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AN INVESTIGATION OF ARCHAEO-FAUNAL COLLECTION FROM THE EARLY STONE AGE SITE OF GADEB, SOUTH CENTRAL ETHIOPIA

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Addis Ababa University.

Approved by Examining Committee

Advisor

Signature Date

Internal examiner

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Declaration

I, Haregwin Belete, hereby declare that this master's thesis entitled An Investigation of Archaeo-Faunal Collection from The Early Stone Age Site of Gadeb, South Central Ethiopia is my own work. The work presented in this thesis is the result of my own research, and all sources of information and assistance have been acknowledged.

Name: Haregwin Belete

Date of submission January 10, 2024

This thesis has been submitted for examination with my approval as the research advisor.

Name: Dr. Alemseged Beldados

Signature

Date

Addis Ababa, Ethiopia

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Abstract

Despite the long history of archaeological research at Gadeb, no faunal studies have been conducted from this site. Thus, its context and the functional associations between the bone remains and Acheulean lithic artifacts is far from being understood. This presentation aims at addressing these critical issues through zooarchaeological methods. We examined taphonomic and taxonomic composition of the faunal assemblages from two excavation localities, i.e., Gadeb 2 and Gadeb 8. Both localities yielded diverse range of taxa including significant presence of water-dependent species such as Hippopotamidae among other ungulates. The overall taxonomic composition, however, suggests the presence of multiple micro-environments within the Gadeb area. Taphonomic results shows that despite the high abrasion of bone surfaces, the Gadeb faunal assemblage showed hominid induced marks indicated by the presence of cut and percussion marks. Furthermore, no carnivore specimen as well as carnivore-modified specimens were identified in the assemblage. Based on these, we conclude that hydraulic sorting and hominid activity as major accumulating agents. The study contributes to our understanding of ecological background, hominid behaviour and site formation of the Gadeb landscape during the Pleo-Pleistocene period.

1. Chapter One – Introduction

1.1. General Background

The late Pliocene period in Africa witnessed significant events in early human evolution, such as major taxonomic diversification and the emergence of stone tool technology (Bobe et al., 2002). In recent decades, zooarcheological and taphonomic studies has played a crucial role in enhancing our understanding of the behaviour of hominids during the Early Stone Age (Domínguez-Rodrigo et al., 2005; Domínguez-Rodrigo et al., 2002; J. C. Thompson et al., 2015). Through the analysis of butchery marks, zooarchaeology has shown functional connections between the world's oldest lithic technology and the processing of animal carcasses into essential edible parts, it has also provided preliminary insights into hominid dietary preferences based on the taxonomic identification of bones with butchery marks (R. J. Blumenschine, 1995; R. Blumenschine & Pobiner, 2007, 2007; Bunn, 1981; Bunn, & Kroll, 1986; Domínguez-Rodrigo et al., 2005; Domínguez-Rodrigo et al., 2002; T. Pickering & Egeland, 2009; T. R. Pickering et al., 2004). According to (Fisher, 1995) and (Assefa, 2006), the study of Bone surface modifications through zooarchaeology can be a major evidence for understanding human interactions with bone assemblages evident for human animal interaction. Furthermore, comprehending the function of the earliest archaeological sites holds significant implications for reconstructing Plio-Pleistocene hominid behaviour (Bunn & Ezzo, 1993; Monahan, 1996).

The archaeological localities of Gadeb are situated along the upper reaches of the Wabe Shebelle River on the south-east plateau of Ethiopia on the plain of Gadeb at elevations ranging between 2300 and 2400m (Figure 1). The Wabe Shebelle River is one of the major rivers of East Africa (Clark, 1987; Clark & Kurashina, 1979a, 1980; Williams et al., 1979). The geological setting to the site is made up of fluvio-lacustrine deposits from Plio-Pleistocene periods (Williams et al., 1979). The present vegetation patterns are not different from Plio-Pleistocene environments of the area; short montane grassland with stands of Acacia and Occasional relict Junipers and in higher elevations *podocarpus* and Juniper forests (Clark, 1987; Clark & Kurashina, 1979b, 1980).

