The Unsanctified Cow: A Zooarchaeological Analysis of the Longvek Royal Palace, Cambodia

Brandon Rayner
Bachelor of Archaeology

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ABSTRACT

Cambodia during the Early Modern period is an area of study which has been largely ignored by archaeologists until recently. Between 2015 and 2019, preliminary investigations of the Cambodia's first Early Modern capital, the city of Longvek were carried out. These initial excavations at Longvek successfully established that the former capital was once a wealthy hub of international trade and commerce. Also, the location of former Longvek Royal Palace was discovered. While this previous research has primarily focused on the rich assemblages of high value ceramic tradeware excavated from the Royal Palace and other sites across Longvek, these excavations have also uncovered a zooarchaeological assemblage of faunal remains associated with the palace.

This thesis represents the first zooarchaeological investigation of the Cambodian Early Modern period through the analysis of the faunal assemblage of the Longvek Royal Palace. This research is focused on two main areas. The first is to use standard zooarchaeological methods to identify what fauna is present in the assemblage and discuss how it was utilised by the occupants of the Royal Palace. The second area concerns the perception and utilisations of cattle during the Early Modern period and, specifically, Longvek. Historical accounts from the preceeding Angkorian period suggest that cows were neither killed or butchered, instead being used only as beasts of burden or with Hindu rituals through the production of milk and butter. However, the presence of cattle remains in the assemblage from the Longvek Royal Palace shows that during the Early Modern period cows were most certainly being butchered.

This research determined that the occupants of Longvek utilised a wide range of both domestic and wild species of large and medium mammal fauna primarily as a food source. Analysis of this fauna suggests butchery and cooking took place at the palace itself. In regards to the perceptions and utilisation of cattle by the occupants of the palace, it was determined that cows were being butchered and possibly even skinned for leather within the palace grounds. The additional presence of cattle remains at a nearby metallurgy workshop, suggests the butchery of cows was commonplace within Longvek and not limited to only the Royal Palace. The implication of this discovery is that a significant shift in the perception of cows took place sometime in the transition from the Angkorian to Early Modern period. This shift of likely due to the rise of Theravada Buddhism during the Early Modern period, and pressure to utilise these animals as an economic resource due to the focus on trade in this period.

DECLARATION

I certify that this thesis:

1. does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university

2. and the research within will not be submitted for any other future degree or diploma without the permission of Flinders University; and

3. to the best of my knowledge and belief, does not contain any material previously published or written by another person except where due reference is made in the text.

Signed: 

Date: 10/10/2024

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CHAPTER 1 - INTRODUCTION

The Early Modern period of Cambodia is a period of the country's history that is often overlooked for the appeal of the earlier Angkorian period. While the Angkorian period is inarguably a major point in Cambodia's past, recent archaeological investigations into the ensuing Early Modern period are beginning to reveal its importance as a time of major change as Cambodia became entwined in bustling global trade networks. Perhaps no other place encapsulates the essence of the Early Modern period more than the archaeological site of Longvek. Situated approximately 45km northwest of the city of Phenom Penh, Longvek represents one of the first capital cities established after a shift away from Angkor. Although Longvek's existence is documented in historical records and local knowledge, preliminary investigations into the city's archaeology only began in 2015. These recent archaeological investigations have shown that Longvek was once a bustling trade city connected to a larger global trade network that spanned through Asia and Europe (Polkinghorne and Sato 2023:592-593). The latest excavations at Longvek have also been able to detect the existence of a substantial wooden structure, which is believed to have been the Royal Palace of Longvek, which would have housed the elite members of Early Modern society (Polkinghorne and Sato 2023:606-607).

As the archaeological inquiry into Longvek is still in its early phases, studies have mainly revolved around the grand questions of how the city fits into the bigger picture of global trade. This focus on trade has also been shaped by the rich assemblages of ceramics from both international and domestic sources. However, excavations at Longvek have also revealed an assemblage of faunal remains that are associated with the elite occupation of the Royal Palace.

The discovery of this faunal assemblage represents an opportunity to inquire into the domestic lives of the people who occupied Longvek during the Early Modern period through the implementation of zooarchaeological methods. This thesis also represents the first zooarchaeological analysis to be conducted on a Cambodian faunal assemblage associated with the Early Modern Period.

Research Aims

The primary aims of this study are to analyse the faunal assemblage excavated from the Longvek Royal Palace using zooarchaeological methods to understand how the occupants of the Royal Palace utilised fauna during the 16th and 17th centuries and to determine how the perception of cattle changed from the Angkorian to Early Modern period. These aims have been achieved by exploring the following questions:

What fauna were exploited by the occupants of the Longvek Royal Palace, and how were they utilised?

How were cattle perceived and utilised by the occupants of the Longvek Royal Palace?

In addition, this thesis aims to achieve the following:

- Catalogue and identify the specimens in the faunal assemblage to their lowest possible taxonomic group or size class.
- Identify and analyse diagnostic taphonomic features of the specimens in the faunal assemblage.
- Determine what fauna was utilised by the occupants of the Royal Palace and for what purposes.
- Expand upon the limited zooarchaeological literature in Cambodia.
- Challenge the traditional narrative of decline and abandonment at the end of the Angkorian period.
- Provide an introductory study into the zooarchaeology of Early Modern Cambodia.

Research Significance

The traditional understanding of the transition from the Angkorian period to the Early Modern Period centres around the erroneous assumption of an abrupt decline of Angkorian power, which forced the capital of Angkor to become abandoned and eventually forgotten. Because of this, the subsequent Early Modern period has been perceived as a dark age, lacking little importance or complexity. This understanding can trace its origins back to French explorers and archaeologists, where this supposed lack of self-determinism was used as one of the means to justify the French occupation of Cambodia. In recent decades, a critical rethinking of these assumptions and reanalysis of colonial archaeological work has begun to shift perceptions of this transitional period.

This recent work is now showing that the transition from the Angkorian to the Early Modern was a complex and nuanced period in which many factors contributed to the decision to move the capital away from Angkor. It is also now known that the former capital continued to be occupied well into the Early Modern period and was viewed as an important religious and cultural hub. While these new perceptions of the shift to the Early Modern period are being accepted, the outdated ideas of decline and abandonment are still, in many ways, ingrained within academic and public spheres (Evans et al. 2023:541-546). This study provides evidence to demonstrate the complexity and adaptive capacity of the occupants of Longvek during the Early Modern period. In doing so, the study continues to challenge the traditional narrative.

This research represents the first zooarchaeological study of an Early Modern period site in Cambodia. The conclusions of this study provide a foundation for further zooarchaeological work to be conducted as more faunal material is undoubtedly excavated from not only Longvek but other Early Modern sites as archaeological interest in the period increases. Further, this research is also significant to zooarchaeology as a field of study in Cambodia as previous as zooarchaeological studies in Cambodia are limited due to poor preservation of faunal remains and a lack of zooarchaeologists in the region. However, this study demonstrates that despite the current lack of preserved faunal remains, zooarchaeological studies can answer critical questions, especially in a period little is known about.

Further, as this is the first zooarchaeological study of an Early Modern period site, it was impossible to undertake comparative analyses of other Early Modern sites; however, with the completion of this study, there will be a preliminary study that can serve as a foundation for future comparative analyses.

As stated previously, archaeological inquiry into the Early Modern period and Longvek has primarily focused on their trade aspects. This study shifts away from the trade of Longvek to focus more on the day-to-day lives of those who lived at Longvek during the Early Modern period. By broadening the scope of archaeological investigations, this study furthers archaeological understanding of Longvek and the Early Modern period.

Chapter Outline

Chapter two of this thesis is a broad literature review. The first section of this review provides an overview of the historical context that relates to the Longvek archaeological site. This includes a summary of the events that occurred during the Angkorian period, the factors at play during the transition to the Early Modern period, and the shift to Longvek as the capital city of the period. Then, the history of previous archaeological studies on Longvek is discussed.

Chapter three includes an overview of Cambodian fauna that have appeared in previous Cambodian zooarchaeological studies and were likely prevalent during the Early Modern period. This chapter also includes a discussion on the religious significance placed on cattle during the Pre-Angkorian and Angkorian periods and the implications of this significance to how cattle were treated and utilised during these periods and into the Early Modern period. Finally, a brief overview of common Angkorian cooking practices is provided.

Chapter four contains a description of zooarchaeology, and an overview of its applications as a field of archaeology. Then, the prevalence of zooarchaeology in Cambodia is discussed, and an overview of Cambodian case studies is provided.

Chapter five pertains to the methods used to collate data and analyse the faunal specimens of the assemblage. This included descriptions of the methods used and reasoning as to why they were employed.

Chapter six provides the results derived from the analysis of the faunal specimens.

Chapter seven is a discussion of the results presented in the previous chapter. This discussion includes an interpretation of the results and offers hypotheses relating to the aims of this study.

Chapter eight concludes the study with a concise summary of its contents and explores the direction of future research.

Terminology

The site ID used for the Longvek site is LVK. The number following this ID denotes the year of excavation e.g. LVK15 stands for Longvek 2015. Numbers after year of excavation denote the trench number e.g. LVK1507 stands for Longvek 2015 trench 07.

CHAPTER 2 – LONGVEK IN CONTEXT

Historical Overview

The Angkorian Empire

To understand the Early Modern period and Longvek itself, it is critical to put it into perspective with what came before. The following section provides a general timeline of the Angkorian period from its conception to its shift into the Early Modern Period.

The Angkorian period is generally agreed upon to span from the 9th to 15th centuries CE, defined by the founding of the Angkor Empire, to the shift of the capital city to Longvek. Before the Empire (Pre- Angkorian Period), Cambodia comprised various independent kingdoms (Coe and Evans 2018:116-117). According to interpretations of inscriptions, the Angkorian status quo changed with the accession of King Jayavarman II, who united several chiefdoms under his leadership. He expanded his reign across the Mekong through military campaigns to encompass ancient settlements at Vyadhupura and to Sambhupura and Hariharalaya. Eventually, Jayavarman II established Mahendraparvata, modern-day Phnom Kulen, as his seat of power and was named *chakravartin* (universal monarch) by Hindu Brahman priests in 802 CE. The king's crowning marks the Angkorian Empire's beginnings (Coe and Evans 2018:118-119).

The first imperial capital of the Empire was the settlement of Hariharalaya. The settlement became an extensive city after 877CE, and its infrastructure, such as the temple Preah Ko and Indratataka, a large *baray* or reservoir, set the framework for characteristics of monumental infrastructure that would come to be associated with the Angkorian period (Coe and Evans 2018:121-122, Chevance and Pottier 2023:81).

Sometime after 890 CE, Angkor became the capital of the Empire. The area of Angkor proved to be a strong position of the seat of power as it is south of the culturally significant Kulen highlands and just north of Tonle Sap, Cambodia's largest body of water. Angkor also benefitted from the nearby Siem Reap River, which would come to fuel the city's sophisticated hydraulic infrastructure (Coe and Evans 2018:124-126). Angkor would remain the heart of the Angkorian Empire until the 14th century, with the exception of a small hiatus between 921 and 928 CE when Koh Ker to the northeast briefly held the title of capital (Coe and Evans 2018:130-132).

During this period, Angkor grew into one of the most sophisticated metropolises of its time with its advanced hydraulic systems, which were the lifeblood of the city, enabling its prosperous agricultural industry (Coe and Evans 2018:130-142).

By the 12th century, the Angkorian Empire remained a powerhouse of Southeast Asia. Under the rule of Suryavarman II, the Empire successfully invaded and occupied the neighbouring kingdom of Champa. However, this decision weakened the Empire as the Cham retook their kingdom and invaded the Angkorian Empire, ransacking Angkor itself. Although Angkor was retaken after a four-year occupation and the Empire continued to construct architectural marvels, the power dynamic that strengthened the Empire was shifting (Coe and Evans 2018:142-160, Evans et al. 2023:547).

The last Sanskrit inscription to be inscribed at Angkor is dated to the early 14th Century (1327 CE). This date is commonly used to denote the change to the Early Modern Period. This abrupt and arbitrary boundary between the two periods is ill-fitted to encapsulate the complicated and nuanced factors accompanying the change. There are also problematic assumptions tied to changing periods (Coe and Evans 2018:160). These factors and issues will be explored further.

Transition to the Modern and the Factors at Play

The change from the Angkorian period to the Early Modern period has traditionally been perceived as a catastrophic collapse of the Angkorian Empire in which the once great Angkor was abandoned and left to slowly surrender to the encroaching jungle. These assumptions, which have been used to justify colonisation, are problematic and incorrect (Evans et al. 2023:541- 542). The dispelling of these outdated ideas also changes perceptions of Longvek and other Middle Period capitals from dwindling seats of power in the shadow of the once great Angkor to carefully calculated positions of power designed to take advantage of new trade opportunities.

This shift away from ideas of collapse is primarily a result of recent re-evaluations of archaeological evidence, showing that many factors at play contributed to the transformation of the Empire during the end of the Angkorian period. These factors include pressure and conflict from neighbouring powers such as Ayutthaya, climatic changes and their effects on Angkor's hydraulic infrastructure, and developing economic opportunities through maritime trade (Evans et al. 2023:543-546).

The Early Modern Period

Although it is evident that occupation continued at Angkor well into the Early Modern period, the period is most associated with the series of new capitals after Angkor (Figure 1). What is currently known about these new capitals is currently limited as archaeological inquiry in Cambodia has traditionally focused on the Angkorian period. Recently, some scholars have shifted their gaze beyond the Angkorian period and have begun to unpack the complexities of what came after (Evans et al. 2023:541, Polkinghorne and Sato 2023:592).

Perhaps the first capital after Angkor was in the region of Srei Santhor. It was this area that, according to the Royal Cambodia Chronicles, became the seat of power for King Ponhea Yat. Srei Santhor was most likely chosen due to its strategic position between the Mekong and Tonle Touc Rivers, which allowed for protection from neighbouring kingdoms and rival Khmer factions at Longvek and Oudong. Srei Santhor's proximity to the Mekong and political dominance allowed it to thrive in the 14th century as diplomatic communications were established with Ming dynasty China which opened the door for trade opportunities (Polkinghorne 2018:261-263, Polkinghorne and Sato 2023:595-596).

Longvek – The Trade Capital

Although Srei Santhor was undoubtedly a significant economic hub, the city of Longvek was even more so. Beginning in the early 16th century, Longvek became the Khmer world's new capital under King Ang Chan's rule. Like Srei Santhor, Longvek was in a prime position along the western bank of the Tonle Sap River for facilitating abundant maritime trade. By the 16th century, Longvek had developed as the Khmer's primary urban centre for global trade and an important hub of religion and politics. A major import in abundance within the archaeological record was trade ware from Ming Dynasty China in the form of blue and white porcelain ceramics (Polkinghorne 2018:263-267, Polkinghorne and Sato 2023:596-600). The urban centre prospered for around 60 years until 1594, when an Ayutthayan force successfully invaded Longvek, forcing the king to retreat to Laos (Polkinghorne and Sato 2023:597). Despite the invasion, Longvek remained a vital node in the Southeast Asian trade network until the mid-17th century (Polkinghorne and Sato 2023:609).

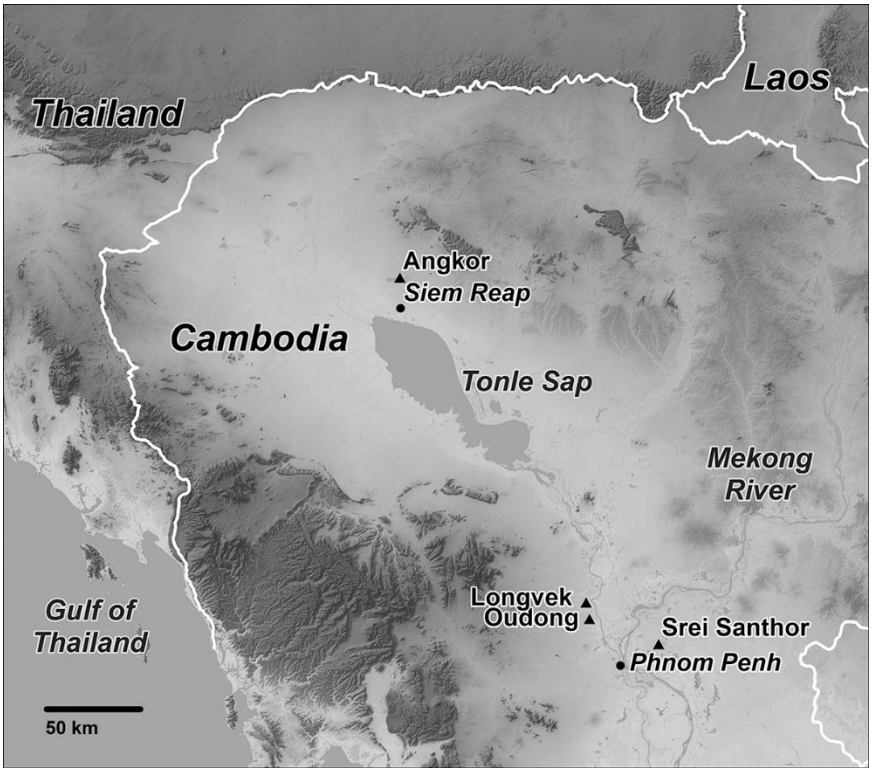

Figure 1: Map of Cambodia showing key locations

The Archaeology of Longvek

The region's inhabitants have long known the existence of Longvek since its first occupation. It is mentioned in important historical documents, namely the Royal Cambodian Chronicles. Despite this, archaeological investigations at Longvek only began in 2015 (Sato and Polkinghorne 2017:67-68, Polkinghorne et al. 2019:3).

Location

The archaeological site of Longvek is approximately 45km northwest of Cambodia's modern capital, Phnom Penh, on the western bank of the Tonle Sap River. The site is defined by earthen embankments, which form a rectangular perimeter around a seven-square-kilometer occupation area, commonly described as a citadel (Figure 2) (Polkinghorne et al. 2016:9, Polkinghorne et al. 2019:3).

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Figure 2: Map of Longvek Archaeological site (Polkinghorne et al. 2019:3).

The Royal Palace

The central occupation mound at the centre of the enclosed citadel, through archaeological excavations, has been identified as the location of the Royal Palace of Longvek, where the wealthy elites of the capital city would have likely resided. The area was determined to be the site of the Royal Palace due to the rich assemblage of high-quality Chinese ceramics. Some of the more notable ceramics include a Chinese brown-glazed jar lid embossed with a coin motif and symbols of good luck. This artefact alone is rare, being the only one excavated outside of Japan from a site in Sakai, Osaka (Figure 3).

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Figure 3: Chinese brown-glazed jar lid sherds displaying embossed coin motif (Polkinghorne and Sato 2023:605).

Another diagnostic find included a sherd of white porcelain intricately decorated vessel, shaped to resemble the likeness of a frog, and various sherds of Southern Chinese three-coloured, green, yellow, and purple glazed pottery, displaying scenes of waterfowl on a lotus pond. These dishes originated from kilns in the Fujan and Quandong provinces and are especially rare to find in the Southeast Asian region (Figures 4 & 5).

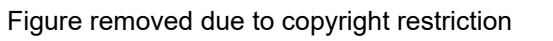

Figure 4: Sherd of white porcelain originally resembling a frog (Polkinghorne and Sato 2023:605).

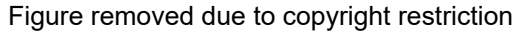

Figure 5:: Southern Chinese three-coloured glazed pottery with a depiction of a waterfowl on a lotus pond (Polkinghorne and Sato 2023:605).

Additionally, excavations at the central occupation mound also confirmed the existence of multiple large wooden buildings due to numerous large iron nails being discovered. The location of the Palace within the citadel likely follows conventions of city planning observed in other substantial cities such as Mahendrapavarta and Phenom Penh where the Royal Palace is situated northwest of the principal temple.

The combination of these points of evidence makes it is likely that the central occupations mound within the Longvek citadel represents the location of the Longvek Royal Palace and thus the occupation place of the elite (Polkinghorne and Sato 2023:600-605).

Excavations in 2015

The 2015 preliminary archaeological investigations into Longvek included the collection of surface artefacts and the excavation of fifteen test trenches across three sites: the Royal Palace of Longvek, a southern enclosure wall, and a copper base metallurgy workshop (Figure 6). These sites were chosen to determine the chronology and characteristics of the elite occupation of Longvek (Polkinghorne et al. 2015:9).

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Figure 6: LiDAR image of LVK15 excavation locations (Polkinghorne et al. 2015:10).

The excavations focused on the site of the Royal Palace, with eleven trenches opened. The site itself is now mostly occupied by a substantial brickworks factory, which limits the area available for inquiry; nevertheless, some areas were identified to have encountered minimal disturbances (Polkinghorne et al. 2015:10).

Excavations determined, through the presence of postholes in most of the trenches, that various wooden buildings once existed at the site. Notably, trench 9 alluded to the existence of a quite

substantial wooden structure through the presence of six large postholes spaced out in a straight line (Polkinghorne et al. 2015:10).

Across the entire site, many ceramic sherds were collected or excavated. Of these ceramics, most were unglazed earthenware produced locally. Additionally, an abundance of Ming Dynasty Chinese porcelain tradeware and a small number of Thai and Vietnamese tradeware were recovered, attesting to the complex trade nature of Longvek at its height (Polkinghorne et al. 2015:41).

A total of forty-one faunal bone specimens were recovered during excavations in 2015. Thirty-nine of these fragments were excavated from Trench 3, and the remaining two from Trench 7. The Trench 3 assemblage was excavated from a 'rubbish pit' feature, including artefacts such as sherds of burned earthenware and Chinese tradeware. The presence of bone, ceramics, and charcoal suggests the rubbish pit represents cooking activities (Polkinghorne 2015:19-20).

Excavations in 2016

The second season of excavations was conducted in 2016 and once again focused on the site now occupied by the brick factory and other sites of interest. The objective of this investigation was to obtain detailed spatial and chronological information regarding the occupation of Longvek and to collect paleoenvironmental data (Polkinghorne et al. 2016:9).

A total of thirteen trenches were opened during 2016 across the sites, with four opened at the brickworks site associated with the Royal Palace. Large amounts of ceramic sherds were unearthed during excavations and were mostly comprised of earthenware. Several imported ceramics were also collected, including blue and white Chinese porcelain, again speaking to the social status of residents surrounding the palace (Polkinghorne et al. 2016:44). Artefacts associated with metalworking were also excavated across the sites (Polkinghorne et al. 2016:48).

Only five faunal specimens were collected in 2016 from the brick factory site in trenches 21 and 25. The faunal specimens from Trench 21 were excavated from disturbed soil levels along with ceramics and crucible fragments. Despite the abundance of artefacts at these levels, they most likely represent a secondary deposit as fill soil (Polkinghorne 2016:19). One of the faunal specimens from Trench 25 was also excavated from a disturbed level; however, the other two specimens were excavated from a fill event in an occupation period. The presence of charcoal-mixed soil and ceramics sherds suggests the fill event was associated with either cooking or rubbish disposal.

Excavations in 2018

The 2018 excavation had ten trenches spread over seven sites. Only one trench was opened at the brick factory site (Trench 28). Despite this, a considerable amount of high-quality Chinese ceramics was recovered from the site. Various metallurgical artefacts were also recovered from the

brick factory and Boeung Samreth. An intact mould furnace was also uncovered at Boeung Samreth (Polkinghorne 2018:1-4).

The 2018 excavations also represent the largest assemblage of faunal material recovered, with a total of two hundred and forty-one faunal bone specimens and one hundred and two shell specimens collected overall. Of these specimens, a total of two hundred and thirty-one were collected from Trench 28.

Excavations in 2019

The 2019 excavation season currently marks the latest investigation at Longvek. A total of eight trenches were open across seven sites at Longvek and Boeung Samreth. No trenches were opened at the brick factory site. Like the previous seasons, the 2019 excavations uncovered a variety of ceramics, including earthenware and tradeware (Polkinghorne 2018:3). Only six faunal specimens were uncovered during excavations, none of which related to the occupation of the Royal Palace.

Overall Conclusions of Archaeological Investigations at Longvek

The archaeological investigations at Longvek have documented critical details regarding the occupation and economics of the early capital. A key result of Longvek's excavations was the identification of basic occupational phases. These phases were identified in 2015 and refined during the 2016 investigations. Phase 1, the stratigraphically lowest and earliest phase, represents the first anthropogenic sediments deposits merging with the underlying natural sediments. The second phase is representative of an intensification of occupation during the 16th and 17th centuries. This phase is quite complex, and many sub-phases have been identified within it. Phase 3 represents a period of little activity. Although the phase is abundant with artefacts, they were likely redeposited secondarily. The final phase, phase 4, consists of topsoil and disturbed layers from modern-day activities such as agriculture and recent military conflicts (Polkinghorne et al. 2016:13). The chronology of these phases has been refined further with AMS ^{14}C dating.

Many of the artefacts recovered from Longvek have been used to analyse the capital's economic systems. The abundance of ceramic sherds uncovered during each excavation season alone speaks to the concentration of activity in Longvek at its height; however, one study expanded the understanding of trade at Longvek further through specialised analysis of some of the ceramic sherds. The 2019 study by Polkinghorne et al. evaluated the geochemistry of 102 storage jars to determine their place of production (Polkinghorne et al. 2019:1). The results determined that most of the storage jars had originated from the Thai kilns of Bang Rachan and Sisatchanalai. The predominance of Thai-made storage jars demonstrates a shift away from using locally made ceramics, which was the standard during the Angkorian period. The production of these Angkorian-made high-fired ceramics likely dwindled towards the end of the Angkorian period with

the rise of international trade. However, these Angkorian ceramics remained culturally important through the Early Modern period as they connected to an Angkorian past (Polkinghorne et al. 2019:2-19). Further, the presence of these internationally made storage jars confirms Longvek's role as a critical trade centre in the Southeast Asian trade network (Polkinghorne et al. 2019:21).

CHAPTER 3 - FAUNA OF CAMBODIA

Cambodia is home to a diverse range of animals that have been utilised as a resource since the Pre-Angkorian period and commonly appear in zooarchaeological assemblages. While many other species are known to have been utilised in Cambodia, the species discussed in this section are the most common and likely to relate to the Early Modern period and Longvek.

Deer

Many species of deer are known to live in Cambodia. Deer are one of the more common groups of large mammals present in the region and a popular game animal. Various species of deer are present in Cambodian zooarchaeological assemblages as early as 500 BCE (O'Reilly et al. 2006:198). Common species in Cambodia include large species such as the eld's deer (*Cervus eldi*), and the sambar (*Cervus unicolor*), as well as smaller species such as the hog deer (*Hyelaphus porcinus)* and the red muntjac (*Muntiacus muntjac)* (Figure 7) (O'Reilly et al. 2006:198, Gray et al. 2012:44). Bas-reliefs of deer are also seen at Angkor Wat. One such relief depicts a large deer pulling a chariot (Figure 8). The relief is in a style and location which indicates it was carved around the mid sixteenth century, aligning with the royal occupation of Longvek and the prevalence of Theravada in the Early Modern period (Polkinghorne et al. 2013:597-600).

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Figure 7: ***Common species of deer in Cambodia. Eld's deer A) Sambar B) Hog deer C) Muntjac D) (WWF).***

Figure 8: 16th-century bas-relief depicting a warrior on a chariot being pulled by a deer (M. Polkinghorne).

Pig

The pig (*Sus scrofa*) is a very common species in modern-day Cambodia and most certainly in the past. In Cambodia today, the pig exists in its domestic and wild forms (Grey et al. 2014:45, Ieda et al. 2017:43). Wild pigs appear heavily in previous zooarchaeological assemblages in Cambodia such as Phum Snay and Vat Komnou cemetery (O'Reilly et al. 2009:209, Ikehara-Quebral et al. 2017:199). Wild pigs are also depicted in various Angkorian bas-reliefs, including in a depiction of cooking at the Bayon (Figure 9) (Coe and Evans 2018:216). Zhou Daguan also comments on the presence of pigs at Angkor during his visit (trans. Harris 2007: 99).

Figure 9: Depictions of wild pigs at the Bayon. (B. Rayner).

Birds

There are many wild bird species in Cambodia; however, the two most prominent bird species are the domestic chicken (*Gallus gallus*) and domestic duck (*Anas platyrhyncus*). Both species appear in Cambodian zooarchaeological assemblages and are mentioned in Daguan's accounts (O'Reilly et al. 2006:205, trans. Harris 2007: 99). Both species were likely kept for their meats and eggs.

Fish

Fish were and continue to be a primary food source in Cambodia. The abundance of fish is mainly thanks to the presence of the Mekong River and Tonle Sap Lake. The lake itself represents one of the world's most productive freshwater ecosystems and provides critical habitats for many of Cambodia's freshwater species (Lustig et al. 2023:309). According to Daguan's accounts, the most common fish at Angkor were various species of carp (trans. Harris 2007: 101). Other species, such as snakeheads and catfish, are also present in the zooarchaeological assemblage of Phum Snay (O'Reilly et al. 2006:207).

Turtle

Turtles are a common species of reptile within Cambodian water systems such as the Mekong. Many species of turtle have appeared in Cambodian zooarchaeological assemblages such as Phum Snay and Laang Spean Cave. Common species include the yellow-headed tortoise, the three-line box turtle, and the rice field terrapin turtle. Turtles in Cambodia are commonly consumed for food which has unfortunately led to many species becoming threatened (Voeun 2008:50, Bochaton et al. 2023:5-6).

Serow

The serow, or mainland serow (*Nemorhadeus sumatraensis*), is a bovid native to Cambodia and the greater Southeast Asian region. Unlike the other bovids already mentioned, the serow is not a cow-like animal, more closely resembling a goat or antelope (Figure 10). The serow is a wild solitary grazer and has been identified in zooarchaeological contexts in sites such as Phum Snay (Voeun 2008:40-41).

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Figure 10: The mainland serow (Adobe Stock).

Cooking Practices of Cambodia

Currently, there is little known about the cooking practices of the Early Modern period regarding the preparation and consumption of meat. Nonetheless, by examining what is known about the cooking practices of the Angkorian period, likely assumptions can be made.

Cooking in Angkor

What is known about cooking in the Angkorian period comes from a bas-relief at the Bayon and from Zhao Daguan's accounts of Angkor. The Bayon relief in question is located on the South Gallery wall. It depicts a scene of cooking in which, from left to right, rice is being poured into a ceramic pot to be cooked over a fire; the centrepiece depicts a small pig being placed into a large ceramic vessel over a fire, likely to be boiled, and to the right, fish is seen roasting on sticks over a fire (Figure 11) (Evans and Coe 2018: 215-216). The central cooking vessel has been described by archaeologist Aedeen Cremin as an earthenware Angkorian stove. Evidence of these cooking vessels has been excavated from sites such as Angkor Thom (Cremin 2014). Daguan's account of Angkor also describes the cooking of rice in what he calls an earthenware pot. While Daguan does not mention the cooking of meat, it can be assumed that it was cooked in a similar way as depicted at the Bayon (trans. Harris 2007: 106).

Figure 11: Bayon bas relief depicting various Angkorian cooking methods (B. Rayner).

Bovines in the Angkorian Empire

Within the Angkorian Empire, bovines held a unique status that saw them venerated. This reverence of cattle is attributed to the influence of Indic traditions from the 2nd century BCE to the 3rd century CE. During this time, there was a growing interaction between India and Southeast Asia, with many Southeast Asian pilgrims travelling to India. Local Southeast Asian rulers also invited Brahmin priests from India. These interactions between the two regions led to Southeast Asia adapting and integrating various Indic concepts of socio-political organisation and religion (Mus et al. 2010:52). Not all aspects of Indic culture were adopted by the Khmer; bovine reverence was an attractive concept as it fits in well with the already long-established local animalistic beliefs (Hendrickson et al. 2023:459-460).

Early evidence of bovine ritualistic symbolism can be seen in faunal remains excavated from the Pre-Angkorian village and cemetery of Phum Snay, where cattle, water buffalo, and other animals were offered as grave goods (O'Reilly et al. 2006:208, Voeun 2008:70). Also, another example is an ablution cistern shaped to resemble a buffalo head (Figure 12). This cistern also dates to the Pre-Angkorian period and was discovered near Angkor Borei (Hendrickson et al. 2023:463).

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Figure 12: ***Pre-Angkorian ablution cistern shaped to resemble a buffalo head (Hendrickson et al. 2023:465).***

A depiction of water buffalo is also present at the Bayon. The scene shows a large water buffalo tied to a tree and surrounded by elites, ascetics, and soldiers (Figure 13). It has been interpreted as representing the ritual sacrifice of the buffalo to bless the reigning king, Jayavarman VII, with a military victory. Since animal sacrifice is usually not associated with Brahminism or Buddhism, the most prevalent religions at the time, sacrifice has been viewed as the persistence of local traditions into the Angkorian period and co-existence with Indic religions. Within contemporary Cambodia, buffalo sacrifice persists in some upland villages and is associated with seeking village protection from the *neak ta* (local spirits) (Hendrickson et al. 2023:465). Spiritual beliefs such as this have their foundations in animism which underpins all other spiritual beliefs in Cambodia (Mus et al. 2010:34-35).

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Figure 13: Depiction of a water buffalo at the Bayon (Hendrickson et al. 2023:465).

Bulls and cows are also prominent in Pre-Angkorian and Angkorian inscriptions and iconography. The bull in Indic belief systems is associated with the god Siva as the god's vehicle, Nandin and likened to attributes of strength and vigour. This link between cattle and Indic beliefs led to bull imagery being used to symbolise the power of Angkorian kings. Sandstone statues of the Nandin bull are prevalent at temples dedicated to Siva (Hendrickson et al. 2023:461). These statues can be seen at the temple Preah Ko, which itself translates to Sacred Cow (Figure 14). Other temples hosting similar Nandin statues include Bakong and Pre Rup.

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Figure 14: Sandstone Nandin from Preah Ko, Siem Reap (Source: ANGKOR TEMPLES IN CAMBODIA).

Cows in the Angkorian Empire were just as significant as bulls. A 12th-century CE stele from Trapeang Don Ong (K. 254) mentions the presence of a cow during the coronation ritual of King Śri Harṣavarman. The text describes the cow as a *dhenu* or sacred cow, which led the procession around the Royal Palace. This description displays the high status of cows held in the empire, and their leading presence in coronation rituals suggests their association with stability and prosperity (Hendrickson et al. 2023:462-463). The importance of cows is further emphasised by the practice of gifting cows to Brahmin priests, which has been recorded in bas-reliefs in both the Bayon and at Banteay Chhmar (figure 15 and 16) (Hendrickson et al. 2023:462-463).

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Figure 15: Bas-relief of a cow and calf with a Brahmin priest at Banteay Chhmar (Hendrickson et al 2023:464).

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Figure 16: Bas-relief of cow and calf with Brahmin priest as the Bayon (Hendrickson et al. 2023:464).

