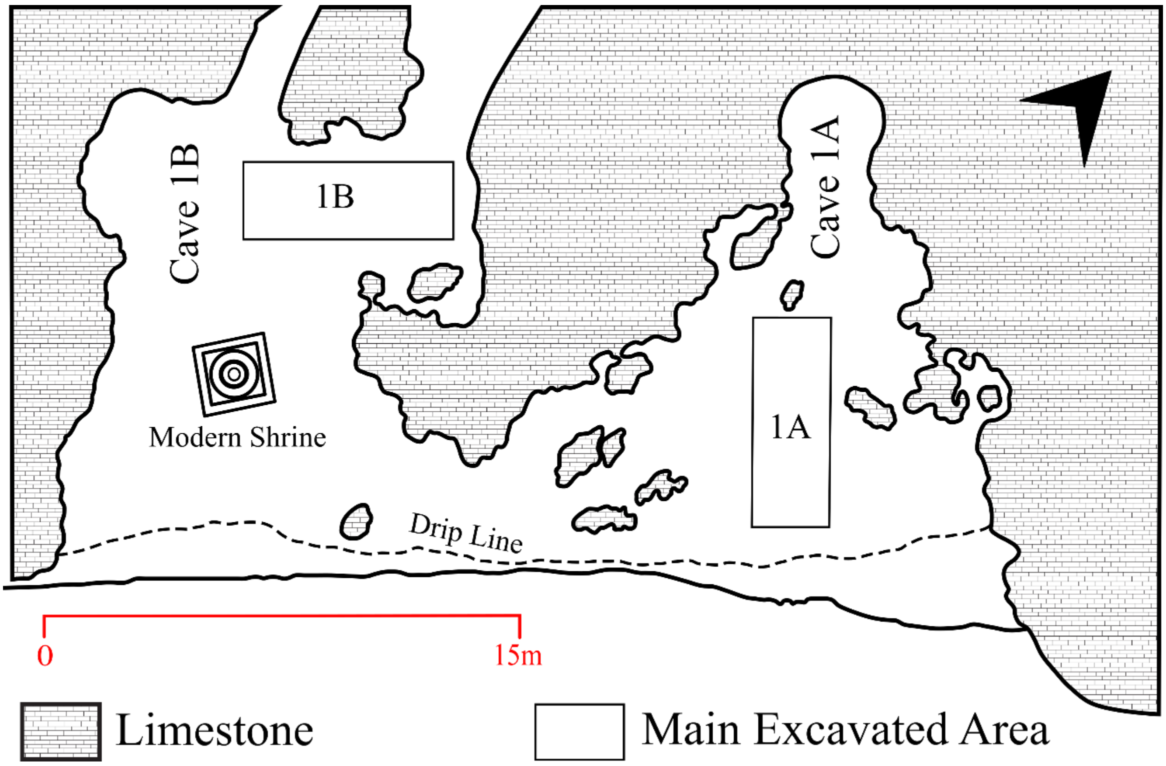


Figure 8. 3 Plan of Badahlin cave 1 and main trenches in 1969 excavation (adopted and modified after Aung Thaw 1971)

Table 8. 1 Excavated layers and their radiocarbon dates of trench 1A. (Adapted from Aung Thaw 1971:127 and 133

Cave	Trench	Layer	Depth	Soil	Lab Reg No.	Sample	Radiometric dates
1A	1	1	13.9cm	topmost layer, brown, slightly calcareous soil	R2547/1	charcoal	1750±81 BP
1A	1	2	13.9cm~57.9cm	brown and light grey, fine grained, highly calcareous soil; 16.51cm thick lime residual layer	-	-	-
1A	1	3	57.9cm~80.7cm	medium grey, very fine grained, shale soil or clay	R2547/4(A) R2547/4(A)	bone carbonate bone collagen	6570±125 BP 11250±200 BP
1A	1	4	80.7cm~105.1cm	brown fine grained, calcareous soil	-	-	-
1A	1	5	105.1cm~(?)	natural soil, yellowish brown, compact, gritty and very calcareous	-	-	-
1A	2	3	No description	No description	R2547/3	charcoal	7740±125 BP
1A	2	4	No description	No description	R2547/5(B) R2547/5(B)	bone carbonate bone collagen	6230±90 BP 13400±200 BP
1B	1	2	No description	No description	R2547/2	charcoal	6570±125 BP

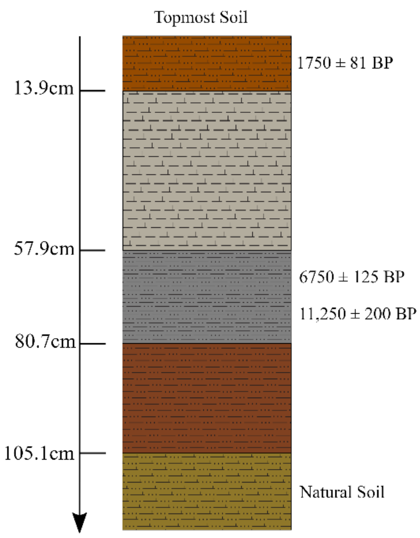


Figure 8. 4 Excavated layers of the main trench 1A (based on Aung Thaw 1971). Note: Original imperial unit is converted into metric unit.

A great number of lithic tools (over 1600) were mostly recovered, although 422 lithic artefacts were taken for further analysis. The artefacts include chopper, chopping tool, hand adze, hand axe or bifacial tool, scraper, perforated stones, pebbles and split or broken pebble. There artefacts have been found in association with faunal remains, shells, charcoal, red ochre and a few chord marked potsherds throughout of the layer sequences (Aung Thaw 1971a). One remarkable occurrence of artefacts at the site is perforated stones, which were often discovered in Neolithic and early metal age sites in the country. To designate the cultural achievement level of the site becomes a debate among the workers. However, there is a similarity between all these statements that they all mainly focus on their favourite date from the site chronological sequences. For example, Kyaw (2017:6) and Than Tun (2005:20) prefers the earliest date 11,000 BP to mention the culture of the site as "upper Palaeolithic", mainly focusing on rock art, while Aung Thaw (Aung Thaw 1971a) uses the later date i.e. 6500 BP to assign as "Neolithic", based on so-called shouldered adze and perforated stones. Myint Aung (2000) also uses the earliest date of the site and some cultural and environmental affinities with Hoabinhian sites from Southeast Asia to suggest as "Mesolithic character", and also claims the site as the western extension of Hoabinhian culture associated with the persistence of chopper-chopping tool tradition. Therefore, instead of strictly viewing the site in a particular cultural aspect, it should be better to question how lithic technology and typological change had been developed at this hunter-gatherer site during the vast chronological sequence, even if all claims are acceptable. Or, at least, it raises a question on BDL1 that what one can study the behaviour of a hunter-gatherer group through lithic artefacts left behind at the site, even though there are some limitation to mention tool variability and lithic technological achievement in chronological order.

8.3 Badahlin cave 2: excavation, stratigraphy and chronology

Badahlin cave 2 is, as mentioned above, some 360m away to the southwest of Badahlin cave 1 (map 8. 1). The cave is much bigger and longer than the former one, and it is composed of three main caverns connecting with a long passage, adjoining more than 3 smaller chambers on the either side. There was an excavation inside the cave in 1969, but no evidence of cultural deposit was found. However, some tools and bone fragments were uncovered in the excavation at the alcove near the entrance of the cave and a few others were detected from the surface collection outside of the cave (Aung Thaw 1971a:127). Therefore, Aung Thaw (1971a:126) argued that Badahlin cave 2 might have not been chosen as a favourable niche to occupy owing to the deep, darkness and clammy inside the cave. However, recent work at Badahlin cave 2 yields the archaeological finds with associated faunal remains and charcoals (Schaarschmidt *et al.* in press).

The excavation at Badahlin cave 2 was conducted at the spot close to western wall in the first chamber and third chamber respectively (figure 8. 6). A total three of 1m square grids named as A, B and E were laid down to detect the archaeological deposit at the first chamber while grid C and D in was conducted in the third one. In the grid A and E, the excavation reached until 2.5m while it was stopped at 0.7m in grid B due to unconsolidated deposit (figure 8. 7). The topmost layer is concealed with flowstone and the upper layers are distributed with calcified sediment and limestones, ranging from pebble to cobble size with irregular shape (Schaarschmidt *et al.* in press). The excavation works in the former one yield artefactual and ecofactual evidences while the latter one shows no sign of cultural deposit. A total of 25 lithic tools in association with faunal remains and charcoals were also found (Marwick 2016). Recent dates by post-infrared infrared stimulated luminescence (pIRIR) suggest the earliest occupation at the sites goes back to some ~30 ka ago (Schaarschmidt *et al.* in press) (table 8. 2).

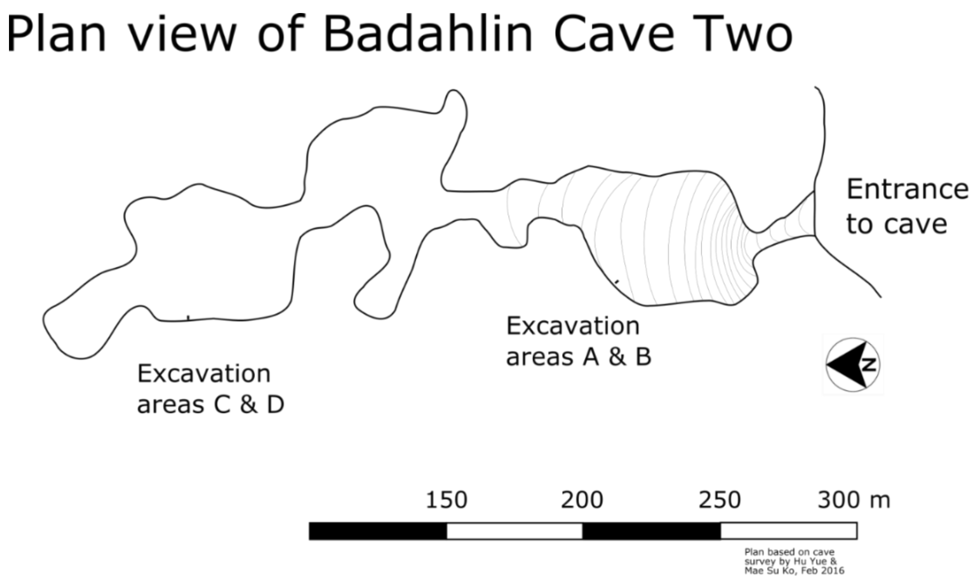


Figure 8. 5 Plan of Badahlin cave 2 (courtesy by Ben Marwick)

Table 8. 2 pIRIR and IR-RF ages of the samples from Badahlin cave 2 and Gu Myaung (Adopted after Schaarschmidt, *et al*. in press)

Sample	**Depth**	**Grain size (µm)**	**Number of grains**	**Age(ka)**		
				pIRIR	**IR-RF(IRSAR)**	**IR-RF(RF_{70})**
BDL2-OSL3	80cm	90-125	1200/326	29.9±1.9	44.2±10.4	54.3±4.6
		180-212	300/47	30.8±2.3	-	-
BDL2-OSL2	150cm	180-212	300/42	52.5±4.5	85.9±5.9	88.8±8.4
BDL2-OSL1	240cm	80-212	300/80	65.5±5.1	89.9±5.9	73.0±5.6
GUMY-OSL3	140cm	90-125	600/14	25.4±5.7	53.1±4.9	59.9±19.4
GUMY-OSL2	202cm	90-125	600/37	26.8±3.6	54.4±4.1	-

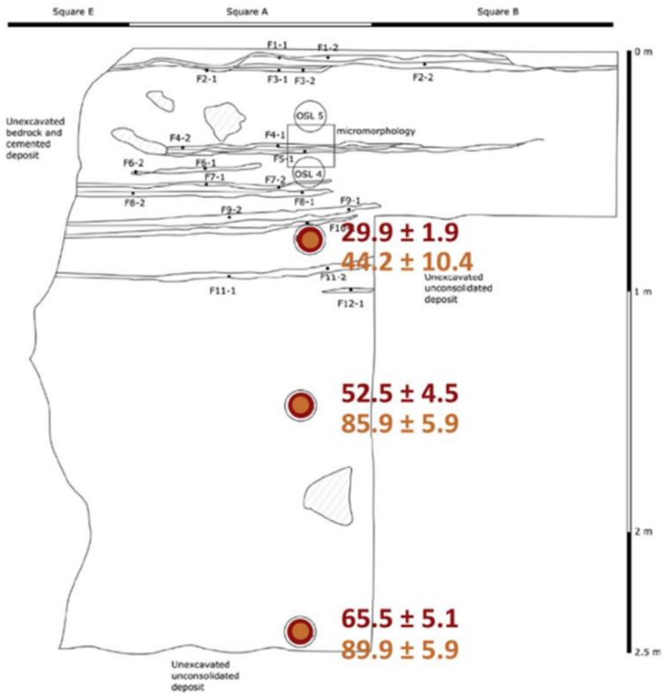


Figure 8. 6 Stratigraphy and its related chronology by pIRIR ages in red and IR-RF ages in orange (After Schaarschmidt *et al.*, in press)

8.4 Gu Myaung: excavation, stratigraphy and chronology

Another limestone cave known as Gu Myaung (long and narrow cave in Myanmar), some 8km away from Badahlin cave 1 and 2. The site takes up on a limestone hill, overlooking to Panlaung river (Schaarschmidt *et al.* in press). The excavation at the site was conducted until 4m in depth and the upper layer about 1.5m, mostly composed of horizontally layered grey-brown silt with some clay and gravel, and hearth feature with ash and charcoal (figure 8. 8). When the depth increase, the hearth feature gradually inclines. The stratigraphic layers cannot be seen clearly from a depth of about 2m, due to its deposit with clay and occasional large rocks (Schaarschmidt *et al.* in press). The excavation reveals a totality of 206 lithic artefacts, faunal remains ranging from medium sized to small sized animals, a few number of fish, crab, and turtle remains and seeds (Marwick 2016). The earliest occupation at the site by pIRIR date goes back to some 25ka (Schaarschmidt *et al.* in press). Raw materials for lithic tool production is mainly based on quartz, limestone and sandstone, similar to Badahlin cave 2.