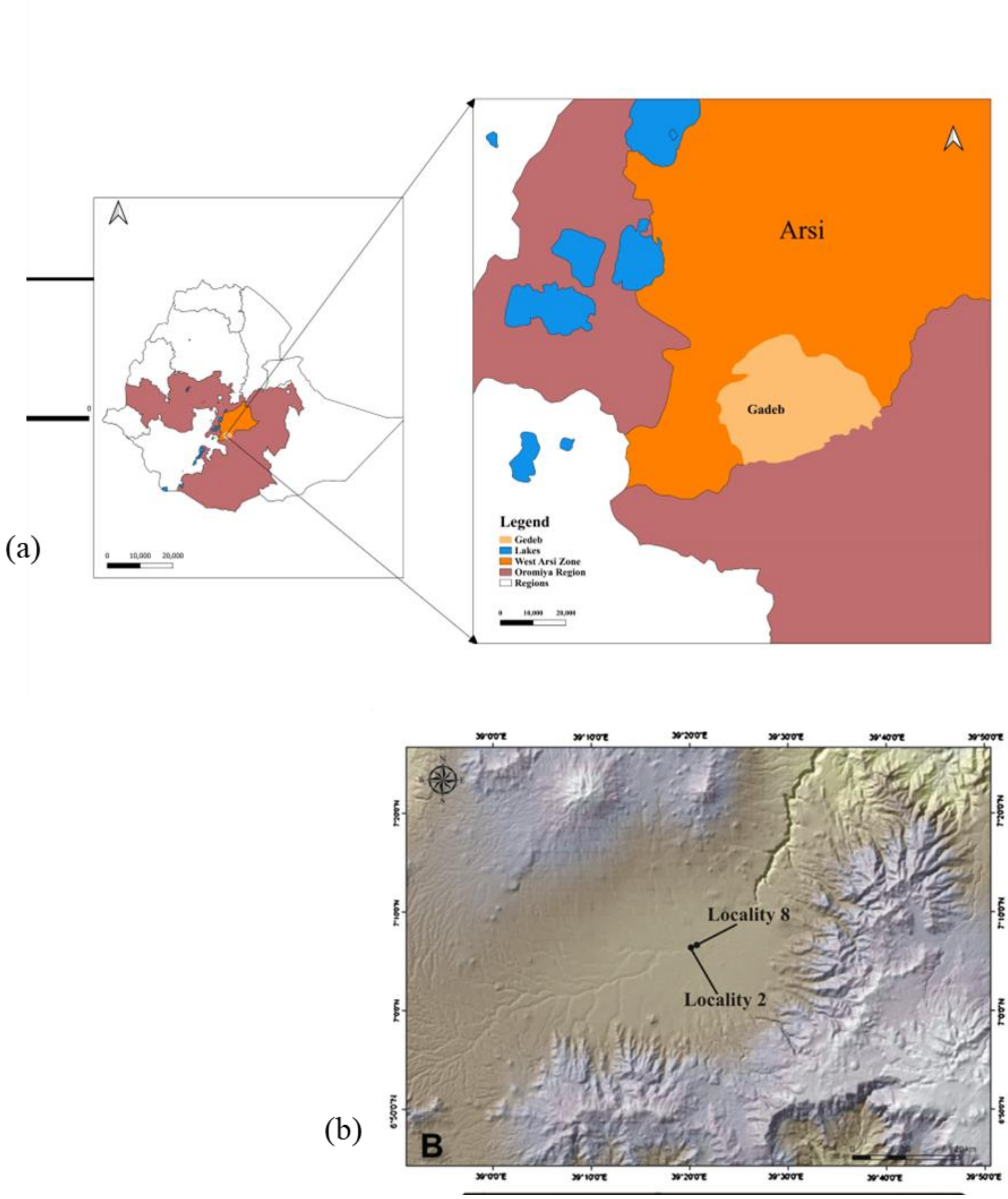


Figure 1: (a) General map of Gadeb localities (b) the two localities (digital Terrain Model of the Gadeb plain with position of Localities 2 and 8) modified from De La Torre, 2011

The upper reaches of the Wabe Shebelle River basin, including the Gadeb plain, were visited by Bough de Bozas, and some archaeological materials were collected in 1901. Comprehensive excavations were conducted at the site only in 1975 and 1977, as part of a project led by Desmond Clark (Clark & Kurashina, 1979b; De la Torre, 2011). Unfortunately, the excavations did not continue further.