The worship of cows was not limited to their imagery; several cow products were also important in religious rituals. Milk was perhaps the most important of these products, being used in various Hindu, Brahmin, and Mahayana Buddhist rituals in the form of daily offerings and ritualistic consumption (Hendrickson et al., 2023:468). Milk consumption may even have been taken up by Angkorian elites however it is unknown as to why (Hendrickson et al. 2023:469).

Butter, and the process of churning milk into butter, was another important product and activity. Milk churning is depicted frequently in Angkorian iconography and is associated with the creation of the *amrta,* an elixir of immortality in Hindu and Brahmanic beliefs (Figure 17) (Hendrickson et al.

2023:467). This link between milk products and health is also apparent in the use of milk, curd, and butter in healing practices within Angkorian hospitals (K. 273, K. 208) (Hendrickson et al. 2023:469).

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Figure 17: Depiction of milk churning on Bas-relief at Angkor Wat (Hendrickson et al. 2023:468).

Bovines within the Angkorian empire also have uses outside of a ritual context. Their main role outside of ritual practices was transportation. Historical accounts from Chinese delegate Zhou Daguan, who visited Angkor in 1296, explain that bovines were not ridden but were only used to haul carts (trans. Harris 2007: 73). Various temple bas-reliefs also depict bovines pulling carts (Hendrickson et al. 2023:473).

Cattle on the Menu?

Despite the abundance of cattle in the Angkorian Empire, its people may not have eaten them. Daguan's account of Angkor states, "There are a great many cows. People do not venture to ride on them when they are alive or eat them when they are dead or flay their hides for leather … their carcasses are left to rot away" (trans. Harris 2007: 73). While the reliability of historical accounts is questionable, there has currently been no Angkorian depictions or inscriptions identified that suggest bovines were consumed (Hendrickson et al. 2023:469).

Comparisons can also be made to the Indic traditions, which were frequently adapted into Angkorian society. Within the development of Hinduism in India, the concept of cow sanctity can be traced to the emergence of *ahimsa* (a concept of non-violence) in the late Vedic period (around 500 BCE). By the fourth century CE, *ahimsa* and cow sanctity had become established doctrines within Hindu scripture (Lodrick 2003:71). Although it cannot be assumed that these concepts of non-violence and cow sanctity were adopted into Angkorian society, they do align with the historical accounts of Zhou Daguan, giving them merit.

Theravada Buddhism and the Onset of the Early Modern Period

Towards the end of the Angkorian period and into the Early Modern period, the Angkorian Empire experienced religious changes, leading to Theravada Buddhism's prominence as a state religion. This change is often pointed to as a driving factor of the Angkorian decline. While it is true that the emergence of Theravada coincided with Angkor losing its status as capital, the argument of Theravada as a destabilising force ignores critical details (Polkinghorne 2022:272, Evans et al. 2023:545).

Many scholars view Theravada as an anti-aristocratic religion that undermined and destabilised established Hindu ideals of the empire. However, this is not the case. The Angkorian Empire had a long history of religious change and coexistence between religions (Evans et al. 2023:544). Further, while Angkorian kings devoted much of their power and influence to the construction of religious infrastructure, there was not necessarily a correspondence between religion and political structure (Polkinghorne 2022:272). Thus, the shift towards Theravada would not have threatened the stability of the Angkorian Empire as it has been claimed (Polkinghorne 2022:272, Evans et al. 2023:544).

Cattle in Theravadin Cambodia

The prevalence of Theravada Buddhism through the Early Modern period led to elements of the Angkorian period, such as the veneration of cattle, to shift. However, how the perception of cattle changed as Theravada Buddhism became the dominant religious system is currently unclear. Some aspects of cattle veneration, such as the practice of buffalo sacrifices to *neak ta*, remained an essential element of indigenous ritual that coexisted with Theravadin Buddhism, surviving into the Early Modern period (Harris 2005:55). Unfortunately, less is known about if the Brahmanical taboos of killing or eating cow persisted. Theravada Buddhism does observe five moral precepts, one of which is to abstain from taking life. While the abstention from killing would seemingly prohibit the butchery of any animal, the consumption of meat was commonplace within Theravadin Cambodia. In many Theravadin villages, this precept is overcome by assigning the role of the butcher to children who are not held to the same moral standard as adults (Harris 2005:79). Further, this restriction does not extend to wild animals such as fish, which makes up a large portion of rural diets (Harris 2005:79). While these Theravadin morals would seemingly permit the butchery of cattle they also do not suggest that cows were no longer view as set apart from other animals.

The earliest historical record of cattle from the Late Modern period come from the 1900 historical account by the French savant Étienne Aymonier where he explains that mandarin bureaucrats would be required to sacrifice an animal such as an oxen or pig. This brief explanation by Aymonier reveals critical details about how cattle was perceived at the end of the Modern period. This brief description reveals that not only were oxen used commonly in sacrifice but were grouped together with other animals such as pigs. It should also be noted that in the original French, Aymonier specifically uses the word *bœuf* which refers generally to castrated bulls known as oxen or bullocks which are primarily used as beasts of burden (Aymonier 1900:71).

When comparing the Angkorian account of Daguan and the Late Modern account from Aymonier, by the time of French colonisation, a significant shift had occurred in how cattle were treated and perceived in Cambodia. Unfortunately, there remains missing details and issues. It is still unclear from Aymonier's account if cattle were commonly butchered, or only permitted to be killed within this ritual setting. While Aymonier's grouping of oxen with pigs suggest the who animals were treated in a similar manner, it is also likely that this is due to the presence of western biases in his account.

Cattle of Cambodia

Cambodia is home to various bovine species that were present during the Angkorian and Early Modern periods. The Gaur (*Bos gaurus*) is Cambodia's largest wild bovine species and endemic to the Southeast Asian region (Voeun 2008:32, Hendrickson et al. 2023:473). Domesticated Gaur are known as Gayal. Today, the species are threatened and only live in a small region of Northern Cambodia (Voeun 2008:32). Other endemic species include the kouprey (*Bos sauvelis*) and the water buffalo (*Bos bubalis*) (Figure 18).

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Figure 18: Endemic bovines of SE Asia: A) Gaur (*Bos Gaurus*) B) Kouprey (*Bos sauvelis*) C) Water buffalo (*Bubulus arnee*) (Britannica, Wikipedia, Flickr).

The two other predominant species of cattle in Cambodia were introduced from other regions. The banteng (*Bos javanicus*) was introduced from Indonesia and the zebu (*Bos indicus*) from India (Figure 19). The zebu, with its origins in India, is closely associated with Hindu cow sanctity and was likely introduced to Southeast Asia as early pilgrims began travelling to the region (Voeun 2008:37-39, Hendrickson et al. 2023:473-474). The zebu's association with Hinduism may have also led the species to be the most prevalent cattle in the Angkorian Empire, as they would have been preferred for religious rituals (Hendrickson et al. 2023:474).

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Figure 19: Introduced cattle of SE Asia: A) Banteng (*Bos javenicus*) B) Zebu* (Bos indicus*) (Brittanica, Wikipedia).

CHAPTER 4 - ZOOARCHAEOLOGY

Zooarchaeology is a subdiscipline of archaeology that aims to answer archaeological questions by analysing faunal remains. Many forms of zooarchaeological analysis can be utilised to answer these questions (Glifford-Gonzales 2018:3-4).

Why Bones?

Faunal remains are a robust material within the archaeological context as they can be studied from a scientific perspective, a cultural perspective, or a mix of both, depending on the question being asked. The uniformitarian nature of faunal remains lends itself well to answering questions about past environmental conditions. In contrast, the use and modification of bones and shells by past societies allow faunal remains to also be analysed within an anthropomorphic context and answer questions relating to resource use and management, diet, trade, economy, and many other aspects of the human experience (Glifford-Gonzales 2018:51, Steele 2015:170). The intrinsic relationship between humans and animals is evident throughout human history and allows zooarchaeology to be relevant to periods and geographic locations (Steele 2015:170).

The prehistoric site of Ban Non Wat in northeast Thailand is a great example of the applications of zooarchaeological methods in Southeast Asia. Due to its long occupation period, which is backed by a strong radiocarbon-dated chronology, Ban Non Wat is a key site in understanding societal change through Southeast Asian prehistory (Higham 2008:33). Excavations at Ban Non Wat commenced in 2003 and continued until 2010. During this excavation period, 637 burials were uncovered across the site, spanning from the early Neolithic to the Late Iron Age. Additionally, evidence of various domestic and industrial activities was also identified (Higham and Higham 2008:3). The rich material record of the site allowed for the occupation to be separated into 12 distinct phases, which were also dated using radiocarbon data (Table 1) (Higham and Higham 2008:4).

Table 1: Summary of Cultural periods defined at Ban Non Wat (Higham and Higham 2008:13).

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Along with the rich material culture identified at Ban Non Wat, the site is abundant in diverse faunal remains. The importance of these remains is particularly evident within the contexts attributed to the Neolithic period. Through the process of wet sieving, large amounts of fish remains could be recovered from Neolithic middens and sedimentary layers. Comparative analysis of these remains determined that the bagrid catfish (Hemibagrus) represented the most abundant species. Other common species included snakehead (*Channa striata*), *Clarias sp.*, and *Ompok*. The presence of these aquatic species and their abundance suggested that the Neolithic occupants of Ban Non Wat relied heavily on water systems to sustain their large sedentary lifestyle (Thosarat and Kijngam 2011:169-170). This reliance on water systems is also evidenced by the heavy presence of shells belonging to freshwater gastropods (Thosarat and Kijngam 2011:182).

A rich assemblage of mammalian fauna was also excavated from Neolithic layers and burials. Smaller bones were also recovered through wet sieving. Of the mammalian species identified, the most abundant were bovids, pig, various species of deer, and dog. The bovid specimens were analyzed and compared to a modern-day collection of domestic cattle from Bangkok which determined the presence of 3 species of cattle (*Bos gaurus, Bos javanicus, and Bos sauveli*) and water buffalo. By comparing the size of the Ban Non Wat cattle phalange elements to those of the modern-day materials it was determined that the almost half of the specimens were within the size range of domestic cattle, with the remaining representing wild cattle. This result suggested that the occupants of Ban Non Wat herded domestic cattle but also hunted wild cattle (Thosarat and Kinjgam 2011:189-191). The presence of these domestic cattle, along with pig and dog shows that Ban Non Wat was actively exploiting domestic species; however, the additional presence of wild species such, as wild cattle and deer, suggests that they were not completely reliant on domestic species (Thosarat and Kijngam 2011:191). Finally, the presence of some wild species, such as

turtles and Javan rhinoceros, makes it likely that wetland ecosystems were present near Ban Non Wat and were utilised for hunting.

Overall, from the faunal remains at Ban Non Wat, important data was derived relating to its occupants' Neolithic lifestyle, such as diet, the subsistence of domestic animals, and exploited ecosystems.

Zooarchaeology in Cambodia

There has been limited zooarchaeological research conducted within Cambodia and none with a focus on the period after Angkor. Despite the limited literature, it is beneficial to overview and discuss these case studies as they are the foundations on which this zooarchaeological study of Longvek stands upon.

Laang Spean Cave

One of the earliest sites dated with an extensive faunal assemblage is Laang Spean cave in Northeastern Cambodia. Laang Spean was first excavated by the French archaeologists Cécile and Roland Mourer in the late 1960s to find evidence of early human occupation in the region. Early on in these initial excavations, Mourer and Mourer uncovered a variety of artefacts, such as lithics and ceramic sherds. Also present was a large assemblage of micro and macrofaunal remains (Heng et al. 2016:165-166). The levels containing faunal materials were dated to a range of 6240 BP to 1200 BP (Heng et al. 2016:166). The faunal remains from these layers could be identified, which showed a diverse range of species. The most abundant macrofauna were small bovids. However, other fauna, such as rhinoceros, cervids, small carnivores, and primates, were also represented. The micro-fauna was also diverse, with species of birds, rodents, fish, turtles, lizards, and snakes all represented (Mourer 1977:37).

Excavation of the site ended in the 1990s and was restarted in 2009 by the French-Cambodia Prehistoric Mission, which excavated a further 37 square metres of the site over six years (Heng et al. 2016:167). These more recent excavations expanded the extensive archaeological record of the site, including a large amount of new faunal material. Much of the new faunal materials were found in units containing Hoabinhian stone tools, a late Pleistocene lithic technocomplex (Forestier 2015:197, Zeitoun 2019:143). Association with these Hoabinhian lithics and evidence of burning led to the conclusion that the faunal assemblage was primarily a result of anthropogenic activities of Hoabinhian hunter-gatherers. Although a diverse range of species was represented in the assemblage, meat weight estimations determined that the primary source of protein would have derived from large ruminants such as bovids and cervids, which would have been supplemented by fish and turtles (Forestier 2015:200-202).

Although the rich faunal assemblage from Laang Spean cave has great potential for in-depth zooarchaeological analysis, it has remained a secondary data set to other archaeological materials until recently. The first zooarchaeological analysis of the assemblage was carried out by Stephane Frère in 2018 with the primary aim of comparing evidence of meat supply strategies from Early Holocene Southeast Asian sites (Frère et al. 2018). The study determined through this comparison showed that meat diet during the Early Holocene was quite varied between sites. Even so, all indicated a large majority of meat came from bovids and cervids (Frère et al. 2018:105).

The only other zooarchaeological research to use the Laang Spean assemblage is a recent 2023 study. This study specifically looked at the exploitation of reptiles and amphibians at Laang Spean and three other Hoabinhian sites in Thailand (Bochaton et al. 2023:5-7). It was determined through this study that although the environmental conditions varied between sites, the exploitation of amphibians was largely homogenous. The study also has constructed data sets that will be valuable for further research into resource exploitation comparison (Bochaton et al. 2023:29-30).

Phum Snay

A site that has seen extensive work in archaeology and zooarchaeology is a Pre-Angkorian village and cemetery of Phum Snay in Northeast Cambodia. Initial excavations of Phum Snay began in 2001, successfully revealing a rich archaeological record at the site. Multiple human burials were uncovered, many of which had associated burial goods present, such as pottery, weaponry, and faunal remains Unfortunately, it also became apparent that significant looting had also taken place at Phum Snay. This looting would have undoubtedly impacted the site negatively, which was taken into account when interpreting the site (O'Reilly et al. 2006:191). Excavations continued in 2002 and 2003 within different areas of the site, which also successfully uncovered multiple human burials. ^{14}C dates calculated using burial-associated charcoal determined an age range of 207 BCE to 239 CE for occupation (O'Reilly et al. 2006:190).

The faunal remains excavated from Phum Snay represent a rich assemblage that spans the occupational age range of the site. The assemblage represents two distinct contexts in which faunal remains were found: as a grave good within burials and as an assemblage accumulated from domestic activities (O'Reilly et al. 2006:208). Zooarchaeological analysis of faunal remains determined distinct differences between the two contexts. The remains determined as grave goods primarily consisted of only domestic species such as pigs, cattle, water buffalo, and chickens. Fish were also present as grave goods within ceramic vessels, which seemed to indicate the fish remains derived from prepared meals left as offerings. In contrast, the assemblage not associated with burials represented a diverse variety of wild fauna, including large mammals such as deer, boar, and wild cats to crocodiles, turtles, and cranes. This variety of fauna present shows that occupants of Phum Snay exploited a broad range of ecosystems such as forests, marshland rivers, and jungles (O'Reilly et al. 2006:209).

Another excavation of Phum Snay took place in 2007, adding to the already rich faunal assemblage (Voeun 2012:231). The faunal remains from the 2007 excavation were analysed by zooarchaeologist Voeun Vuthy (Voeun 2008:10). Of the 2007 assemblage, a total of 1752 mammal remains and 513 fish remains were collected. Voeun filtered the remains down to 320 terrestrial vertebrate remains and 366 fish remains for further analysis (Voeun 2008:28). The selected remains were likely the most diagnostic specimens of the larger collection and thus had the potential to convey valuable data. The methods used for analysis included taxonomic identification, osteological measuring, and taphonomic and spatial distribution analysis (Voeun 2008:25-27).

Through these methods, Voeun determined that most terrestrial remains were that of large mammals, with 37% belonging to the Bovidae family, 37% to Cervidae, and 17% to Suidae (*Sus scrofa*). Of the fish remains, it was determined that the overwhelming majority represented species that reside in shallow, slow-moving waters and are typically found within the waterways of rice paddies (Voeun 2008:68-69). Many of the bones displayed evidence of human modification, such as butchery marks and burning, suggesting cooking practices (Voeun 2008:62-66). Also identified was a pattern in animal remains offered burial goods, with some burial only receiving either the left or right sides of an animal. It was hypothesised that this pattern indicated the division of hunters into two groups in which kills would be divided, with one group receiving the left side a carcass and the other the right (Voeun 2008:70).

Vat Komnou Cemetery, Angkor Borei

Similar to Phum Snay, Vat Komnou cemetery, located in what is now Angkor Borei, has a dated use period of 200 BCE to 200 CE (Ikehara-Quebral et al. 2017:192). Also present is the inclusion of faunal remains as grave goods (Ikehara-Quebral et al. 2017:197). In total, over 32,000 faunal specimens were recovered from the site. However, more than 14,000 of these were not identifiable beyond class level. Zooarchaeological analysis of these remains was, once again, done by Voeun, as well as William Belcher, who were able to construct an in-depth table of the species represented in the assemblage (Ikehara-Quebral et al. 2017:199-201). Voeun and Belcher determined that both wild and domestic species were present in the assemblage, and all significant taxa of local species were also present. The prominent species represented was the domestic pig (*Sus scrofa*) which comprised 30% of the entire assemblage. Also in abundance were fish remains, with a total of 7236 identified fragments, almost half representing the snakehead murrel fish (*Channa striata*). These results indicate a heavy reliance on pigs as a food source and burial offering. The significant presence of the snakehead murrel is indicative of burial offerings and is associated with Hindu and Buddhist traditions (Ikehara-Quebral et al. 2017:199-202).

Faunal specimens excavated from Vat Komnou were also included in Teresa Ingalls' 2010 study of variation in Southeast Asian bovid dental morphology. The study concluded that the species banteng

(*Bos javenicus*), was likely present at the site from at least 131 CE, making it the earliest recorded presence of the species in a Southeast Asian site (Ingalls 2010:90). The presence of banteng at the site further suggests the surrounding environment would have consisted of open grasslands and sparse patches of forest, the preferred habitat of the banteng. This environmental interpretation aligns with paleoenvironmental data derived from sediment in the nearby Angkor Borei *baray* (Ingalls 2010:93).

CHAPTER 5 - METHODS

Data Collation

The raw data collected during zooarchaeological analysis was collated onto a Microsoft Excel spreadsheet. The following categories were used to organise the raw data:

- Site/Year – The site and year in which the specimen, or group of specimens, was excavated.
- Trench – The trench that specimens were excavated from.
- US – Further contextual information denoting trench, location, spit, and artefact type.
- Radiocarbon age – ^{14}C date attributed to specimen.
- Old no. – the catalogue number used during excavations before additional cataloguing.
- Cat. No. – The attributed catalogue number of each specimen or group of specimens. The catalogue number was determined prior to faunal analysis.
- NSP - Number of specimens in each Cat. No.
- NISP - Number of identifiable specimens in each Cat. No.
- Width(mm) – Measurement of the width of specimens.
- Length(mm)- Measurement of the length of specimens.
- Weight (g) - recorded weight of specimens.
- Material – bone type for each specimen, i.e bone or tooth.
- Age Estimate – Estimation of biological age of specimen.
- Size Class – The size class of the animal identified from the specimen.
- Class – Refers to the taxonomic class attributed to an identified specimen, e.g. Mammalia, Aves.
- Order – Refers to the taxonomic order attributed to an identified specimen, e.g. Artiodactyla.
- Family – Refers to the taxonomic family attributed to an identified species, e.g. Bovidae, Cervidae.
- Genus – Refers to the genus attributed to an identified specimen, e.g. Bos, Sus.
- Species – Refers to the species attributed to an identified species, e.g. Garus, Babalus.
- Butchery/Gnaw Marks – Determination of evidence of butchery or gnaw marks.
- Burn – Determination of evidence of burning.
- Diagnostic – Y/N option for presence of diagnostic features
- Identification – Final description of a specimen based on analysis.
- Observations – Additional observations noted about each specimen.
- Photo No. – File name of the photos taken of each specimen.

Quantification

Number of Specimens (NSP*)*

The number of specimens (NSP) refers to the total number of specimens within a zooarchaeological assemblage. The NSP is collected simply by counting the number of specimens within an assemblage. NSP is the most basic level of zooarchaeological quantification, and often the first method applied to an assemblage. In a zooarchaeological context, a *specimen* refers to the archaeological remains of a skeletal element. A specimen can be either a whole skeletal element or a fragment of an element (Glifford-Gonzalez 2018:12).

Number of Identifiable Specimens (NISP)

The number of identifiable specimens (NISP) is a count of the total number of specimens that have been determined as identifiable. An identifiable specimen in this context refers to a taxonomically identifiable specimen, usually down to the genus or species level. In the case of highly fragmented assemblages such as the one in this thesis, the NISP can also include specimens that can only be identified to a higher level of taxonomic identifiability (Glifford-Gonzalez 2018:187).

Minimum Number of Individuals (MNI)

The MNI is an estimate of the lowest number of individual animals within an assemblage. Usually, this number is derived by determining the most abundant skeletal element in each taxon. The calculation of MNI can also consider other factors, such as age estimation and differing strata, which can allow more individuals to be distinguished. MNI is commonly used to negate the biases created by the NISP, such as the overrepresentation of specimens due to fragmentation (Glifford-Gonzalez 2018:187-189).

In the case of this assemblage, the MNI will consider the abundance of skeletal elements prescribed to each taxon and the stratigraphic location of specimens. This was decided due to the distinctiveness of strata and differing dates derived from AMS ^{14}C dating, which make it unlikely that specimens from differing strata belong to the same individual animal.

Weighing

The weight of specimens was calculated using standard electronic scales to one decimal point and recorded in grams (g). Before weighing, specimens were cleaned using a toothbrush to remove excess dirt and debris, which would have skewed weight results. Highly fragmented specimens, which were bagged in groups based on their excavation contexts, had their weight calculated as gross total instead of individually. The method of weighing similar specimens together is a standard method, as it allows the average size of specimens to be quickly determined by comparing the total weight to the NSP of the group (Beisaw 2013:123).

Measurements

Specimens were measured using standard calipers and recorded in millimeters (mm). The method of measuring is primarily based on the 1976 guide by Angela von den Driech, with some alterations to fit the needs of this research. This guide is widely regarded as an international standard for zooarchaeological measurements (Driesch 1976, O'Reilly et al. 2006:196). According to these guidelines, only bones that are unfragmented should be measured. However, there are exceptions for fragments that have measurable diagnostic features intact. Also, generally, only the bones of fully grown fauna should be measured as an estimate of size is unreliable as animals grow at varied rates (Driesch 1976:4).

In regard to this assemblage, measurements of most specimens were still taken regardless of fragmentation or age to provide contextual data on the size of specimens. These measurements, however, were not used for species identification.

Identification

Element Identification

The skeletal element that a species represents is determined through an in-depth comparison between the unidentified element and comparative materials. Most, if not all, intact skeletal elements possess diagnostic features that allow them to be identified as one element or another. This is usually easier said than done within an archaeological context, as it is common for specimens to become fragmented, which can make a specimen unidentifiable as it loses diagnostic features. Some fragmentary specimens are still, however, highly diagnostic, such as the articular ends of long bones. Another factor that can limit how diagnostic a specimen is the age of the animal it was derived from, as diagnostic features such as epiphysis are not present.

In the case of this thesis various comparative materials were used to make element identifications (Fillios and Blake 2006, Adams and Crabtree 2012, Beisaw 2013).

Size Class

Size class refers to the general physical size of the animal a specimen has been attributed to. The size class is usually the broadest classification and is used if a taxonomic classification cannot be determined below the level of class (Beisaw 2013:120).

There are various ways in which size classes can be grouped, however, this thesis is using a grouping primarily adapted from the framework present in Fillios and Blake 2006 (Figure 20) (Fillios and Blake 2006:xxvii).

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Figure 20: Size classes of animals present in the assemblage. Adapted from (Fillios and Blake 2006).

Age Determination

There are many methods for determining the age of an animal at its time of death; however, this study will incorporate a limited number of these methods. The first method is to study the rate of epiphysial fusion in mammals. As mammals age, the epiphysial fusion at the articular ends of many bones occurs at a predictable rate. This rate of epiphysial fusion is well-recorded in domestic species; however, it is less reliable in wild species (Glifford-Gonzales 2018:116).

Another method of age determination is to analyse the pattern of tooth eruption and wear in animals. Tooth eruption occurs at a predictable rate in most mammals and then also begin to wear down as the animal gets older. From these changes, a general age can usually be determined (Glifford-Gonzales 2018:125).

This study incorporated both the epiphysial fusion and tooth eruption methods to determine the age of elements. For the epiphysial fusion method, elements were placed into the broad categories of juvenile and adult based on whether epiphyses were fused or unfused. As the assemblage lacked any mandible specimens on which tooth eruption patterns could be observed, age determination from tooth specimens was estimated from tooth wear alone. Teeth that displayed significant wear were estimated to be adult, whereas teeth with minimal wear were estimated to be juvenile.

Taxonomic Identification

Much like element identification, taxonomic identification involves comparing specimens to a range of comparative materials. In taxonomic identification, some elements are more diagnostic than others. For example, while you may be able to identify a single vertebra to the order or family level, another element, such as a mandible, would be far easier to identify at the species level.

Some species are also more difficult to identify than others due to similarity in skeletal morphology. This is especially true in some domestic species such as cattle which are also identical in skeletal morphology. Domestic species in many contexts are also commonly cross-bred to create a hybrid, which is almost impossible to tell from skeletal morphology alone.

Identification in this thesis was completed using a variety of comparative materials, including the Flinders University Palaeontology Comparative Collection, which contains examples of domestic animals. While these materials were adequate for identifying specimens for a specific group of animals such as pigs, cows, or deer, there was a lack of access to comparative materials of Cambodian fauna. The lack of Cambodian faunal materials limited the identification of some specimens past broad classifications, such as fish or turtle; however, some specimens could be identified by comparing measurements and images to other zooarchaeological analyses conducted in Cambodia, such as Voeun 2008 which did have access to adequate comparative collections (Voeun 2008).

Taphonomic Analysis

Burning

All specimens in the assemblage were analysed for the presence of burning. The presence of burned remains in an assemblage can indicate food preparation activities such as cooking. Generally burned bone can be categorised into two distinct stages. The first stage, charred or carbonised, is when bone turns black. Carbonisation occurs when bone is burned at a relatively low (200 to 450 C) temperature for short periods of time. The percentage of a bone that becomes burned can vary between light charring across the bone, to completely blackened bone.

The second stage of burning is known as calcification. Calcification occurs when bone is exposed to high heat (600-700 C) for an extended amount of time. When bone is calcified, it takes on a white appearance with a chalky texture. Calcified bone is often very brittle and highly fragmented.

It is also possible for bone to be both carbonised and calcified. This usually occurs when meat is being roasted, and temperature is uneven through the bone, causing the exterior of the bone to be calcified while the interior remains carbonised. When this occurs, it also usually means that the bone was intact when burning (Lyman 1994:384-388, Beisaw 2013:109-110).

For this study, specimens are separated into three main categories for burning, which are unburned, carbonised, and calcified. The specimens will be sorted into these categories by identifying the burning characteristics described above. It should also be noted that specimens that display both carbonisation and calcification are categorised as calcified.

Butchery Marks

Butchery marks are distinctive marks on a bone's surface that occur when an animal carcass is being processed with a cutting tool such as a knife or stone tool that is dragged across the bone's surface. Butchery marks are often rare even in sites heavily associated with butchery practices as hitting hard bone with a tool can blunt it (Beisaw 2013:105). Thus, the more experienced a butcher is, the less likely they are to produce butchery marks.

Butchery marks created by tools such as knives can be identified by their long appearance and tapered point at the maximum depth which creates a V-shaped cross-section (Lyman 1994:297, Beisaw 2013:105-106).

There are three main activities that can result in the production of butchery marks, which are skinning, disarticulation, and filleting, each of which can be identified by the pattern and location of butchery marks on an animal or element. Butchery marks from skinning are found on the shafts of the lower leg bones, phalanges, and along the lower margins of the mandible and skull. Disarticulation marks are commonly found on the articular ends of bones, where they can be easily separated from each other. Disarticulation marks can also be seen on the surface of vertebrae and pelvic bones. Last, filleting marks run parallel along the long axis of bones (Lyman 1994:298).

For this study, specimens were analysed for the diagnostic butchery marks described above. This was done using the naked eye and microscope at both the macroscopic and microscopic levels. Similarly, images of identified butchery marks were taken using a standard digital camera and at an extended magnification using a Dinolite digital microscope.

Gnaw Marks

Gnawing marks can occur on bones when an animal has gnawed on a bone. These marks can often resemble butchery marks; however, they have distinct characteristics that set them apart. Unlike butchery marks, carnivore tooth furrows display a tapered point and lack the distinctive V-shaped cross-section. Gnawing marks can also take the form of carnivore tooth pits, which occur when a carnivore's canine punctures through the bone's surface, creating a distinct circular puncture. Tooth pits commonly occur at the articular ends of bones. Rodent gnawing, which resembles small rectangular scratches, is also common on bone (Beisaw 2013:112). Rodents gnaw marks are usually paired as they are produced by a rodents four large incisors on the mantle and mandibular.

In this study, gnaw marks were analysed for the characteristics described above. The methods used were the same as those used to identify butchery marks.

Dating

The dating of specimens was done through AMS ^{14}C dating. Dates were calibrated using the OxCal program version 4.4.4, and using a mixed curve method 50%:50% of SHCal20 data and IntCal20 data with an error of +/- 10% (Hogg et al. 2020, Reimer et al. 2020). It was necessary to use this mixed curve method as Cambodia is located within the tropical region which is not accurately represented by either IntCal20 or SHCal20 due to a lack of long tree ring ^{14}C records. Further, atmospheric ^{14}C in this tropical region may also be influenced by monsoonal seasons which causes a mixing of North and Southern hemisphere air masses, which is also mitigated by using the mixed curve method (Hogg et al:773-774).

The dates produced using this method have a 95% percent confidence of accuracy and are displayed as a range.

CHAPTER 6 - RESULTS

NSP and NISP

A total of 256 bone and tooth specimens were counted in the overall assemblage. Of the NSP, 71 bone specimens were classified as identifiable to either an animal-size group or some level of taxonomic classification. The small number of NISP in the specimens was primarily due to the poor condition of the assemblage, which saw many of the specimens highly fragmented and thus significantly limited identifiable diagnostic features.

Although only 28% of the initial assemblage was deemed identifiable, many of the non-identifiable specimens still provide valuable data through other features such as butchery marks and evidence of burning. Other specimens deemed non-identifiable can be identified as specific skeletal elements but provide no features to attribute to taxon or size classes. These specimens are also still able to provide data in relation to skeletal element frequency.

Faunal Identification and Analysis

Element Identification and MNE

The NISP was made of twelve distinct skeletal elements, which were comprised of 5 molars, 2 canines, 3 incisors, 6 metapodials, 1 radius, 3 ribs, 2 tibia, 1 vertebra, 2 fish vertebrae, 2 turtle shell plates, 1 turtle coracoid, and 3 unidentified fish bone fragments. The MNE of the assemblage was calculated to a total of 30 skeletal elements (Figure 22).

Faunal Identification

The identifiable specimens of the assemblage were identified to varying levels of classification, with the broadest levels being size class and taxonomic class, and the most specific being taxonomic species level.

Size Class

The broadest classification of the identifiable specimens is by the general size classes of small, medium, and large (Table 2).

Size Class by NISP		
Large	**Medium**	**Small**
12	40	9

Size Class by MNI		
Large	**Medium**	**Small**
5	4	4

Table 2: Summary of animal size class by NISP and MNI.

By comparing the size classes by NISP and MNI, it seems that while the identified specimens predominantly represent the medium size class, the MNI of each size class is evenly represented.

Taxonomic Identification

Identifiable specimens were classified into varying levels of taxonomic identification from class to species (Table 3).

Class	Order, Family, Genus, Species	Common Name	NISP	MNI
Mammalia		Mammal	35	
	Artiodactyla	cow, deer, pig	6 (26)*	
	Cervidae	deer	2	
	Axis Pornicus	Hog deer	1	1
	Bos or Bubulus	Cow or Water Buffalo	6	3
	Bos	Cow	5	2
	Nemorhaedus sumatransis	Serow	3	1
	Sus scrofa	Pig	3	2
Reptilia	Testudines	Turtle	3	1
Osteichthyes		Fish	5	
Total			**69**	**10**

Table 3: Faunal list of overall assemblage *aggregate NISP of all Artiodactyla identified, including those already listed.

Of the 69 total identified specimens, 6 were able to be identified at the species level. These species included the hog deer (*Axis pornicus*), the serow (*Nemorhaedus sumatraensis*), and the pig (*Sus scrofa)*. The MNI of these species was determined to be 1 hog deer, 1 serow, and 2 pigs in the overall assemblage. It could not be determined if the pig specimens were representative of its wild or domestic forms.

One identified specimen represented the hog deer, which was a distal end fragment of a metapodial bone (Figure 21). Although the comparative material of this species was not accessible, the identification could be made by comparing the osteological measurements of this specimen to those found in Voeun's zooarchaeological analysis Phum Snay, in which this species was also present (Voeun 2008:76).

The serow was also represented by a distal metapodial fragment (Figure 22). The element was identified as serow as because despite the specimen's small size that resembles that of the Cervidae family, it lacks distinct cervid morphological features such as a concave groove that runs along the shaft of the bone (Adams and Crabtree 2012:225). The lack of cervid features suggests the specimen is from the Bovidae family but smaller than the cattle species, which only leaves the only small bovid in Cambodia, the serow (*Nemorhaedus sumatraensis*). This species is also present in the previously mentioned Phum Snay assemblage (Voeun 2008:40-41). Unfortunately, due to the severe weathering of the specimen, the absence of the distal condyles, and, again, the lack of adequate comparative material, this identification requires additional verification.

The presence of pig in the assemblage was represented by incisor dentition fragments. The specimens were determined to be pig (*Sus Scrofa*) canines as they displayed diagnostic morphology such as the deep single root and flat blade-like shape of the tooth (Figure 23).

Figure 21: Specimen #1920. Metapodial distal fragment identified* to Axis pornicus *(anterior view).

Figure 22: Specimen #1936. Metapodial distal end and shaft identified to* Nemorhaedus sumatraensis *(anterior view).

Figure 23: Sus scrofa incisor fragments (A) Specimen #1175 (B) Specimen #946.