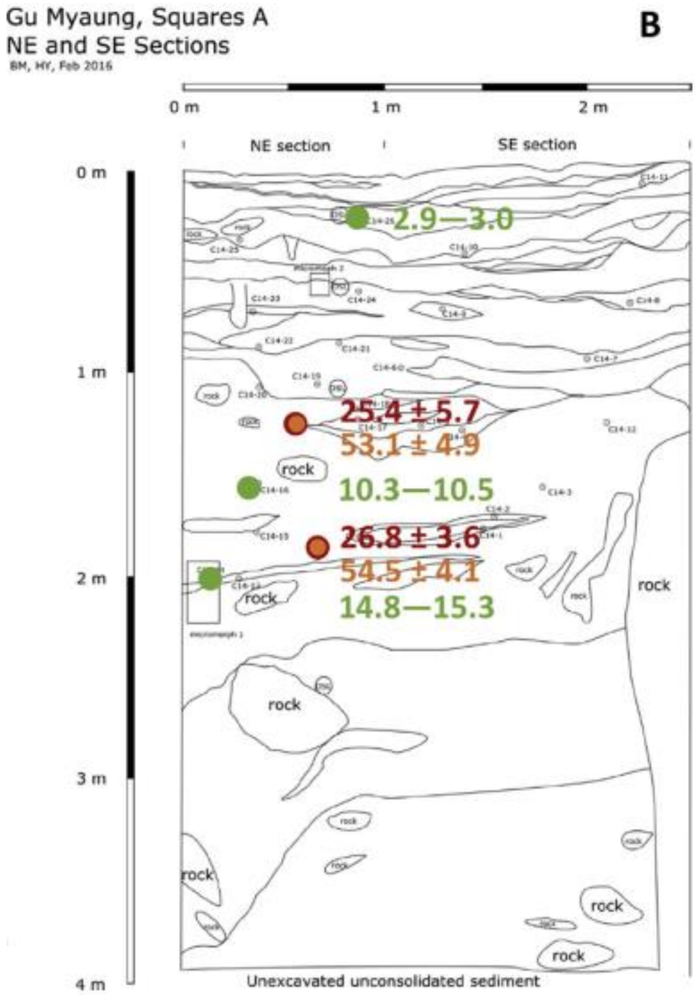


Figure 8. 7 Stratigraphic layers of Gu Myaung and its associated chronological order with pIRIR ages in red, IR-IR ages in orange and radiocarbon dates in green (After Schaarschmidt *et al.* in press)

8.5 Results

8.5.1 BDL1 Lithic Artefacts

In 1969 excavation, most of the lithic artefacts were yielded from the trench 1A and 1B follows in the second position, but least number of artefacts were uncovered from trench 2 and B (figure 8. 9). The excavated lithic artefacts can be categorized according to their typo-technological sequences (Aung Thaw 1971a), such as pebbles, split pebbles, hand axe or bifacial tool, hand adze, choppers, chopping tools, scrapers and perforated stones. In this analysis, it follows his typological classification. Core tools such as chopper, chopping tool, hand axe and hand adze, were found in association with pebbles and flakes tools such as scraper in all layers of the trenches. Moreover, a special tool type of pebble such as a few number of perforated stones fragments were often uncovered at the excavation. Among 113 lithic artefacts, most lithic artefacts are made of sandstone and quartzite while siltstone, igneous rock, granite, basalt and limestone are the second largest group than other materials such as rhyolite, dolomite, chert and fossil wood (figure 8. 10).

Apart from pebbles, split or broken pebbles and perforated stones, the sample size of lithic artefacts is 77 out of 113. Scrapers group (n=32) is the most influenced number in this study, and chopper (n=26) group follows that. The third group is chopping tool (n=12), rounded pebble (n=16) and split or broken pebble (n=12). The fourth group is hand axe and perforated stones (n=8) and these tools are less than 10 in quantity. The least number of tool type is hand adze (n=1). According to the descriptive statistics (table 8. 3 and figure 7. 11), mean length of hand axe or bifacial tool is the largest in metric dimension among other types, but mean width is rather smaller than chopper.

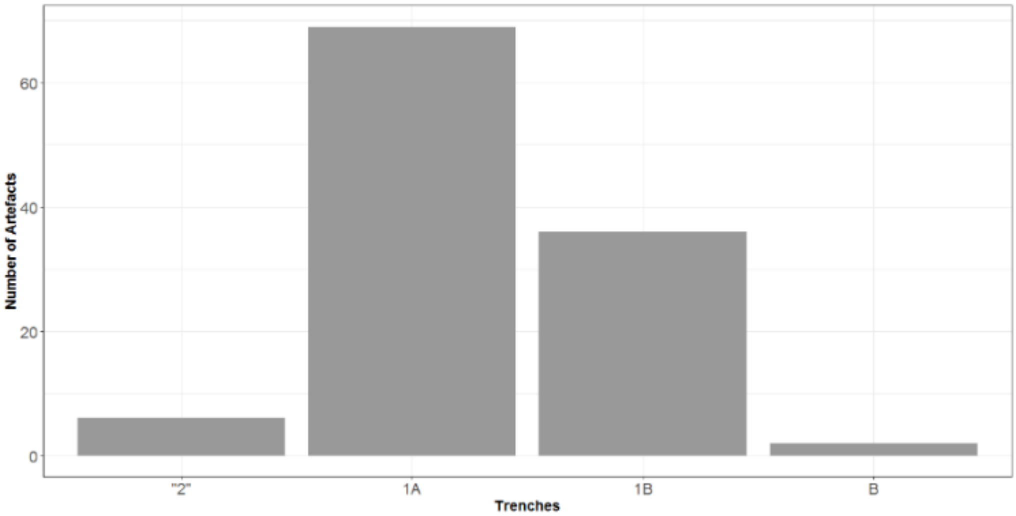


Figure 8. 8 A bar graph showing the trenches and their associated lithic artefacts at Badahlin cave 1 excavation

Similarly, mean thickness of chopper is the most extensive one while scraper possesses the smallest mean thickness. Among them, hand adze is not only the longest in length, but also thickest in width. However, the sample size (n=1) is too small to compare with others. In width and length ratio, hand adze and hand axe are very similar, but in the case of thickness and width ratio, chopping tool and hand axe are the same. Similarly, chopping tool and scraper show nearly the same result in thickness and length ratio.

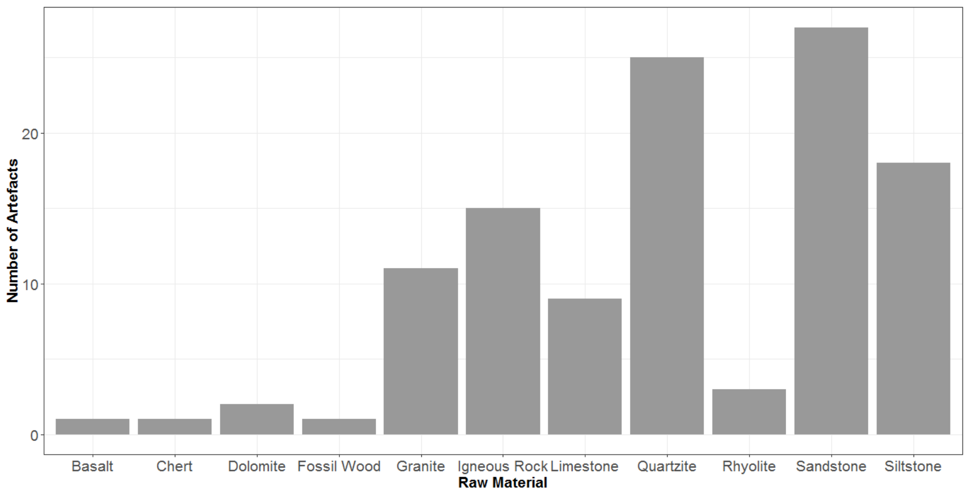


Figure 8. 9 A bar chart showing the frequency of raw materials applied for the manufacture of lithic artefacts at BDL1

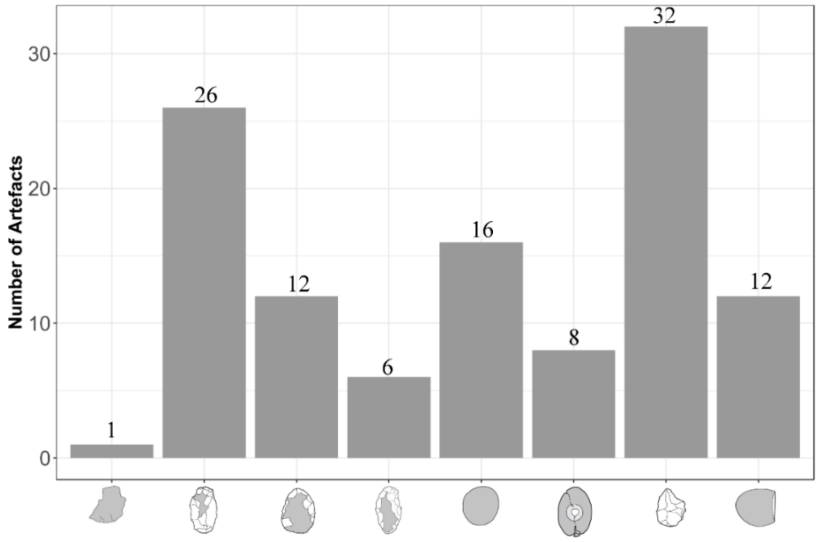


Figure 8. 10 Typology of artefacts and their respective frequency (left to right: adze, chopper, chopping tool, hand axe or bifacial, pebble, perforated stone, scraper and split or broken pebble)

Table 8. 3 Statistical summary of lithic artefacts typology from BDL1

Type	n	Length(mm)			Width(mm)			Thickness(mm)			Width/	Thickness/	Thickness/
		Mean	SD	CV	Mean	SD	CV	Mean	SD	CV	Length	Width	Length
Chopper	26	95.21	26.08	27.39	65.11	11.91	18.29	41.3	9.47	22.93	0.70	0.63	0.43
Chopping Tool	12	88.58	17.05	19.25	57.34	15.75	27.47	28.6	7.09	24.80	0.64	0.50	0.32
Hand Adze	1	139	-		72	-		25.2	-		0.52	0.35	0.18
Hand Axe	6	115	12.99	11.29	60.5	12.8	21.16	29.6	2.93	9.90	0.53	0.50	0.26
Scraper	32	54.53	9.71	17.80	43.68	10.57	24.20	19.8	7.09	35.8	0.80	0.45	0.36
Total	22												

Table 8. 4 Difference between flake and core tools

	Flakes		Core	
	Unifacial	**Bifacial**	**Unifacial**	**Bifacial**
n	25	7	39	6
Length(mm)				
Mean	54.28	55.43	94.3	115
SD	9.97	9.41	24.40	12.99
Width(mm)				
Mean	42.92	46.43	62.89	60.5
SD	11.48	6.20	13.43	12.80
Thickness(mm)				
Mean	19.15	22.13	36.98	29.6
SD	6.97	7.63	10.60	2.94

A total of 77 lithic artefacts are divided into two types: flake and core, and each category, in turn, can be subdivided into two as follows_ unifacial and bifacial. In core tools group, bifacial ones are quite longer than the unifacial ones, but, these artefacts are quite smaller in mean width and thickness value than unifacial core tools (table 8. 4). Therefore, it is suggested that cylindrical shaped stones were mostly chosen to produce bifacial core tools. Generally, either flake or core, bifacially flaked artefacts are obviously smaller in number than the unifacial ones. Therefore, it is suggested three points. First, all bifacial core tools are hand axe in typology and they are elongated than others, showing the achievement of advance lithic technology at the site, although it is not sure to say these artefacts were contemporary or later than others in age. In addition, most of them are pointed, but others are isosceles triangle type (figure 8. 12 and figure 8. 13). Second, most bifacial core tools are made of quartzite when they are compared with unifacial ones (figure 8. 14), very similar to those from BDL2 and GUMY sites. Therefore, it is suggested that quartzite might have been mostly chosen for manufacturing bifacial tools. The third point is that there are some flake scars at the butt and slightly or obviously notched on either one or both sides, probably prepared for hafting.