Prior to the excavations, an extensive geomorphological and archaeological reconnaissance was carried out in the area by a team from the University of California at Berkeley and Macquarie University in 1974 and 1975 (Clark & Kurashina, 1980). Limited fieldwork was also conducted in 1990, focusing on sampling deposits for stratigraphic correlations (Bereket Haileab & Brown, 1994). Since then, no further fieldwork has been undertaken, possibly due to the damming of the Upper Wabe Shebelle River at the Melka Wakena Hydroelectric power station, which partially flooded the area in the 1980s (Bereket Haileab & Brown, 1994; De la Torre, 2011). By the time De la Torre visited the site in 2008, the deposits containing the archaeological remains were already submerged under water, although upper sections of the sedimentary sequence were still partially exposed (De la Torre, 2011).

1.2. Statement of the Problem

After the 1975/77 excavations, further fieldworks did not continue at the Gadeb archaeological site. However, several studies have been conducted on the lithic materials (Clark, 1987; Clark & Kurashina, 1979b, 1979a, 1980; De la Torre, 2011; Kurashina, 1978, 1987), the geology (Eberz et al., 1988; Getaneh Assefa et al., 1982; Williams et al., 1979), and environment (Bonnefille, 1983) of Gadeb. In many cases, archaeological assemblages from the Plio-Pleistocene periods lack well-preserved faunal remains associated with artifacts, or archaeological studies heavily focus on lithic material (Forrest et al., 2018)

In the case of Gadeb, faunal remains have been recovered from several archaeological horizons (2A, 2B, 2C 2E, 8D, 8E, and 8F) and provisional identifications were made by Denis Geraards (Clark & Kurashina, 1980). However, these faunal remains have been reported without further analysis and interpretations. Although a large collection of diverse taxa is stored in the collection department of the Ethiopian Heritage Authority (EHA), the taxonomic composition, the degree of hominin contribution to the fossil accumulation in the site, and the complex taphonomic history of the site formation remain unexplored. Additionally, localities such as Gadeb 8F have been described as "specialized activity sites" where hippopotamus likely had been butchered (Clark, 1987). Stone tools found in association with hippo remains have been referred to as tools used in the butchery process and were found in primary context with the hippo remains (Clark & Kurashina, 1979b). However, these interpretation by previous researchers are mainly based on the study of lithic artifacts from the locality and field observations of bone and artifact associations. No study has been conducted to examine the modification patterns on faunal remains that could support this statement.

Therefore, this research aims to investigate the role of hominid behaviors and non-hominid taphonomic agents in the site formation process. It involves assessing cut marks made by stone tools, conchoidal flake scars from hammerstone percussion, carnivore tooth marks, striations from sedimentary abrasion, and other surface modifications on bones. Furthermore, the study examines the modification patterns on bones recovered from the 'special activity site', to evaluate the extent to which the traces on the fauna support the interpretation made by previous researchers. In addition, I studied the taxonomic composition in this site to understand the paleoenvironment.

1.3. Research Questions

Based on the statement of the problem, several questions arise that require investigation. For this study, the following three main questions are addressed:

- What is the taxonomic composition and skeletal element representation in Gadeb localities?
- To what extent did hominids contribute to the faunal assemblage?
- What are the complex taphonomic processes involved in the site formation process?

1.4. Objective

1.4.1. General Objective

This study aims to understand the taphonomic processes and the taxonomic composition of Gadeb archaeological site complex.