Twelve specimens were able to be identified to the genus level. 5 of the specimens were identified as *Bos*, while the other 7 were determined to belong to either *Bos* or *Babalus*. The *Bos* genus comprises all the Cambodian cattle species while *Babalus* is representative of the water buffalo. The specimens identified as *Bos* consisted of 4 metapodial elements and one proximal phalange (Figures 24 and 25). These elements were compared to specimens from the Flinders University Palaeontology comparative collection (Figure 26). The specimens could be attributed to *Bos* as they displayed none of the robustness seen in the skeletal morphology in the same elements of *Babalus arrne*.

Figure 24: Specimen #1819 metapodial distal condyle fragments classified as genus* Bos *(anterior view).

Figure 25: Specimen #1951 Proximal phalange classified as genus* Bos *(anterior view).

Figure 26: Specimen #1953 metapodial classified as genus* Bos *with comparison to* Bos taurus *metacarpal from the Flinders Palaeontology comparative collection FUR326 (anterior views).

The elements determined to belong to either *Bos* or *Babalus* included 2 molars and 3 incisors. The morphology of the molars and incisors was determined to be consistent comparative images (Figures 27 and 28) (Hillson 2016:65). While attempts have been made to determine Southeast Asian bovine species from dental morphology, they require significant in-depth analysis that was not possible without access to an adequate comparative collection (Ingalls 2010).

Figure 27: Specimen #1179. Incisor identified as* Bos *or* Babulas*.

Figure 28: Specimen #1886. Molar identified as* Bos *or* Babalus *(dorsal view).

A total of 2 specimens were identified to the family level of Cervidae. These specimens were a metapodial fragment and one complete left radius. Only the proximal end and the shaft were present on the metapodial fragment, which was diagnostic enough to attribute the specimen to deer as it displayed the long and thin morphology of cervid metapodials, however, species could not be determined as more diagnostic measurements such as element length and distal width could not be taken (Figure 29).

The radius specimen displayed diagnostic features consistent with that of cervids. While the element is complete, the radius lacks diagnostic features that can be attributed to one species. Species identification based on the length of the element is also not viable as the distal epiphysis is unfused, suggesting it belonged to a juvenile (Figure 30) (Adams and Crabtree 2012:211).

Figure 29: Specimen #1937. Metatarsus proximal fragment identified as cervid (dorsal view).

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Figure 30: Comparative left radius of white-tailed deer (anterior view) and specimen #1945, a left radius (anterior view) identified as a juvenile cervid (Adams and Crabtree 2012:211).

A total of 5 specimens could be identified to the order level as either artiodactyla or testudines. 2 specimens were identified as artiodactyla due to their size, which eliminates the possibility of smaller mammals and reptiles, only leaving large or medium mammals. While it is possible these specimens are from another order, such as Carnivora, these are far less likely to appear in a domestic assemblage than Artiodactyla, such as deer, pigs, or cattle.

The 3 remaining specimens were identified as testudines, which represent all species of turtles. The testudines specimens include 2 shell plates and 1 coracoid (Figure 31). These elements were compared to images and descriptions from other zooarchaeological research in Cambodia (Voeun 2008:52, Botchaton et al. 2023:8-12). While these specimens are diagnostic, access to a comparative collection of Cambodian turtle species is required before these specimens can be identified to a lower taxonomic classification.

Figure 31: Specimens #1961 turtle shell plate (A), #1961/1 coracoid fragment (B), #1888 shell plate (C).

The remaining specimens, 26 in total, were able to be identified to the broadest taxonomic classification, class. 21 of these specimens were identified as mammalian rib fragments (Figure 32). These rib fragments were classified to the order Mammalia due to the presence of inner cancellous bone and squarish cross-section with mammal rib morphology (Beishaw 2013:69).

Figure 32: Specimen #2294. Mammalian rib fragments.

The remaining specimens were classified as Osteichthyes which encompasses all bony fish. The elements include 2 fish vertebrae fragments and 5 unidentified bone elements. The vertebrae are identifiable by their resemblance of a thread spool with depressed ends (Figure 33) (Beishaw 2013:67-68).

The 5 unidentified bone elements were attributed to fish as they display the general characteristics of being light, flat, and lacking cancellous bone (Beishaw 2013:19).

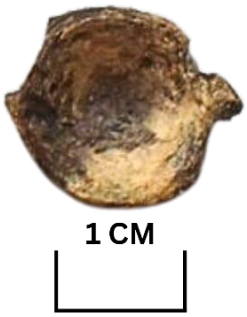


Figure 33: Specimen #1950/1. Fish vertebrae.

Taphonomic Analysis

Both identifiable and unidentifiable specimens were analysed for various taphonomic variables. For this analysis, taphonomy features include natural and anthropogenic processes.

Burning

Of the 261 specimens in the overall assemblage, a total of 139 were determined to display characteristics associated with burning, making up 54% of the assemblage (Figure 34). 135 of these burned specimens were determined to be either partly or completely calcified, with the remaining 4 specimens being carbonised. Some specimens exhibit characteristics of both calcification and carbonisation i.e. calcified on the bone surface and carbonised on the inside of the bone. These specimens have been characterised a calcified (Figure 35).

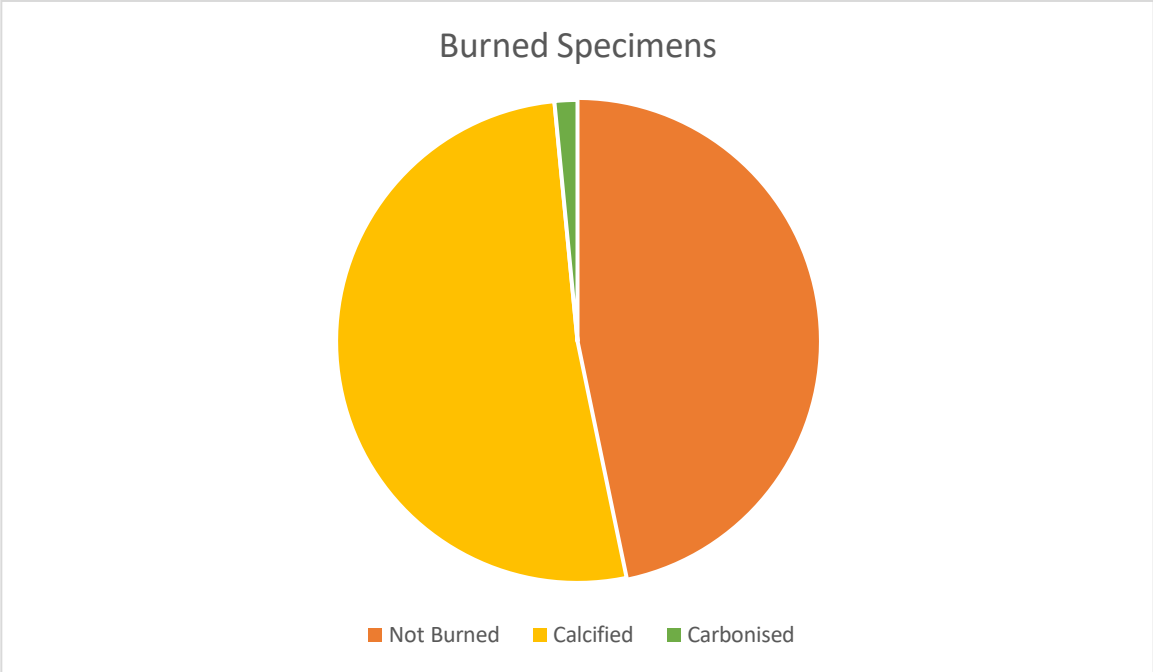


Figure 34: Chart illustrating the total number of burned specimens.

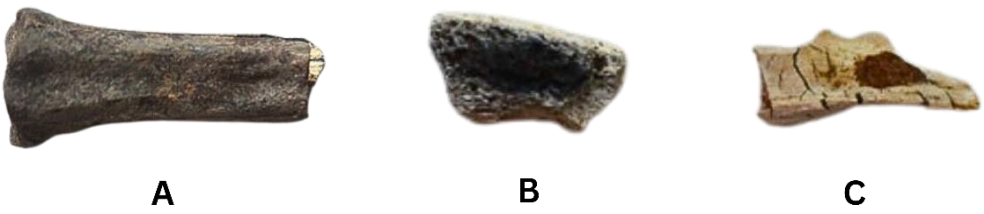


Figure 35: (A) Carbonised bone (B) Partly calcified bone (C) Calcified bone.

Butchery and Gnaw Marks

Eight specimens displayed evidence of butchery activity through the presence of cut marks, and two displayed evidence of gnawing, including one specimen that displayed both. All except for two of the specimens displaying butchery marks were identified as rib fragments, with the two remaining specimens being an unidentified bone fragment and the proximal phalange of *Bos*. The butchery marks identified on the rib bone fragments show the standard diagnostic features of a slice created by a knife.

The location and appearance of the butchery marks on the rib specimens are consistent with the activity of standard butchery and disarticulation of the rib bones from the thoracic vertebrae. The butchery marks present on the unidentified bone fragment express at least four clear slice marks. As the element and orientation could not be determined, these butchery marks could have resulted from any of the main butchery activities i.e. butchery, skinning, or filleting. The *Bos* phalange displays two parallel slice marks running laterally on the anterior surface of the shaft. These marks are consistent butchery marks created when skinning a large animal such as cattle (Figure 36).

The two specimens that display evidence of gnawing are a rib fragment and a bovid cattle metapodial element. The rib fragment displays the characteristics of a carnivore tooth furrow where a canine has been dragged through the bone (Figure 37). The second specimen shows a puncture mark on one of the distal condyles where a canine has been pushed into the bone (Figure 38).

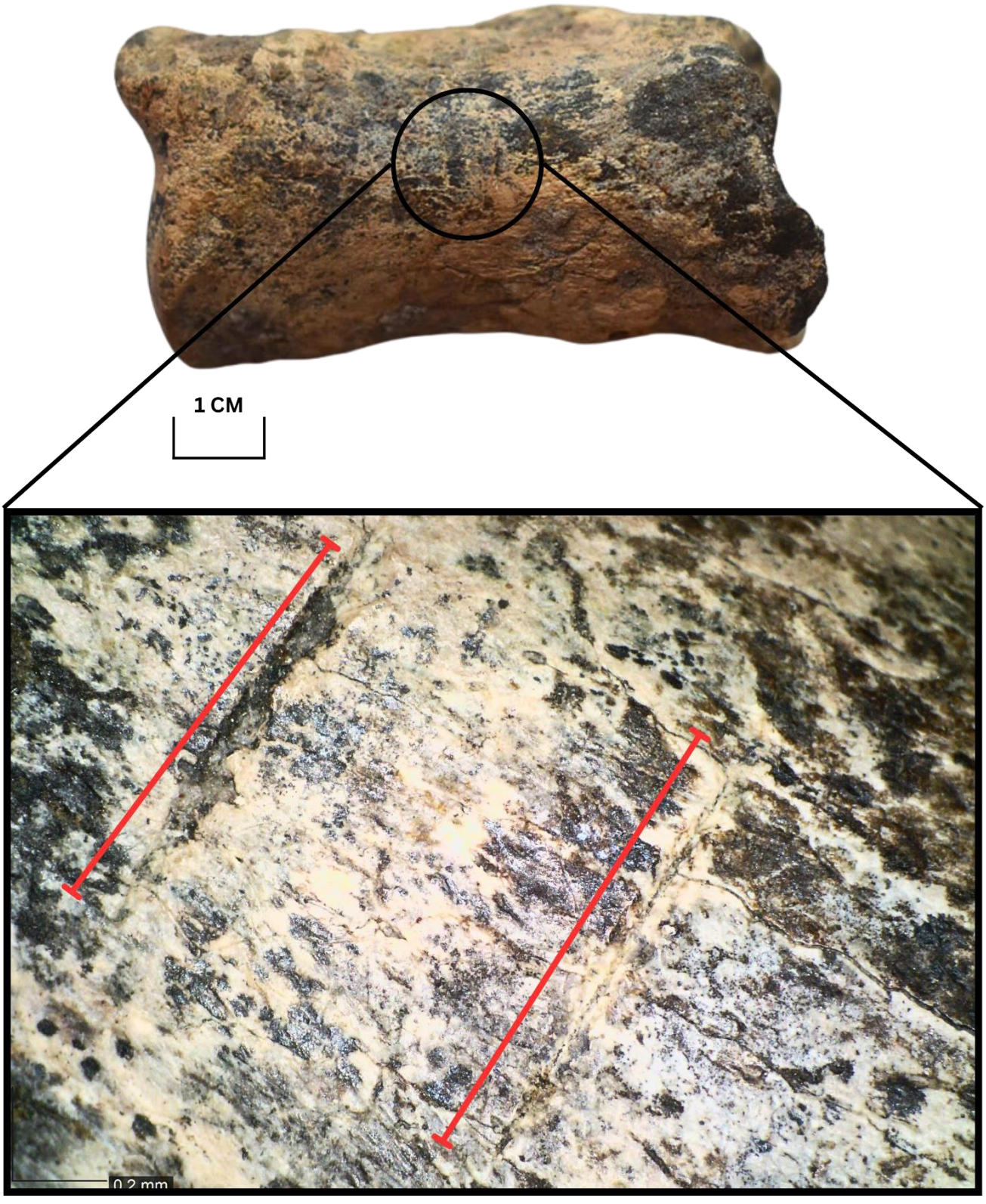


Figure 36: Specimen #1951* Bos *proximal phalange displaying butchery slice marks.

Figure 37: Specimen #2294 Rib fragment with carnivore tooth furrow.

Figure 38: Specimen #1953 Bovid metapodial with carnivore puncture mark.

Excavation Overview

Most diagnostic faunal specimens analysed in this study were excavated from pit features. Each of these pits likely represent the disposal of rubbish. The following is an overview of each pit feature described relating to faunal materials. Additionally, a small number of diagnostic specimens were excavated from LVK1507 relating to the metallurgy workshop that was a focus during the 2015 season. The following section overviews the material excavated from these pit features and the metallurgy workshop.

Rubbish Pit 1 (Trench LVK1503)

The first rubbish pit was excavated from Trench 3 in the 2015 excavations of the Royal Palace (Figures 39, 40 and 41). The feature, located along the western side of the Royal Palace, was discovered in situ with post-hole features likely to be the remnants of a wooden building. The pit contained 39 faunal specimens that could only be broadly identified to *Mammalia.* The pit also contained various fragments of earthenware, some of which displayed evidence of burning, and Chinese tradeware dating to the 16th century Ming Dynasty. This date is also backed up by the 14C dating of the pit feature, which produced two age ranges of 1502 to 1650CE (OZX165) and 1508 to 1658CE (OZW839) (Figure 39 and 40). Of the tradeware excavated, the most notable identified were rim and base sherds of Jingdezhen blue and white porcelain ceramics (Figure 43). Not only do these sherds date to the late 16th century, but as rare and high-quality tradeware, they attest to the high status of the Royal Palace occupants (Polkinghorne pers. Comm. 17 January 2024). The pit also contained large amounts of charcoal, giving the feature its blackened appearance (Figure 42).

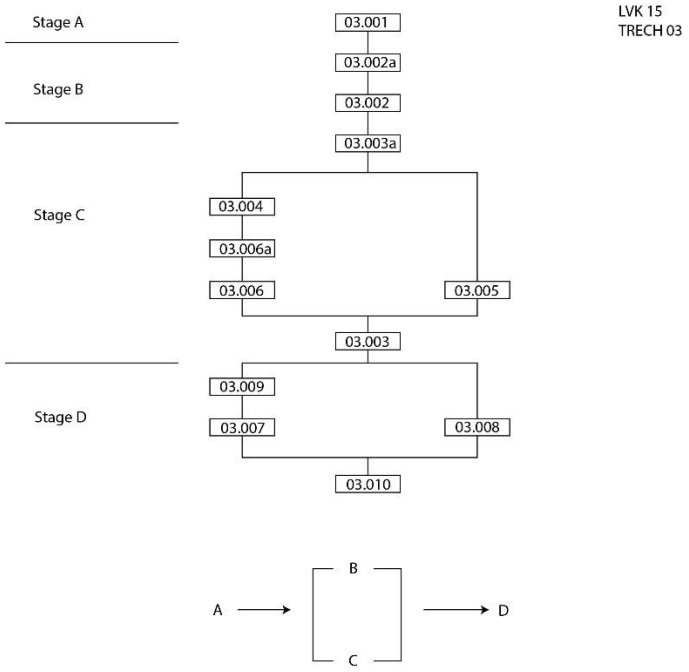


Figure 39: Harris Matrix of LVK1503 (Pit Feature 03.004) (Suy Pov).

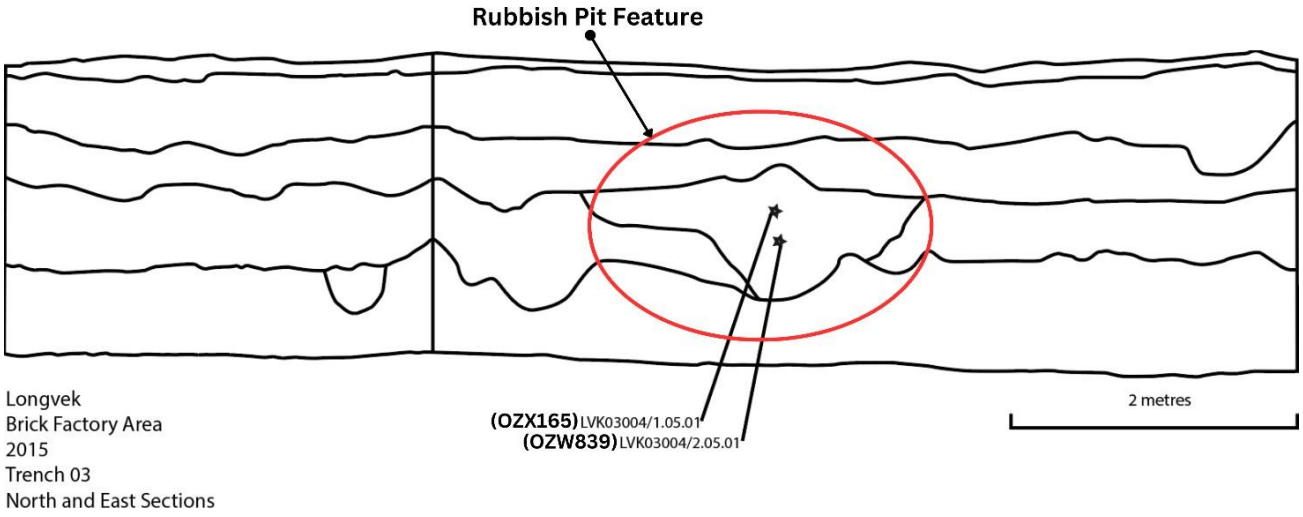


Figure 40: North and East sections of trench 03. ^{14}C dates obtained from LVK3004/1.05.01 and LVK3004/2.05.01.

Figure 41: LVK1503 excavation of rubbish pit feature (S. Tep).

Figure 42: LVK1503 rubbish pit feature with various artefacts in situ.

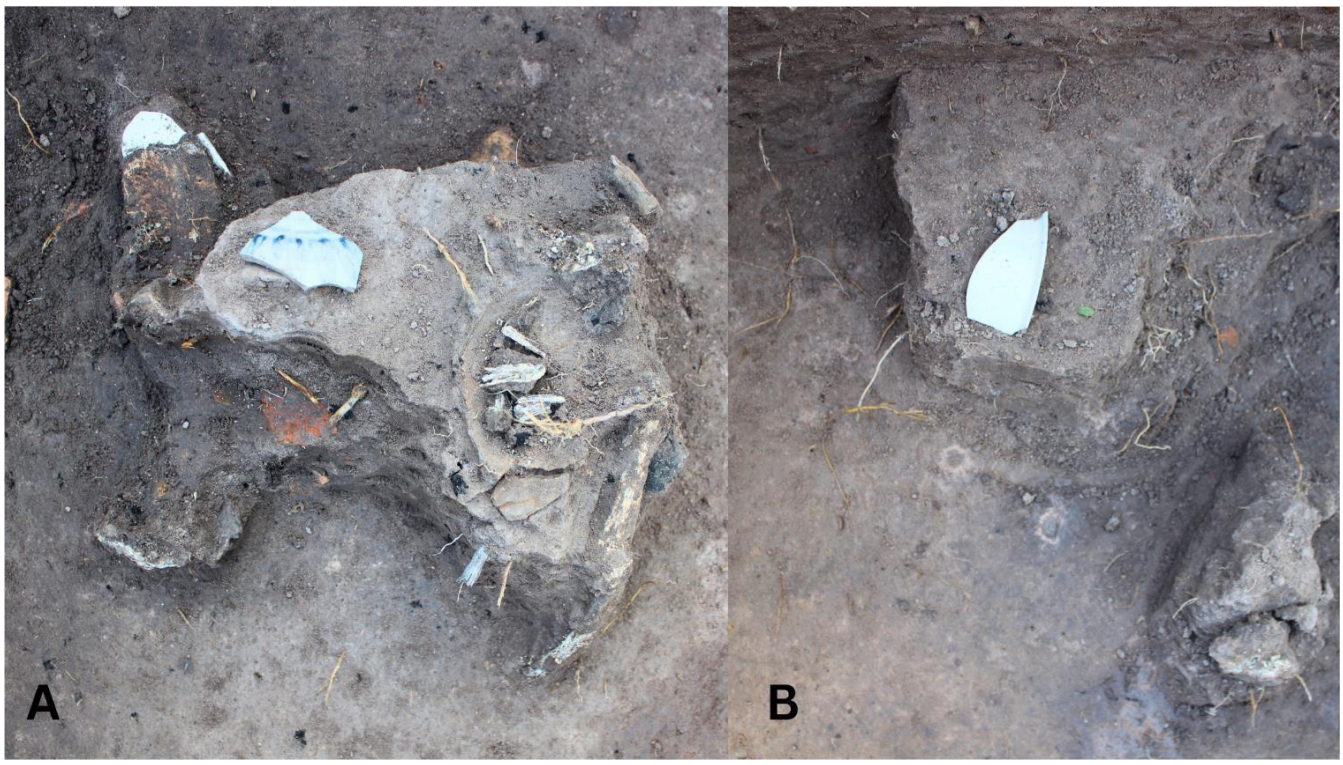
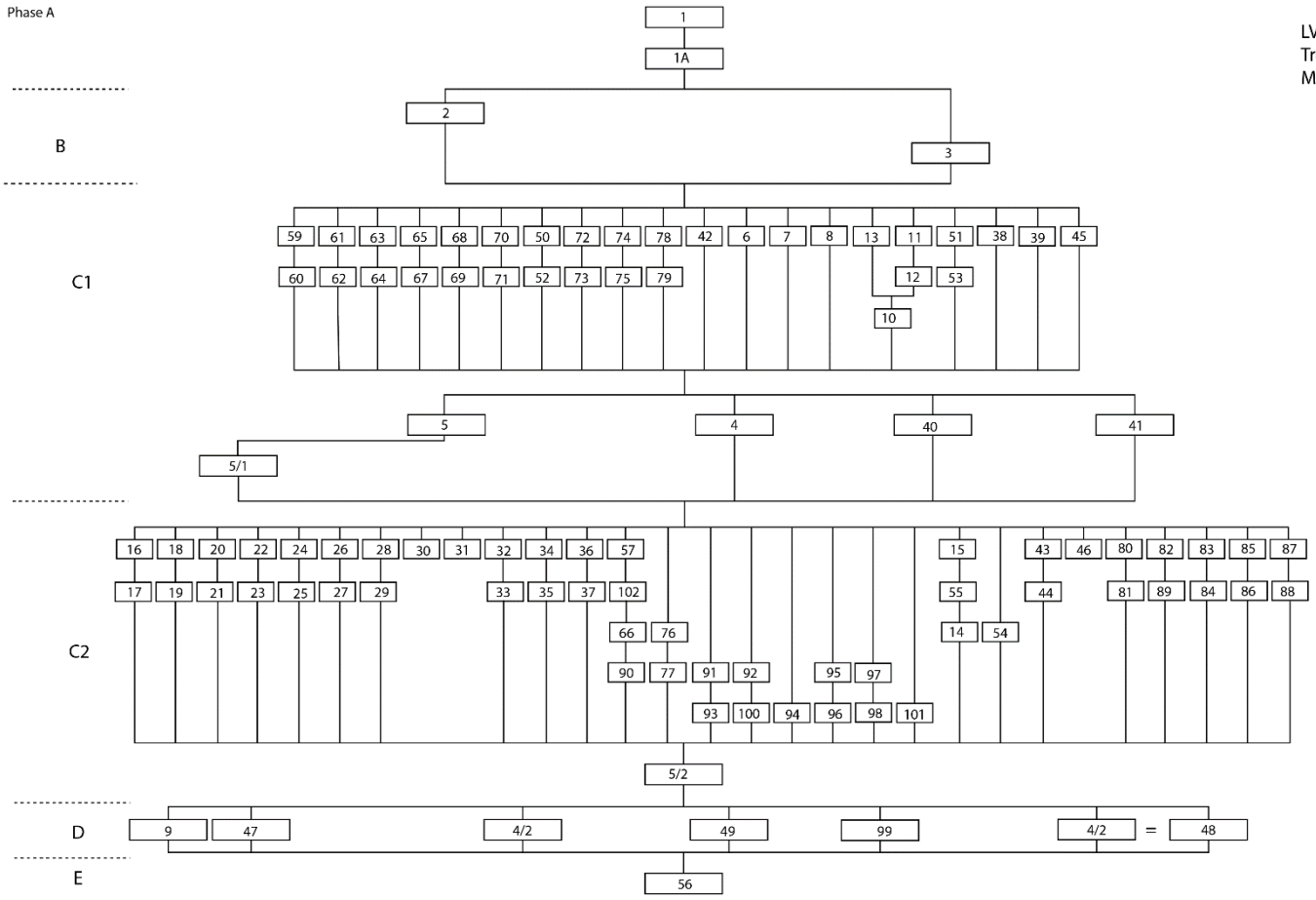


Figure 43: High-value Jingdezhen porcelain ceramic sherds in situ LVK1503 (A) base of bowl (03004/1.01.02) (B) rim of bowl (03003/1.01.01).

Rubbish Pit 2 (Trench LVK1828)

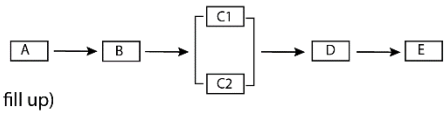
The second rubbish pit feature was excavated from Trench 28 of the 2018 excavations. This feature consists of a series of cut-and-fill events that make up a large overall general rubbish pit. The pit extends from contexts 47 to 66 with faunal specimens being excavated from 49,57 and 66 (Figure 44). AMS ^{14}C dating results determined context 57 was dated within a range of 1456CE and 1630CE (OZX167) (Figures 45, 46, 49 and 48).



LVK18
Trench 28
Matrix Harı

Phase A: It is compact new layer for the preparing brick factory.

Phase B: May be the soil that people stop using for a short period.



Phase C1: Middle period. Even they raised up the land up but still in middle period (2st fill up)

Phase C2: Middle period, same as C1 but itl is first raise up.

Phase D: First stage of middle period. Start occupation.

Phase E: Natural Layer

Note: 28.058 is not allocated (marked in context sheet)

Figure 44: Harris Matrix of LVK1828 (Suy Pov)

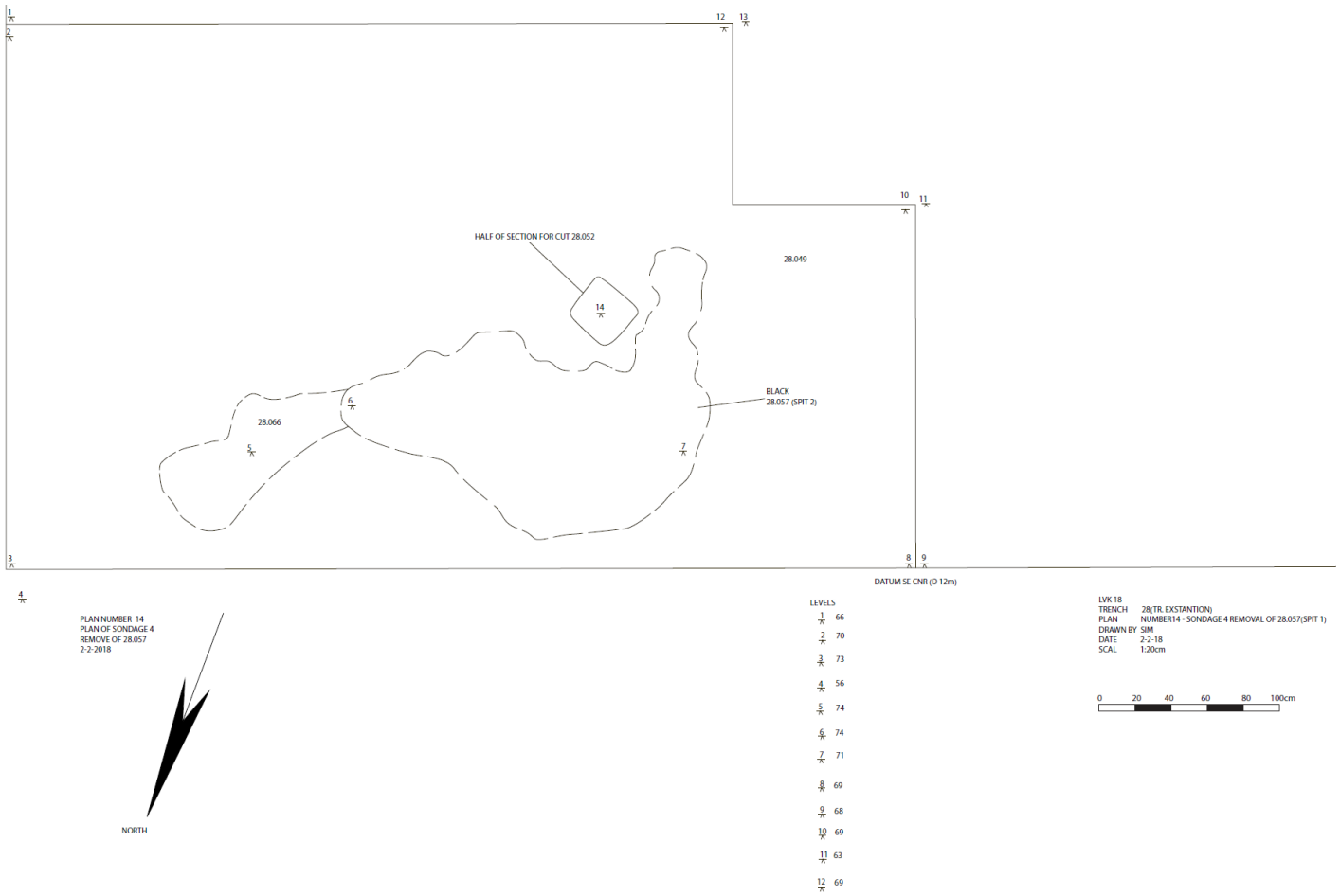


Figure 45: Plan of LVK1828 depicting rubbish pit feature (contexts 57 and 66).

Figure 46: LVK1828 rubbish pit feature (contexts 57 and 66) (S. Mackey).

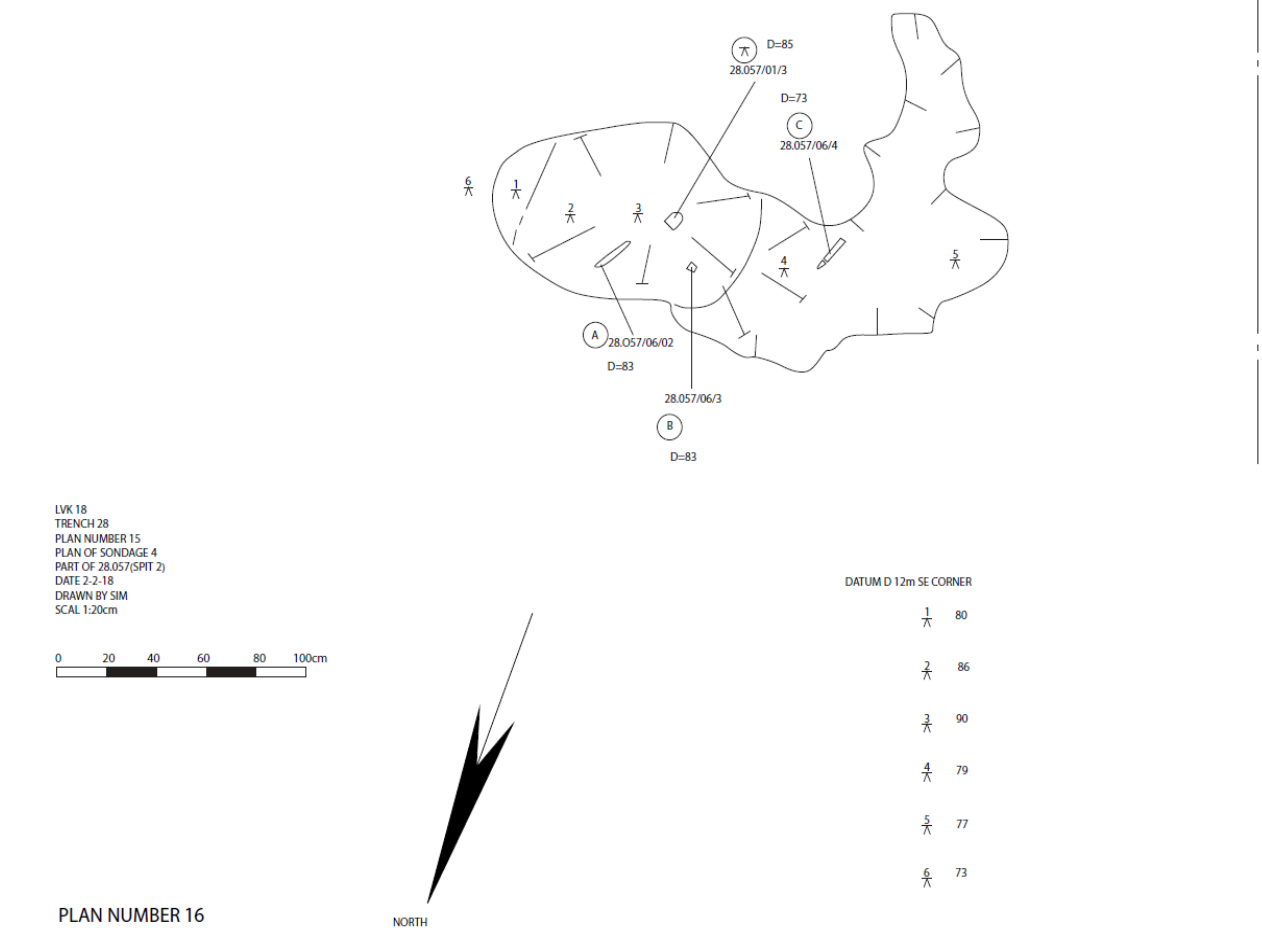


Figure 47: Plan of LVK1828 rubbish pit feature (context 57 spit 2).