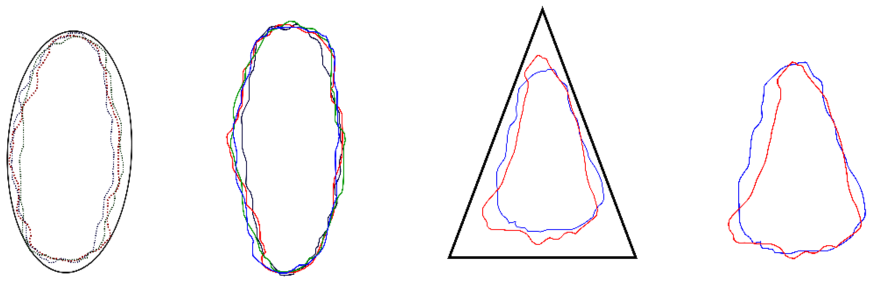


Figure 8. 11 Oval and isosceles triangle outlines of bifacial tools (adapted after Aung Thaw 1971)

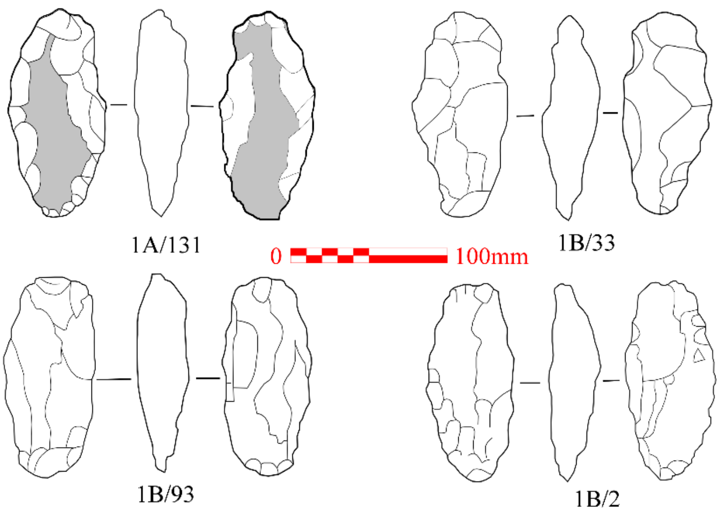


Figure 8. 12 Some hand axe or bifacial tools from BDL 1 (redraw after Aung Thaw 1971)

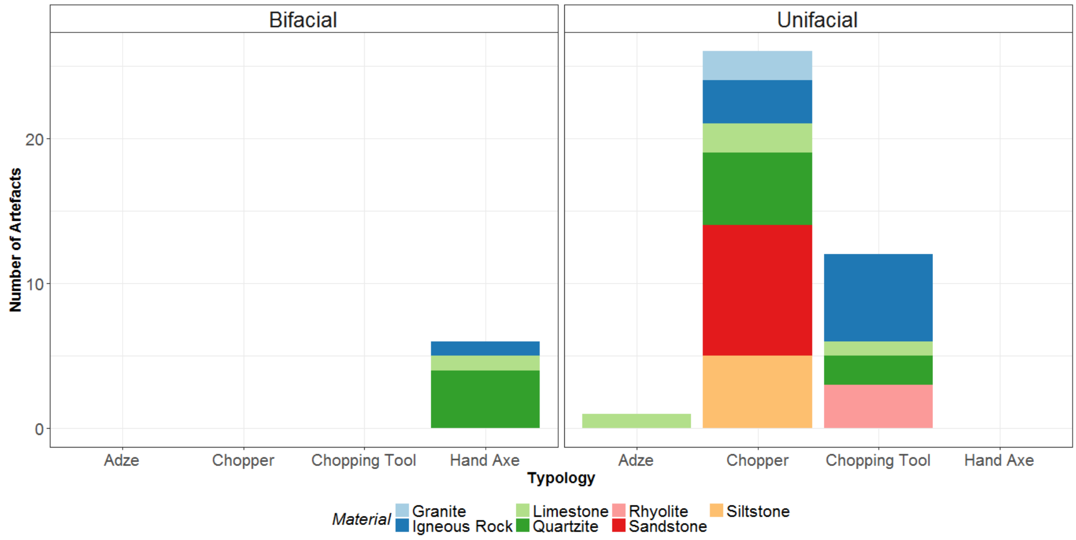


Figure 8. 13 A bar chart showing the frequency of bifacial and unifacial core tool typology and raw materials

Unlike to the bifacial core tools, unifacial ones are shorter in length, but slightly larger in mean width and thickness. Most artefacts are flaked only on distal end and some areas on lateral margin. There are two main types of unifacial flaked tools: cylindrical and oval shapes. In some cases, one of the surfaces is completely chipped off. Most chopping tools belong to oval shape while choppers are often cylinder in shape. Admittedly, some choppers show the achievement of technological advancement, but might have been rather late. For instance, sample No 1A/192 and 1B/29 are choppers according to Aung Thaw (1969b:19). These two specimens are rather different in terms of their typological variation being despite sharing the common features such as unifacially flaked on ventral surface and multidirectional flaking. The former one is circular in cross-section while the latter is acute triangle in shape (figure 8. 15

and figure 8. 16. The latter one is more advance in typology, seemingly more effective in grasping and hafting. Similarly, there are two main types of chopping tools: bifacial chopping tools and unifacial chopping tools. Bifacial chopping tool does not belong to completely flaked on ventral or dorsal surface. The number of flake scars on dorsal surface are sometimes lesser than the ventral one. The latter one can be subdivided into two main types: completely flaked on ventral surface and partially flaked to form a working edge. However, they share the same multidirectional flaking from the periphery to the centre method (figure 8. 17)

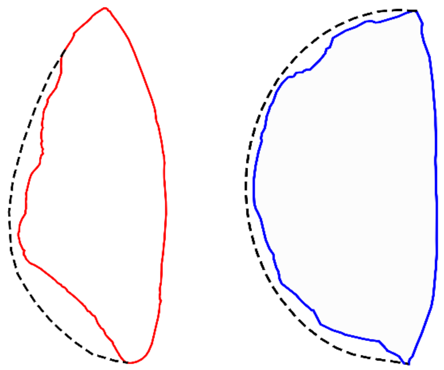


Figure 8. 15 Schematic diagram of original pebble shape and the tool types

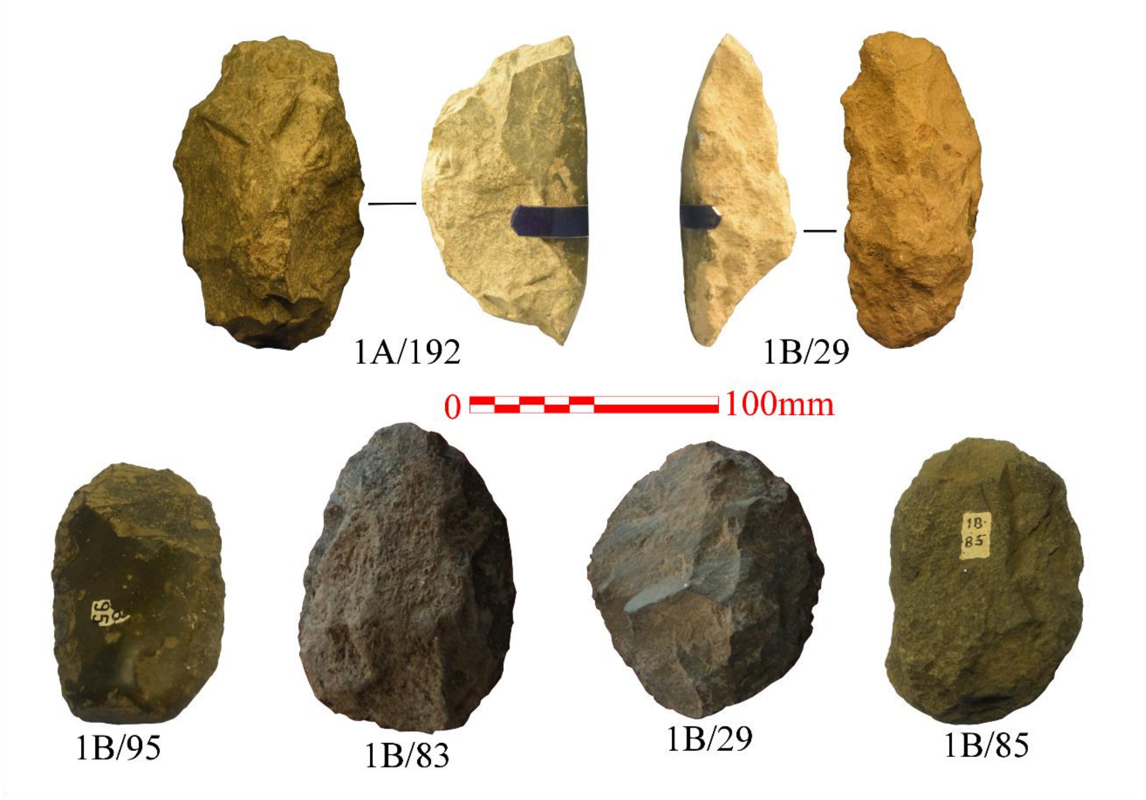


Figure 8. 14 Chopper and chopping tools from BDL1: choppers in upper row and chopping tools in lower row

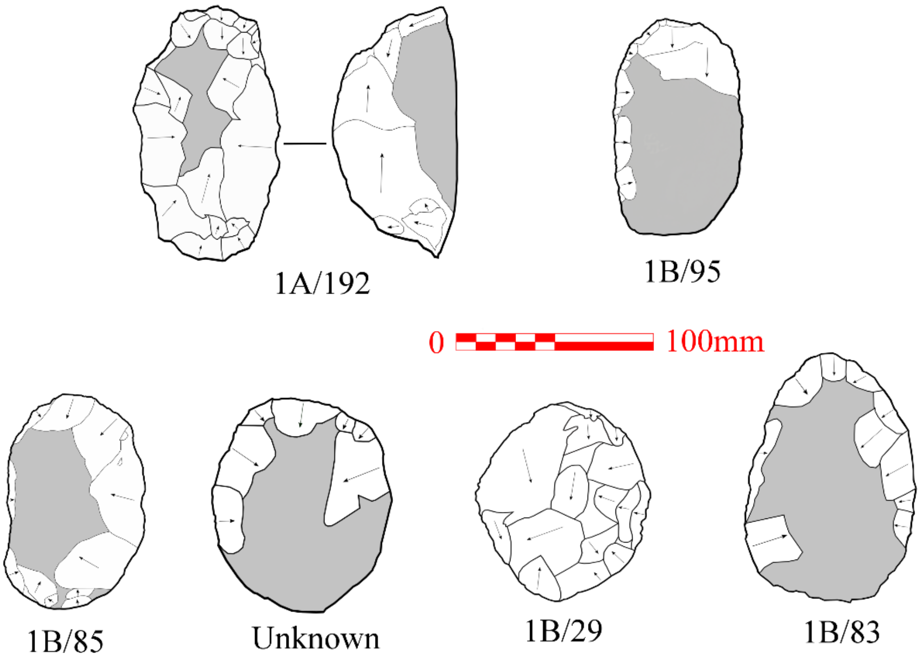


Figure 8. 16 Choppers and chopping tools with centripetal or multidirectional flaked scars

In flake tools typology, scarpers are the most common type and they are the only one category made of flake (figure 8. 18). Quartzite was mainly used as raw materials for manufacturing in both bifacial and unifacial scarper groups. Igneous rock is the second largest raw materials in unifacial scrapers whereas it constitutes as a small number in bifacial scrapers. These artefacts are slightly larger than the unifacial ones in metric dimension (table 8. 4). It indicates that bigger size of pebbles, possible split or broken, might have been chosen for manufacturing flake artefacts flaked on both surface. It is possible that bifacial flaking reduces more area of pebble than those of unifacially flaked. Moreover, multidirectional flaking method, especially flaked scars gradually accumulated at the centre, was also applied like the core ones. Obviously, no retouch is found on the working edge (figure 8. 19).

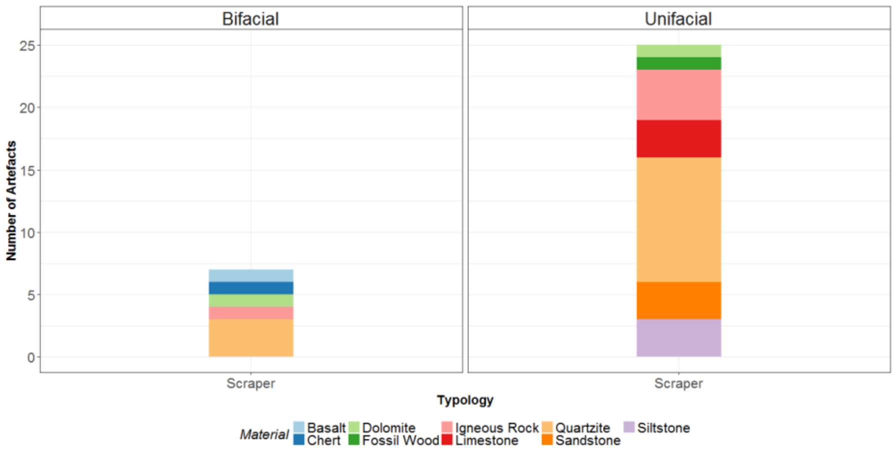


Figure 8. 17 Frequency of raw material types and artefact typology

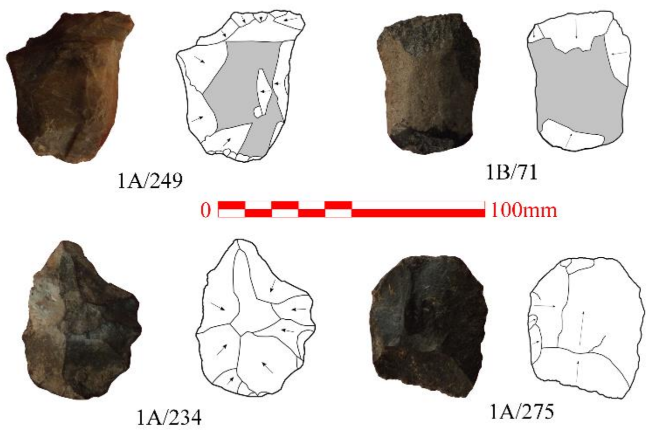


Figure 8. 18 Scrapers group

One remarkable find at the site is perforated stones, remaining to inquire the function of these artefacts. Aung Thaw (1971a:132) suggests these artefacts might have been used as digging weight for agricultural purpose, but no evidence for food production at the site has been obtained yet. Sorensen (1975:173) proposes that the term "perforated stones" should continue to be used instead of others such as macehead, net sinker, club head, bark beaters and weight stones, suggesting a functional purpose. Imdirakphol *et al.* (2017:369) convey that such artefacts are a marker of non-Hoabinhian entity enclosed within a larger Hoabinhian space. Therefore, more works is needed to understand why and where these artefacts were used. Nearly all of these artefacts from BDL1 are fragmental pieces, but some could be refitted to see the complete form (figure 8. 20). These perforated stones made of siltstone (n=5) and sandstone (n=3) and they are rather different from those found at Neolithic, early metal age and urban sites in the country. Some were prepared to make a hole at the centre while some have only impression at the centre. The diameter of the hole at the centre is about 11mm. As described by Aung Thaw (1971a:128), the production stages of perforated stones can be seen through their typology (figure 8. 21).