1.4.2. Specific Objectives

In addition to the general objective, the specific objectives of this study are as follows.

i. Conducting curation on the faunal assemblages. Given that the faunal remains have not received proper curation (cleaning, organization, treatment, and storage) since their recovery and preliminary identification by Denis Geraards, curation is crucial. Curation of the faunal remains was essential before any analysis.

ii. Taxonomic identification of faunal remains recovered from Gadeb localities. Despite the preliminary identification of general taxa by Denis Geraards, a detailed taxonomic classification and interpretation have not been conducted.

iii. Identifying the taphonomic agents (anthropogenic and non-anthropogenic) responsible for the accumulation of bones within the archaeological layers by examining traces on bone surfaces/bone surface modification.

iv. Study possible implications of the faunal assemblages

v. Reconstruction and understanding of the ecological context of the study areas through the faunal remains.

1.5. Significance of the Study

Despite Gadeb being one of the very few east African early stone age sites located on the high elevation areas, no detailed study of the fauna has been conducted. This thesis aimed to contribute to the understanding of broader human evolution through the analysis of faunal remains. This zooarcheological investigation from Gadeb faunal remains provide interesting supplementary evidence for behavioural traits and activities of the hominid groups of Lower and Middle Pleistocene times in the central highlands of Ethiopia. It provides insights into the extent of taxonomic composition, site formation process and the affiliation between the different taxa composition and the Hominins.

The faunal identification offers a sample of what taxa existed in or around Gadeb at the time. The analysis shows animals as the preferred accumulators but does not necessarily provide an accurate image of all the animals that existed in and around the site in the same time frame. An examination of different aspects of a bone fragment, suggests how the organism's remains got into the site. Assefa (2002) suggests that integrating various types of observations on a given faunal assemblage, instead of exclusively focusing on a single class of zooarcheological evidence, yields the most productive zooarcheological studies in terms of addressing broader anthropological issues.

1.6. Scope of the Study

A significant amount of archaeological material has been discovered at the Gadeb early Stone Age site although this study focuses specifically on the faunal remains. The site's earliest date is at about 2.3 Ma, but the cultural sequence begins at 1.4 Ma. My study frame is from middle to late Pleistocene. The investigation included analysing bone surface modifications (BSM) caused by non-human such as carnivores and post-depositional processes, and by hominins employing stone tools, particularly for carcass butchery processing and accessing marrow activities.

1.7. Structure of the Thesis

This thesis consists of five chapters. The First Chapter provides an introduction, including the background of the Gadeb site, the significance of the study and the objectives. The Second Chapter provides a summary of previous studies on the geology and archaeology of Gadeb and general overview of taphonomic studies. The Third Chapter presents materials and methods. Results and data analysis are presented in Chapter Four. Chapter Five is dedicated to the interpretation, discussion, and conclusion.

2. Chapter Two – Literature Review

2.1. Geological and Paleo-Geographical Setting of Gadeb

The archaeological localities of Gadeb are situated on the plain of Gadeb, near the headwaters of the Webi Shebelle River, on the Ethiopian Southeast volcanic uplands at an elevation of 2300 to 2400m (Clark, 1987; Clark & Kurashina, 1979a; Williams et al., 1979). The Webi Shebelle meanders through the Plain of Gadeb on the west side of the Southeast plateau, where several localities containing artifacts and faunal remains have been found along a stretch of approximately 70km, starts from Melka Likimi in the east and extends westward along the river to localities near Gadeb, situated 20km north of the main road between the towns of Adaba and Dodola (Clark & Kurashina, 1980). The current vegetation pattern of the region is characterized by montane grassland with stands of Acacia, occasional relict Juniper trees, and higher elevations covered by Juniper, and Podocarpus forests (Clark, 1987; Clark & Kurashina, 1979b). Present-day vegetation is not significantly different from the Plio-Pleistocene period, according to Clark and Kurashina (1979a).