Figure 48: LVK1828 pit feature (context 57 spit 2) (S. Mackey).

The faunal remains of the pit were represented by a total of 61 specimens, of which 27 were identifiable to some at a taxonomic or size level. The pit contained various artefacts, including bricks, charcoal, and faunal remains. Also excavated were more highly valued tradeware ceramics, including a partly intact Thai high-fired Kendi spout (Polkinghorne pers. Comm. 17 January 2024) (Figure 49).

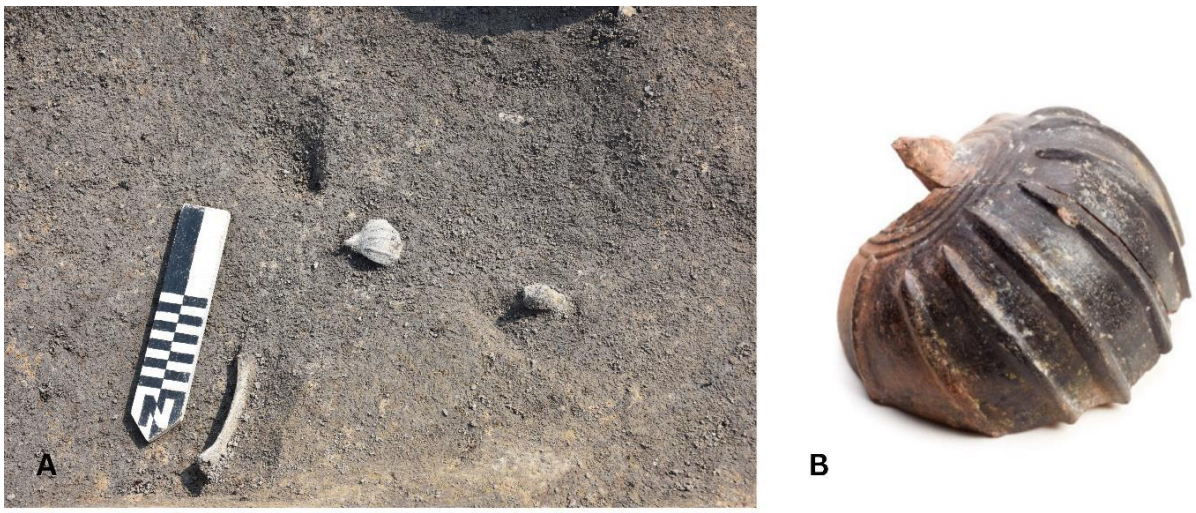


Figure 49: (A) Kendi spout in situ within pit (B) Kendi spout after processing (S. Mackey, Y. Sato).

Rubbish Pit 3 (Trench LVK1828)

The final rubbish pit feature, comprising contexts 92 and 94, was also excavated from trench 28 in the 2018 excavation season. Context 92 was described as a fill feature that could have also been a trample zone (Figure 50 and 51).

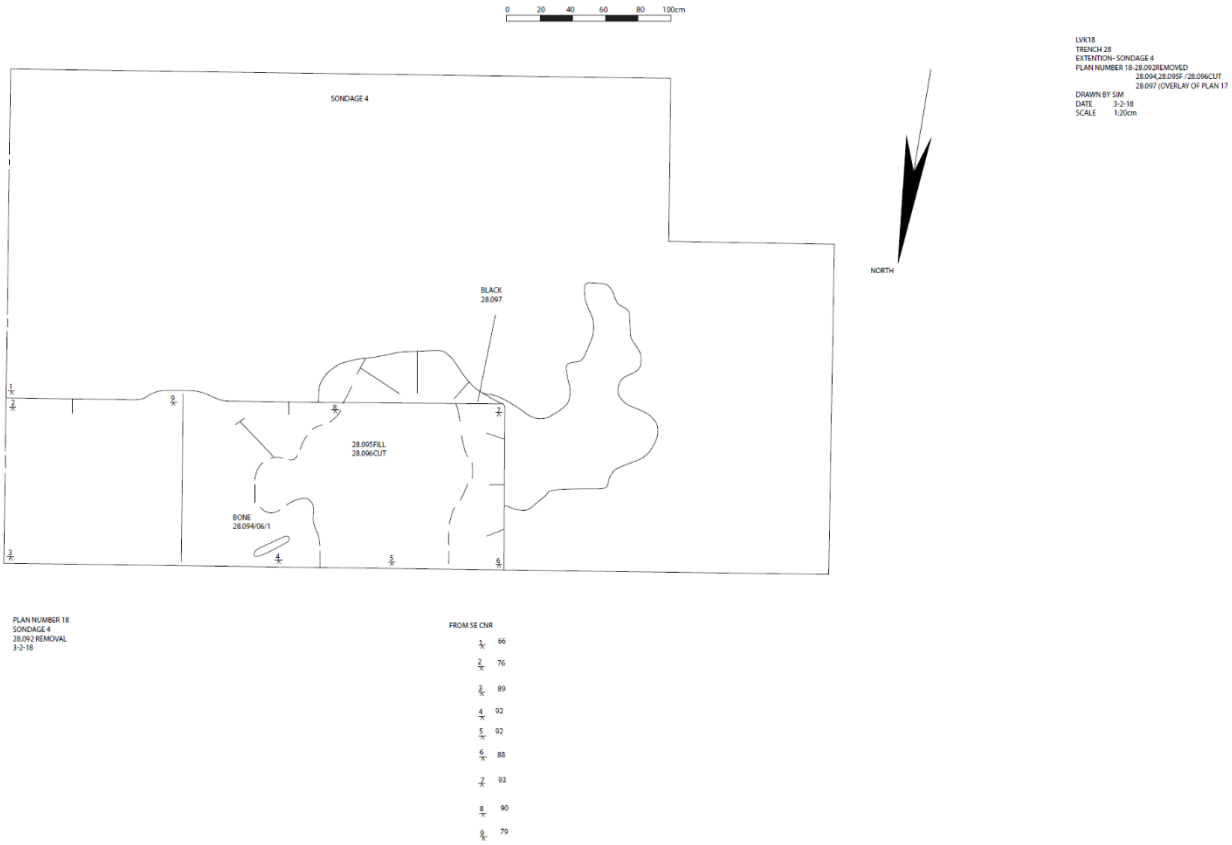


Figure 50: Plan of LVK1828 rubbish pit feature (contexts 92 and 94).

Figure 51: LVK182 rubbish pit feature after completed excavation. Artefact situated centrally is* Bos *metapodial fragment (#1953) (T. Sokha)

Both contexts were excavated directly under general pit 1 and likely represent a separate fill event within the larger pit 1. These contexts are described as separate from the first pit because of the difference in faunal specimens observed. Much like general pit 1, this pit contained artefacts such as trade ceramics, brick, and faunal remains; however, charcoal was not present. Through the presence of diagnostic tradeware, the pit was relatively dated to the late 16th to early 17th centuries.

This pit only contained a total of five faunal specimens; however, all the specimens were diagnostic. All these specimens were identified as an unknown species of cow (*Bos*) and consisted of two metapodials and one proximal phalange. One of the metapodials is only represented by a small distal fragment, however, the other metapodial is almost completely intact, with only one of the distal condyles broken off. This condyle fragment is present in the assemblage. The proximal phalange is a complete specimen in excellent condition (Figure 52).

Figure 52: LVK1828 (context 94)* Bos *metapodial fragment in situ (#1953) (T. Sokha).

Metallurgy Workshop (LVK1507)

The faunal specimens from Trench 7 were identified as tooth fragments of an unknown cattle species (Figures 53 and 54). While the specimens were excavated from a shallow depth (110mm), other artefacts, such as stone tools used for smithing, were uncovered within the same context. Further excavations of Trench 7 uncovered postholes and waste materials of copper metallurgy. These artefacts suggest that the site of Trench 7 represents a copper-base metallurgy workshop (Polkinghorne 2015:38).

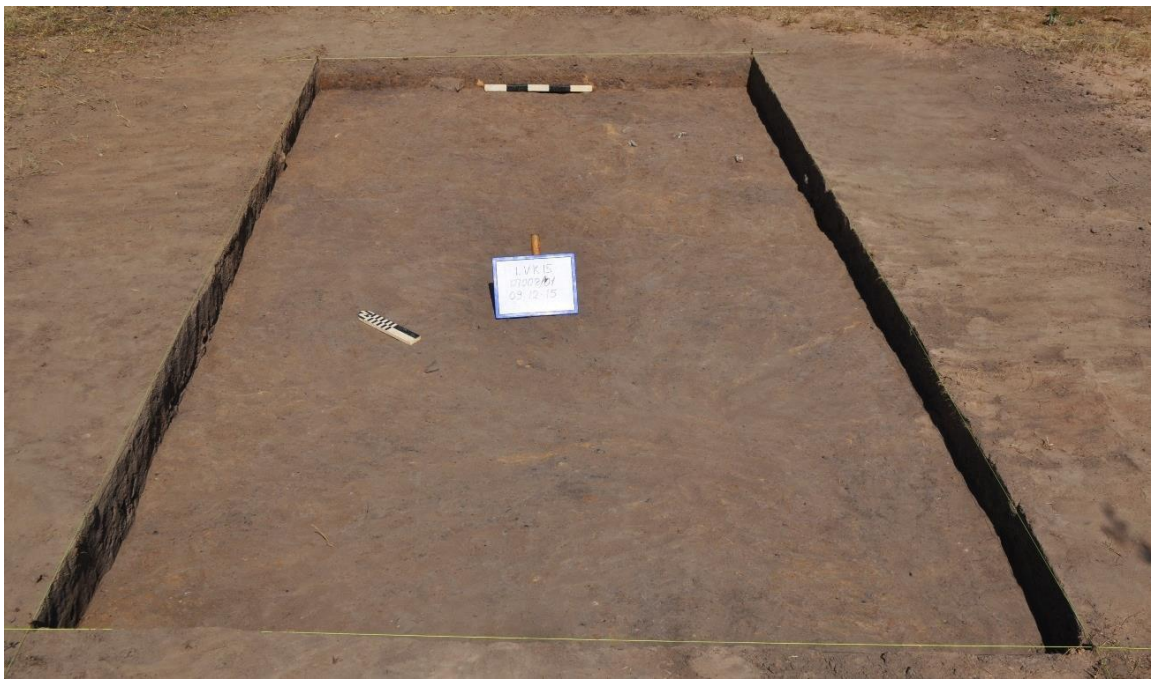


Figure 53: LVK1507 trench 7 excavation. In situ faunal specimens in the top right corner (Suy Pov).

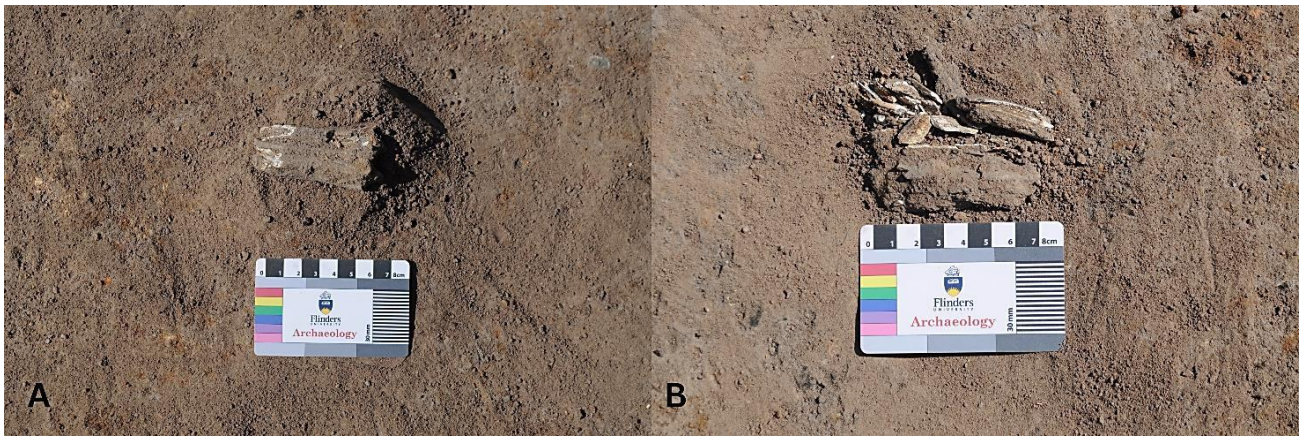


Figure 54: LVK1507 trench 7 faunal specimens in situ (A) specimen #45* Bos *molar (B) specimen #46* Bos *molar (Suy Pov).

Dating

While many stratified radiocarbon ages have been determined from excavations at Longvek, only three of these dates are related to zooarchaeological materials. During the 2015 excavations, two date ranges were obtained from a rubbish pit feature in trench 03. The ^{14}C dates, OZX165 1502 to 1650CE (95.4% confidence) and OXW839 1508 to 1658CE (95.5% confidence), which were obtained from different spits of the same context, indicate that this rubbish feature likely dates to the 16th century. These date ranges represent a total of 39 specimens, including rib fragments, long bone fragments, and unidentified fragments (Figures 55 and 56).

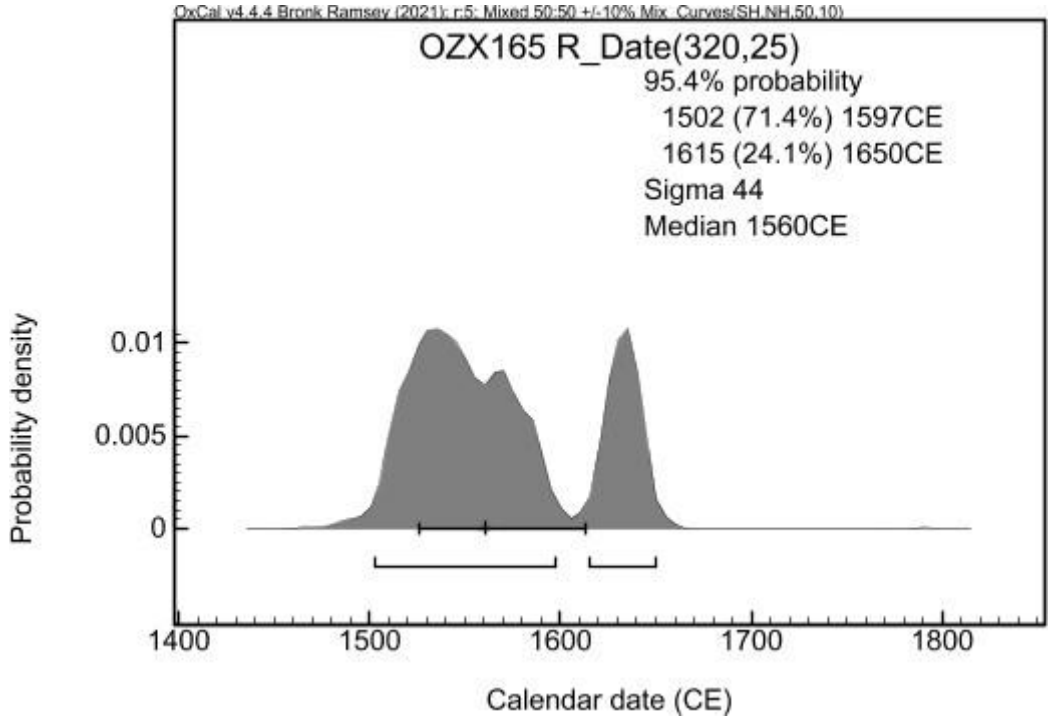


Figure 55: OZX165 ^{14}C result. Date range of 1502 - 1650CE (95.4% probability).

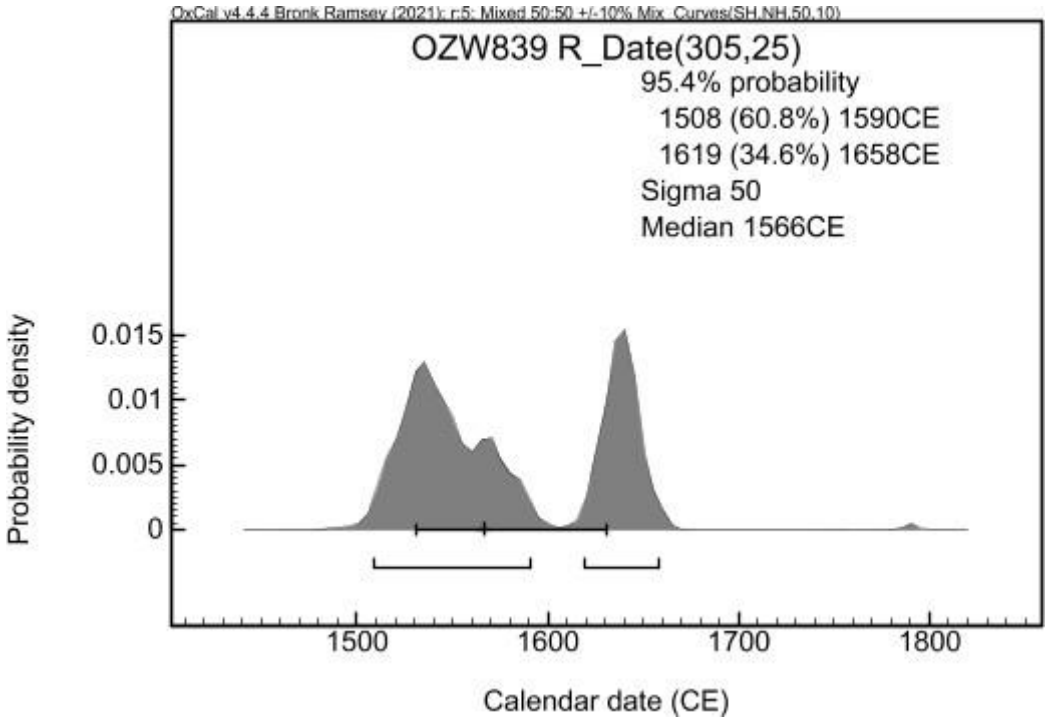


Figure 56: OZW839 ^{14}C result. Date range of 1506 – 1658CE (95.4% probability).

The third date was obtained from trench 28 from the 2018 excavations in a context which also contained large amounts of zooarchaeological materials. OZX167 determined this context to date between a calibrated range of 1456 to 1630CE (95.4% confidence) (Figure 57). A total of 45 specimens were excavated from the context associated with this date, including the metapodial of a serow, incisor of a cattle bovid, femur of an unknown cervid, and various unidentified bone fragments.

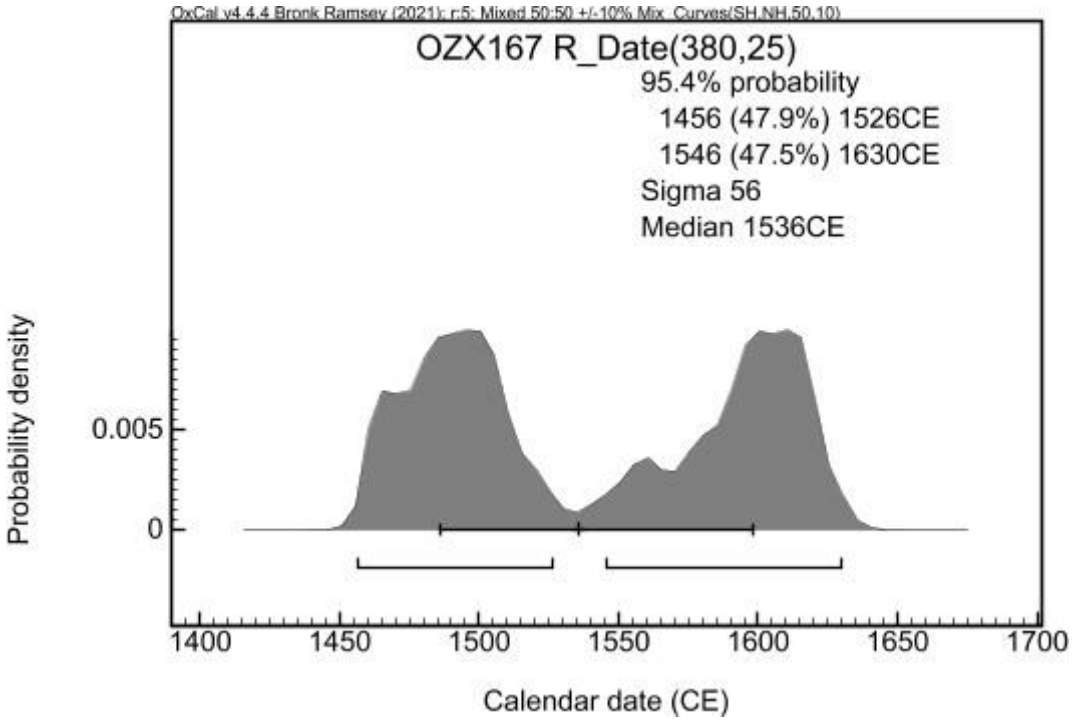


Figure 57: OZX167 ^{14}C result. Date range of 1456 – 1630 CE (95.4% probability).

While other specimens do not have an associated absolute date, their relative age can be determined by comparing their contextual position to that of ^{14}C dated contexts. Undated specimens can also be dated by their relation to other diagnostic artefacts, namely, porcelain tradeware. This information is elaborated on in the 'Overall Conclusions of Archaeological Investigations' section of this study.

Table 4 Summary of date ranges.

Date ID	Date Range	# of associated specimens
OZX165 (trench 03)	**1502 - 1650CE**	39
OZW839 (trench 03)	**1506 – 1658CE**	39 (the same specimens as OZX165)
OZX167 (trench 28)	**1456 – 1630 CE**	45

Contextual Overview

This contextual overview collates the results obtained in this study to highlight their relationship (Table 5).

Table 5: Overview of the data derived from this study. *Age ranges derived from C14 dating **numbers in (#) are the total number of specimens.

Context	NSP	NISP	% Butchered / Gnawed**	% Burned**	Taxon Represented	Elements Represented	Date
Trench 3 'rubbish pit'	39	25	B=10%(4) B & G= 3%(1)	0%	*Mammalia*	Rib Fragments, Bone Fragments	1502 to 1650CE, and 1508 to 1658CE*
Trench 7	2	2	B=0% G=0%	0%	*Bos or Bubulus*	Molar	Undetermined
Trench 21	3	2	B=33%(1) G=0%	66%(2)	*Sus Scrofa, Unknown Artiodactyla*	Canine, Molar, Bone Fragments	Late 17th Century
Trench 25	3	3	B=0% G=0%	0%	*Sus Scrofa*	Molar, Canine	16th to 17th centuries
Trench 28 Context 4 & 5	67	4	B=0% G=0%	94%(63)	*Mammalia, Bos, Bos or Bubulus*	Metapodial, Molar, Incisor, Bone Fragments	17th century
Trench 28 Context 10 & 13	3	3	B=0% G=0%	0%	*Testudines*	Turtle Shell, Coracoid	Modern
Trench 28	3	0	B=0% G=0%	100%(1)		Bone Fragments	Modern

Context 38							
Trench 28 Context 41 & 42	6	1	B=0% G=0%	83%(5)	*Mammalia, Artiodactyla*	Bone Fragments	Late 16th century or later
Trench 28 Context 47 & 48	15	0	B=0% G=0%	100%(15)	*Mammalia*	Bone Fragments	Early 16th Century
Trench 28 Context 49	5	1	B=0% G=0%	100%(5)	*Axis Pornicus*	Metapodial, Bone Fragments	Early 16th Century
Trench 28 Context 57, 66	56	26	B=0% G=0%	87%(49)	*Bos, Bos or Bubulus, Cervidae, Artiodactyla, Osteichthyes, Sumatraensis*	Metapodial, Incisor, Fish Vertebra, Fish Bone Fragment, Bone Fragments, Vertebra, Radius, Rib	1456 to 1630CE*
Trench 28 Context 92 & 94	4	4	B=25%(1) G=25%(1)	25%(1)	*Bos*	Metapodial, Proximal Phalange	Late 16th Century to Early 17th Century
Trench 28 Surface Collection	1	0	B=0% G=0%	100%(1)		Bone Fragment	

Trench 29	5	0	B=% G=0%	0%		Bone Fragments	16th or 17th Century
Trench 32 Contexts 04 & 08	23	0	B=0% G=0%	35%(8)		Bone Fragments	16th or 17th Century
Trench 32 Contexts 12, 14, & 17	17	0	B=0% G=0%	76%(13)		Bone Fragments	16th or 17th Century
Trench 32 Contexts 22 & 23	4	0	B=0% G=0%	50%(2)		Bone Fragments	16th or 17th Century

CHAPTER 7 - DISCUSSION

Fauna in Context

This study's results cover an extensive range both spatially and chronologically at a time when Cambodia was transforming economically and culturally. The faunal specimens analysed were excavated from multiple trenches at Longvek including four from the Royal Palace, providing an invaluable dataset to infer what animals were utilised by the Early Modern occupants and for what purposes.

Overall, this assemblage can be understood as four distinct contexts. Three of these contexts can be described as rubbish pits, the first of which is likely directly related to cooking activities within the Palace itself, whereas the other two pits most likely represent the processing of animal carcasses, including cattle, in the form of butchery. A small number of bovid remains were also excavated from the Metallurgy workshop site, however due to the small number of specimens recovered and the high chance of disturbance, the origin of these remains can only be speculated.

The presence of butchered cattle remains in this assemblage seems to imply that a shift had a occurred between sometime between the Angkorian Period and the Early Modern period which saw cattle no longer being perceived as sanctified animals that no harm should be done to, to an animal that was now butchered even within the grounds of a Royal Palace.

The results of this study will now be discussed further.

Rubbish Pits

Across the site, many specimens were excavated from archaeological features described as rubbish pits. These rubbish pits are defined by their rich and concentrated but highly fragmented assemblage of varied artefacts. The identified features also contain a high presence of charcoal.

Rubbish Pit 1 - Food Preparation Refuse (Trench LVK1503)

The specimens represented in this feature consisted of fragments of ribs likely belonging to large mammals such as cattle or deer and other bone fragments that could not be identified as an element or species. Four of these rib fragments displayed evidence of butchery consistent with the disarticulation of a carcass.

This rubbish pit is likely associated with a food preparation area of the Royal Palace and thus used for the disposal of faunal and food remains, broken or disused ceramic plates and pots, and other materials associated with cooking.

Interestingly, none of the faunal remains within the rubbish pit display evidence of burning despite the heavy presence of charcoal. This perhaps suggests that the pit's contents were not burned as part of the disposal process, but rather, the charcoal waste from stoves and other fires was disposed of in this pit. The lack of burning on the faunal remains suggests that meat was not cooked over a fire but rather by a different method, such as boiling. Boiling would align with the depictions of cooking seen at the Bayon, where a whole pig can be seen being lowered into a large ceramic pot, assumingly to be boiled (Figure 11) (Coe and Evans 2018:215-216). While the remains at Longvek suggest carcasses were disarticulated before cooking, they were likely boiled similarly. For this to be determined, further analysis will be required to look for evidence of boiling, such as pot polish or changes in the bone's chemistry and ultrastructure (Glifford-Gonzalez 2018:326-327).

Rubbish Pit 2 - General Rubbish Pit (Trench LVK1828)

Although almost half of the specimens from this pit remain unidentified bone fragments, the identified specimens represented a range of elements and taxon. The specimens present included metapodial fragments of a deer and serow, fish vertebra and other fish elements, rib fragments, and the incisor of either a *Bos* species or water buffalo. It can be observed that all the taxon identified except for the *Bos* or *Bubulus* incisor, represent wild species. An additional five specimens were excavated from the context below the rubbish pit, which included four unidentified bone fragments and the metapodial fragment of a hog deer. Additionally, elements such as metapodials and dentition likely represent waste from early in the butchery process with the removal of elements less rich in meat, however none of the elements show evidence of butchery marks which may be because or burning or weathering.

Unlike the previous rubbish pit of Trench 3, 88% of the specimens in Trench 28 showed evidence of burning. Most of these burned specimens were at various stages of calcification, while a small amount only showed signs of light charring. This variation in the severity of burning could indicate an uneven distribution of heat during the burning process, which is likely to occur if waste was being burned in a large pit such as this. Another explanation for this variation in the severity of burning is that specimens have been burned in different settings, such as cooking or being used as fuel, prior to being moved to this rubbish pit. While cooking is less likely to cause burning on elements such as metapodials, it cannot be ruled out for the many burned unidentified bone fragments.

With these details in mind, this rubbish pit was likely used as a more general pit for waste than that of the kitchen pit, as the artefacts present are quite varied, and the pit itself is much larger. The presence of mostly wild animal specimens suggests that hunted animals were processed within proximity of the palace itself. While the pit itself cannot be associated with cooking, these wild animals were likely hunted and butchered for the purpose of consumption; the possibility that these

specimens were processed for other reasons, such as ritualistic practices, also cannot be ruled out.

Rubbish Pit 3 - General Rubbish Pit (Trench LVK1828)

The faunal specimens from rubbish pit 3, apart from being highly diagnostic, also display well-preserved evidence of butchery. Most notable are the two distinct parallel slice marks across the anterior surface of the proximal phalange. These marks are a good indicator that this animal was skinned in the early stages of the butchery process. As only distal limb bones are present, the rest of the carcass was likely processed further at a different location, such as a food preparation area described earlier. While many of the specimens display a small amount of light charring it is unclear if this is due to the burning of the pit itself, or another cause as no charcoal was excavated from the feature. The large metapodial specimen also displays a large carnivore tooth pit. As the pit is from the location of the Royal Palace and likely within a densely population area, this tooth pit was likely not caused by a wild animal but rather a dog.

Butchery Area (Rubbish Pits 2 and 3 LVK1828)

The faunal specimens excavated from rubbish pits 2 and 3 likely represent the early waste discard of butchery activities. This is because most of the elements identified are from the distal ends of the appendicular skeleton which are commonly discarded early into the butchery process as they lack meat. Additionally, the *Bos* specimens from general pit 2 displayed butchery marks, including evidence of skinning on the proximal phalange element. This evidence of skinning could suggest that cows were being butchered to produce leather, however, it could also represent a stage of the standard butchery process.

The presence of wild animal butchery activities taking place at the Royal Palace itself may suggest these wild animals were being hunted specifically for the occupants of the palace. For these animals to be butchered at the Royal Palace on the central occupation mound, they would have had to be transported a considerable distance from where they were killed. It is possible that the animals were first divided into more manageable sections prior to their delivery to the Royal Palace. However, there are no preserved specimens displaying chopping marks to suggest this. It is also possible that the animal whole animal carcasses were being transported to the Palace whole, but this would have required far more effort.

It is unclear as to why these animals were being butchered at the Royal Palace itself. As wild fauna seemed to be exempt from the abstention of killing placed as seen in the moral precepts of Theravadin Buddhism, these animals could have been hunted by the occupants of the Royal Palace themselves (Harris 2007:79). While it is unlikely that the occupants of the Royal Palace would have truly needed to hunt for their own food, the activity of hunting could instead relate to status, ritual, or entertainment.

Metallurgy Workshop (LVK1507)

This assemblage was not excavated from the Longvek Royal Palace but rather from an area recognized as a small metallurgy workshop. Nevertheless, it is included in this discussion due to the presence of cattle specimens.

The presence of faunal specimens in what was likely a metallurgy workshop is unusual and could have occurred for various reasons. The first and most likely explanation is that these specimens have been secondarily deposited and have no relation to the workshop. This is due to the context's shallow depth, increasing the chances of disturbing artefacts.

Additionally, only the two cattle tooth specimens were excavated from the workshop context, neither of which displayed evidence of butchery or burning.

While it remains unlikely that these specimens have any relation to metallurgy activities, their presence could suggest the use of bone in the metallurgy process. These specimens could also simply be waste from a meal; however, no rubbish pit feature was identified during excavation. Finally, the specimens may suggest that the workshop was within proximity to an area used for butchery. While all these reasons for the presence of faunal remains are possible, it remains difficult to determine with certainty the origins if these specimens due to limited evidence.

Nevertheless, the presence of these cattle specimens at this site shows that the utilization of cows after their death was not limited to the Royal Palace but commonplace within Longvek.

Whose Rubbish?

As this overall assemblage is associated with the Royal Palace of Longvek, it can be easy to assume that it all relates directly to the royalty living at the palace; however, it is important to consider that the palace would not have been occupied solely by the elite. It is known from historical records that prior to French colonisation, the Royal Palaces of both Oudong and Phnom Penh hosted serval classes of Early Modern society. Apart from the royal family themselves, these Royal Palaces housed and employed a wide range of people. The residing king at any given time is said to have employed two hundred to three hundred women as dancers, concubines, musicians, and singers. The royal family was also waited on by several young pages and indebted slaves employed workers who likely carried out most of the domestic duties (Coe and Evans 2018:265-266). During this period, the Royal Palaces were frequented by Mandarin bureaucrats who formed a class of their own (Coe and Evans 2018:268-269). While this description of Royal Palace occupancy comes from the end of the Modern period, it is likely that the Early Modern Longvek Royal Palace would have held a similar dynamic.

As this is the first exploration of zooarchaeological material from the Middle period, concerning elite occupation or otherwise, there are no pre-established characteristics that can be used to identify any specific class in the zooarchaeological record. The assemblage is indeed associated with the Royal Palace both spatially and through its relation to high-quality ceramic tradeware; however, due to the nature of rubbish pit assemblages and the complex dynamics of Early Modern Royal Palaces, it is difficult to attribute the faunal specimens to any one class or group of people.

Exploited Fauna of the Middle Period

Although this assemblage remains challenging to identify taxonomically, it has shown that a range of species, both domestic and wild, were exploited by those living in and around the Longvek Royal Palace during its Middle Period occupation. Most species identified were either large or medium mammals such as cows, pigs, and deer. Of the cattle specimens that displayed diagnostic features relating to age, all were estimated to be adult at their time of death. This suggests that these specimens represent females, as males in a domestic setting are often slaughtered before their first year (Crabtree 1990:163-164). However, the lack of juvenile cattle specimens may also suggest cattle was not being bred primarily for consumption but rather other uses such milk and butter production or beast of burden as they were during the Angkorian period. While the species of cattle could not be determined in the zooarchaeological analysis, it is likely that the specimens represent a breed of *Bos Indicus*, such as the Kor Khmer, as they were one of the more common species of cattle in the Angkorian period (Hendrickson pers. Comm. March 22 2024).