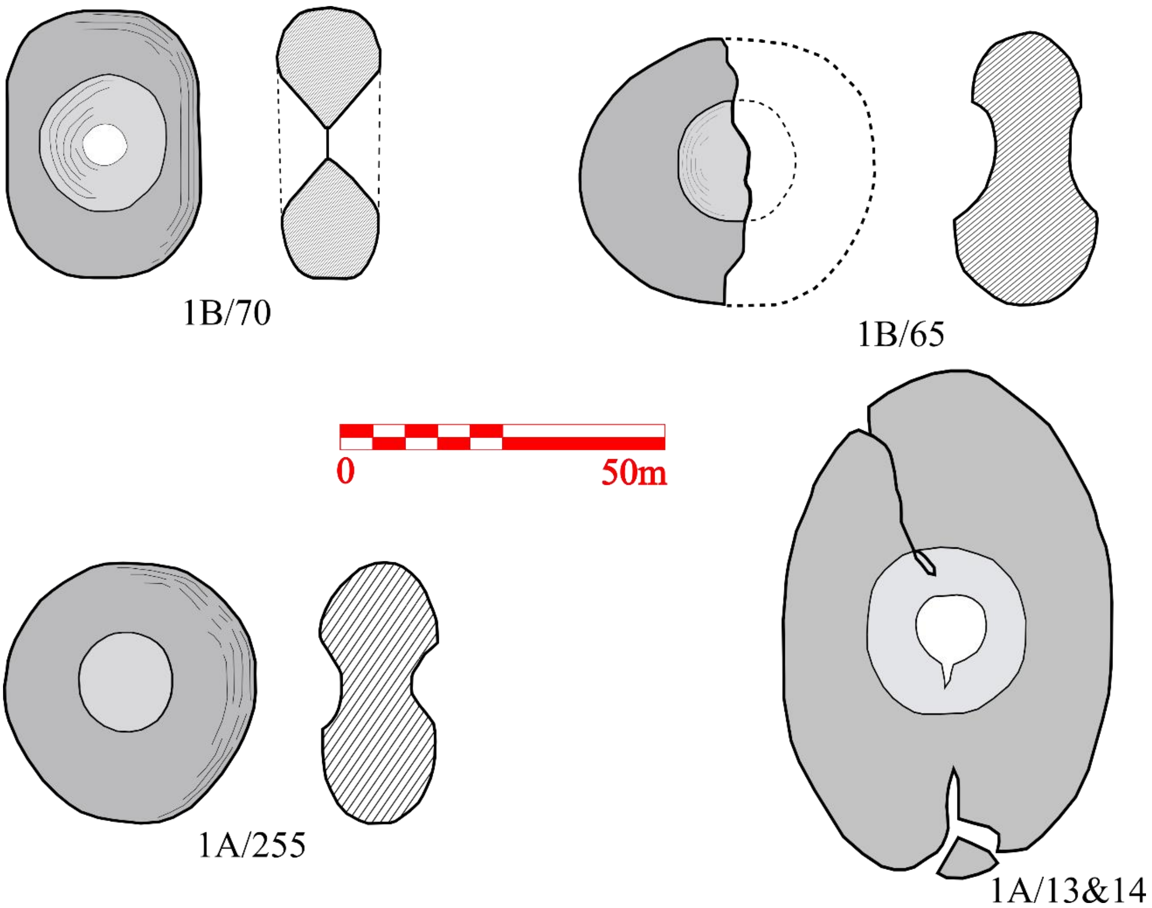


Figure 8. 19 Excavated perforated stones from BDL1 site (redraw after Aung Thaw 1971)

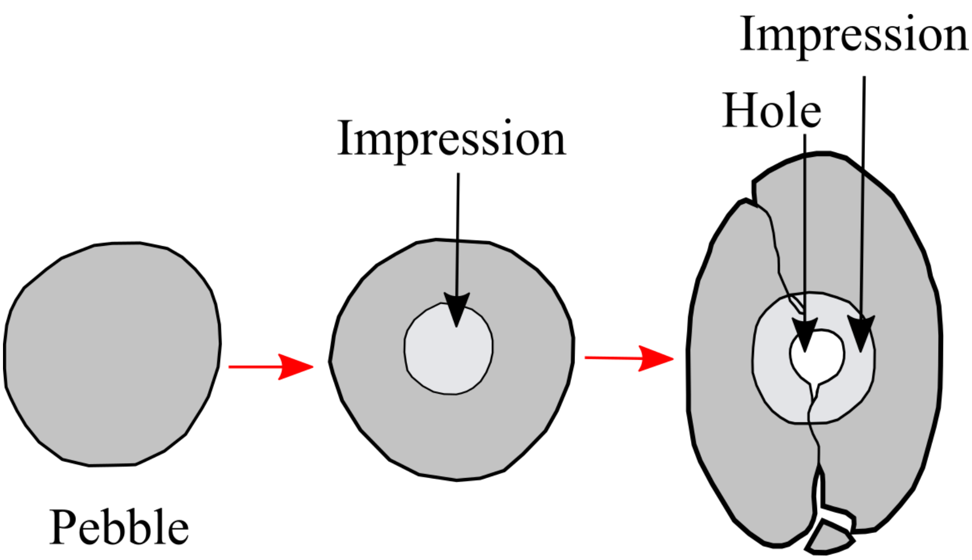


Figure 8. 20 Production stages of perforated stones

In summary, BDL1 lithic artefacts might have been passed through at least two technological sequences. Rounded and split pebbles found in association with lithic tools indicate that these were intentionally collected to produce artefacts. Aung Thaw (1971a:128) maintains these pebbles might have been used as anvil, hammerstone, grinding stone, raw material and whetstone in accordance with the traces of contamination and damage on them. However, these pebbles strongly verify the production of lithic artefact at the site when they are related with others. One can clearly see the typo-technological sequences of lithic artefacts at the site as shown in the following figure 8. 22. First, rounded and oval shaped pebble including several raw materials were collected and then initial flaking was started on the periphery of a pebble. Later, it would be ended in complete flaking only on ventral surface or partially detached on both ventral and dorsal surface to form a chopping tool. In flaking process, some could be broken and it could lead to produce a flake tool such as scraper. Otherwise, some naturally flaked or unintentionally removed by over force pebble might have been gradually chipped off to form a scraper. In the case of cylindrical pebble, it would be used for manufacturing a bifacial tool or hand axe with small cortex area on the dorsal surface. Some bifacial tools or hand axes have no cortex area on both surfaces. Some would be discarded or transformed into a scarper when these artefacts were broken. However, admittedly, bifacial tool or hand axe are more advanced in detachment method and typology (figure 8. 22).

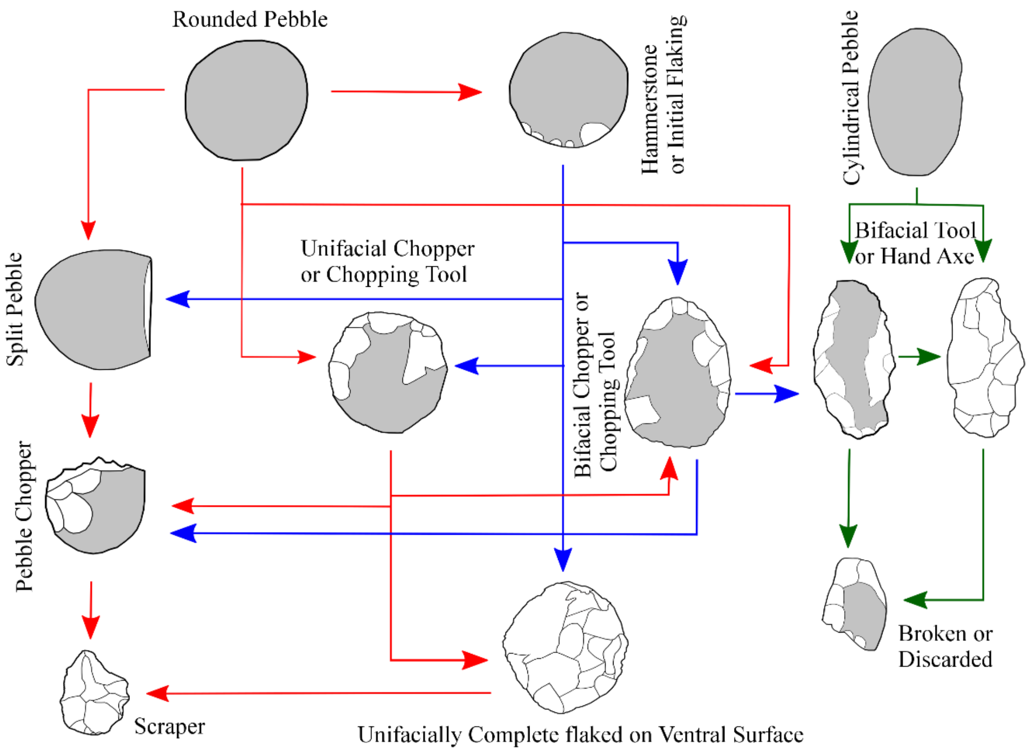


Figure 8. 21 A schematic diagram of technological sequence in BDL1 lithic artefacts

8.5.2 BDL2 Lithic Artefacts

Unlike to BDL1, the artefacts found in association with faunal remains are relatively rare. Most lithic artefacts were uncovered in square A while square B and E are very fewer in number as shown in figure 8. 23. Every square is assigned by 10cm contexts until 80cm (Marwick 2016). The artefacts can be classified into their typo-technological sequences such as bifacial tool, core, flake and unifacial chopper. In this analysis (n=14), core is the largest group (n=10) while others are very smaller in number such as chopper (n=1), flake (n=2) and bifacial tool or hand axe (n=1) respectively. These artefacts are made of limestone, quartz and sandstone.

Since the sample size per each artefact type is too small except for core, the statistics summary come from the combination of excavation squares. Among them, as shown in figure 8. 23, most selected lithic artefacts come from gird A in which maximum number of artefacts have been found between 40cm and 60cm in depth (figure 8. 24). According to table 8. 5, chopper is the largest dimension than others. There are a few detachments only on the periphery of a surface to form a working edge. After that, bifacial tool stands as second position in metric dimension. There are a few flake scares on the lateral margins of both surfaces. It is rectangular shape and clearly shows the application of multidirectional flaking method (figure 8. 25).

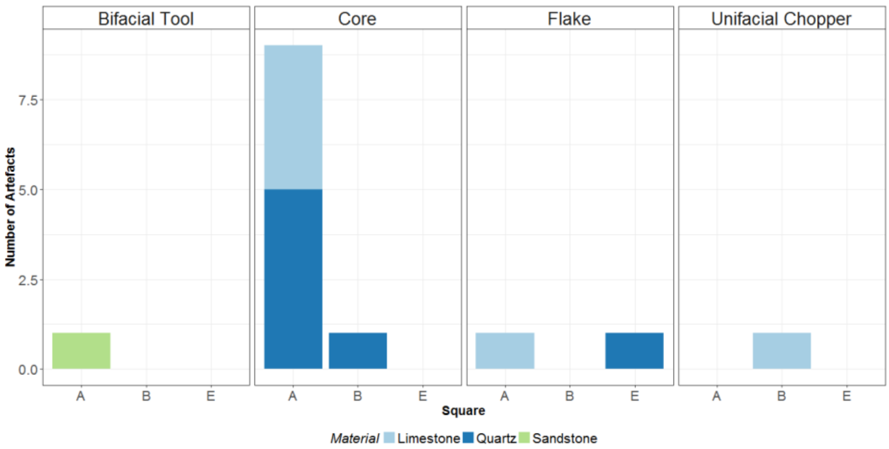


Figure 8. 22 Selected pieces of artefact types and raw materials per square

According to stratigraphic context, bifacial tool is 10cm lower than chopper, which was found at 40cm depth in context B4 at square B. There are two types of cores found at the excavation at BDL2. One type of core is multiplatform core and another one is multidirectional core. The weight of the core varies from the minimum value 95.3g to the maximum value 348g (figure 8. 26). In contrast to core, the number of flakes is very smaller in number. These flakes show no sign of retouched, but cortex area on dorsal surface shows they were flaked from a nodule or pebble. One question raises to argue why artefacts as well as flakes are too sparse than cores at the site. Being high diversity of raw materials and fresh fracture surface, as mentioned by Marwick (2016), it can be understood that these artefacts are in secondary deposit and they had been transported from a short distance where they were used and discarded. It was, therefore, likely to be a temporary occupation of a hunter-gatherer group at the site.

Table 8. 5 Statistical data of artefacts at BDL2

Type	n	Length(mm)		Width(mm)		Thickness(mm)		Weight	Width/ Length	Thickness/ Width	Thickness/ Length
		Mean	SD	Mean	SD	Mean	SD				
Core	10	46.43	25	53.58	11.67	33.04	13.68	177.96	1.15	0.62	0.71
Flake	2	33.33	15.28	38	1.13	11.3	14.57	41.75	1.14	0.3	0.34
Bifacial tool	1	89.9	-	57.9	-	25.7	-	218.1	0.64	0.44	0.3
Chopper	1	122.2	-	71.55	-	37.2	-	422.8	0.6	0.52	0.3
Total	14										

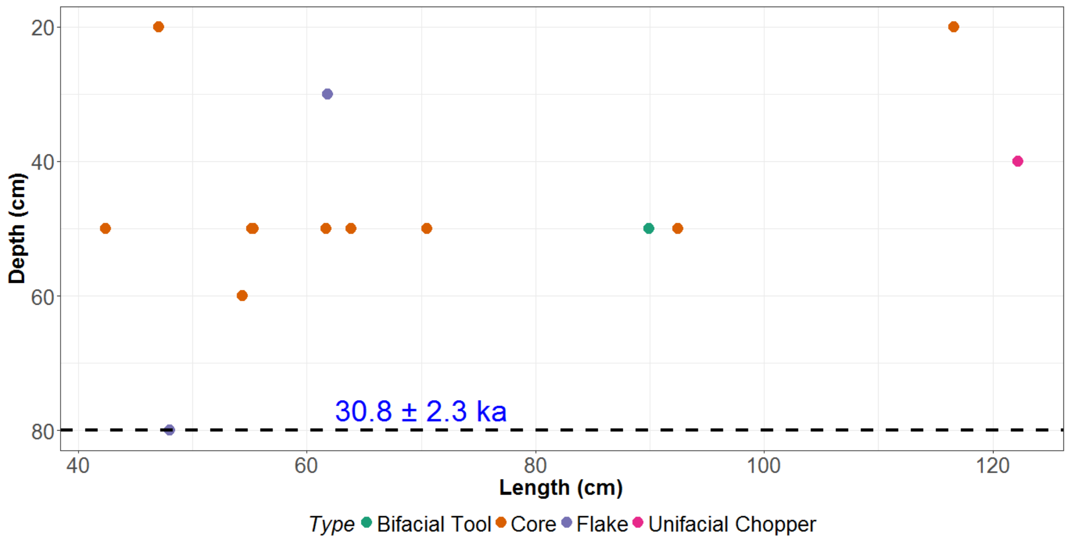


Figure 8. 23 Frequency of artefacts in depth and the earliest cultural depositional date by pIRIR at BDL2 (Based on Schaarschmidt *et al.* in press).