According to Williams et al. (1979), the oldest exposed diatomites along the edge of the gorge overlie basalts that have been dated to 4.35 Ma, 2.69-2.71 Ma, and 2.51 Ma. Pliocene diatomites, dated between 2.7 and 2.34 Ma, indicate the presence of a Pliocene Lake formed behind a natural lava dam created by basaltic eruptions. The nearby shield volcanoes of the Bale Mountains are a possible source of these lavas. Pollen and diatom evidence studied by Bonnefille, (1983) indicate a significantly cooler and drier climate between 2.5 and 2.35 Ma, with an abundance of highland and montane grassland pollen dominating the pollen diagram. By 2.35 Ma, Pliocene Lake Gadeb had diminished to a series of small lakes and swamps located near the centre of the basin (Williams et al., 1979). The former lake's approximate extent can be deduced from deposits that reach elevations up to 2340m. The lake had a minimum surface area of 155km^2 and was at least 40m deep. The analysis of 215 diatomite samples reveals a diverse and rich flora. The increase in detrital material towards the top of the lake sequence reflects a fall in lake level, as evidenced by the diatom flora, followed by a progressive drying out of the lake.

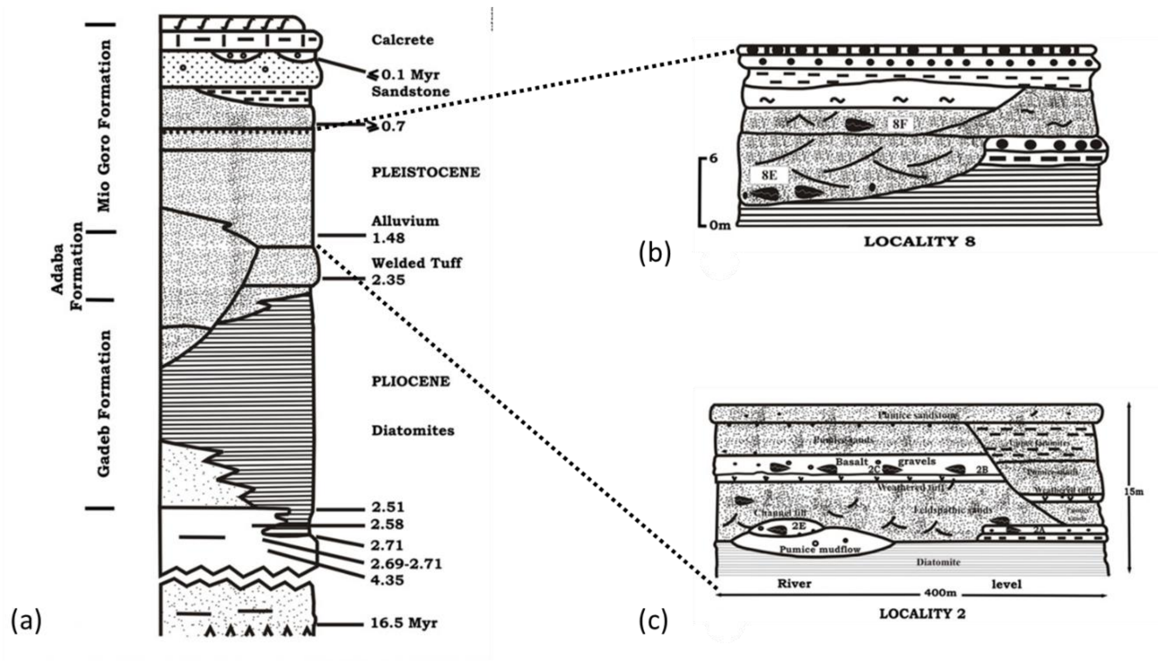


Figure 2: (a) General stratigraphy of the Gadeb sequence (adapted from Eberz et al., 1988). (b) & (c) stratigraphic sequence in Locality 8 and Locality 2 (adapted from Williams et al., 1979)

However, silts and sands accumulated during the final regression of Pliocene Lake Gadeb occasionally contain thin diatomaceous horizons deposited during brief periods of more swampy conditions. These discontinuous lenses are found only in a few sections near the centre of the basin and cannot be correlated from one section to the next. These ponds persisted during subsequent phases of river erosion and deposition, which coincided with the arrival of tool-bearing hominids. Overlying the Pliocene diatomites are widespread artifact-bearing gravels and finer sediments (Williams et al., 1979). Bonnefille (1976) suggests that during Acheulian times, riparian forests consisting of montane species flanked by Acacia grassland would have existed on the high plains of the Southeast Plateau, based on evidence from the comparable locality of Melka Kunture on the Ethiopian Plateau across the Rift.