Although large and medium mammals dominate the recovered faunal material, it is unlikely that these animals were the primary source of meat for those living at the Royal Palace. Longvek is situated along the bank of the Tonle Sap River, which supplied the city with abundant riverine resources, notably freshwater fauna such as fish and amphibians. These resources were most certainly exploited by the occupants of Longvek, including the elites of the Royal Palace. The significant absence of fish and other small vertebrate remains is likely due to the excavation method and the fragile nature of smaller specimens.

Changing Perceptions and Utilization of the Cattle

The most surprising aspect of this assemblage is the presence of cattle remains. As previously discussed, during the Angkorian period, cattle were viewed as sacred animals and were heavily intertwined in Hindu ritual practice through their prevalent imagery and use of products such as milk and butter but not butchered. Further, despite their abundance in the Angkorian Empire, there is no evidence to suggest cattle were consumed for food or used for any other purposes except as beasts of burden. This is also suggested by Daguan's accounts of Angkor, as he states that cows are neither consumed for their meat nor even skinned for leather and are left to decay where they die (trans. Harris 2007:73).

If cattle were truly neither eaten nor even butchered during the Angkorian Period, their presence in this Middle Period assemblage with evidence of butchery demonstrates a significant shift in how these animals were perceived by those living at the time. As the sanctity of the cows during the Pre-Angkor and Angkorian periods is associated with the adoption of Hindu beliefs, it is likely that the catalyst for this change in the status of cattle was the rise of Theravada Buddhism at the transition of the Angkorian and Early Modern periods.

Although the veneration of cattle was no longer required within this Theravadin setting, it is unusual that the butchery of cows seems to already be commonplace in the Early Modern period, as this assemblage suggests. The sanctity of cows would have been a long-ingrained concept in the previous Angkorian period and not likely to be quickly abandoned due to a shift in the dominant religion alone. It could be suggested that the move to Longvek and focus trade represented another pressure for changing perceptions of cows as they could have represented a valuable trade resource in the form of beef and leather.

While cattle would have been a valuable economic resource, they may have still been viewed differently from other animals. As mentioned previously, the faunal specimens associated with cattle suggest all individuals were adults at their time of death, suggesting these animals were not primarily bred for their meat. As the butchery of cattle was likely only recently adopted by Cambodian society, it is possible that cattle were not yet being specifically bred for meat production but rather lived out their lives much as they did in the Angkorian period, but with their added utilisation after death. This would mean that cattle would continue to be used primarily as beasts of burden but then killed at an older age to either be eaten or sold as meat and leather.

The cattle represented in the zooarchaeological assemblage from the Royal Palace have provided critical but limited insight into the status of cattle in Early Modern Cambodia. As this is the first investigation into the topic, much remains unclear. As research continues into Early Modern

Cambodia and specifically Longvek, it is likely that more data will be produced to shed light on the status of this once sanctified animal.

Limitations and Bias

This study was directly affected by limitations and biases, which unavoidably influenced its results. The first limitation is the lack of accessibility to adequate comparative materials to aid in the identification of specimens.

This limitation meant that most specimens, despite showing diagnostic features, could only be identified broadly, except for species that happened to have detailed data recorded in other Southeast Asian zooarchaeological studies. Despite this lack of comparative material, identifications could still be made using various comparative image resources and the comparative collection located in the Flinders University Paleontology Department; however, most of these resources are based heavily on American and European fauna, lacking most species endemic to the Southeast Asian region. This reliance on European and American faunal representations can introduce the bias of an overrepresentation of species of globally widespread species, such as most domesticates and endemic species remaining unidentified. The predominant use of comparative images and drawings rather than physical specimens also hinders the identification process, as images and drawings can often not accurately represent a specimen's diagnostic features. Ideally, the specimens should be identified in the same room as the comparative collection.

The final biases stem from the assemblage and the methods used in extracting artefacts. This assemblage is significantly fragmented due to a variety of factors such as anthropogenic activates, and the general taphonomic forces present such as weathering. The fragmentation due to these factors inflates the number of individual specimens in the assemblage. While this issue is somewhat addressed by the calculation of MNI regarding taxonomic abundance, there is no way of knowing if other features expressed in unidentified bone fragments, such as the number of specimens that display evidence of burning, are being overrepresented by fragmentation.

Bias in the assemblage is also influenced by the nature of bone itself. Bone morphology in terms of density and hardness can vary greatly depending on its biological function. This attribute of bone causes some specimens to preserve better than others and thus be overrepresented in an assemblage. This can be seen in this study with the abundance of intact tooth specimens present. While it is possible that there is an anthropogenic reason as to why these teeth are present, it is more likely that hard enamel of the teeth was more resistive to the natural taphonomic process and thus only represent a small portion of the original assemblage which has since decayed.

The size of specimens also leads to bias. Small specimens, such as the bones of fish, birds, and

small reptiles, often are not preserved well due to their small size. This issue is exacerbated during archaeological excavations as the process can often destroy these delicate pieces. Additionally, small specimens are often not collected as they fall through sieves and remain on site. This issue tends to leave many zooarchaeological assemblages overrepresenting large species and skeletal elements.

Cambodian cattle in the zooarchaeological context

While Cambodian bovines vary significantly in appearance and are easily identifiable in their living form, it has proven difficult to distinguish species from skeletal morphology alone. This issue has led to many Cambodian and Southeast Asian publications leaving the identification of bovids at the family level. For most research, this level of identification may be adequate for simply determining that cattle are present in an assemblage. Still, valuable information could be derived if bovines were identified down to the species level. Most bovine species prefer specific environmental conditions, and thus, their presence or absence in an assemblage can be used as a complementary data set for paleoenvironmental reconstruction (Ingalls 2010:93). In relation to Longvek, paleoenvironmental reconstruction using cattle is, unfortunately, less viable due to its domestic setting as environmental conditions were likely artificially tailored to accommodate cattle (Hendrickson pers. Comm. March 2024).

Similarly, if a site is in a domestic context, such as this thesis' assemblage, the presence or absence of domestic cattle species can be used to infer a plethora of information about trade, economics, ritual, and domestic activities (Ingalls 2010:1).

As stated, the limiting factor for bovid species identification is skeletal morphological similarity between Southeast Asian species. In the zooarchaeological context, further difficulty is added in distinguishing species, as remains are often poorly preserved (Hendrickson et al. 2023:474). Another factor to consider is limited access to comparative materials. The comparative collections that do exist also do not include reference materials for some species, leaving them with no comparisons (Ingalls 2010:3). Many species are also able to crossbreed, which often cannot be distinguished from skeletal remains (Ingalls 2010:95).

Work has been done to find ways to make bovid identification more accessible in Southeast Asia, notably the work of Teresa Ingalls in her 2010 master's thesis. This work aimed to develop a method for determining species through the analysis of morphological differences in dentition. While the research was able to identify distinct identifiers in all four studied species (water buffalo, guar, zebu, and banteng), crossbreeding between species continued to be a prevalent issue (Ingalls 2010:95). In later assemblages such as the one from Longvek, crossbreeding is likely to present as

domestic species are often purposefully cross-bred (Ingalls 2010:95). Currently, there is no reliable way to identify cross-bred bovines from their dental morphology; however, other methods such as mitochondrial DNA analysis may be more viable (Ingalls 2010:97-98). With this in mind, to accurately differentiate species and identify cross-breeding in bovids from the Early Modern period moving forward, DNA studies are needed.

CHAPTER 8 - CONCLUSIONS

Archaeological investigations into the Early Modern capital of Longvek began in 2015 and, since then, have confirmed that the city was once a bustling hub of international trade.

Archaeological investigation also confirmed the existence of the Longvek Royal Palace on the central occupation mound in the city. Previous archaeological inquiry at Longvek has focused on the trade aspects of the city, however, the discovery of faunal remains at the site of the Royal Palace provided an opportunity for broader research.

Despite the fragmentary nature of this assemblage, it was determined that the occupants utilised a wide range of fauna from both domestic and wild sources. The species identified include pig, cow, serow, hog deer, and other large and medium mammals, which could not be identified to a taxonomic level. While the assemblage predominantly represented large and medium mammals, the occupants of Longvek and the Royal Palace would have certainly also utilised the riverine resources at their disposal, consuming other fauna such as freshwater fish, bivalves, and amphibians.

In comparing the identified faunal specimens to their in situ locations and associated artefacts, separate faunal contexts were identified. Most notably, several rubbish pit features could be determined. The first of these was excavated from the location adjacent to the western edge of the Royal Palace. Various ceramic artefacts were also identified along with the faunal specimens, some of which displayed evidence of burning. Additionally, three of the faunal specimens displayed evidence of butchery marks. These lines of evidence were used to conclude that this rubbish pit was directly associated with food preparation at the Royal Palace. Unfortunately, due to the significant fragmentations of the faunal specimens and the undiagnostic nature of rib elements, the species represented in this assemblage could not be determined; however, due to the general size of some of the rib fragments, it is likely they represent large or medium mammals such as cow or pig.

Two other distinct rubbish pit features were also identified. Both features are also associated spatially with the Royal Palace. While both pits identified potentially derive from the same large rubbish pit feature, they have been separated into two distinct features due to the difference in the faunal specimens seen in both. General pit 1 represents predominantly wild species. While no butcher marks could be determined from these specimens, the skeletal elements present are indicative of butchery waste, suggesting carcasses were being butchered on the site of the Royal Palace. This butchery of wild animals at the palace itself may relate to hunting by the occupants of the Royal Palace for ritual or entertainment purposes.

The faunal specimens of general pit 2 solely represented an unknown species of Bos, likely *Bos*

indicus, due to the domestic setting. These specimens showed clear evidence of butchery, including skinning and disarticulation. The presence of butchered cow specimens suggests that the supposed ban on killing and even butchering cattle seen in the Angkorian period was no longer followed in the Early Modern period. The likely cause of this change in the perception and treatment of cattle of the shift to Theravadin Buddhism as the dominant religion of the period. It is also likely that cattle would have represented a valuable resource in the booming trade economy of the Early Modern period and Longvek.

The presence of cow remains at an additional site, described as a metallurgy workshop, could demonstrate that the recent shift to cow butchery was not confined to the Royal Palace and was likely commonplace within the city of Longvek. However, more evidence is required to determine if this is the case.

Although the Royal Palace is heavily associated with the elite occupation of Longvek, it is difficult to know if this faunal assemblage relates to these elites also. Historical records from the later capital cities of Oudong and Phnom Penh show that it was not only the elite royal family that occupied their Royal Palaces but also pages, dancers, concubines, indebted slaves, and Mandarin bureaucrats (Coe and Evans 2018:265-269). As there are no indicators that allow this assemblage to be associated with any of these groups, the assemblage could represent any of them.

Future Research

This research represents the first zooarchaeological inquiry into any Early Modern period site in Cambodia. Thus, more research is still to be done. As more archaeological excavations at Early Modern sites commence, more faunal assemblages will undoubtedly be uncovered. Even at the time of writing this, more faunal remains have been discovered from Early Modern associated sites such as Srei Santhor. As more of these assemblages begin to be studied, comparisons between them will undoubtedly be made and patterns and characteristics identified. A significant data gap in this assemblage was the lack of small vertebrate remains from fauna such as fish and amphibians. This misrepresentation of small fauna is likely due to the methods used in the initial excavation of the site. Soil samples have been collected from these contexts but have not been screened for faunal remains. For these small fauna to be accurately represented, different methods should be utilised in excavations that take into account these small specimens. As fish and other small riverine resources likely made up a large part of the Early Modern diet, their inclusion in zooarchaeological studies in the future is critical.

Regarding the perception of cows during the Early Modern period, this research confirms they were being butchered. While this alone shows a significant shift from the Angkorian period, there is still much left unanswered. It will be beneficial moving forward if more cow specimens can be identified and studied to determine if cow butchery was truly commonplace in the Early Modern period or

limited to certain groups, such as the occupants of the Royal Palace. Additionally, the role of cattle in relation to the economy of Longvek and other Early Modern sites can be explored further.

Finally, one of the main limiting factors of this research was the highly fragmented nature of the assemblage itself, which left most specimens unidentifiable. One solution implemented in other zooarchaeological studies with similar issues is zooarchaeology by mass spectrometry (ZooMS). This method can accurately identify the species of a bone specimen by analysing the preserved protein within the bone (Buckley 2017:227-228). The main advantage of this method is that it does not rely on the morphological differences of specimens for its identification and thus can be used on even fragmented specimens. This method could also be used to differentiate between different species of cattle which is difficult when only analysing morphology. Additionally, the proteins used in this analysis preserve well within bone and can last thousands of years (Buckley 2017:227-230). In the context of zooarchaeology in Cambodia, where faunal remains are rarely preserved due to the climatic conditions. This, unfortunately, can also lead to the degradation of proteins used in ZooMS. However, these methods have been used successfully on materials from other tropical regions, such as Sri Lanka and Papua New Guinea (Wang et al. 2021:4-10). As these methods are not reliant on the diagnostic morphology of bone, their implementation is likely the best way forward to ensure robust data can be extracted from these limited specimens.

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Appendices

Appendix 1 – Faunal Catalogue

Site/Year	Trench	US	Carbon Date	Old no.	Cat. no.	NISP	NSP	MNE	Width (mm)	Length (mm)	Weight (g)	Material	Age Estimate	Size Class	Class	Order	Family	Genus	Species	Butchery / Gnaw Marks	Burn	Diagnostic ?	Identification	Observations	Photo No.
LV K15	7	07.002/1		07.002/1.04.1	45	1	1	1	30	74	33.8	tooth	adult	Large	Mammalia	Artiodactyla	Bovidae	Bos or Babulus	/	N	N	Y	Molar	Bos Molar	DSC_0107-0117
LV K15	7	07.002/1		07.002/1.04.1	46	1	1	1	25	70	24.2	tooth	adult	Large	Mammalia	Artiodactyla	Bovidae	Bos or Babulus	/	N	N	Y	Molar	Bos Molar - Fragmented	DSC_0118-0126
LV K15	3	03.004/1	1566	03004/1.06.02	2291	11	16	1	/	/	25.7	bone	/	Medium	Mammalia	/	/	/	/	Butchery	N	Y	Rib	Rib bone fragments	DSC_0083-106
LV K15	3	03.004/1	1566	03004/1.06.02	2291/1	0	3		11	17	<0.1	bone	/	/	/	/	/	/	/	N	N	N	Bone fragment	Bone Fragments	DSC_0127-0140
LV K15	3	03.004/2	1566	03004/2.06.1	2292	0	6		22	31	9.2	bone	/	/	/	/	/	/	/	Butchery	N	Y	Rib Bone	Rib bone fragments, slicing and cut butchery present maybe rodent gnawing	DSC_0151-0157
LV K15	3	03.004/3	1566	03004/3.06.01	2293	4	4	1	14	94	13.6	bone	Juvinile	/	Mammalia	Artiodactyla	/	/	/	N	N	Y	Tibia	Distal Tibia end fragment,	DSC_0141-0150

Site/Year	Trench	US	Carbon Date	Old no.	Cat. no.	NISP	NSP	MNE	Width (mm)	Length (mm)	Weight (g)	Material	Age Estimate	Size Class	Class	Order	Family	Genus	Species	Butchery / Gnaw Marks	Burn	Diagnostic?	Identification	Observations	Photo No.
																								Unfused epiphysis, deer?	
LV K15	3	03.004/3	1566	03004/3	2294	10	10	1	26	68	58.1	bone	/	Medium	Mammalia	/	/	/	/	Both	N	Y	Rib	Rib fragments clear butchery marks, cutting and slicing	DSC_0158-0168
LV K16	21	21.003		21.003(5-10m)	946	1	1	1	13	22	2.5	tooth	/	Medium	Mammalia	Artiodactyla	Suidae	Sus	Scrofa	N	N	Y	Canine	small tooth fragment, entire surface burned, maybe incisor	DSC_0169-0174
LV K16	21	21.002		21.002(10-15m)	978	1	1	1	20	19	2.5	tooth	/	Medium	Mammalia	Artiodactyla	/	/	/	N	Y	Y	Molar	Small tooth fragment, burned,	DSC_0186-0189
LV K16	21	21.002		21.002(10-15m)	978/1	0	1		6	19	0.7	bone	/	/	/	/	/	/	/	Butchery	Y	Y	Bone Fragment	cutting marks, possibly rodent marks?	DSC_0190-0194
LV K16	25	25.002		25.002(0-5m)	1099	1	1	1	9	43	4.4	toot	/	Medium	Mammalia	Artiodactyla	/	/	/	N	N	Y	Molar	Tooth fragm	DSC_0175-

Site/Year	Trench	US	Carbon Date	Old no.	Cat. no.	NISP	NSP	MNE	Width (mm)	Length (mm)	Weight (g)	Material	Age Estimate	Size Class	Class	Order	Family	Genus	Species	Butchery / Gnaw Marks	Burn	Diagnostic?	Identification	Observations	Photo No.
												h												ents, molar or premolar	0177
LV K16	25	25.004		25.004(0-5m)	1176	2	2	1	16	45	10	tooth	/	Medium	Mammalia	Artiodactyla	Suidae	Sus	Scrofa	N	N	Y	Canine	2 tooth fragments, Roots burned	DSC_0178-0185
LV K18	28	SURFACE COLLECTION		NEAR TRENCH AND BRICFACTORY	1731	0	1		16	17	3.3	bone	/	/	/	/	/	/	/	N	Y	Y	Bone Fragment	bone fragment	DSC_0201
LV K18	28	004		28.004/01/6	1757	0	2		12	23	4.4	bone	/	/	/	/	/	/	/	N	Y	Y	Bone Fragment	long bone fragment, maybe long bone or rib, burned	DSC_0202-0203
LV K18	28	004		28.004/01/7	1765	0	1		9	34	5.4	bone	/	/	/	/	/	/	/	N	Y	Y	Bone Fragment	long bone fragment, burned	DSC_0204-0205
LV K18	28	004		28.004/01/9	1768	0	3		13	19	3.3	bone	/	/	/	/	/	/	/	N	Y	Y	Bone Fragment	tooth fragment and bone fragments, burned	DSC_0206-0207

Site/Year	Trench	US	Carbon Date	Old no.	Cat. no.	NISP	NSP	MNE	Width (mm)	Length (mm)	Weight (g)	Material	Age Estimate	Size Class	Class	Order	Family	Genus	Species	Butchery / Gnaw Marks	Burn	Diagnostic?	Identification	Observations	Photo No.
LV K18	28	004		28.004/02/1	1772	0	2		18	52	15.5	bone	/	/	/	/	/	/	/	N	YB	Y	Bone Fragment	Long bone fragment, rodent gnawing present	DSC_0208-0212
LV K18	28	004		28.004/02/1	1772/1	0	1		20	21	1.4	bone	/	/	/	/	/	/	/	N	Y	N	Bone Fragment	small long bone fragment, small mammal?	DSC_0213-0216
LV K18	28	004		28.004/06/1	1779	1	1	1	13	50	10.3	tooth	Adult	Large	Mammalia	Artiodactyla	Bovidae	Bos or Babulus	/	N	N	Y	Incisor	Large mammal incisor, either cattle or horse	DSC_0217-0221
LV K18	28	004		28.004/06/3	1780	0	48		/	/	123.2	bone	/	/	/	/	/	/	/	N	Y	Y	Bone Fragment	various burned bone fragments	DSC_0222-0223
LV K18	28	005		28.005/01/1	1784	0	1		9	23	2.5	bone	/	/	/	/	/	/	/	N	Y	Y	Bone Fragment	bone fragment	DSC_0224
LV K18	28	005		28.005/01/11	1794	0	1		7	14	0.7	bone	/	/	/	/	/	/	/	N	Y	Y	Bone Fragment	bone fragment	DSC_0225
LV K18	28	005		28.005/06/1 spit 2	1819	2	2	1	34	25	7.1	bone	Adult	Large	Mammalia	Artiodactyla	Bovidae	Bos	/	N	N	Y	Metapodial		DSC_0226-0230

Site/Year	Trench	US	Carbon Date	Old no.	Cat. no.	NISP	NSP	MNE	Width (mm)	Length (mm)	Weight (g)	Material	Age Estimate	Size Class	Class	Order	Family	Genus	Species	Butchery / Gnaw Marks	Burn	Diagnostic ?	Identification	Observations	Photo No.
LV K18	28	005		28.005/01/6 spit 2	1852	0	1		20	26	6.4	bone	/	/	/	/	/	/	/	N	Y	Y	Bone Fragment	bone fragment, burned	DSC_0231-0232
LV K18	28	005		28.005/01/8 spit 2	1865	0	1		16	19	2.5	bone	/	/	Mammalia	/	/	/	/	N	Y	Y	Bone Fragment	bone fragment burned	DSC_0233-0234
LV K18	28	005		28.005/06/2 spit 2	1886	1	1	1	26	48	27.5	tooth	adult	Large	Mammalia	Artiodactyla	Bovidae	Bos or Babulus	/	N	N	Y	Molar	Bos Molar	DSC_0235-0237
LV K18	28	005		28.005/06/2 spit 2	1887	0	2		9	30	3.3	bone	/	/	Mammalia	/	/	/	/	N	Y	Y	Bone Fragment	bone fragments heavily burned	DSC_0238-0239
LV K18	28	010		28.010/06/1 spit 2	1888	1	1	1	15	14	0.6	bone	/	Small	Reptilia	Testudines	/	/	/	N	N	Y	Turtle Shell Plate	bone fragment	DSC_0240
LV K18	28	038		28.038 SONDAGE 1	1907	0	3		11	34	7.5	bone	/	/	/	/	/	/	/	N	Y	Y	Bone Fragment	bone fragment burned	DSC_0241
LV K18	28	042		28.042/06/1	1919	1	1	1	28	67	31	bone	/	Medium	Mammalia	Artiodactyla	/	/	/	N	N	N	Long bone fragment	Long bone shaft tibia? Deer?	DSC_0242-0244
LV K18	28	049		28.049/06/1	1920	1	1	1	27	36	9.8	bone	adult	Medium	Mammalia	Artiodactyla	Cervidae	Axis	pornicus	N	YB	Y	Metapodial	Hog Deer metapodial	DSC_0245-0247
LV K18	28	049		28.049/06/1	1920/1	0	4		24	37	9.9	bone	/			/	/	/	/	N	Y	Y	Bone Fragment	bone fragments, maybe	DSC_0248-0250

Site/Year	Trench	US	Carbon Date	Old no.	Cat. no.	NISP	NSP	MNE	Width (mm)	Length (mm)	Weight (g)	Material	Age Estimate	Size Class	Class	Order	Family	Genus	Species	Butchery / Gnaw Marks	Burn	Diagnostic?	Identification	Observations	Photo No.
																								mandible, skull or rib?	
LV K18	28	057		28.057/06/2 sondage 4	1932	0	2		20	85	24.2	bone	adult	/	Mammalia	Artiodactyla	/	/	/	N	Y	N	Bone Fragment	Long bone fragments, very thick cortical bone ~8mm	DSC_0251-0255
LV K18	28	057		28.057/06/3 sondage 4	1933	0	1		20	30	7	bone	/	/	Mammalia	Artiodactyla	/	/	/	N	Y B	Y	Bone Fragment	Long bone fragment, thick cortical bone	DSC_0256-0257
LV K18	28	057		28.057/06/3 sondage 4	1934	1	1	1	42	43	12.5	bone	/	Large	Mammalia	Artiodactyla	/	/	/	N	N	Y	Vertebra	Thoratic vertebrae fragment, spinous process, vertebral foramen	DSC_0258-0259
LV K18	28	057		28.057/06/4 sondage 4	1935	0	1		19	43	17.5	bone	/	/	/	/	/	/	/	N	Y B	N	Bone Fragment	long bone fragment, tibia, deer or dog?	DSC_0260-0263

Site/Year	Trench	US	Carbon Date	Old no.	Cat. no.	NISP	NSP	MNE	Width (mm)	Length (mm)	Weight (g)	Material	Age Estimate	Size Class	Class	Order	Family	Genus	Species	Butchery / Gnaw Marks	Burn	Diagnostic ?	Identification	Observations	Photo No.
LV K18	28	057		28.057/06/4 sondage 4	1936	3	3	1	21	143	29.5	bone	Juvinile	Medium	Mammalia	Artiodactyla	Bovidae	Nemorhaedus	sumatraensis	N	N	Y	Metapodial	proximal tibia and shaft frgaments, small mammal, dog? Small deer?	DSC_0264-0267
LV K18	28	057		28.057/06/5 sondage 4	1937	1	1	1	14	45	17.8	bone	adult	Medium	Mammalia	Artiodactyla	Cervidae	/	/	N	YB	Y	Metapodial	proximal metacarpal small deer species	DSC_0268-0270, 0351
LV K18	28	057		28.057/06/6 sondage 4	1938	1	1	1	13	43	5.6	tooth	Adult	Large	Mammalia	Artiodactyla	Bovidae	Bos or Babulus	/	N	N	Y	Incisor	bos incisor	DSC_0271
LV K18	28	057		28.057/06/7 sondage 4	1939	0	1		44	19	19.4	bone	/	/	/	/	/	/	/	N	Y	Y	Bone Fragment	longbone fragment articular surface, large	DSC_0272-0273
LV K18	28	057		28.057/06/8 sondage 4	1940	0	1		22	41	10	bone	/	/	/	/	/	/	/	N	Y	Y	Bone Fragment		DSC_0274-0275
LV K18	28	057		28.057/06/9 sondage 5	1941	14	14	1	/	/	18	bone	/	Medium	Mammalia	/	/	/	/	N	Y	Y	Rib	ribs, very fragmented	DSC_0276

Site/Year	Trench	US	Carbon Date	Old no.	Cat. no.	NISP	NSP	MNE	Width (mm)	Length (mm)	Weight (g)	Material	Age Estimate	Size Class	Class	Order	Family	Genus	Species	Butchery / Gnaw Marks	Burn	Diagnostic?	Identification	Observations	Photo No.
LV K18	28	057		28.057/06/10 sondage 5	1942	0	18		/	/	14.9	bone	/	/	/	/	/	/	/	N	Y	N	Bone Fragment	rib fragments	DSC_0277
LV K18	28	057 spit 2		28.057/06/2 sondage 4	1945	1	1	1	11	121	30.9	bone	juvenile	/	Mammalia	Artiodactyla	Cervidae	/	/	N	N	Y	radius	unfused epiphysis	DSC_0278-0282
LV K18	28	066		28.066/06 sondage 4	1948	1	4	1	18	41	11.3	tooth	adult	Large	Mammalia	Artiodactyla	Bovidae	Bos or Babulus	/	N	Y	Y	Incisor	bos incisor, mandible fragments	DSC_0283-0284
LV K18	28	066		28.066/01 sondage 4	1950	3	5	3	/	/	6.8	tooth	/	small	Osteichthyes	/	/	/	/	N	Y	Y	Unidentified Fish Bone Fragments		DSC_0285-0289
LV K18	28	066		28.066/01 sondage 4	1950/1	1	1	1	12	14	2.3	bone	/	small	Osteichthyes	/	/	/	/	N	Y	Y	Fish Vertebra	fish vertebrae	DSC_0290-0291
LV K18	28	066		28.066/01 sondage 4	1950/2	0	1		13	35	4.1	bone	/	/	/	/	/	/	/	N	N	N	Bone Fragment	long bone fragment	DSC_0292
LV K18	28	092		28.092/06/1 sondage 4	1951	2	2	1	34	67		bone	Adult	Large	Mammalia	Artiodactyla	Bovidae	Bos	/	N	N	Y	Metapodial	proximal phalange, metapodal distal fragments, butchery presen	DSC_0293-0300

Site/Year	Trench	US	Carbon Date	Old no.	Cat. no.	NISP	NSP	MNE	Width (mm)	Length (mm)	Weight (g)	Material	Age Estimate	Size Class	Class	Order	Family	Genus	Species	Butchery / Gnaw Marks	Burn	Diagnostic ?	Identification	Observations	Photo No.
																								t, cut marks	
LV K18	28	092		28.092/06/1 sondage 4	1951	1	1	1				bone	Adult	Large	Mammalia	Artiodactyla	Bovidae	Bos	/	Butchery	N	Y	Priximal Plalange	proximal phalange, metapodal distal fragments, butchery present, cut marks	DSC_0293-0300
LV K18	28	094		28.094/06/1 sondage 4	1953	1	1	1	40	188	382	bone	Adult	Large	Mammalia	Artiodactyla	Bovidae	Bos	/	Gnaw	Y	Y	Metapodial	Cattle metapodial almost complete fragment, butchery in form of cut marks and percussion marks extensive	DSC_0301-0306
LV K18	28	013		28.013/06/1	1961	1	1	1	11	11	0.5	bone	/	Small	Reptilia	Testudines	/	/	/	N	N	Y	Turtle Shell Plate	Fish cranial bones	DSC_0307-0308
LV K18	28 EXT	047		28.047/01/2	1962	0	3		14	26	7.1	bone	/	/	/	/	/	/	/	N	Y	Y	Bone Fragments	long bone fragments,	DSC_0309-0310

Site/Year	Trench	US	Carbon Date	Old no.	Cat. no.	NISP	NSP	MNE	Width (mm)	Length (mm)	Weight (g)	Material	Age Estimate	Size Class	Class	Order	Family	Genus	Species	Butchery / Gnaw Marks	Burn	Diagnostic?	Identification	Observations	Photo No.
																								burned	
LV K18	28	048		28.048/06/1 sondage 2	1964	0	8		/	/	18.8	bone	/	/	/	/	/	/	/	N	Y	Y	Bone fragment	bone fragments, burned	DSC_0311
LV K18	29	004/05		029.004/05.06.01	1975	0	5		/	/	7.7	bone	/	/	/	/	/	/	/	N	N	N	Bone fragments	bone fragments	DSC_0312
LV K18	28 EXT	041		28.041/06/1	2005	0	1		14	21	1.9	bone	/	/	/	/	/	/	/	N	Y	Y	Bone fragment		DSC_0313-0314
LV K18	28 EXT	042		28.042/01.01	2011	0	1		30	33	11.5	bone	/	/	/	/	//	/	/	N	Y	Y	Bone fragment	Longbone fragment, burned	DSC_0315-0316
LV K18	28 EXT	042		28.042/01/2	2015	0	1		21	15	2.6	bone	/	/	/	/	/	/	/	N	Y	Y	Bone Fragment	bone fragment, burned	DSC_0317
LV K18	28 EXT	042		28.042/01/4	2030	0	2		17	23	5.6	bone	/	/	Mammalia	/	/	/	/	N	Y	Y	Bone Fragment	long bone fragments, burned	DSC_0318
LV K18	28 EXT	047		28.047/01/1	2051	0	3		11	39	10.6	bone	/	/	Mammalia	/	/	/	/	N	Y	Y	Bone Fragment	longbone fragments and rib fragment. Burne	DSC_0319-0320

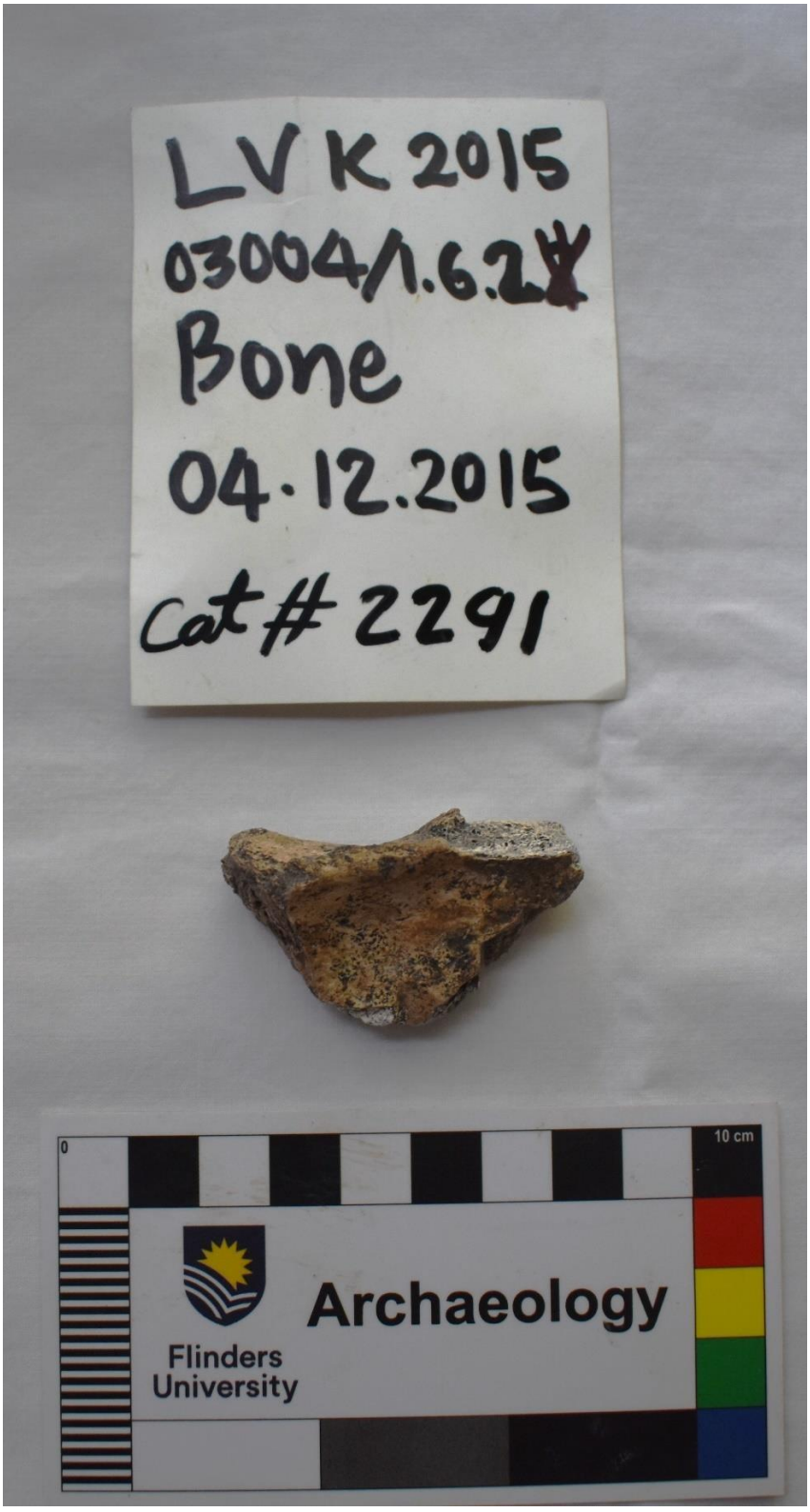
Site/Year	Trench	US	Carbon Date	Old no.	Cat. no.	NISP	NSP	MNE	Width (mm)	Length (mm)	Weight (g)	Material	Age Estimate	Size Class	Class	Order	Family	Genus	Species	Butchery / Gnaw Marks	Burn	Diagnostic ?	Identification	Observations	Photo No.
																								d	
LV K18	28 EXT	047		28.047/01/2	2068	0	1		26	29	15.6	bone	/	medium	Mammalia	Artiodactyla	/	/	/	N	Y	Y	Bone Fragment	fragment very burnt	DSC_0321-0322
LV K18	32	004/02		32.003/02/06 bag01	2093	0	8		/	/	2.1	bone	/	/	/	/	/	/	/	N	Y	Y	Bone Fragment	bone fragments, some burned	DSC_0324
LV K18	32	004/02		32.003/02/06 bag03	2094	0	4		/	/	1.2	bone	/	small	/	/	/	/	/	N	N	N	Bone Fragment	small bone fragments	DSC_0323
LV K18	32	004/02 sceening		32.003/02/06 bag04	2095	0	5		/	/	3.9	bone	/	/	/	/	/	/	/	N	N	N	Bone Fragment	small bone fragments	DSC_0325
LV K18	32	008/01		32.008/01/06 bsg (01)	2098	0	6		/	/	2.3	bone	/		/	/	/	/	/	N	N	N	Bone Fragment	small bone fragments	DSC_0326
LV K18	32	012/03		32.012/03/06 (01)	2099	0	3		/	/	0.8	bone	/	/	/	/	/	/	/	N	N	N	Bone Fragment	small bone fragments	DSC_0327
LV K18	32	014/01		32.014/01/06 bag (01)	2100	0	1		6	11	<0.1	bone	/	/	/	/	/	/	/	N	N	N	Bone Fragment	small bone fragment	DSC_0328
LV K18	32	017/03		32.017/03/06 (01)	2104	0	13		/	/	1.3	bone	/	/	/	/	/	/	/	N	Y	Y	Bone Fragment	small bone fragments, burned	DSC_0329
LV K18	32	022/01		32.022/01/06 (01)	2107	0	2		/	/	<0.1	bone	/	/	/	/	/	/	/	N	Y	Y	Bone Fragment	small bone fragm	DSC_0332