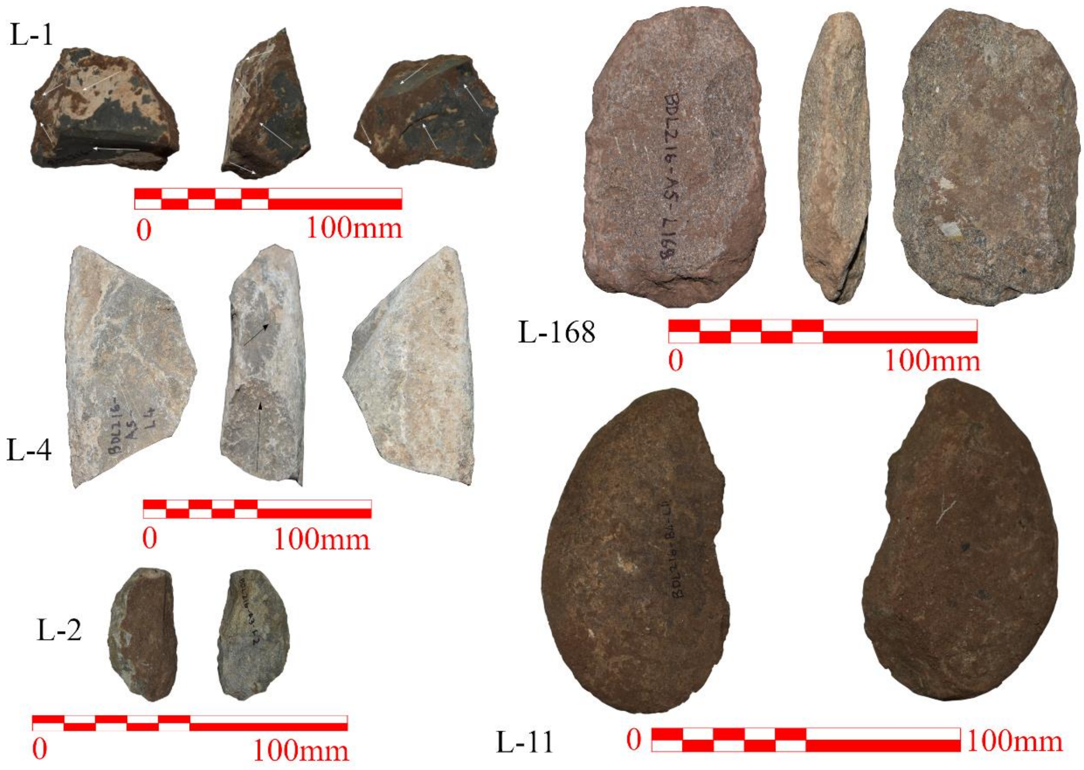


Figure 8. 24 Lithic Artefacts from BDL 2. L-1: multiplatform core, L-4: multidirectional core, L-2: flake, L-168: bifacial tool or hand axe and L11: chopper

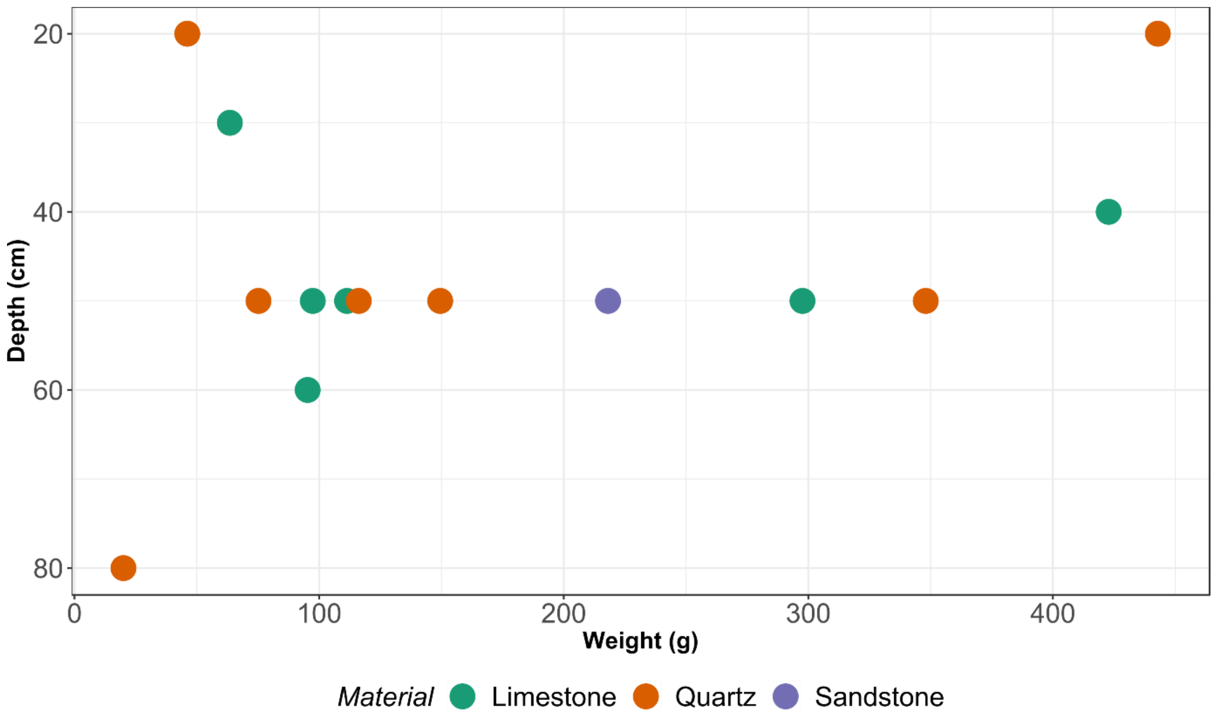


Figure 8. 25 Distribution of artefacts' weight in accordance with depth

8.5.3 Gu Myaung Lithic Artefacts

Along with aquatic animal remains, lithic artefacts were discovered throughout the whole layer sequences until 4m in depth (Marwick 2016). However, the frequency of lithic artefacts is different in them. Marwick (2016) denotes that most lithic artefacts were found from the upper 2m in depth whereas artefact number decreases as the square deeps (figure 8. 27)8. In this analysis, the artefacts are classified in accordance with their techno-typology and it includes chips/shatter (n=38), flake (n=81), biface (n=2), chopper (n=1), core (n=2), pebble (n=2) and split pebble (n=7). Like raw materials from BDL 2, quartzite is the most influence group for manufacturing of lithic artefacts than others. Limestone are the second largest group while sandstone and igneous rock are the least number of raw materials in the whole series (figure 8. 28).

According to the artefact sample sizes among three sites, Gu Myaung site possesses several number of chips/scatter and flakes than others. Furthermore, these artefacts are the largest number in typo-technological groups at the site. In this analysis, chips/scatter are generally assigned as less than 2.5cm and flakes are regarded as the pieces greater than 2.5cm. It clearly shows that the great number of chips/scatter and flakes are quartz (figure 8. 28). Both types of artefacts have no retouch, but some from the latter might have been used as scrapers. It is, therefore, generally suggested that flakes and chips/shatters were either by-products of manufacturing tools or the main purpose to produce as flake tools at the site. The latter was probably used as flake tools since the ratio of core tools to flake are relatively different.

Figure 8. 26 Frequency of artefacts per depth and the earliest occupational layer dated by pIRIR based on Schaarschmidt et al 2018.

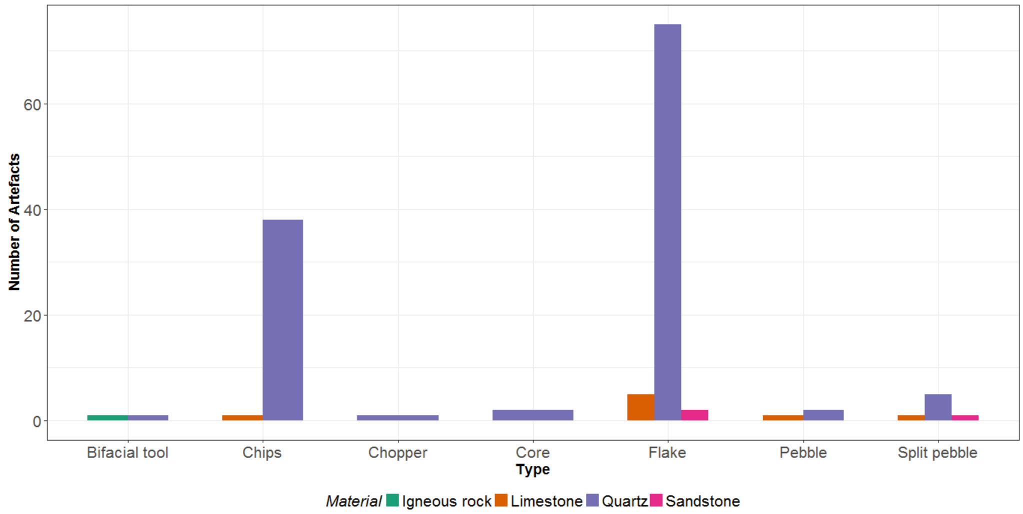


Figure 8. 27 Frequency of raw materials and lithic artefact types

In other artefact groups (table 8. 6) bifacial tools are the largest in dimensional measurement while chopper is the second largest in the whole series. However, chopper is the largest one, related to the weight, in all artefacts group (figure 8. 29 and figure 8. 30). It is remarkable that chopper was likely to be produced after the bifaces, according to the stratigraphy (figure 8. 27), at the site. These two bifacial tools are found in different context in depth. Sample L-155 was found in 90cm in depth while L-166 was discovered at the depth of 115 cm. Therefore, these two samples are believed that they might have been produced in different periods. Cores are very fewer in number, but they have the same flaking method compared with those from BDL1.

Table 8. 6 Statistics summary of lithic artefacts from Gu Myaung

Type	n	Length(mm)		Width(mm)		Thickness(mm)		Weight	Width/ Length	Thickness/ Width	Thickness/ Length
		Mean	SD	Mean	SD	Mean	SD				
Chips/shatter	39	19.52	3.53	15.14	5	6.4	5.14	1.36	-	-	-
Flake	82	39	13	26.3	10.5	11.8	8.2	13.45	0.67	0.45	0.3
Bifacial tool	2	120.7	0.42	68.85	2.5	33.4	6.8	356.1	0.57	0.48	0.28
Chopper	1	106.3	-	71.5	-	31.9	-	339.7	0.67	0.45	0.3
Core	2	98.75	0.07	64.5	10.2	40.5	1	301	0.65	0.63	0.41
Pebble	2	79.1	38.66	53.4	11.06	28.2	12.12	-	-	-	-
Split pebble	7	65.26	23	45.65	13.43	32.77	15	-	-	-	-
Total	14										