2.2. Archaeology of Gadeb

Clark & Kurashina, (1980) reported the discovery of 15 localities over a 3km stretch along the river at Gadeb, where Plio-Pleistocene fluvial & lacustrine sediments are exposed as cliff sections on the outside of the meanders. The Pliocene sediments in the central parts of the basin were likely deposited in standing water and are unlikely to contain artifacts (Clark & Kurashina, 1979b). Artifact-bearing fluviatile sands and gravels overlay the Pliocene lacustrine diatomites and clays. These fluviatile sediments occupy erosional channels and postdate a welded tuff dated to 2.35±0.2 Ma, which overlies the lake deposits. A notable erosional unconformity separates the lacustrine and fluviatile series (Williams et al., 1979). There are no artifacts associated with the alluvium interbedded with the diatomites or with the paleosol horizon. Clark & Kurashina, (1979a) suggest that intensive examination of the paleosol horizon concludes that there is no evidence of artifacts or other hominid activity. According to their study, cultural evidence appears when Pliocene Lake Gadeb had mostly dried out after the breaching and downcutting of the dam and the formation of the gorge. This evidence dates to between 1.5 and >0.7 Ma based on K/Ar and paleomagnetic reversal evidence. The artifacts occur on paleosols adjacent to the banks and in association with gravels of shallow stream courses draining into the ponds and swamps that still occupied the lower and central parts of the basin.

The cultural horizons are exposed by the meanders of the main river, occurring in the more central parts of the exposed floor of the former Pliocene Lake. Examination of the southern flanks near the base of the Bale Mountains, which rise to over 4000m, produced only occasional artifacts of the Developed Oldowan type, suggesting that the more outlying parts of the basin may have been less favourable living places for hominids. Based on the evidence from Gadeb, Clark & Kurashina, (1979a) propose that hominids appeared on the Ethiopian high plateau only after 1.5 million years.

At Gadeb, artifacts are found in fluvial tile sands or sediments. These artifacts, predominantly made of local basalt and welded tuff, belong typologically to the Developed Oldowan and Acheulian technologies (Clark, 1987; Clark & Kurashina, 1979a; Williams et al., 1979). Occasional obsidian tools are also present, and Williams and colleagues (1979) suggest that since the raw material is not available in the Gadeb area, they must have come from sources in the Rift, approximately 100km away.

Developed Oldowan artifacts are found in a tin gravel capped by mudstone, unconformably overlying the diatomite at Locality 2A (Clark & Kurashina, 1979a). A pumice mudflow with artifacts dating to 1.48 million years BP is also present. Further artifact concentrations contain alternating horizons of felspathic sands, clays, gravels, and weathered tuffs, with varying proportions of Acheulian and Developed Oldowan components (Clark, 1987).

(Clark, 1987) suggests that no significant sorting of artifacts has occurred, and many assemblages remain unaltered. Overall, the artifacts and faunal remains are in fresh condition and unabraded, indicating that while the lightest elements may have been removed, significant transport of the assemblages by the stream can be ruled out. However, some resorting has taken place, resulting in the mixing of individual episode concentrations. Clark (1987) believes that the localities were likely favoured due to their abundant resources, including plant foods, the frequent presence of carcasses for scavenging, the availability of suitable stone for tool making, and easy access to water.