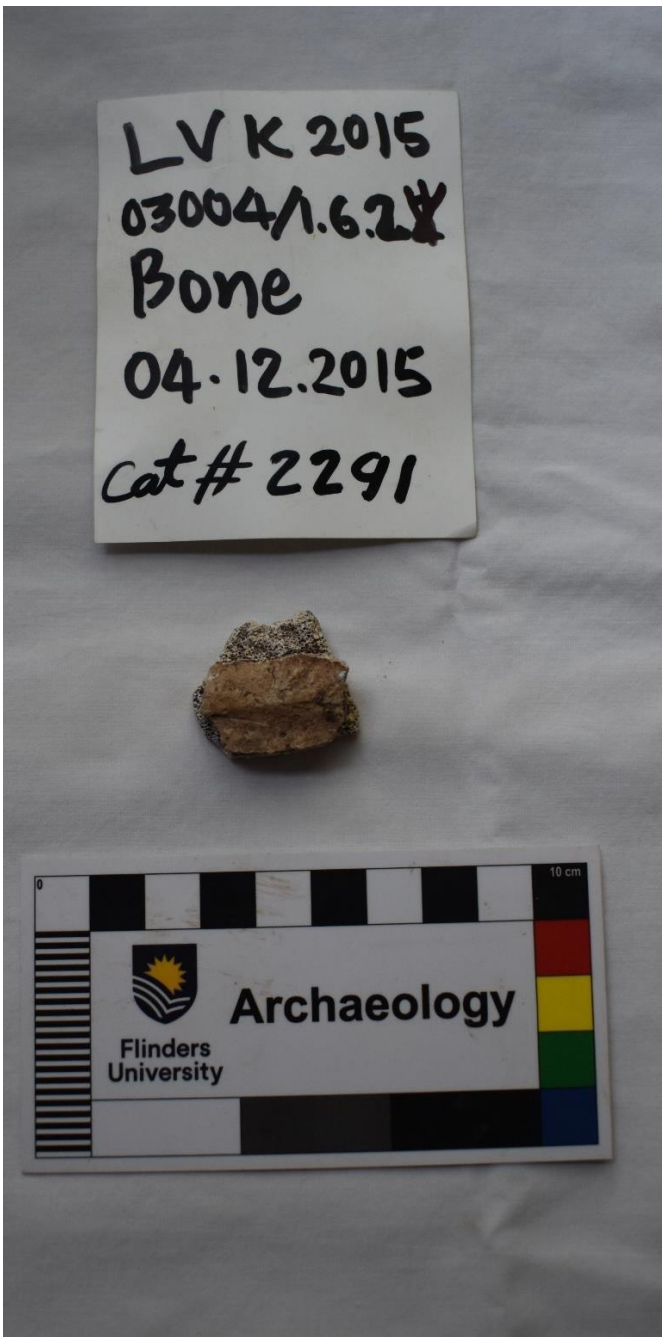
Site/Year	Trench	US	Carbon Date	Old no.	Cat. no.	NISP	NSP	MNE	Width (mm)	Length (mm)	Weight (g)	Material	Age Estimate	Size Class	Class	Order	Family	Genus	Species	Butchery / Gnaw Marks	Burn	Diagnostic ?	Identification	Observations	Photo No.
																								ents	
LV K18	32	023/01		32.023/01/06 (01)	2108	0	2		/	/	<0.1	bone	/	/	/	/	/	/	/	N	N	Y	Bone Fragment	verry small bone	DSC_0333
LV K19	37	004/01		37.004/01.06.01	2485	1	1	1	12	13	1.1	bone	/	small	Osteichthyes	/	/	/	/	N	N	Y	Fish Vertebra	fish vertebrae	DSC_0334
LV K19	43	001/06		43.001.06.01	2501	0	5		25	43	13.6	bone	/	medium/large	Mammalia	Artiodactyla	/	/	/	N	Y	Y	Bone Fragment	mandible fragments, burned	DSC_0343-0344
LV K18	28	013		28.013/06/1	1961/1	1	1	1	/	/	/	bone	/	Small	Reptilia	Testudines	/	/	/	N	N	Y	coracoid	Fish cranial bones	DSC_0307-0308

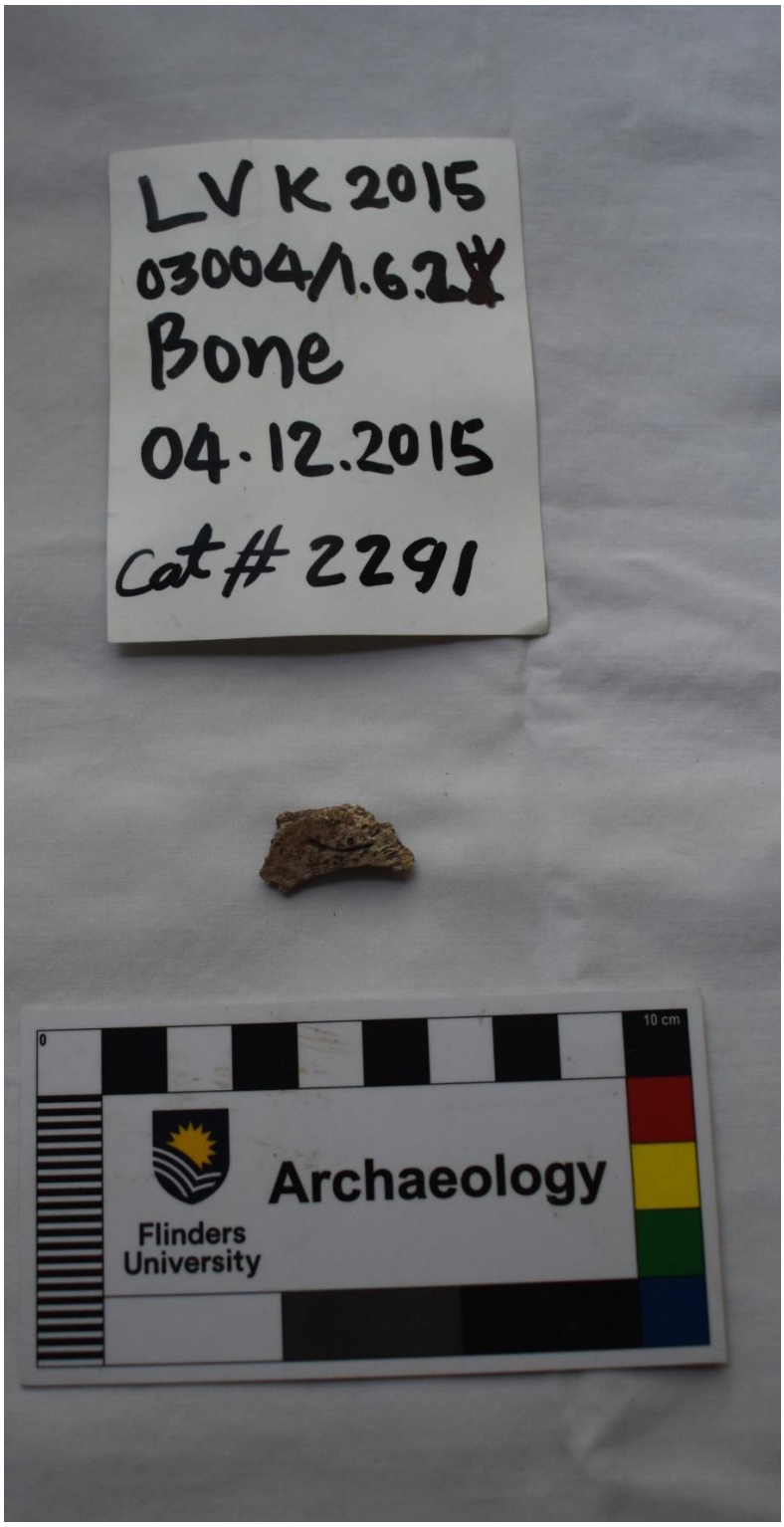
Appendix B – Faunal Images

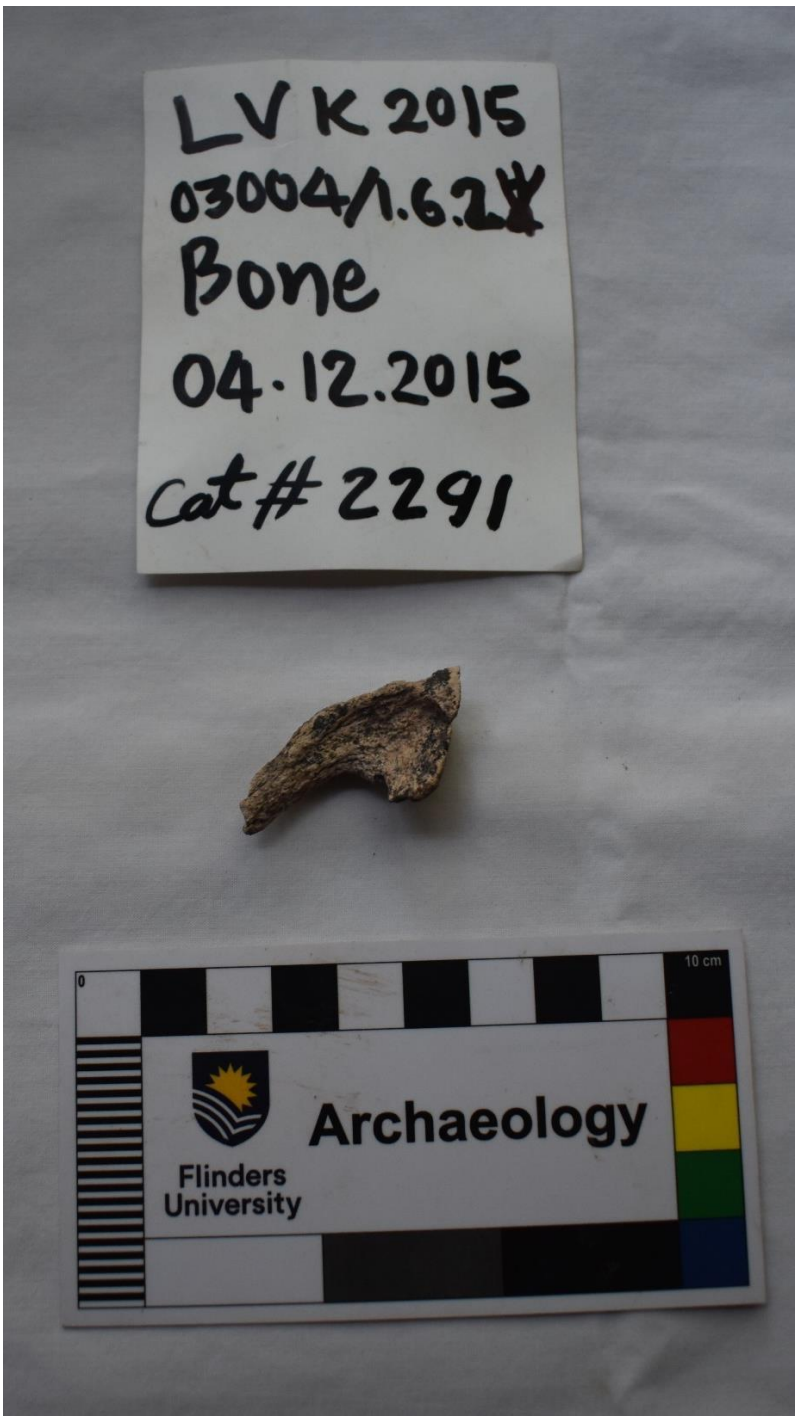
The following faunal images correspond to the ‘Cat no.’ column of the faunal catalogue.

LVK15




LV K 2015
03004/1.6.2
Bone
04.12.2015
Cat# 2291
0
10 cm
Archaeology
Flinders
University


LV K 2015
03004/1.6.2
Bone
04.12.2015
Cat# 2291
0
10 cm
Archaeology
Flinders
University


LV K 2015
03004/1.6.2
Bone
04.12.2015
Cat# 2291
0
10 cm
Archaeology
Flinders
University


LV K 2015
03004/1.6.2
Bone
04.12.2015
Cat # 2291
Archaeology
Flinders University


0
10 cm
Archaeology
Flinders University
LVK15
0700 2/1
Teeth of animal
cat # 45


LVK15
07002/1
Cat #45


LVK 15
07002/1
Teeth of animal
cat# 46
0
10 cm
Flinders University
Archaeology


LVK15
03004/1.62
Bone
17/02/23
Cat#2291/1
0
10 cm
Flinders University
Archaeology

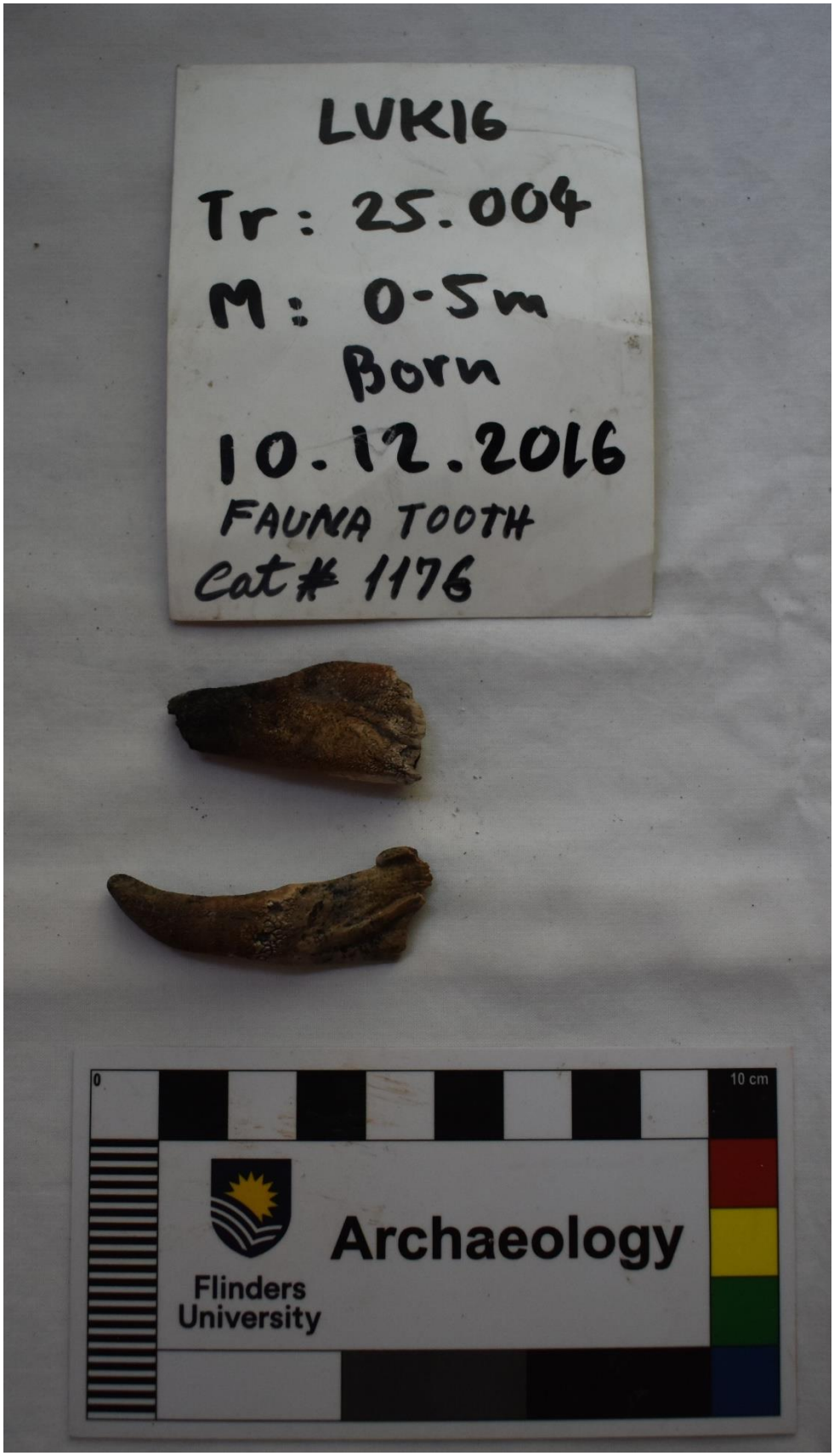

LVK1S
03.004/3.06.01
Bone
08.12.2015
cat#2293
0
10 cm
Flinders University
Archaeology


LVK 2015
03004/2.06.1
Bone
04.12.2015
cat #2292
0
10 cm
Flinders University
Archaeology


LVK 15
0300413
0300412
0300411
bone, ceramic, soil
charcoal.
06.12.2015
Cat# 2294
Archaeology
Flinders University

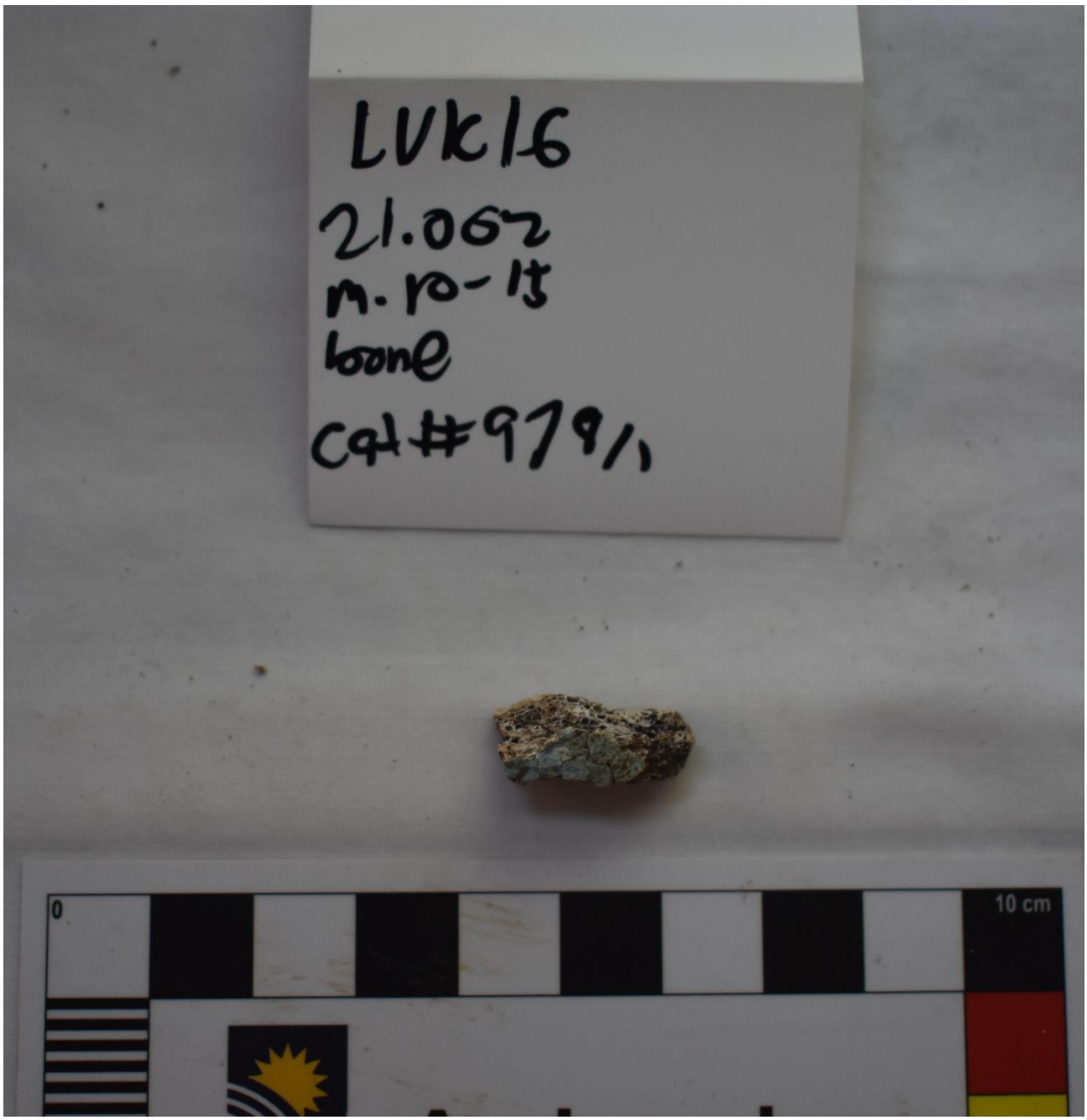
LVK16


LVK16
25-002
M-0-5
Bone
Cat # 1099
0
10 cm
Flinders University
Archaeology

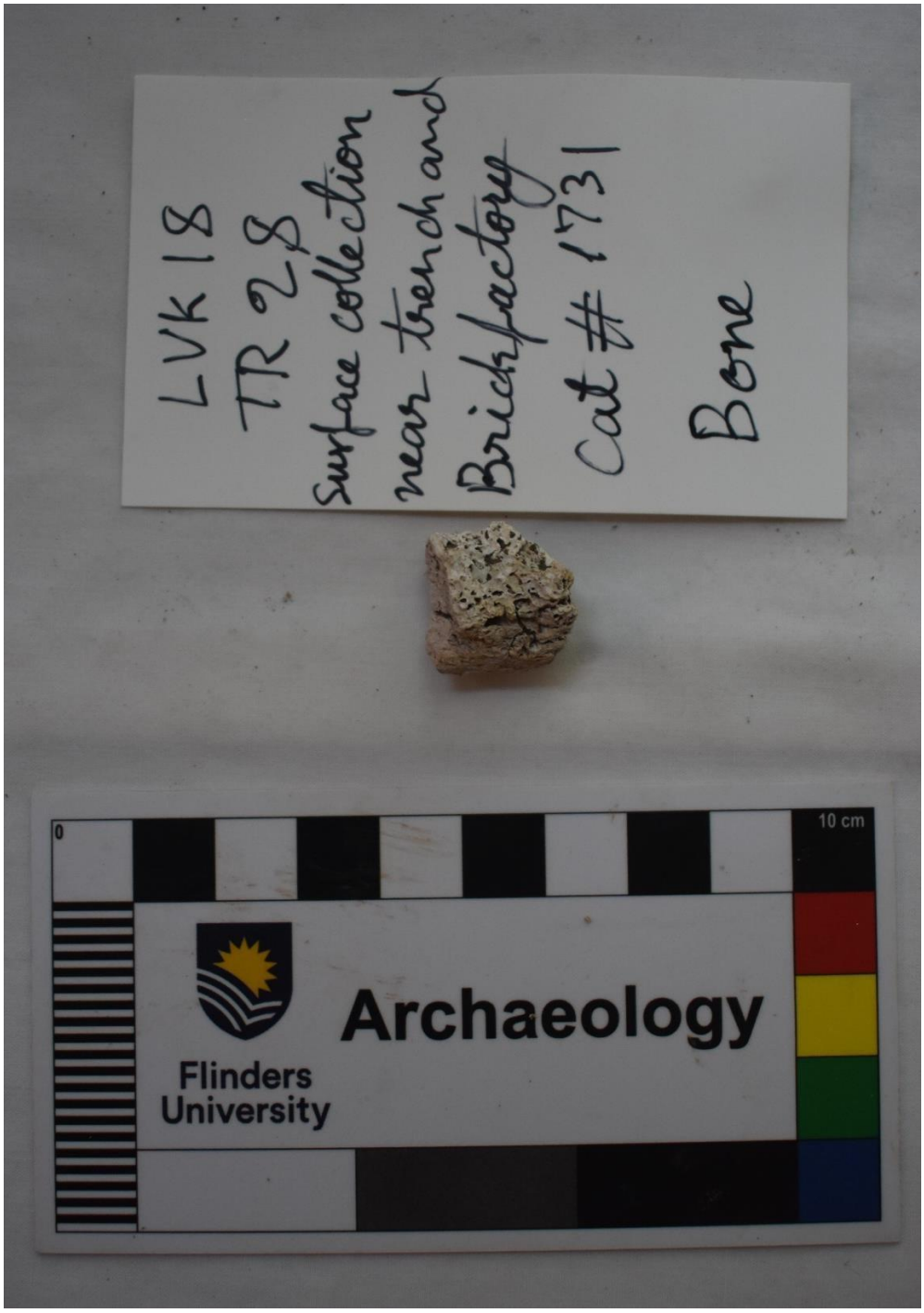

LUK16
Tr: 25.004
M: 0-5m
Born
10.12.2016
FAUNA TOOTH
Cat# 1176
0
10 cm
Flinders University
Archaeology

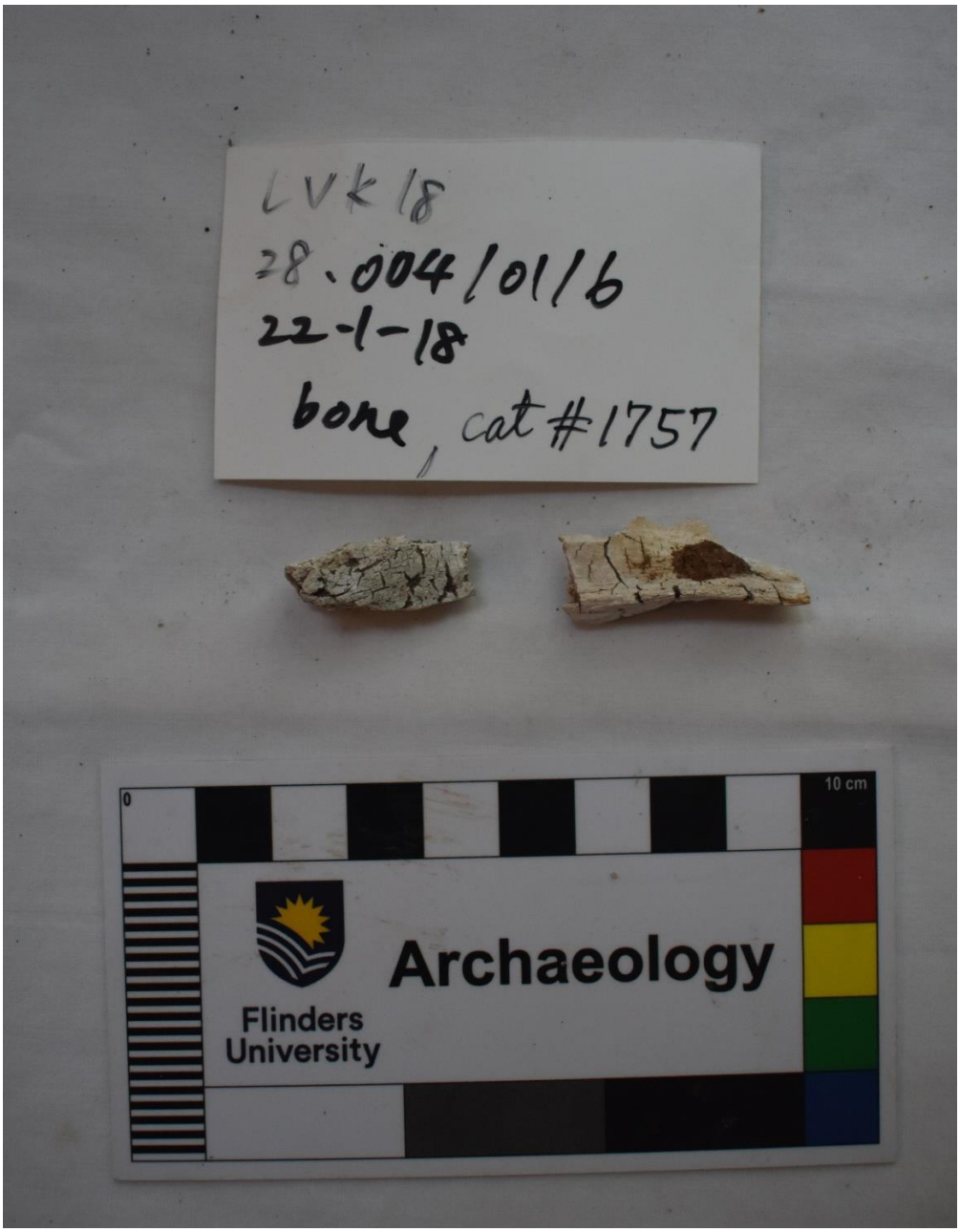

LVK16
21.002
M. 10-15
Bone
Cat # 978
0
10 cm
Archaeology
Flinders
University

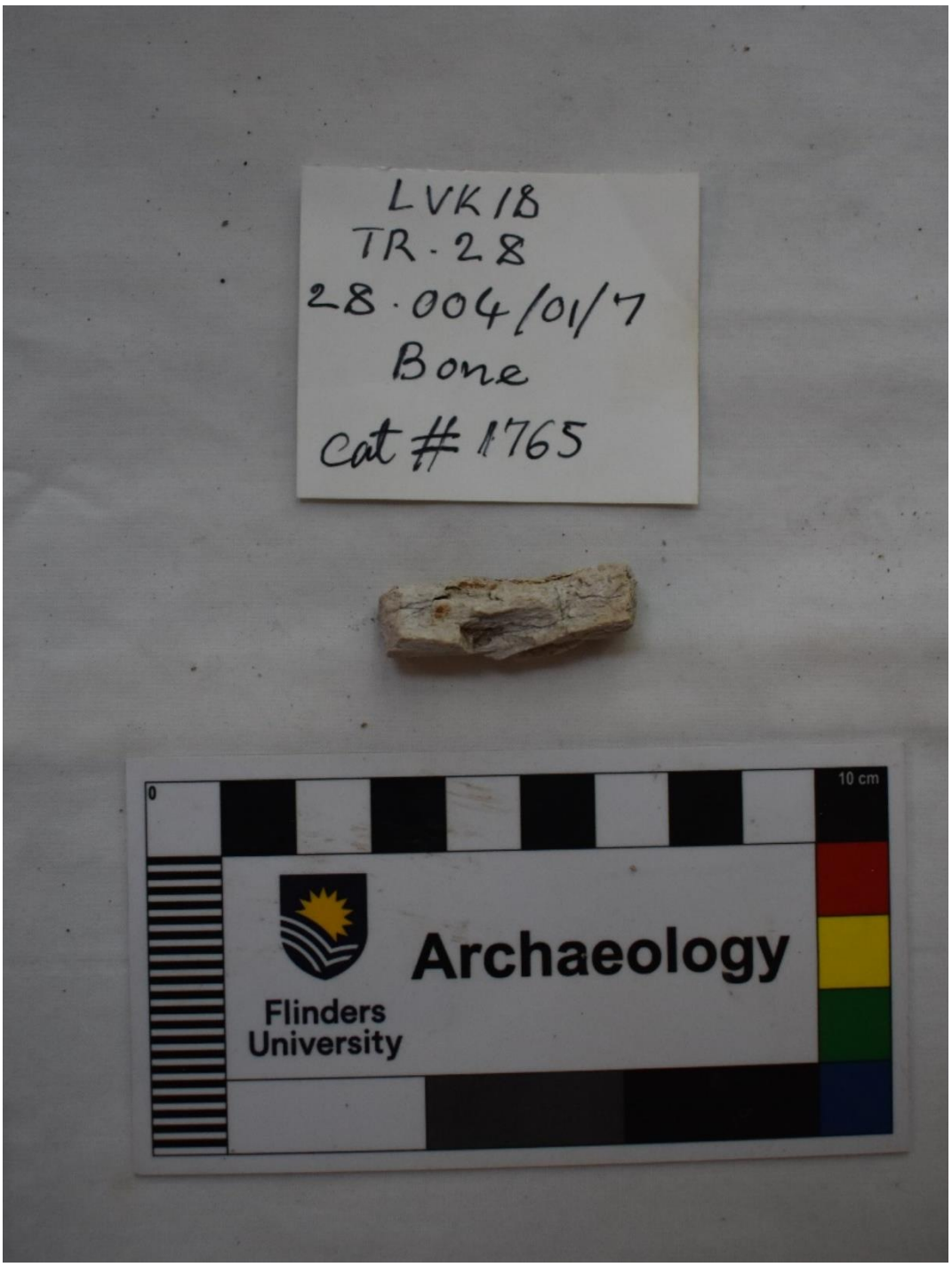

LVK16
21.062
m. 10-15
bone
Cat#9791
0
10 cm
Archaeology
Flinders
University


LVK16
21.062
m. 10-15
bone
Cat#9791
0
10 cm

LVK18


LVK 18
TR 28
Surface collection
near trench and
Brickfactory
Cat # 1731
Bone
0
10 cm
Archaeology
Flinders
University