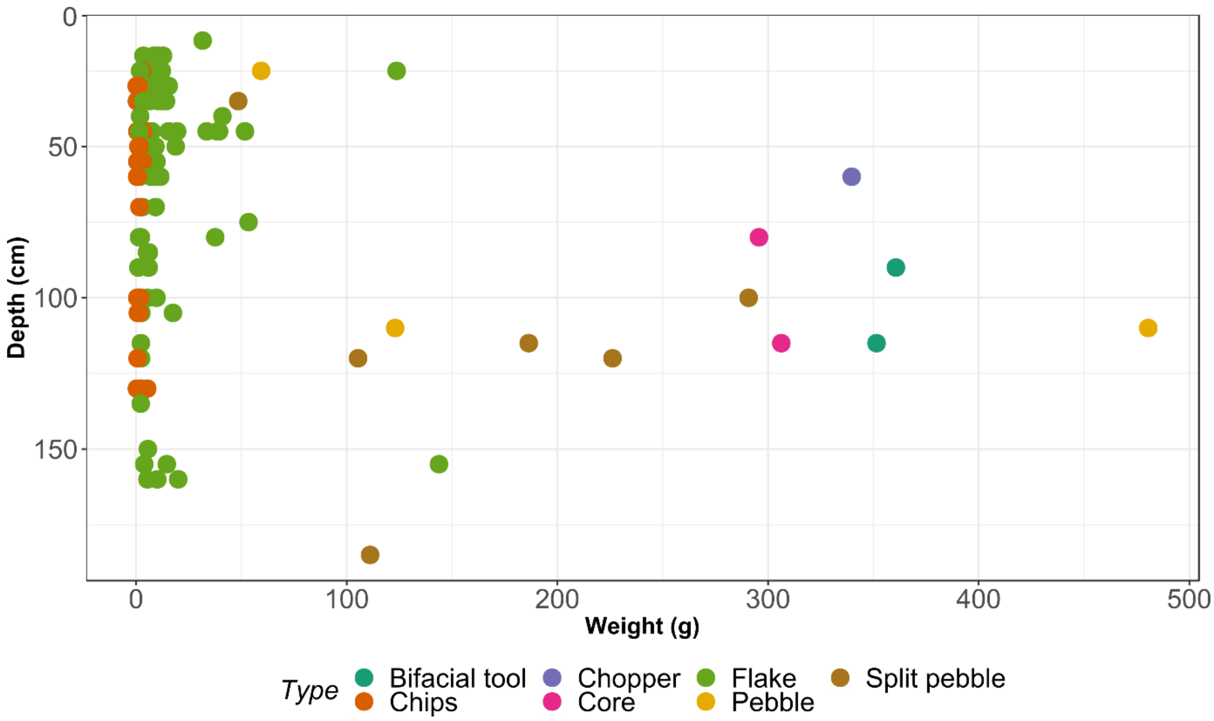


Figure 8. 28 Distribution of artefacts per depth

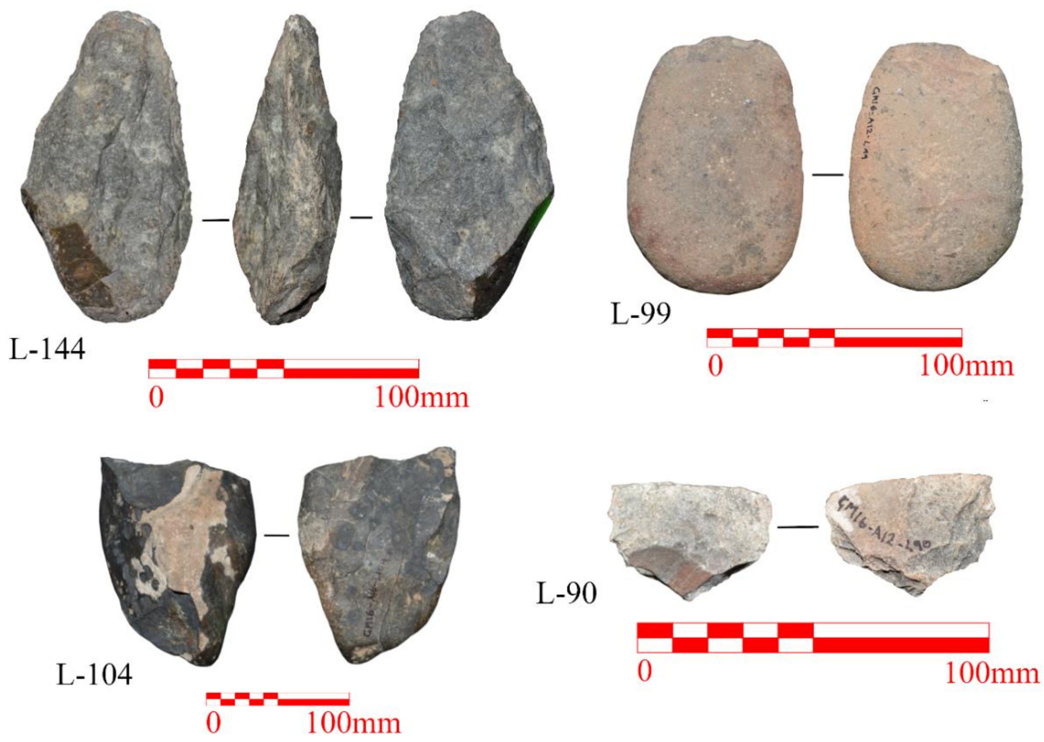


Figure 8. 29 Gu Myaung lithic artefacts; L-144: Biface, L-99: Chopper, L-104: Core, L-90: Flake

8.6 Results

As mentioned before, these three hunter-gatherer sites are good examples to show the characteristics of pebble tool culture from upland karstic region. One remarkable thing, a chronological difference of the site habitation, is obvious among them. However, their earliest chronological dates obtained so far is not too much different. Lithic artefacts from these three sites exhibit the behavioural pattern of hunter-gatherer community from late Pleistocene to middle Holocene. One question raises to claim how these three sites indicate the same pebble tool culture from upland karstic region.

Generally, there are two ways to show how these three sites have the same lithic tradition. The first one is basic flaking method to produce the artefacts, although the sample sizes for lithic artefact typology among these sites are rather different from each other. One can easily recognize these artefacts have been produced by using the same flaking technique_ multidirectional method since objective pieces of lithic such as choppers, bifacial tool and cores indicate such kind of flaking method was applied in those sites (figure 8. 31 and cf. figure 8. 22). These objective pieces are mostly produced from flat river pebbles while the cores are flaked from rounded river pebbles. In the case of biface, it is remarkable that two artefacts from the depth 90cm and 115cm in GUMY indicate technological change from simple edged biface to almost completely flaked biface. Therefore, typological variation of bifaces from BDL2 and GUMY can be distinguished into three_ oval, rectangular and triangular in shape (figure 8. 32). Cores can be distinguished into three kinds_ single platform core, multiplatform core without cortex and multiplatform core with cortex. Single platform core might have been an initial stage to produce the latter. Since flakes were struck off from every corner of a pebble, core becomes smaller and smaller (figure 8. 33). Here, the concept of multidirectional flaking method is based on the removal of flakes in more than one direction and the use of more than one striking platform (Andrefsky 2005:145).

However, as the time went on, lithic artefacts become smaller and seems to be more effective in function. For instance, chopper from BDL2 is larger in metric dimension than from those of BDL1 (figure 8. 34: 1&2; table 8. 7) but thickness is smaller than the latter. Similarly, in the case of bifaces, metric dimension of BDL1 are smaller in size, pointed and slightly notched on one side (figure 8. 13) while those from BDL2 and GUMY are oval or square shape (figure 8. 34: 2,3&4; table 8. 8), bigger in size and cortex area percentage is generally larger than the former. Although sites' occupational chronology is different from each other, one can clearly see the continuation of lithic technological tradition through lithic artefacts (figure 8. 35).

Table 8. 7 Comparative metric dimension of chopper size between BDL1 and BDL2

Chopper	Site	
	BDL 1	BDL2
n	26	1
Length (mm)	95.22	122.2
Width (mm)	65.11	71.55
Thickness (mm)	41.3	37.2
Width/Length	0.68	0.58
Thickness/Width	0.63	0.51
Thickness/Length	0.43	0.3

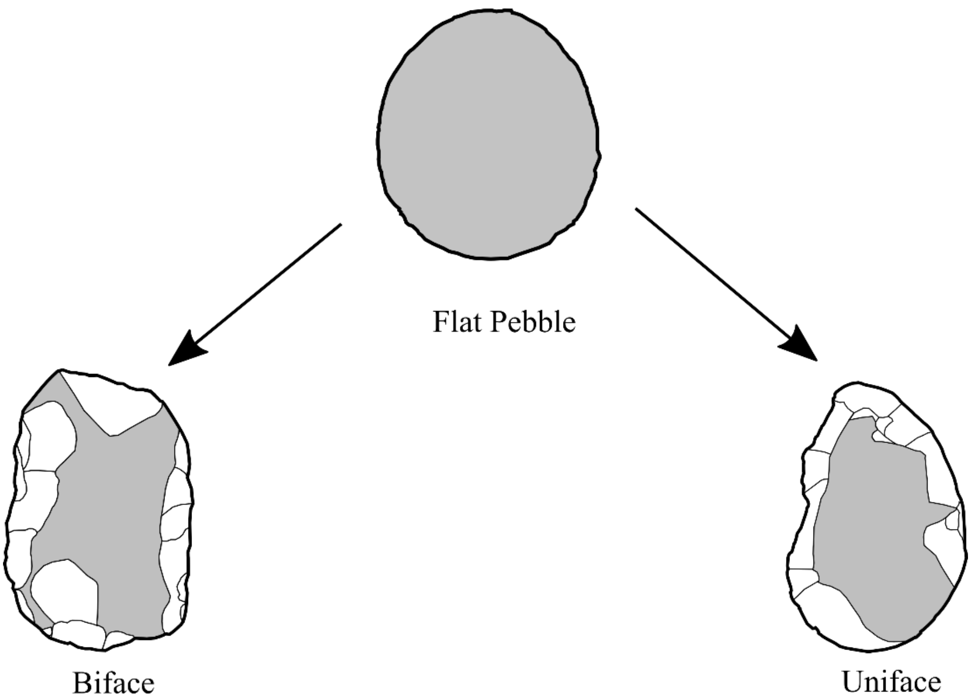


Figure 8. 30 Technological sequences of reduction to produce chopper and bifacial tool. Biface has more flake scars on ventral and dorsal surfaces

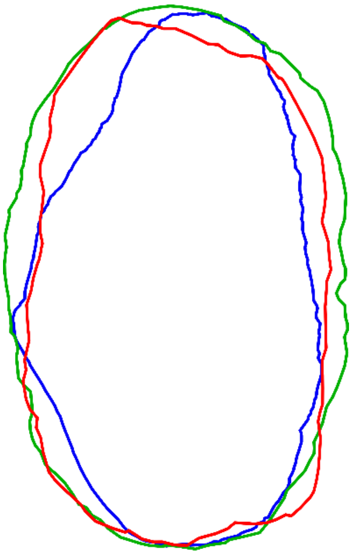


Figure 8. 31 Typological variation of biface from BDL2 and GUMY. Red line from BDL2 while blue and green outlines from GUMY (cf. figure. 8. 12)

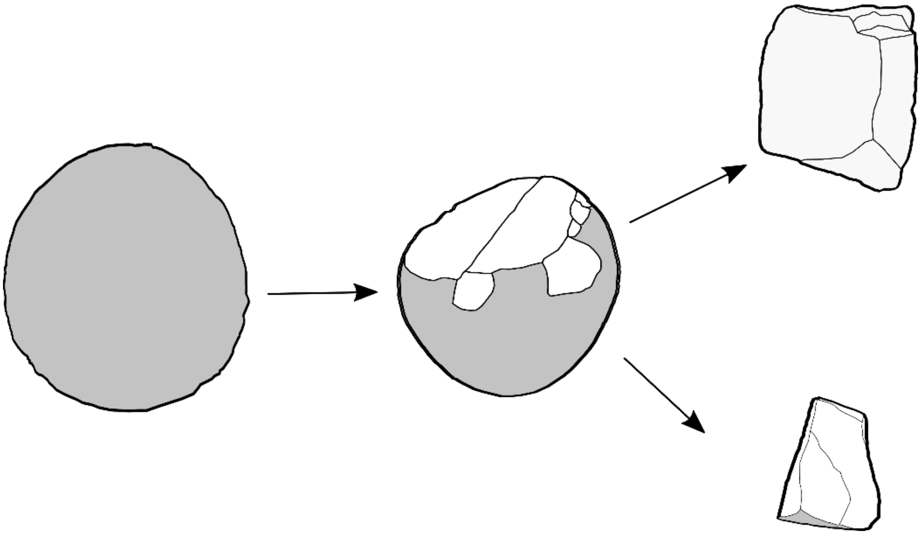


Figure 8. 32 Reduction sequences of cores from BDL2 and GUMY

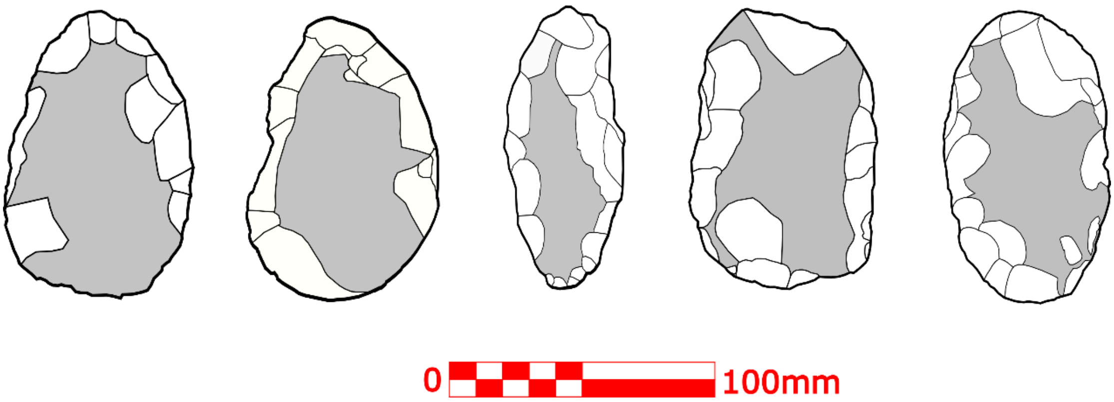


Figure 8. 33 Comparison of bifacial tools. 1: chopper from BDL1, 2: Chopper from BDL2, 3: Biface from BDL1, 4: Biface from BDL2 and 5: Biface from GUMY.

Table 8. 8 Comparison of biface metric dimensions among BDL1, BDL2 and GUMY

Biface	Site		
	BDL1	BDL2	GUMY
n	6	1	2
Length (mm)	115	90	120.7
Width (mm)	60.5	58	59
Thickness (mm)	29.6	25.7	33.4
Width/Length	0.52	0.64	0.5
Thickness/Width	0.5	0.44	0.57
Thickness/Length	0.26	0.28	0.27

Table 8. 9 Statistics summary of lithic artefacts from BDL1, BDL2 and GUMY

Type	n	Site	Length (mm)	Width (mm)	Thickness (mm)	Width/ Length	Thickness/ Width	Thickness/ Length
Chopper	26	BDL1	95.21	65.11	41.3	0.7	0.63	0.43
Chopping Tool	12	BDL1	88.58	57.34	28.6	0.64	0.5	0.32
Hand Adze	1	BDL1	139	72	25.2	0.52	0.35	0.18
Bifacial tool	6	BDL1	115	60.5	29.6	0.53	0.5	0.26
Scraper	32	BDL1	54.53	43.69	19.8	0.8	0.45	0.36
Core	10	BDL2	65.95	53.58	33.04	1.15	0.62	0.71
Flake	2	BDL2	54.93	38	11.76	1.14	0.3	0.34
Bifacial tool	1	BDL2	89.9	57.9	25.7	0.64	0.44	0.3
Chopper	1	BDL2	122.2	71.55	37.2	0.6	0.52	0.3
Flake	82	GUMY	38.98	26.3	11.76	0.67	0.45	0.3
Bifacial tool	2	GUMY	120.7	68.85	33.4	0.57	0.48	0.28
Chopper	1	GUMY	106.3	71.5	31.9	0.67	0.45	0.3
Core	2	GUMY	98.75	64.5	41	0.65	0.63	0.41
Total	178							

Table 8. 10 Student *t*-test results for the mean values of the main artefacts among the three sites. Values inside the boxes shows they are statistically different.