2.2.1. Gadeb Archaeological Localities

Gadeb Locality 2

The Gadeb 2 and Gadeb 8 localities share a similar fluvial depositional sequence. The sediment sequence begins with basaltic gravels and feldspathic sands, followed by alternating layers of feldspathic and pumiceous materials, and is capped with massive pumice sediments (Williams et al., 1979). The oldest archaeological remains found at Gadeb date back to approximately 1.48 million years ago (mya) in Locality 2A, embedded in the iron-stained base of ferruginous gravels near the erosive contact with the Gadeb formation diatomite. The excavation area at this locality measures 6x2.5m, and the artifacts found there are mostly abraded, indicating a secondary context. Developed Oldowan-type artifacts dominate this locality (Getaneh. Assefa et al., 1982; Clark, 1987; Clark & Kurashina, 1979b; De la Torre, 2011). These occurrences are followed by further Acheulian and Developed Oldowan artifact components (locality 2E, 2B (Figure 3) and 2C), contained within alternating horizons, feldspathic sands, clays, gravels, and weathered tuffs (Clark, 1987; Clark & Kurashina, 1979b). Most of the artefact-bearing sediments postdate a 1.5Myr pumice deposit and may be older than 0.7Ma (Williams et al., 1979). Gadeb 2D provided only fauna from current bedded sands and fine gravels, Gadeb 2B is at a slightly higher (c. 1.5m) elevation than Gadeb 2C and is probably, therefore, somewhat later in age: Gadeb 2D is c. 1.0m lower than 2C. The distance between 2B and 2C is c.400m (Clark & Kurashina, 1980).

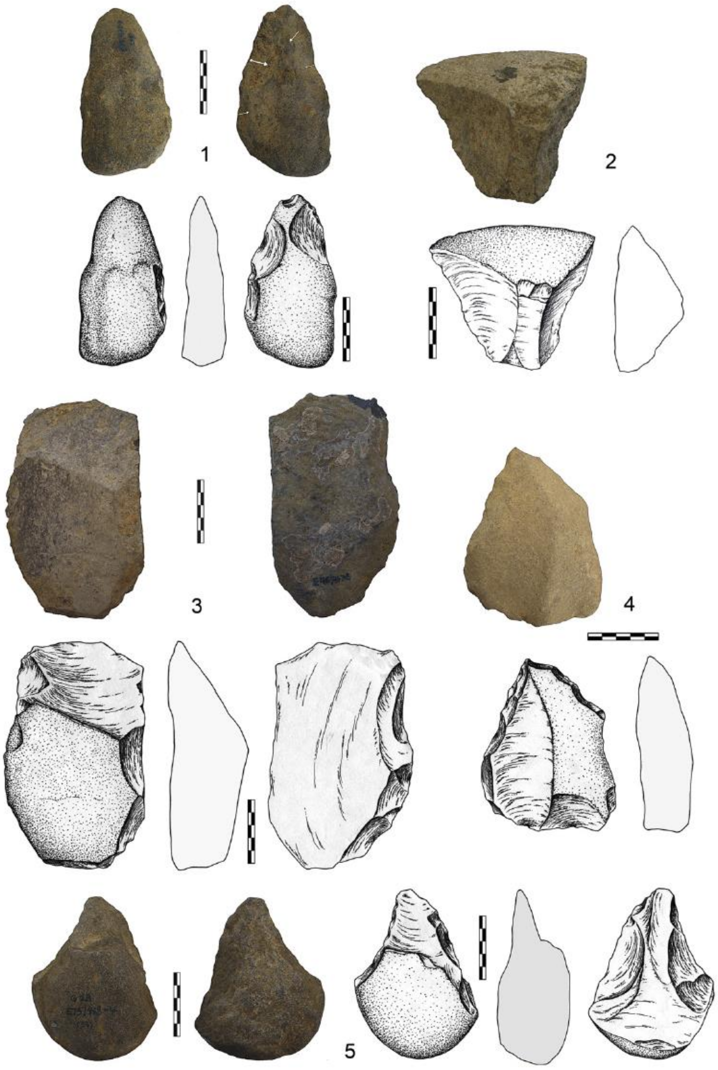


Figure 3: Large unmodified flakes ((#2) and LCTs ((#1, 3-5) in Gadeb 2B (De La Torre, 2011)

In Locality 2E, an excavation area of $40m^2$ revealed an area of hominid activity, indicating occupation during a period when the channel floor was temporarily exposed. The artifacts found here show slight to moderate abrasion, suggesting that Locality 2E represents a primary context site that has experienced some but not extensive resorting before deposition (Clark & Kurashina, 1979b). Provisional work by D. Geraards and S. Edwards, as reported by Clark and Kurashina (1979b), identified several fossil bone fragments and teeth associated with the artifacts at Locality 2E. The faunal remains included hippopotamus, elephant, various bovids, zebra, and pig. Based on the taxa composition, the assemblage suggests the presence of game animals available on the high plateau during that time.