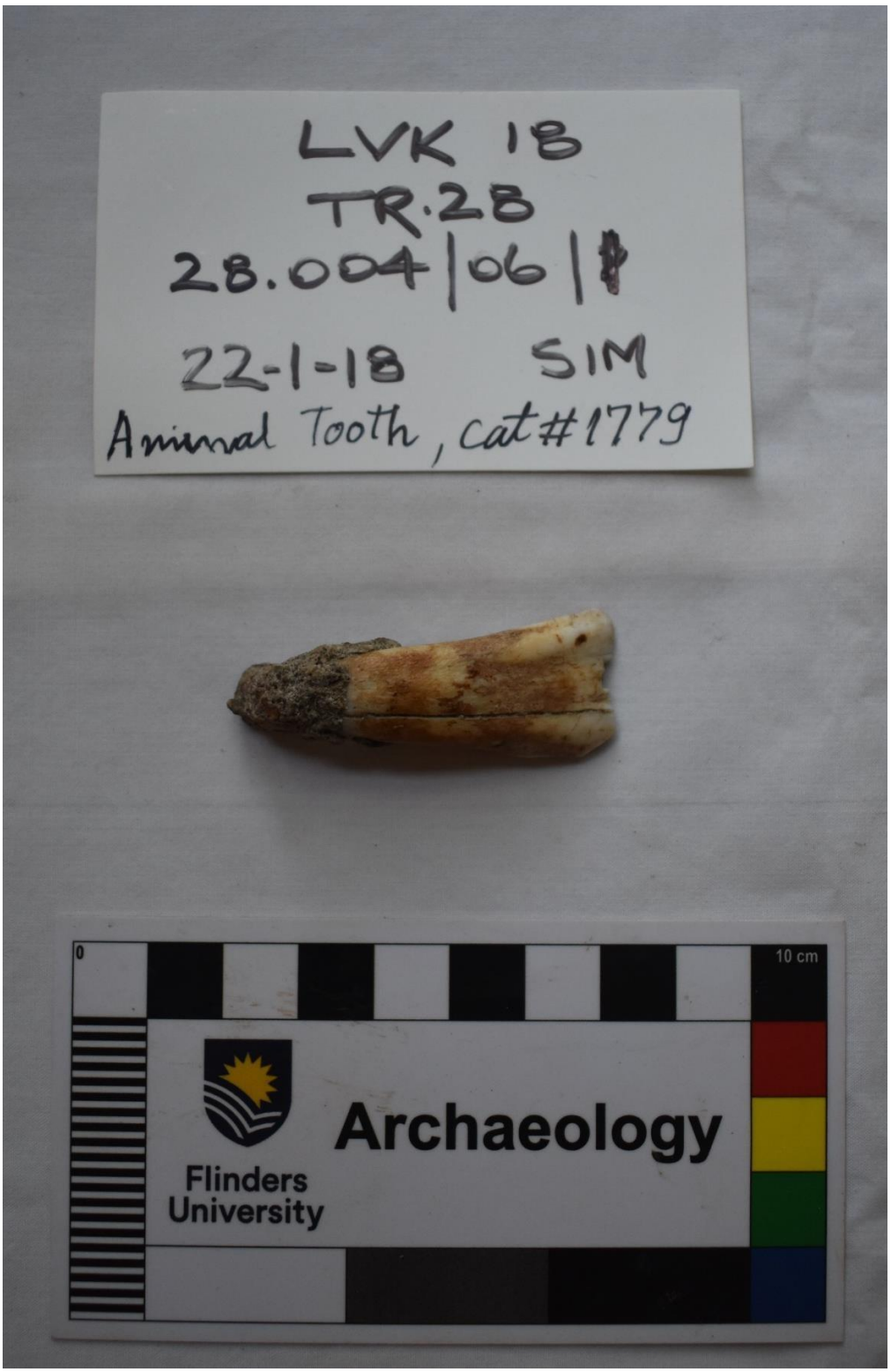

LVK18
28.004/011b
22-1-18
bone, cat #1757
0
10 cm
Archaeology
Flinders University


LVK18
TR-28
28-004/01/7
Bone
cat # 1765
0
10 cm
Flinders University
Archaeology


LVK 18
TR-28
28.004/01/9
Bone
cat #1768
0
10 cm
Archaeology
Flinders University


LVK18
TR.28
28.004/02/1
23-1-18
Bone ; cat# 1772
0
10 cm
Archaeology
Flinders
University


LVIC18
TR.28
28.004/02/1
18/02/23
#1772/1
0
10 cm
Archaeology
Flinders
University

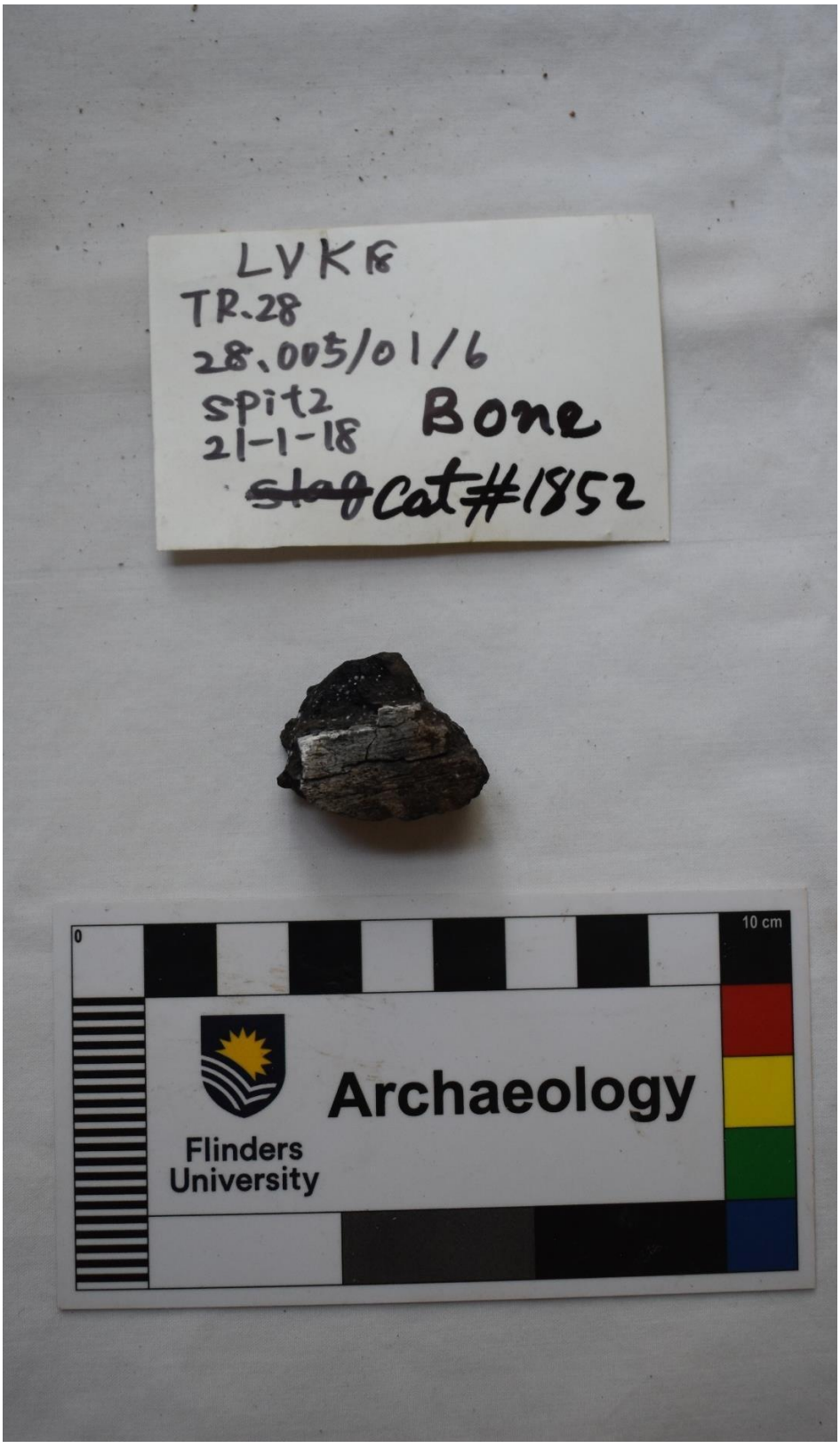

LVK 18
TR.28
28.004|06|1
22-1-18 SIM
Animal Tooth, cat#1779
0
10 cm
Flinders University
Archaeology


LVK 18
TR.28
28.004|06|1
22-1-18 SIM
Animal Tooth, cat#1779
0
10 cm
Archaeology
Flinders University

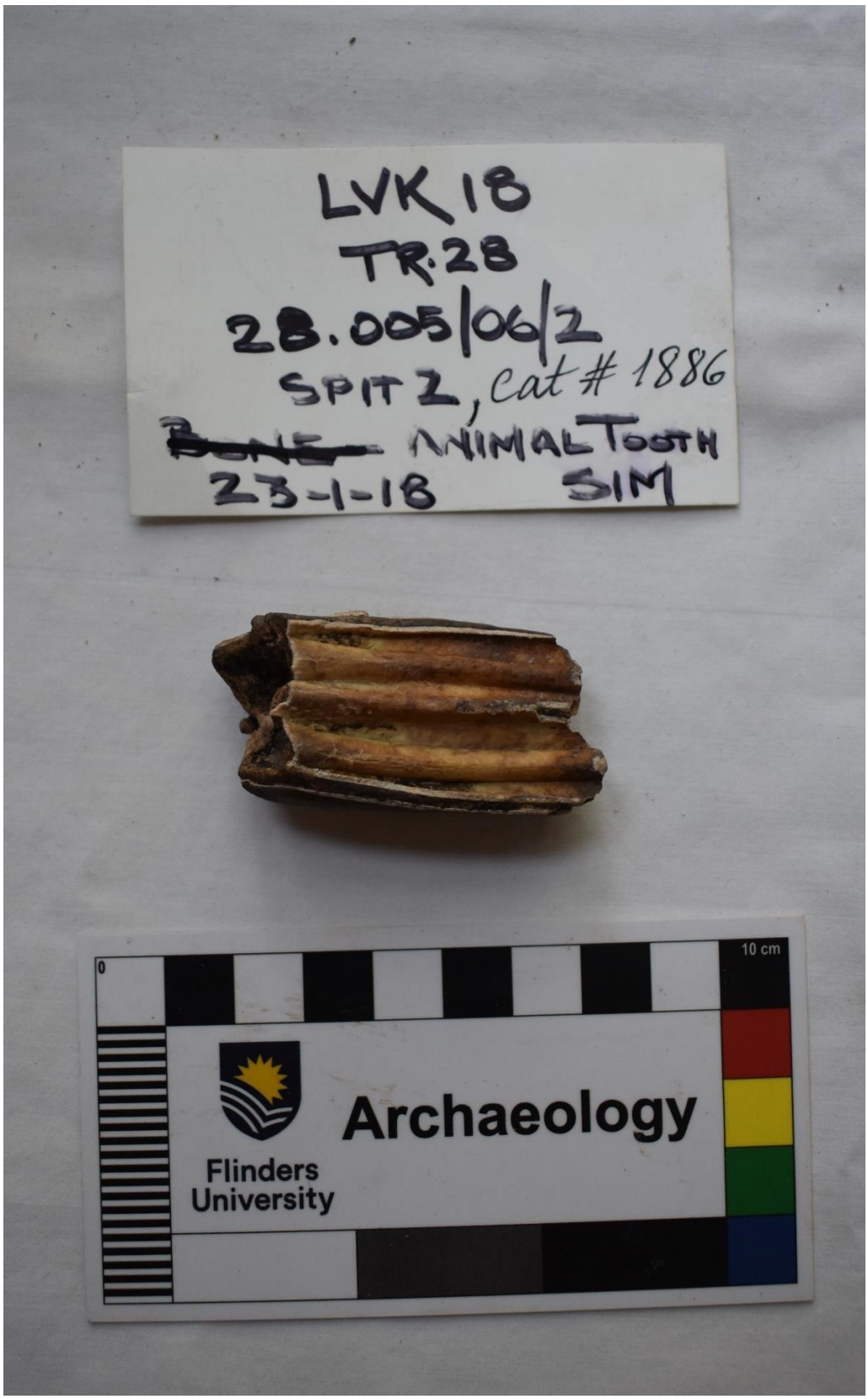

LVK 18
Cat#1780 TR. 28
28.004/06/3
FROM 0-4m
BONE 23-1-18
Archaeology
Flinders University


LVK18
TR.28
28.005/01/1
Bone
Cat # 1784
0
10 cm
Flinders University
Archaeology


LVK 18
TR. 28
28.005/06/1
(SPIT 2)
BONE, Cat# 1819
21-1-18
SIM
0
10 cm
Archaeology
Flinders University

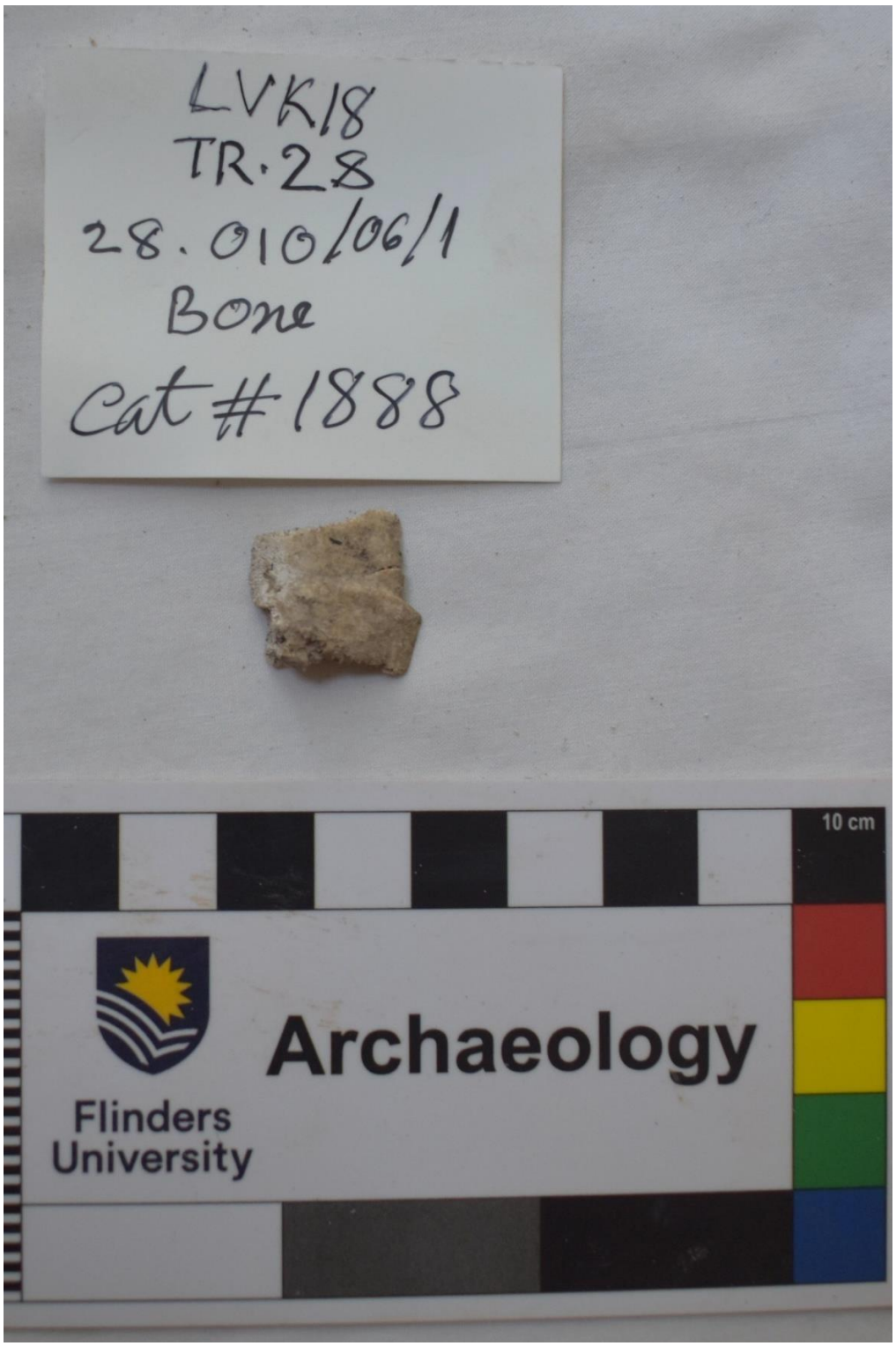

LVKF
TR.28
28.005/01/6
spit2
21-1-18
Bone
~~slag~~ Cat#1852
0
10 cm
Archaeology
Flinders
University


LVK18
TR·28
28.005 spit 2
Bone
cat #1865
0
10 cm
Flinders University
Archaeology


LVK 18
TR.28
28.005/06/2
SPIT 2, cat # 1886
~~BONE~~ ANIMAL TOOTH
23-1-18 SIM
0
10 cm
Archaeology
Flinders University


TR 28
23-1-18
Flinders
University

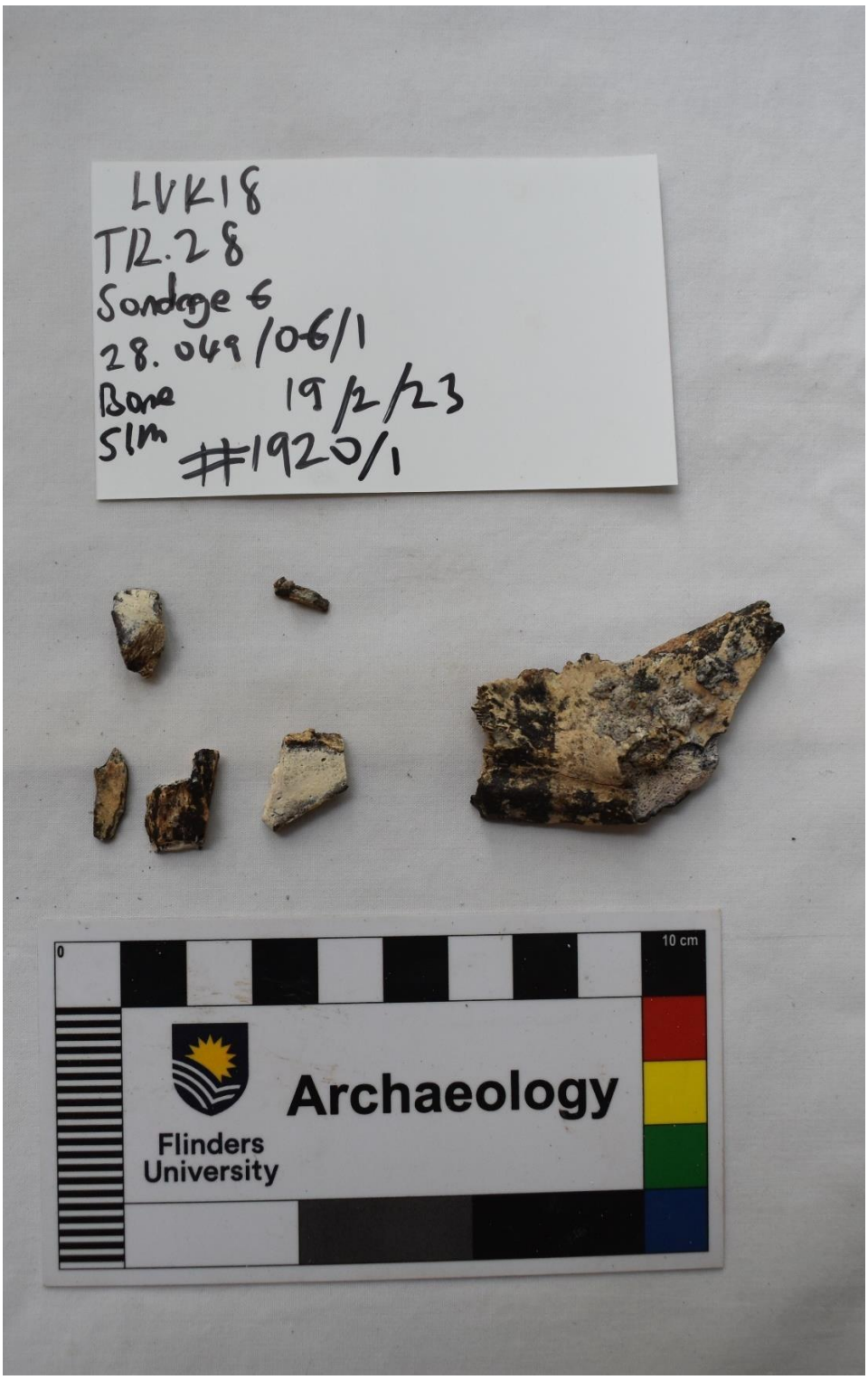

LVK18
TR.28
28.005 spit 2
Bone
Cat #1887
0
10 cm
Archaeology
Flinders
University

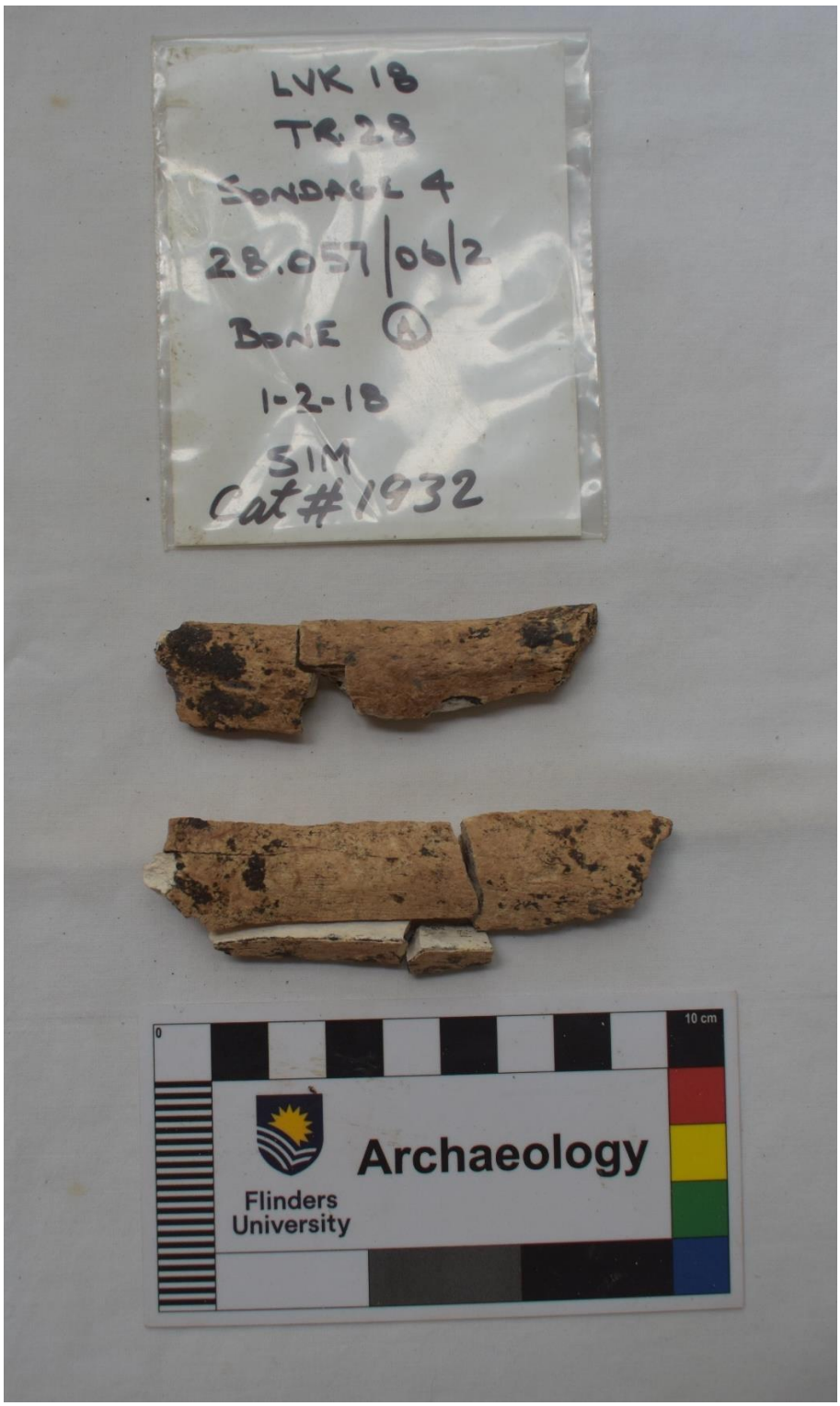

LVK18
TR.28
28.010/06/1
Bone
Cat #1888
10 cm
Archaeology
Flinders
University

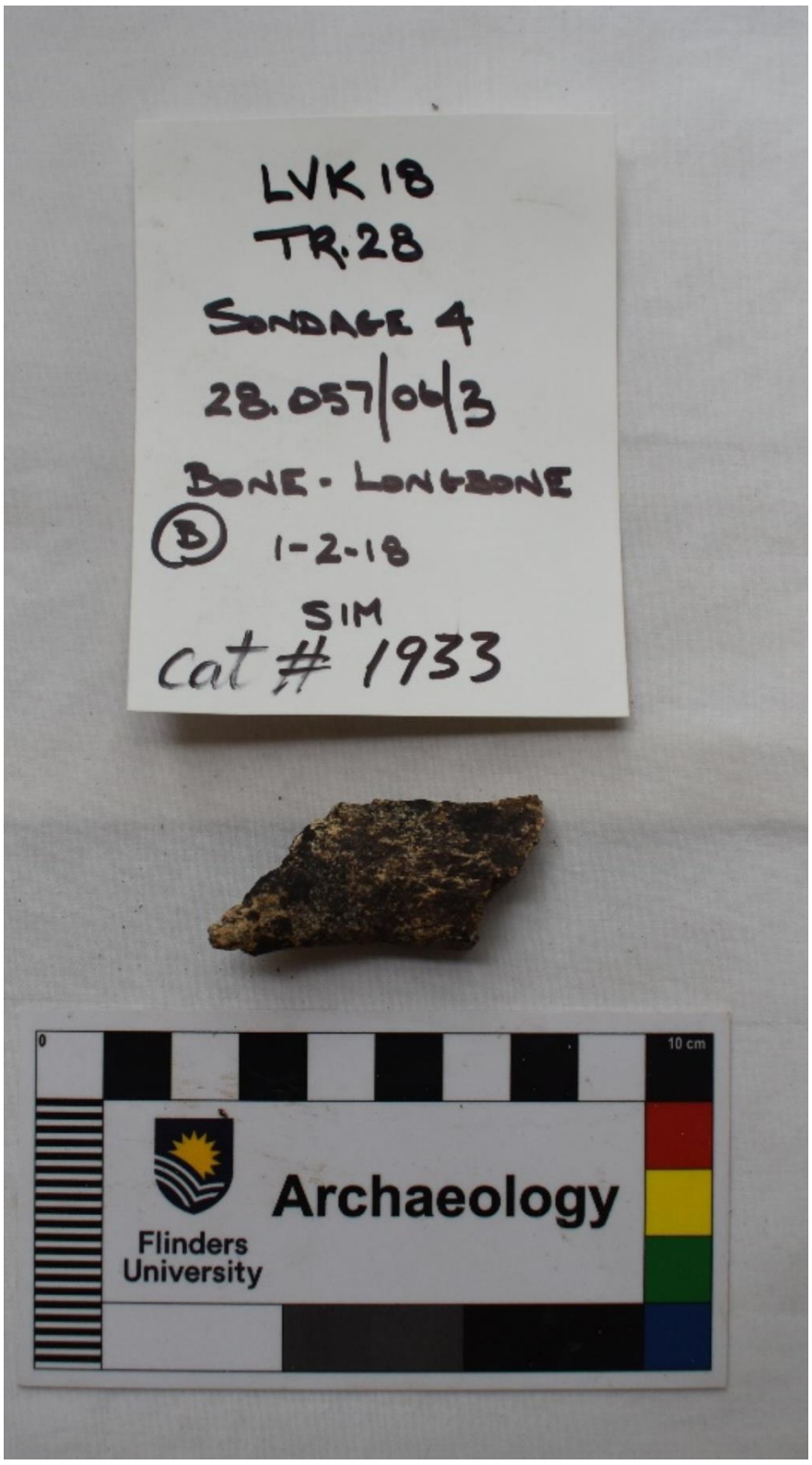

LVK18 Bone
Trench 28 cat# 1907
Sondage 1: 28.038
Animal bone
23 Jan 2018
0
10 cm
Flinders University
Archaeology

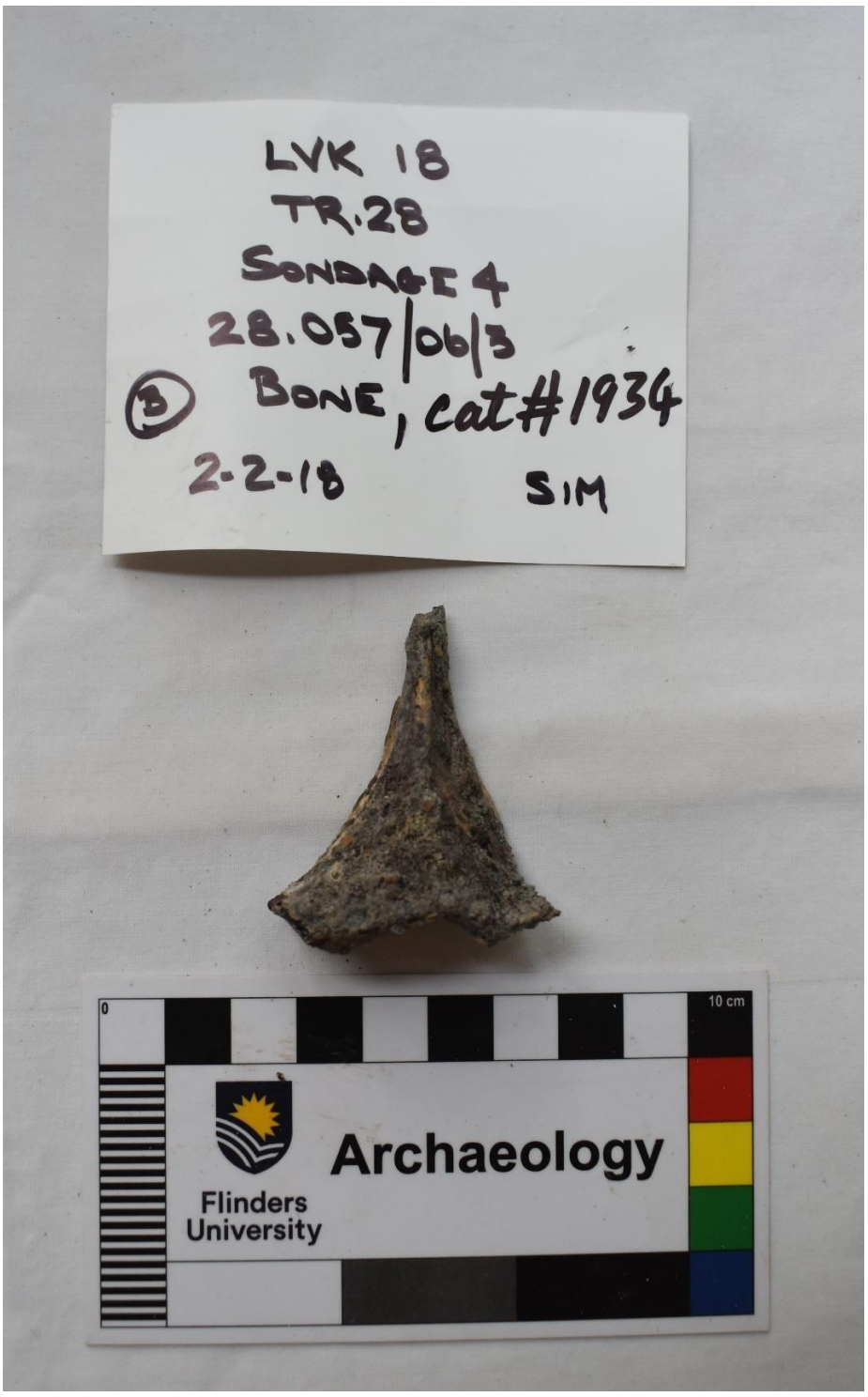

LVK 18
TR.28
28.042/06/1
25-1-18
SIM
BONE
Cat
1919
0
10 cm
Flinders
University
Archaeology


LVK18
TR.28
SONDAGE 6
28.049/06/1
BONE
4.2.18
SIM
cat# 1920
0
10 cm
Archaeology
Flinders
University


LVK18
TR.28
Sondage 6
28.049/06/1
Bone 19/2/23
Sim #1920/1
0
10 cm
Archaeology
Flinders University


LVK 18
TR 28
SONDAGE 4
28.057/06/2
BONE (A)
1-2-18
SIM
Cat #1932
0
10 cm
Archaeology
Flinders University


LVK 18
TR. 28
SONDAGE 4
28.057/06/3
BONE - LONGBONE
B
1-2-18
SIM
cat # 1933
0
10 cm
Archaeology
Flinders University

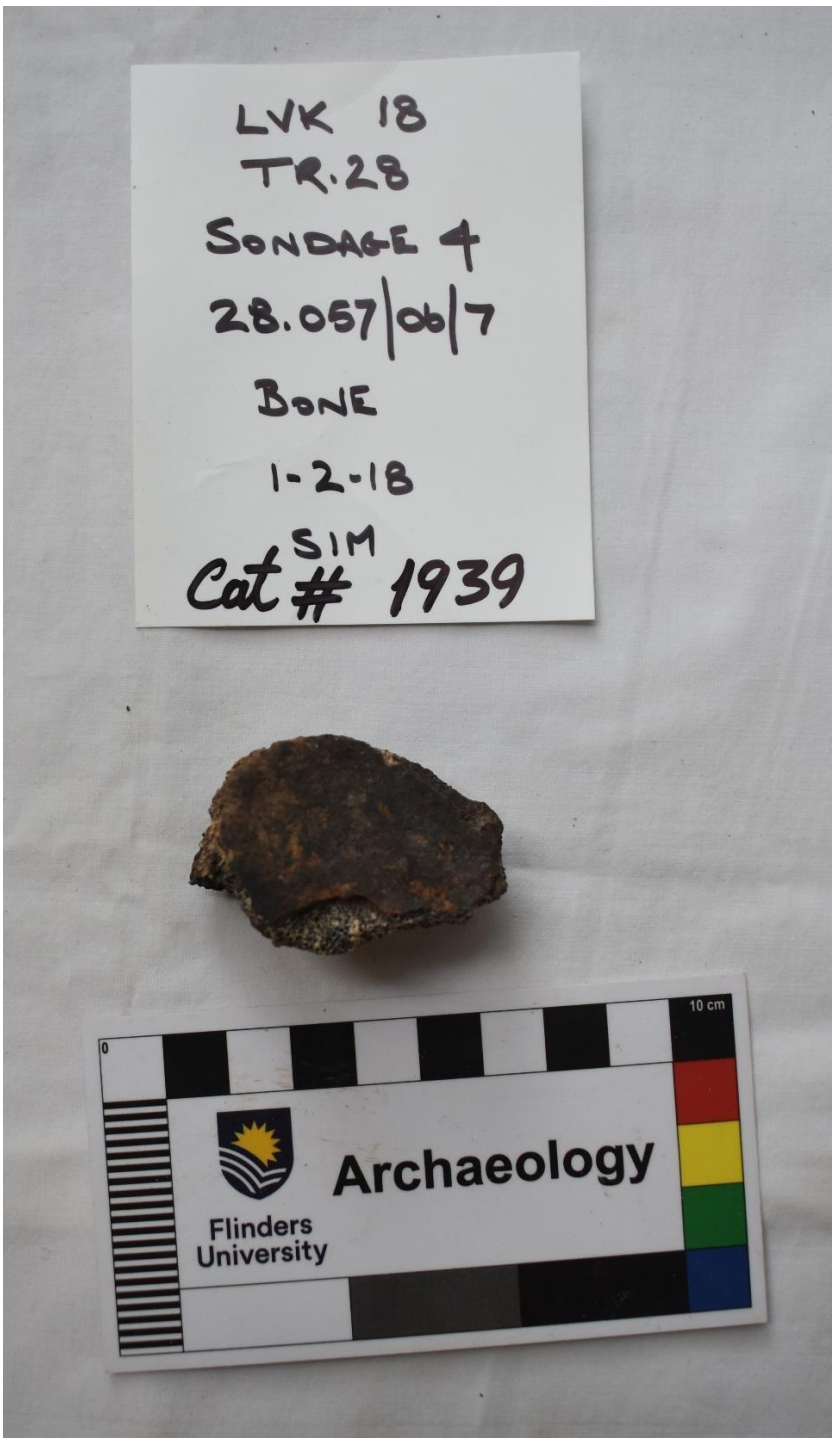

LVK 18
TR.28
SONDAGE 4
28.057/06/3
B BONE, cat#1934
2-2-18 SIM
0
10 cm
Flinders University
Archaeology