Site	n	Type	Length (mm)			Width (mm)			Thickness (mm)		
			t	df	*p* (two-tail)	*t*	df	*p* (two-tail)	*t*	df	*P* (two-tail)
BDL1:GUMY	6:2	Bifacial Tool	1.0729	5	0.332	1.515	6	0.1821	0.7681	1	0.5709
BDL2:GUMY	10:2	Core	4.5954	9	0.001299	1.3502	2	0.3379	1.8075	9	0.1028
BDL1:BDL2	32:2	Flake:Scraper	0.0552	1	0.9641	2.7977	21	0.0107	0.8192	1	0.5598
BDL2:GUMY	2:82	Flake	2.2549	1	0.2496	8.3248	9	1.539e-05	0.045	1	0.9713
BDL1:GUMY	32:82	Scraper:Flake	6.9624	75	1.095e-09	7.9147	56	1.05e-10	5.1958	65	2.203e-06

Secondly, a student *t*-test is conducted for the comparison of lithic artefacts among the three sites. However, there are some limitations for dimensional analysis of lithic artefacts. Despite the absence of some artefact typology such as chopper, chopping tools and hand adze in selected specimens from BDL2 and GUMY, bifacial tool, core, flake and scrapers among three sites are analysed. In depth statistics (table 8. 9) are also conducted when the sample size of a category is sometimes too few to calculate for *t*-test (table 8. 10) and it intends to determine the significant of similarity and dissimilarity. It is notable that there is no difference in the ratio of metric indices in artefact type among three sites, except for width by length ratios in cores and flakes from BDL2. Scrapers and flakes are regarded as the same class since they have the common feature being absence of retouch in BDL1 (Aung Thaw 1971a:127), BDL2 and GUMYU (Marwick 2016). In this analysis, null hypothesis is that there is no difference of mean values between particular lithic artefacts typology among the sites. If *p*-value is less than 0.005, null hypothesis is rejected and two data sets are statistically different. According to *t*-test results, metric dimension of scrapers and flakes from BDL1 and GYMU are statistically significantly different. Nevertheless, flake size comparison among BDL1 and BDL2, and BDL2 and GYMU indicates that only mean width value is significantly different while mean values of length and thickness is not different.

Similarly, mean length of cores from BDL2 and GYMU are different, but width and thickness means are not statistically different. On the other hand, mean values of bifacial tools from BDL1 and GUMY are not different in accordance with *t*-test's results and their descriptive statistics. There is a bifacial tool in BDL2, but it is too few to regard as sample size for *t*-test so that it cannot be used for *t*-test comparison. It is the largest one in metric dimension among the three sites. It is also remarkable that contexts in which choppers found are generally later than the contexts in which bifacial tools are found (cf. figure 8. 24 and figure 8. 27). Therefore, it can be assumed that bifacial tools are generally earlier than the choppers in BDL2 and GUMY. For BDL1, there is no clear description of stratigraphic layers and associated artefacts so that it is difficult to suggest which artefact type seems to be earlier or later or contemporary. However, bifaces from BDL1 seems to be later than those from BDL2 and GUMY as mentioned before. According to the chronological sequences (Aung Thaw 1971b:4; Schaarschmidt *et al.* in press) lithic artefacts from these sites can be regarded as shown in figure 8. 34. When lithic artefacts from these three sites are compared as shown in figure 8. 35, it is obvious that the same flaking technique was applied to the artefacts. And it seems to be continued from late Pleistocene to middle Holocene.

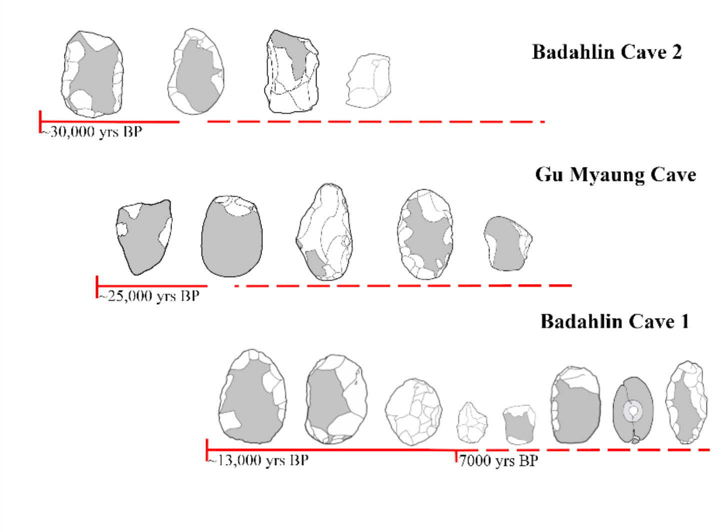


Figure 8. 34 Lithic artefacts from BDL1, BDL2 and GUMY sites in accordance with their chronological order

8.7 Conclusion

Lithic technology and typological variability of the sites such as BDL1, BDL2 and GUMY can be observed as good examples of late Pleistocene to middle Holocene hunter-gatherer communities' response to the environment. Lithic tradition in Myanmar has been often regarded as technological stagnant than progressive owing to the absence of hand axe or bifacial tool. It seems, furthermore, even most local workers prefer to use the word technological stagnant regardless the discovery of bifacial tools from BDL1 since 1969. However, not only BDL1, but also recent works at BDL2 and GUMY support the use of bifacial tools by hunter-gatherer communities from upland karstic region. Therefore, from cultural progressive point of view, it can be seen as technological development. Unifaces are later than bifaces at BDL2 and GUMY according to layers, and flakes or scrapers might have been increasingly used than the former. Uniface, biface and cores show the same flaking method was practiced in this area.

Chapter 9

Lithic artefacts and some theoretical models

9.1 Introduction

Previous two chapters have presented technological and typological analyses of lithic artefacts from hunter-gatherer sites in central belt and Shan plateau. These archaeological evidences from these two regions reflect different characteristics and lithic technological traditions. These chapters explain how technology and typological variation of lithic artefacts in both sites might have happened in those region through the analyses. Also, it implicitly describes about the constraints of the evidences and limited information of the data, which are usually familiar for the archaeologists. It still needs to reconstruct mobility and settlement pattern of the forager communities in these regions and which theory is appropriate and potential for lithic artefacts from Myanmar. However, it is noteworthy that available Myanmar assemblages in the study are very limited not only themselves, but also associated information. Some theories discussed in chapter 6 are chosen to evaluate hunter-gatherer communities in, they are known as original affluent society, forager mobility and cultural model. As a second part of this chapter, it will also discuss comparative study on lithic artefacts from Myanmar.

9.2 Original affluent society

As described in chapter 6, an old theory because which is not commonly used in archaeological studies is "hunter-gatherer definition", or "Original Affluent Society" as termed by Rowley-Conwy (2001), of Lee and de Vore (Lee, Richard B. and de Vore 1968). Main expected characteristics of the community are small group organization, no permanent settlement, a very low-level amount of personal property suggesting an egalitarian system, members disperse into smaller forager units, no group maintain exclusive rights for local resource, lack of surplus food, and no group strongly attached to a single food resource. Viewing these hunter-gatherer communities in central belt with these factors, it can be compared from the artefact type and distribution in the sites from central belt as follows; the fluctuation of the artefacts type in EAP and LAP shows these communities might have been primarily moving along the course of main river, except for two sites at the foot of Mt. Popa. On the other hand, the artefact density per sites (if artefacts are considered as personal property) are lower than 100 and the maximum rate is 75 in number in Early Anyathian Phase (EAP) and no more than 20 in Late Anyathian Phase (LAP) (map 5. 5), according to the field work (Win Kyaing 2010b). As a corollary, it seems the fact that they might have been moving around the territory with small number of artefacts as their personal property, and raw materials seemed not to be a constraint for them since these are distributed and easily available in the area. This nomadic way of life seems to be there is no attachment to a single food resource. In the contrary, there is no artefact made of exotic materials have been recognized in the area and it turns out to suspect on the facts that the maintaining of local resources and strongly attached to a single food resource. On the other hand, lack of flora and fauna evidence often leads to the dilemma on what kind of subsistence pattern they used. Regarding with the disperse of smaller forager unit, it is difficult to measure from the available data (table 9. 1).

Table 9. 1 Theoretical facts and archaeological evidences from central belt

Criteria	**Central Belt**
-Living in small group	-Low density of artefact (< 100)
-Moving a lot	-Distribution of site along the river only
-Low level of personal property	-Low density of artefacts (< 100) in EAP
	-Low density of artefacts (< 50) in LAP
-Disperse into smaller forager unit	- ?
-No exclusive rights for local resource	- Artefacts only made of locally available materials
-Lack of surplus food	- ?
-No group strongly attached to a single resource	- Artefacts only made of locally available materials

Table 9. 2 Theoretical facts and archaeological evidences from Shan plateau (High percentage means rich evidence)

Criteria	**Shan Plateau**
Living in small group	High density of artefact (>100) at BDL 1 Low density of artefact (<50) at BDL 2 High density of artefacts (>100) at GUMY
Moving a lot	Permanent (?)
Low level of personal property	High density of artefacts (>100) at BDL1 Low density of artefacts (<50) at BDL2 High density of artefacts (>100) at GUMY
Disperse into smaller forager unit	Different type of fauna
No exclusive rights for local resource	Some distant to small river (about 4km) from BDL1 Some distant to small river (about 4km) from BDL2 Close to river (less than 1km) from GUMY
Lack of surplus food	Different type of fauna in high percentage
No group strongly attached to a single resource	High percentage of fauna including aquatic animals Raw materials from water resource

On the other hand, the archaeological evidences from Shan plateau are considered under the theoretical factors, as shown in table 9. 2. Living in small group may be appropriate for Badahlin 2 (BDL2), but not for Badahlin 1 (BDL1) and Gu Myaung (GUMY) if the artefacts

(>100) are considered as a decisive evidence for that reason. Only smaller number of artefacts from BDL2 (<50), the rest ones from other two sites give a hint for permanent living at the sites. Different types of fauna evidences at three sites show the group may be dispersed as a small unit for collecting food. However, the fifth theoretical factor is difficult to prove because high percentage of fauna remain at the sites and diversity of raw materials at BDL1 appears to be the character of exclusive right to local resource. Also, it seems that high faunal remains at the site show a pattern of storage food. Generally, the evidences from these cave sites including some faunal remains such as aquatic animals, and the acquisition of raw materials from water resource reflect a sign of attachment to a single resource.

9.3 Mobility strategies

There are two types of forager mobility strategies, as shown in table 9. 3, known as forager or residential mobility and logistical mobility (Binford 1980). As mentioned in chapter 6, Shoocongdej (2000) tested the model against the assemblages from western Thailand. She used sound resolution of chronological sequences and archaeological evidences to test the model. In contrast to her, the accessibility of archaeological assemblages in Myanmar to that model is too limited due to available data and information as described above. Therefore, archaeological sites from both regions are generally considered rather than a single site.

Table 9. 3 Characteristics of foraging strategies

Mobility Strategies	Residential mobility	Logistical mobility
Habitation	Residential movement	Base camp Task group
Resource Patch	Homogeneous	Heterogeneous resource patch
Storage	Absence	Presence
Field camp	Absence	Presence

Table 9. 4 Characteristics of central belt and Shan plateau

Criteria	**Central Belt**	**Shan Plateau**
Habitation	-Artefact density (<100) -Homogeneous nature of raw materials	-Artefact density >100 at BDL1 -Artefact density <50 at BDL2 (flake% < core%) -Artefact density >100 at GUMY (flake% > core%) -Small diversity of raw materials
Resource patch	-Homogeneous (?)	-Heterogeneous (Aquatic animals presence at some sites)
Storage	-Absence (?) of fauna	-Presence of fauna
Field camp	-Absence (?)	-Presence (?)

As shown in table 9. 4, if the sites are considered from the evidence in hand, hunter-gatherer sites from central belt seem to be residential mobility while those from Shan plateau can be recognized as logistical mobility. Because the latter reflect a small diversity of faunal remains at the sites from large mammals to the aquatic (table 4. 2 and 4. 3). Additionally, the density of artefact per site at central belt in EAP and LAP is smaller than those from Shan plateau. As a corollary, these two reasons reflect to consider possible mobility strategies for each region. On the contrary, the artefacts from BDL2 is also lesser than other two caves and it leads to opposite interpretation, i.e. residential than logistical. The discovery of faunal remains found at the sites in Shan plateau generally indicates the sign of heterogeneous nature in resource patch since small diversity of raw materials are used to find at the sites while the sites from central belt signify homogeneous nature of raw materials. Faunal remains from Shan plateau may reflect the nature of storage. Dealing with field camp, no concrete evidence has been recognized to support this. However, large parts of faunal remains are considered from pre-processing point of view together with field camp, it is probable.

9.4 Cultural model

Another important model for defining technological achievement in hunter-gatherer communities between East and West is a cultural model, which is often known as "Movius line". As described in chapter 5, it has been a long-term debate among the archaeologists since Movius designated a boundary line between east and west by the absence and presence of bifacial tool or hand axe. Adopting western classical lithic cultures, East and Southeast Asia is viewed as cultural static or retardation for a long cumulative technological trend. That cultural model is very significant for Myanmar because lithic artefacts from the country indicate no sing of technological development, according to Movius (1943) and his model was a commonly accepted theory for lithic technology in Myanmar. Moreover, the country is closely located to his cultural boundary line to the west than other countries and the technological development region is not too far from Myanmar. On the other hand, as described in chapter 2, early human migration route passed from that area and continued to no technological development are via Myanmar. The immediate question raises that why the developed technology (here it means biface technique) was not introduced in Myanmar through prehistoric migration in late Pleistocene, but no satisfactory answer has been attainted. Yet, in the contrast to the west and central belt of Myanmar, hand axe or bifacial tools have been found at the sites in Shan plateau in the east of the country (Aung Thaw 1971a; Marwick 2016). However, the voice could not much louder in Myanmar and international scholarship since 1971. Admittedly, these evidences are very low in frequency in relation to Indian. In fact, these excavated finds are important and significant because these can change and alter that cultural static and dynamic model on the lithic technology of Myanmar lead to look for if it was a localized development technology or the exotic technology from elsewhere of the east. Indeed, it is a new contribution in lithic technology of Myanmar as well as in regional context.

In this section, three theoretical models have been discussed to evaluate hunter-gatherer communities in Myanmar. Among them, original affluent society is too strict and only appropriate for the communities which have no permanent settlement. This model is not appropriate for hunter-gatherer communities in Shan plateau whose ecological remains are found at the sites. For forager mobility organization model, limited information of data is too strict to access to apply for this model. Cultural model is to reconsider the concept on lithic artefacts from Myanmar and its regional context.