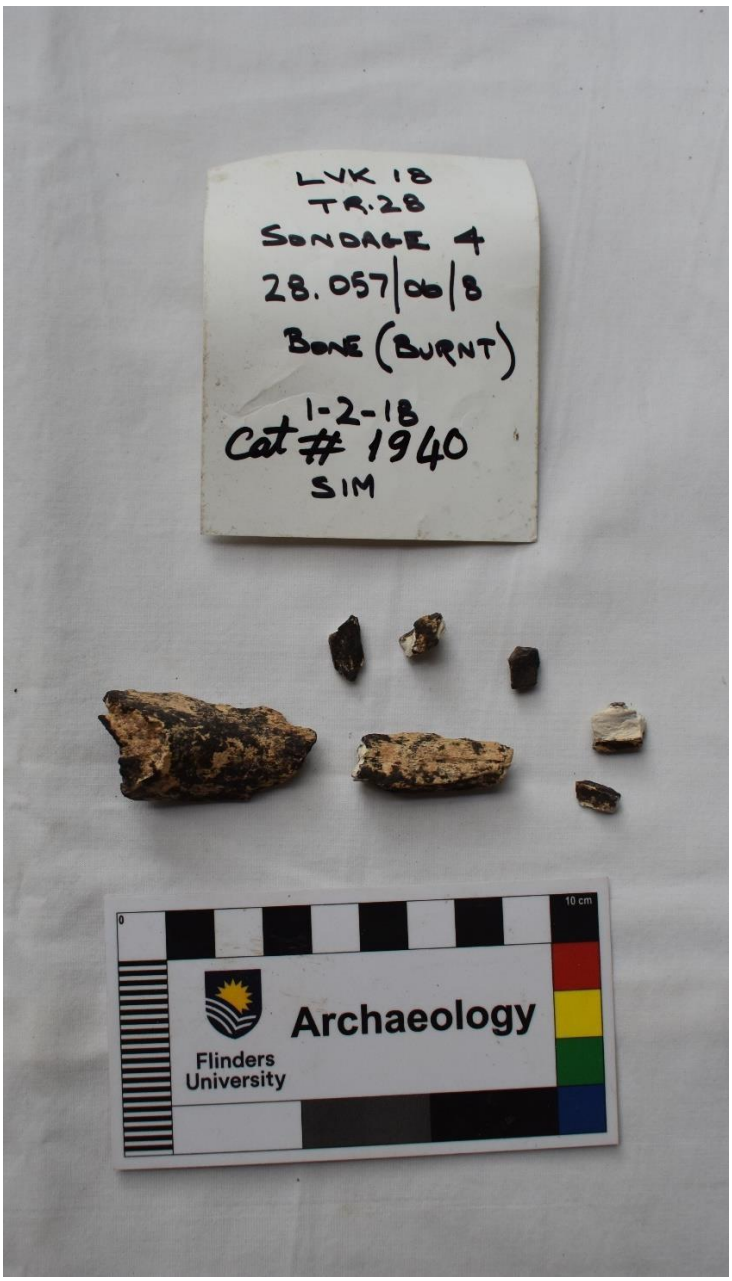

LVK 18
TR.28
SONDAGE 4
28.057/06/3
(B) BONE, cat#1934
2-2-18
SIM
0
10 cm
Archaeology
Flinders University


LVK 18
TR.28
SONDAGE 4
28.057/06/4
BONE C
1-2-18
SIM
Cat #1935
0
10 cm
Archaeology
Flinders University

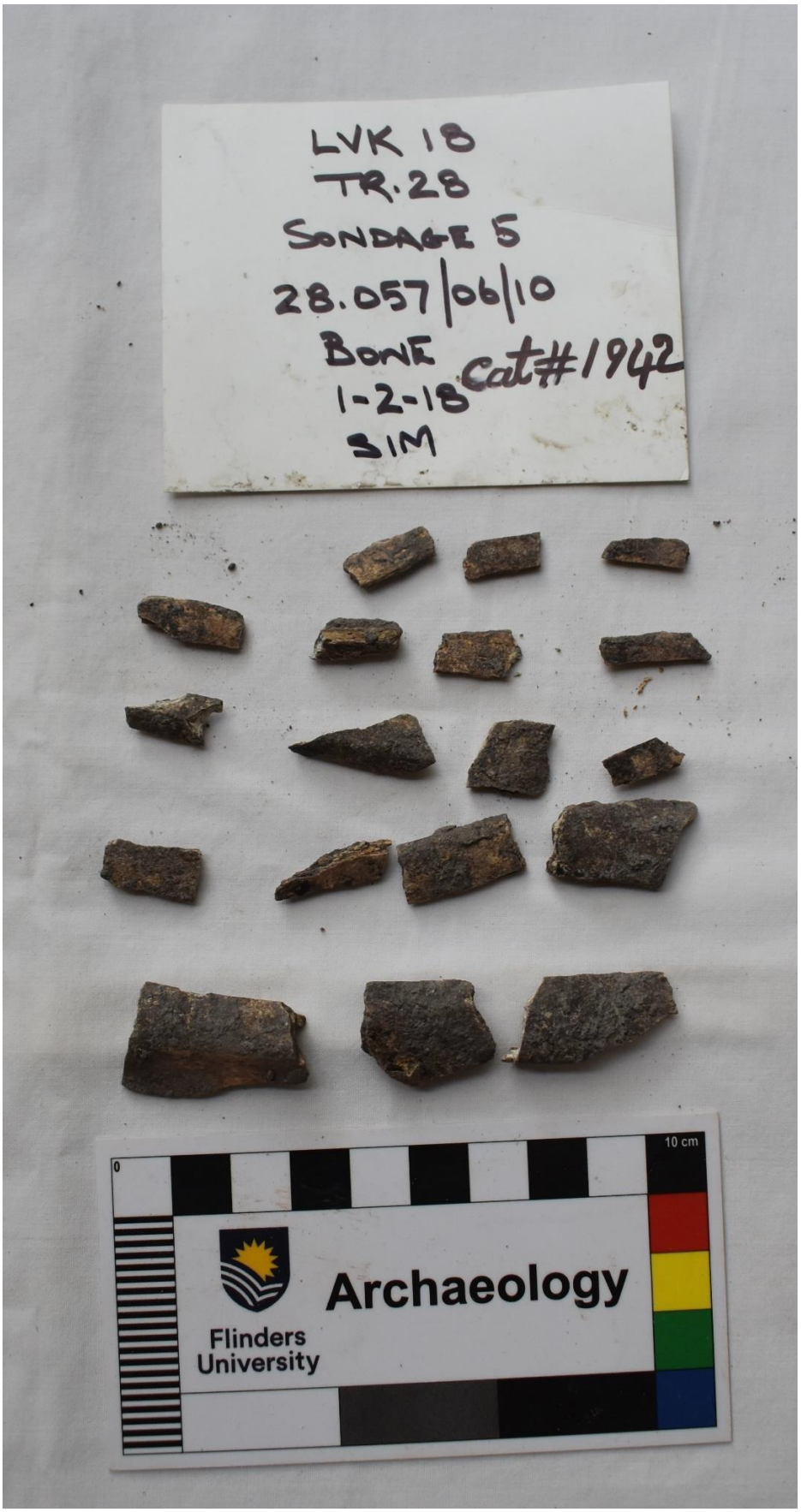

LVK 1B
TR.28
SONDAGE 1
28.057/06/4
© BONE; cat#1936
2-2-18 SIM
0
10 cm
Archaeology
Flinders University


SIM
Cat # 1937
0
10 cm
Archaeology

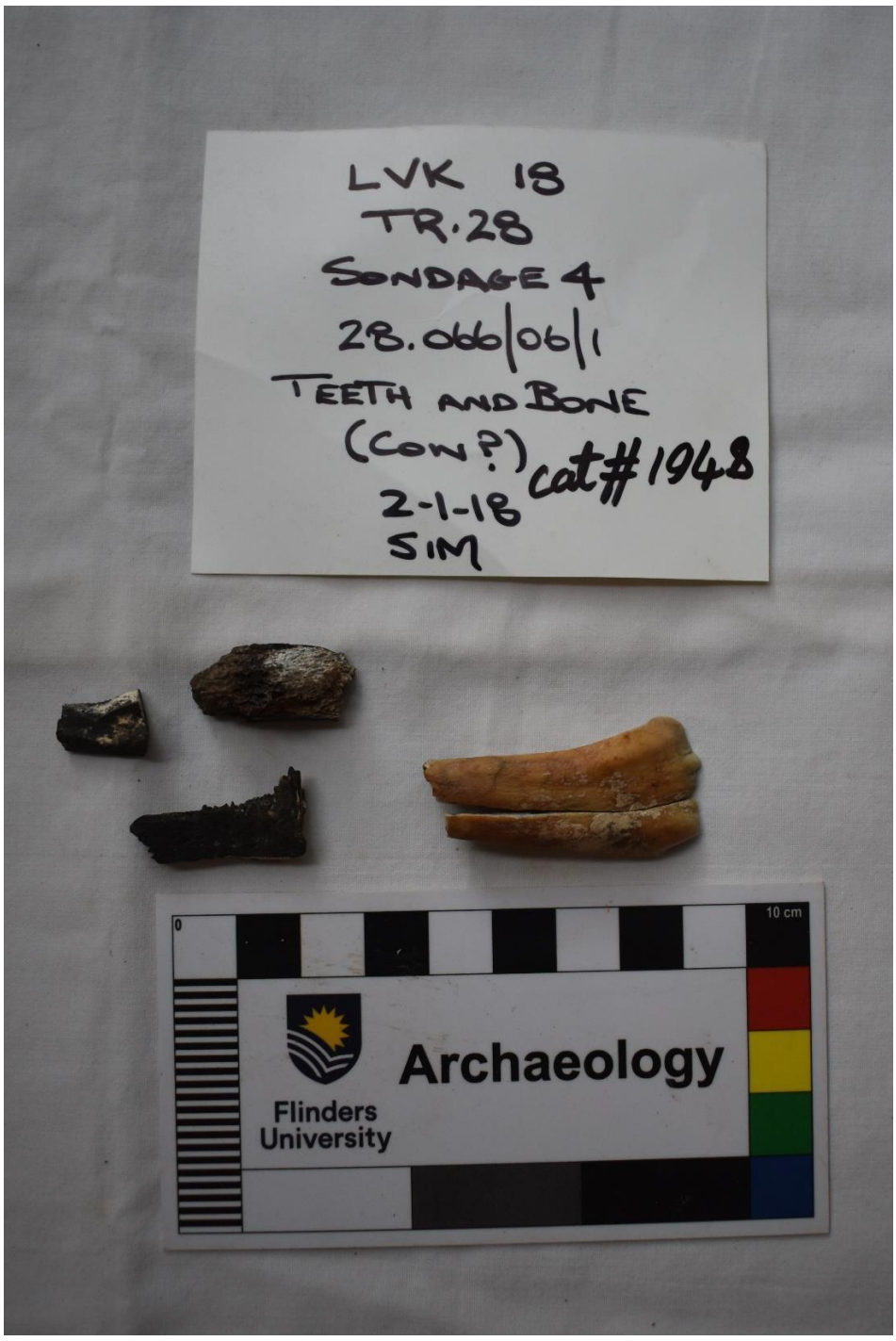

LVK 18
TR.28
SONDAGE 4
28.057/06/7
BONE
1-2-18
SIM
Cat # 1939
0
10 cm
Archaeology
Flinders University


LVK 18
TR.28
SONDAGE 4
28.057/06/8
BONE (BURNT)
1-2-18
Cat # 1940
SIM
0
10 cm
Archaeology
Flinders University


LVK 18
TR. 28
SONDAGE 5
28.057/06/9
BONE
1-2-18
SIM
cat#1941
0
10 cm
Archaeology
Flinders University


LVK 18
TR. 28
SONDAGE 5
28.057/06/10
BONE
1-2-18
SIM
cat#1942
0
10 cm
Flinders University
Archaeology


LVK 1B
TR.2B
SONDAGE 4
2B.057|06|2
A BONE (COW?)
2-2-18 SIM
Cat # 1945
0
10 cm
Archaeology
Flinders University


LVK 18
TR.28
SONDAGE 4
28.066/06/1
TEETH AND BONE
(CON?) cat# 1948
2-1-18
SIM
0
10 cm
Flinders University
Archaeology


LVK18
TR-28
SONDAGE 4 Bone
28.066/01
3.2.18 Cat#1950
0
10 cm
Archaeology
Flinders
University

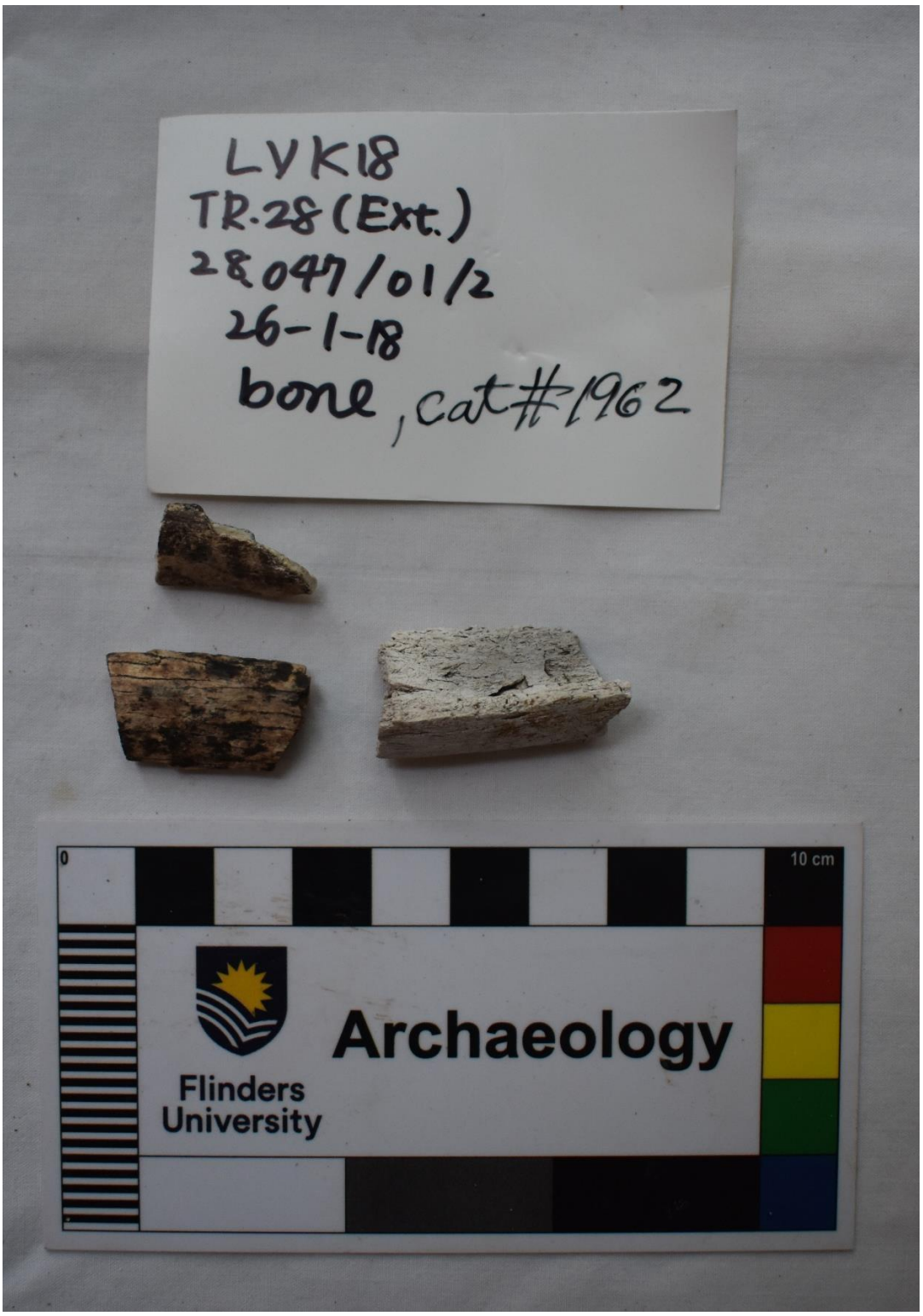

#H950/1
0
10 cm
Archaeology
Flinders
University

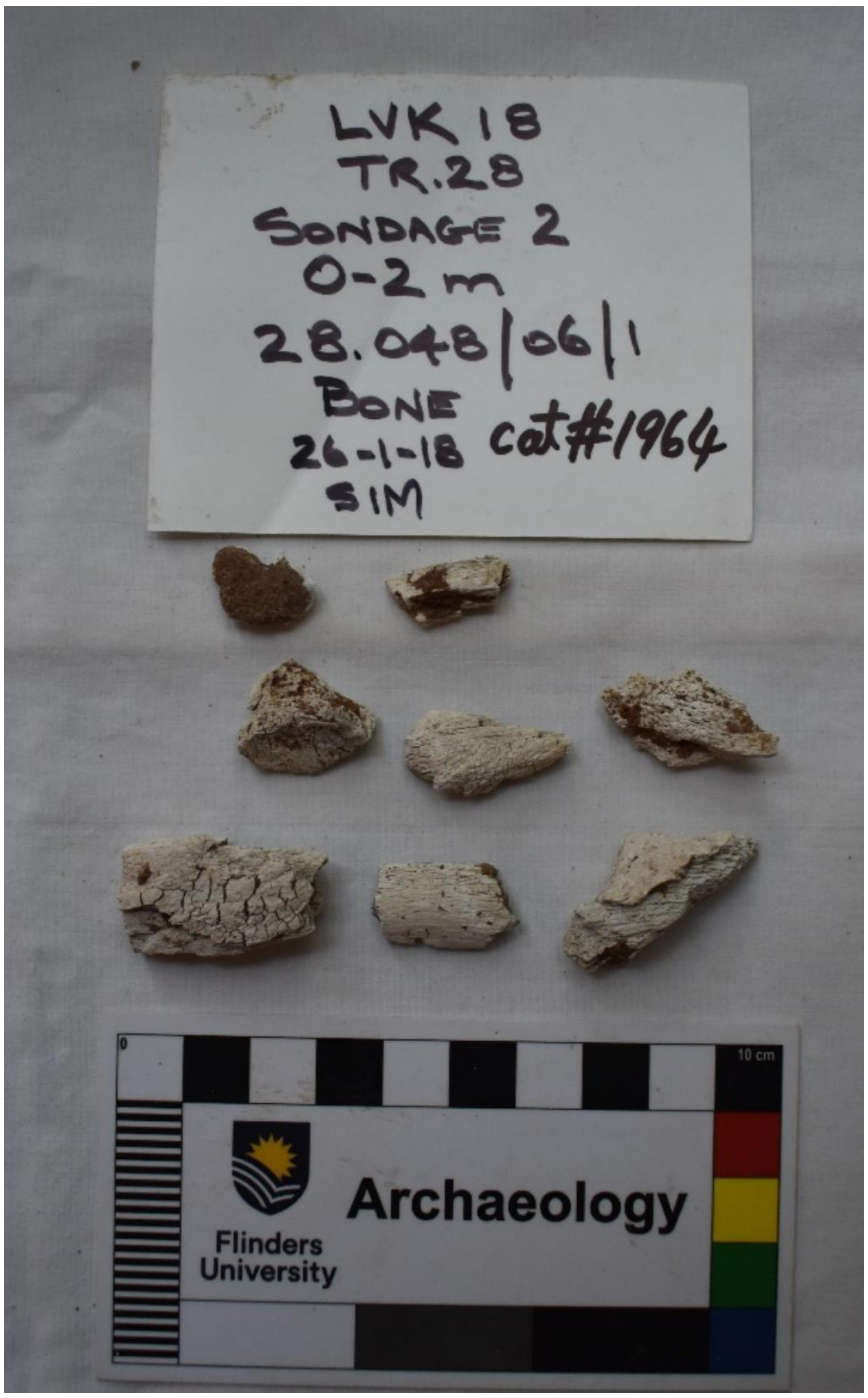

#1950/2
0
10 cm
Archaeology
Flinders University

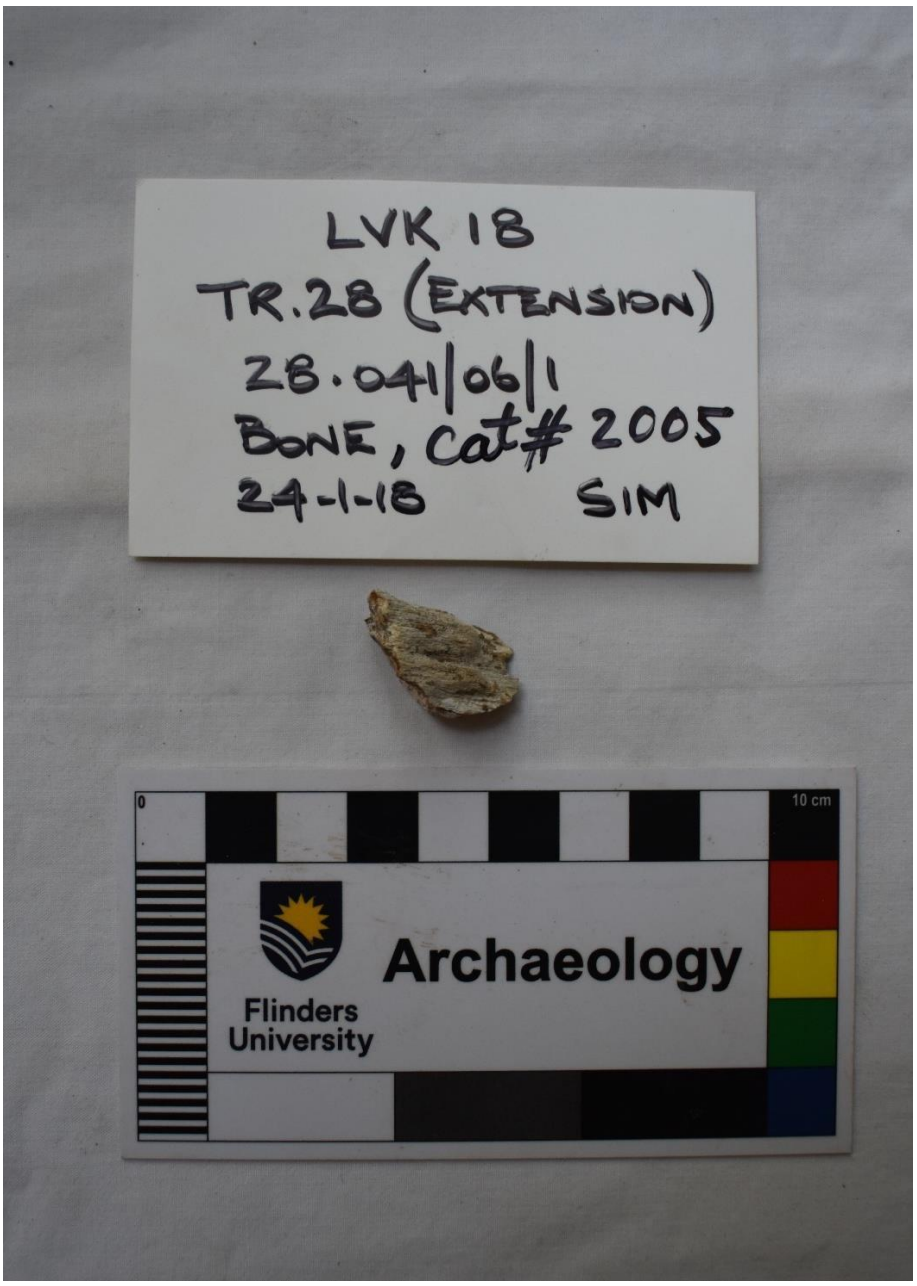

LVK 18
TR. 28
SONDAGE 4
28.092/06/1
BONE, cat#1951
3-2-18
SIM
Archaeology
Flinders University

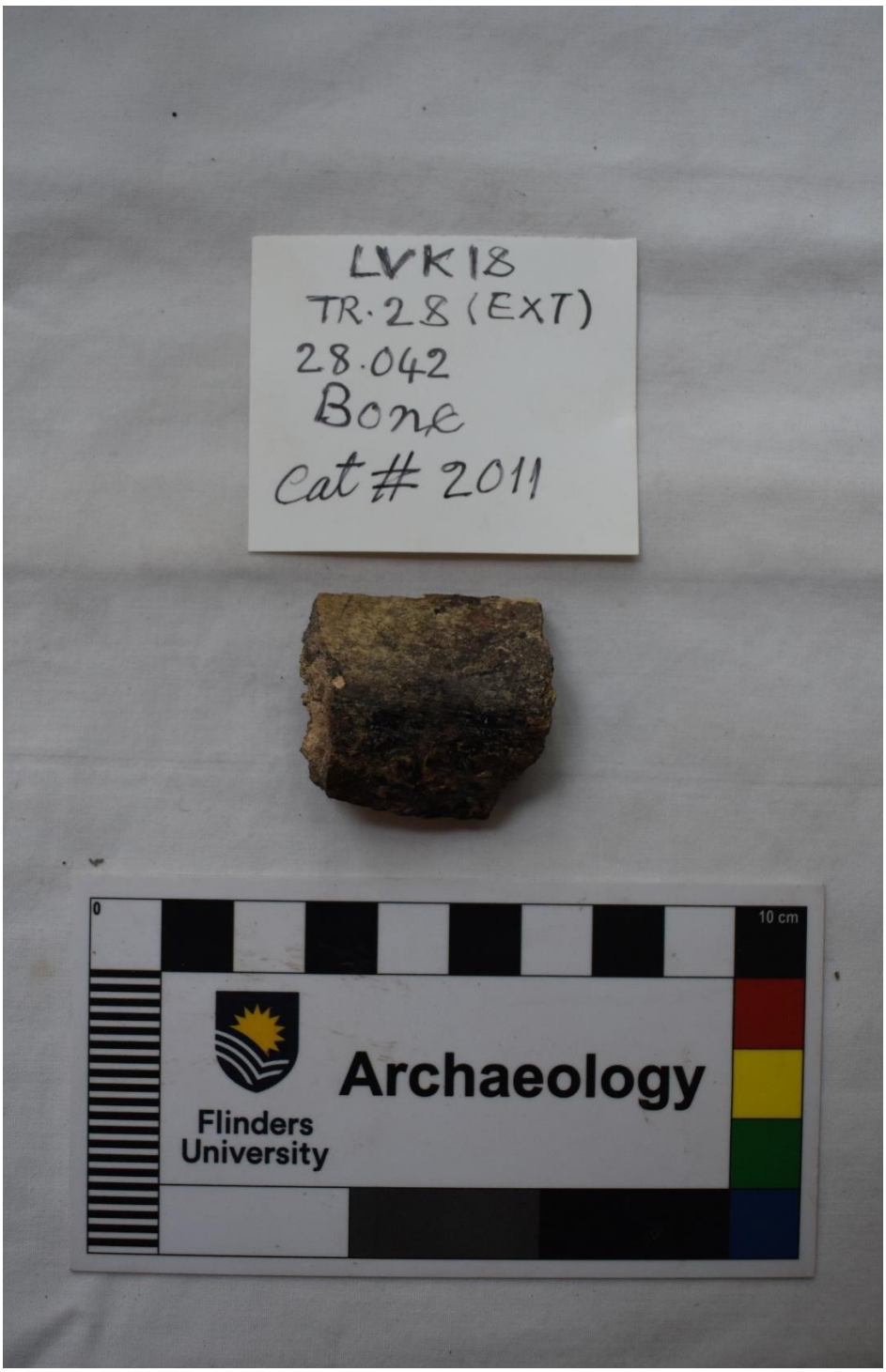

LVK 18
TR.28
SONDAGE 4
28.094/06/1
BONE, cat#1953
3-2-18
JIM
0
10 cm
Archaeology
Flinders University


LVK18
TR28
28.013
Bone
Cat#1961
0
10 cm
Flinders University
Archaeology

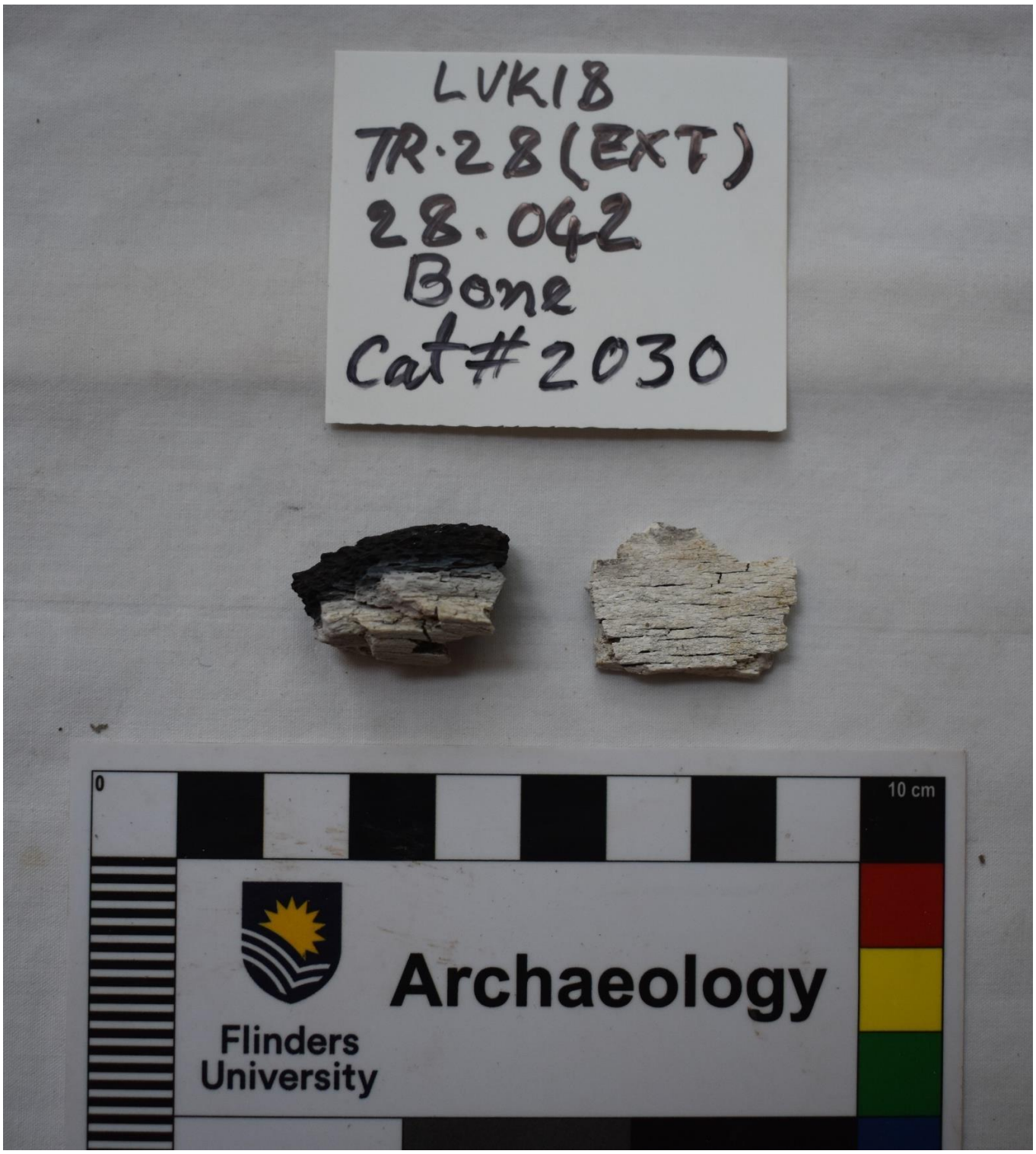

LVK18
TR.28 (Ext.)
28.047/01/2
26-1-18
bone, cat#1962
0
10 cm
Archaeology
Flinders University


LVK 18
TR.28
SONDAGE 2
0-2 m
28.048/06/1
BONE
26-1-18 cat#1964
SIM
0
10 cm
Archaeology
Flinders University


LVK 18
TR.28 (EXTENSION)
28.041/06/1
BONE, Cat# 2005
24-1-18 SIM
0
10 cm
Archaeology
Flinders University


LVK18
TR·28 (EXT)
28.042
Bone
cat # 2011
0
10 cm
Flinders University
Archaeology


LVK18
TR·28(EXT)
28.042
Bone
Cat #2015
0
10 cm
Flinders University
Archaeology


LVK18
TR·28(EXT)
28.042
Bone
Cat#2030
0
10 cm
Archaeology
Flinders
University


LVK18
TR·28(EXT)
28.047
Bone
cat# 2051
0
10 cm
Archaeology
Flinders
University


LVK18
TR. 28 (EXT)
28.047
Bone
Cat#2068
0
10 cm
Archaeology
Flinders
University

LVK19


CAT# 2485
1 # 1.2g
Fish Bone
0
10 cm
Archaeology
Flinders University