9.5 Technological difference in local scale

As a second part of this chapter, comparative analysis between lithic assemblage from central belt and Shan plateau has been discussed. As shown in figure 9. 1, an imaginary faint demarcation line can be drawn for the difference of lithic technology between central belt and Shan plateau in local scale. In the case of central belt, typology of stone artefact and raw materials are homogeneous in nature while those from Shan plateau show dynamic condition. According to analysis in chapter 7, flaking technique was likely to be the same from EAP to LAP. However, in the case of Shan plateau, flaking method seems to be the same in basic. For example, a bifacial tool from BDL2, dating back to ~30,000 yrs, can be linked to those from BDL 1 and GUMY. In BDL 2 and GUMY, the production is too simple, but, in BDL2, the production stages of lithic artefacts at the site is more complicated than others.

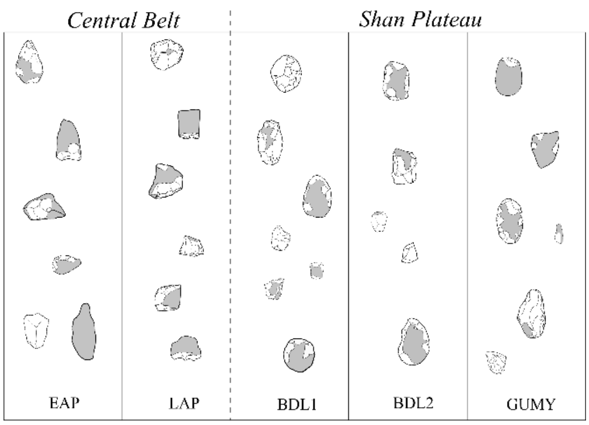


Figure 9. 1 Lithic artefacts from central belt and Shan plateau

Lithic technological timeline has been drawn as shown in figure 9. 2. Although the absolute date for lithic technology from central belt has not been attained yet, it might have been somewhat older than Shan plateau. According to the dates of the sites (Aung Thaw 1971a; Schaarschmidt *et al.* in press) from Shan plateau, it is tentatively interpreted as it was likely to be originated from late Pleistocene to middle Holocene period. Recent Neolithic culture seems to be originated from 5000 yrs.

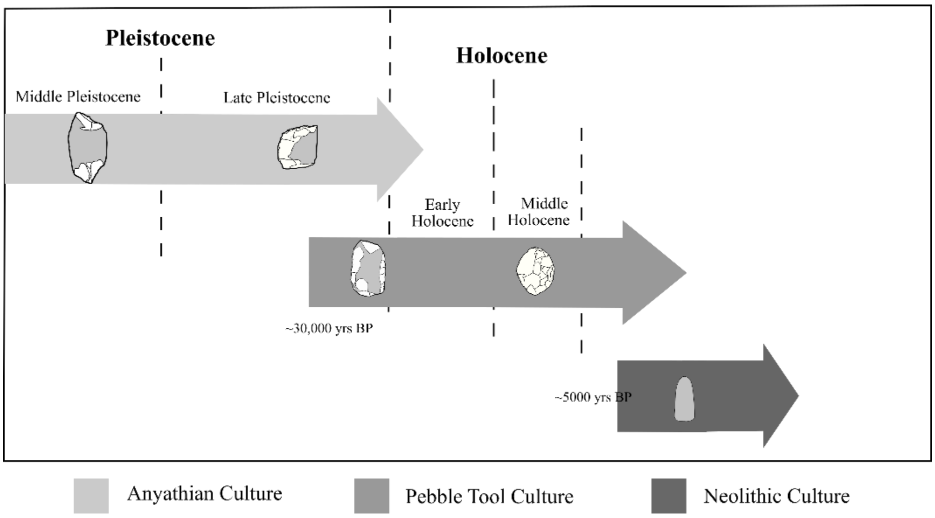


Figure 9. 2 Schematic lithic technological timeline.

9.6 Conclusion

This chapter have explored appropriate model to evaluate hunter-gatherer communities. According to limited nature of information and data, it is not easy to assign at a single site level. Instead, a regional level is considered to reveal an appropriate mobility strategy. As a second part of the chapter, it discusses about main cultural difference between central belt and Shan plateau. Lithic cultural trend should be view as a separated nature.

Chapter- 10

Conclusions, discussions and future direction

10.1 Introduction

The archaeological assemblage from hunter-gatherer sites in central belt and Shan plateau play an important role for the understanding on the prehistoric forager communities adaptation to the environment and their cultural or technological development in Myanmar. This chapter will summarize main research outcomes, discuss their significance and further suggestion for the future.

10.2 Research questions

This thesis, as described in chapter 1, will answer the following research questions;

Question 1- How lithic technology and typology of forager communities in Myanmar have changed over time?

Question 2- What are the main indicators of the culture?

Question 3- How this technology can contribute to what extent in local and regional scale?

10.3 Overviewing the thesis

The second chapter of this thesis discusses about research development of lithic studies in Myanmar and how these works were initiated. It explains important fieldworks in central belt and the excavations at Shan plateau. These areas are the main important part of the study area for the thesis. The third chapter explicitly emphasizes on the main differences of environmental setting between hunter-gatherer sites in central belt and Shan plateua. In turn, the environmental setting migh have been an important catalyst for the emergence of different lithic tradition and hunter-gatherer behavioural pattern in both regions. Seemingly, it might have been also effected on the technology and subsistene pattern of the forager communitites from both region in the past.

The fourth chapter discusses the faunal evidences found at hunter-gatherer sites central belt and Shan plateau. It also mentions difference nature site formation process and disturbances which are responsible to discover the ecofactual open air sites and cave site in Myanmar. However, no floral evidence has been reported as far but a few faunal remains partially contribute the subsistence pattern of prehistoric hunter-gatherer sites from the late Pleistocene to middle Holocene.

The fifth chapter has presented the spatial distribution pattern of hunter-gatherer sites from central belt and Shan plateau. The sixth chapter discusses two parts: the first part mainly concerns with some theories such as optimal foraging theories and technological theories which have been tested and should be considered for the archaeological assemblages in southeast Asia. Each model has their limitation or has been limited in accordance with the nature of the data. The second part of the chapter mainly deals with classification and lithic analysis procedure and statistical methods which have been applied in the thesis.

The seventh chapter has addressed the nature of lithic artefacts from hunter-gatherer sites in central belt and results of lithic analysis have been presented. Like chapter 7, chapter 8 is the stone tools analysis on the artefacts from three cave sites from Shan plateau, lithic technology and typological variability of the sites such as BDL1, BDL2 and GUMY can be observed as good examples of late Pleistocene to middle Holocene hunter-gatherer communities' response to the environment. In chapter 9, some appropriate models are tried to test against to evaluate hunter-gatherer communities from both regions. As a second part of the chapter, it discusses about main cultural difference between central belt and Shan plateau. Lithic cultural trend should be view as a separated nature. The ninth chapter is

10.3 Research outcomes

The first research question is explicitly concerned with two areas known as central belt and Shan plateau in which several hunter-gatherer sites are located. As explained in chapter 1, two areas are generally defined according to previous research works and current availability of archaeological data. In order to answer that question, lithic analysis procedure and statistical analysis described in chapter 6 have been conducted.

10.3.1 Artefacts from central belt

The research outcome based on the analysis indicates that the most common raw materials utilized in the area are fossil wood and silicified tuff while less number of raw materials are quartzite and igneous rock. Igneous rock and quartzite are the least number of raw materials used for the production of the artefacts. Flint is scarcely occurred in the area. By observing these facts, it is remarkable that prehistoric hunter-gatherers from central belt mainly relied on the raw materials could be easily available around the sites. In the other words, it seems the foragers mainly exploited the nearest raw material source rather than those from the distance. Similarly, the evidences in hand reflect that the foragers might have tried different kind of raw materials to produce artefacts in Early Anyathian Phase (EAP), but they mainly relied on the fossil wood than other materials in Later Anyathian Phase (LAP). The acquisition of raw materials and artefacts type relationship shows fossil wood and silicified tuff are the most common type of raw materials often chosen for the production of chopper. Silicified tuff, fossil wood and igneous rock in order are usually selected for making of chopping. Scrapers are produced from nearly all type of such raw materials.

The most common artefacts are chopper, chopping tool, hand adze and scraper as shown in the previous data. New tool deign has not been recognized. In the former research (Movius 1944), it was difficult to describe the size of the artefact, this work proposed that chopping tool is the largest dimension in the artefact type. Dealing with chronology, the current study proposes that it is better to use two cultural system instead of five cultural phases even it cannot attain absolute chronology. When artefacts are compared in accordance with two main cultural system, the size becomes smaller in later than earlier phase which is generally assigned from middle Pleistocene to late Pleistocene (Movius 1943).

10.3.2 Artefacts from Shan plateau

The analysis of artefacts come from three cave sites, namely Badahlin cave 1 (BDL1), Badahlin cave 2 (BDL2) and Gu Myaung (GUMY). These three sites are the best example from late Pleistocene to middle Holocene (Aung Thaw 1971a; Schaarschmidt *et al.* in press). The best example of production stages for stone artefacts come from the assemblage of BDL1. The most common use of raw materials for the production are sandstone, quartzite, limestone, quart, granite and siltstone which are river pebbles come from the stream near the site. In contrast to the sites from central belt, BDL1 and GUMY have a higher number of flakes than core or core tools. A variety of lithic artefacts can be seen at BDL1, ranging from pebble to perforated stones, but BDL2 reflect higher number of cores than flakes and it shows that these were brought from a short distance or elsewhere (Marwick 2016).

When technology of the tool is considered, all have the same flaking techniques. Likewise, when similar artefact type between the sites are analysed to know how much they are different from each other, the size of artefacts is not generally different. No sign of perforated stone has been found at BDL2 and GMYU, only BDL1. Therefore, based on the same flaking technique shows these sites have the sign of cultural transmission or some kind of contact within the sites. On the other hand, the presence of perforated stones at BDL1 only shows that a new group of people or a new technique was introduced at the site. Another significant fact is that all three sites possess bifacial tools which have been presented in chapter 8. It shows the technological development. The results of lithic analysis reflect different nature of technology and typology trend of central belt and Shan plateau. However, not only BDL1, but also recent works at BDL2 and GUMY support the use of bifacial tools by hunter-gatherer communities from upland karstic region. Therefore, from cultural progressive point of view, it can be seen as technological development. Unifaces are later than bifaces at BDL2 and GUMY according to layers, and flakes or scrapers might have been increasingly used than the former. Uniface, biface and cores show the same flaking method was practiced in this area.

10.3.3 Indicators for the culture

In order to know the second question, environmental setting described in chapter 3, study of faunal remains among the cave sites presented in chapter 4 and spatial distribution pattern of forger sites in both regions mentioned in chapter 5 have been undertaken. This study proposes two types of environmental models which were likely to be the main drivers for prehistoric hunter-gatherer communities in central belt and Shan plateau in the past. Key environmental indicators such as topography, elevation and geological setting are viewed as decisive conditions for settlement pattern, raw material acquisition, artefact type and even the culture. The first model, usually found in the lowland plain or central belt, defined as Anyathian model, which can be characterized by prehistoric occupations as open-air sites near to main water resource, fossil wood and silicified tuff as primary raw materials and mainly use of heavy duty tools such as chopper and chopping tools with relatively lower flake percentage. The second model can be illustrated with forager communities from the karstic Shan plateau. This model can be characterized by occupation in the cave or rock shelter sites some distance to the seasonal streams, several types of river pebbles ranging from limestone to quartz utilized as main raw materials, heavy duty tools with higher flake percentage. These two models obviously explain the different features between lithic traditions of hunter-gatherer communities in central belt and Shan plateau. To be specific the detailed structure of forager communities in the region are tested against the theory of original affluent society model (Rowley-Conwy 2001) and mobility strategies model (Binford 1980). Most character of original affluent society consistent with those from central belt, although the model is not appropriate for the communities in Shan plateau. Similarly, mobility strategies model has been tested but according to limited nature of data and information, it is not good to test. Another theory, known as culture model, developed by Movius (Movius 1944). It is easily overcome with the discovery of hand axe or bifacial tool from the three cave sites from Shan plateau. However, it is not suitable for those from central belt.

10.3.3 Contribution of culture in local and regional scale

As described above, the bifacial tools are very important for the cultural achievements of Myanmar since the country is very close to famous Movius's line. However, Anyathian cultural horizon is generally close to that line, and if prehistoric migration passed from west to east through Myanmar along with use of hand axe or biface technology might be handed to those from central region. However, the finding of hand axe or biface was at the eastern part of Myanmar where is more distant than central belt and it shows some kind of technological innovation in the local scale. On the other hand, these bifaces support the side of Movius line is no longer valid for demarcation of presence and absence of hand axe or biface.

However, there are two criticisms for Anyathian culture from Myanmar. The first criticism deals with the chrono-stratigraphy of the artefacts from hunter-gatherer sites from central belt. Another criticism belongs to the artefacts from that area. The first one questions the date of terraces of are uncertain and they were formed due to the result of fault movement around the area (Dennell, Robin 2014b). Therefore, the terraces in which artefacts were discovered are not from Plio-Pleistocene and hence the date of the artefacts are not reliable. In order to verify this criticism, local geological map is used to evaluate the terraces' location, these terraces are on the Plio-Pleistocene geology bed (map 3. 2, map 5. 3 and map 5. 4). Therefore, the date for the location should be check with scientific method to be reliable. The second criticism for artefacts from central belt generally focus on only fossil wood, but another lithic artefact such as silicified tuff and quartzite are not criticized and the number of artefacts are for Early Anyathain is not enough (Hutterer 1977; Dennell, Robin 2014b). However, there are some forager sites where fossil wood artefacts found in Bengladesh and India (Chakrabati 1997; Roy and Ahsan 2007; Hazarika 2013; Roy 2016). Therefore, fossil wood artefacts might have not only been used in Myanmar, but also in other sites which mentioned before. Therefore, a conclusion can be drawn that these two criticisms are likely to be weaker when more excavations will need to reveal the evidences.

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