Gadeb Locality 8

Gadeb Locality 8 is situated 2km east of Locality 2, and artifacts were found eroded in several places (Clark & Kurashina, 1980). Acheulian or Oldowan artifacts found in association with channel sands are mostly composed of a large number of artifacts (Clark, 1987). Excavated localities at Gadeb, including 8A, 8D, 8E, and 2D, represent areas of hominid activity located in or on the edge of channels, sand, or gravel bars, exhibiting high concentrations of artifacts that show general freshness, indicating limited fluvial redeposition (Clark, 1987).

In the 8A excavation area at Gadeb, measuring 2x4m, most of the artifacts display heavy to moderate degrees of abrasion and preferred orientation, indicating a secondary context and movement by the stream. Faunal remains were discovered in this area, and preliminary analysis identified dental remains of *Hippopotamus amphibius*, Alcelaphini as well as other postcranial remains of Bovidae and Elephantidae. Hippopotamus presence is widespread in this locality (Clark & Kurashina, 1980).

Locality 8A, 8D and 8E are associated with basalt gavels and feldspathic sands resting on an erosional unconformity cut down into the later Pliocene diatomites. Locality 8E covers a larger excavation area of $100m^2$. The small 8A excavation produced a surprising number of 1849 artefacts. Excavations 8D and 8E were 30 m apart and exposed the edges of a channel and its banks to the south-east. To the south and west the gravel was 10-15 cm thick while at the eastern end the artefacts rested directly on the diatomite. Locality 8D excavation covered 3x5m excavation area and revealed a primary context of artifacts and faunal remains (Clark & Kurashina, 1979b).

In the 8E excavation, which shares the same occupation surface as 8D, 20,276 artifacts and a small quantity of faunal remains were recovered. The faunal remains consisted mostly of unidentifiable small fragments and isolated teeth, with hippopotamus being the most common, represented by two complete large incisors and several molars including fragments. Bovids followed as the next most common group, with zebra also present. whether in the Acheulian or in Developed Oldowan sites (Clark & Kurashina, 1979b). According to (Clark, 1987), locality 8E has two crucial records for understanding human evolution at the time: the use of fire and population movement or exchange of material. This locality provided marginal evidence, in the form of burned rock, which could be evidence for intentionally used fire. And four handaxes made of obsidian, a raw material not found in Gadeb but in the Rift valley,100km to the west, have been found. (Clark, 1987) believes this indicates that population movement or exchange between the plateau and the rift was taking place between 1.4 and 0.7mya

Gadeb Locality 8F

Excavated localities at Gadeb indicate regular reoccupation over an extended period of time. The large assemblages of artifacts and their paleo-topographic context suggest multiple reoccupations of the site, possibly on a seasonal basis. At the time of excavation and analysis, Locality 8F represented the only individual activity site (Clark, 1987).

(Clark, 1987; Clark & Kurashina, 1979b), propose possible contextual relationship between the lithic assemblage and fossils. This ‘special activity site’ Gadeb 8F, is situated on a palaeosol approximately 4.5m above 8E. An area of 8x5m excavation revealed discrete concentration of artifacts associated with the butchered remains of a hippopotamus. According to Assefa et al., (1982) and Kurashina, (1978) on De la Torre, (2011), several hippo bones, including three tusks, one left scapula and one rib were found possibly corresponding to a partial skeleton. The spatial association with the lithics suggests that the "scapula, long bone, and rib fragments lay together with two sub-spheroids and a spheroid, which were used to break up the bones to access the marrow".

The assemblages resemble in general Developed Oldowan artifacts but includes three better-made handaxes, one cleaver and two knives. The commonest shaped tools are small side-scrapers, polyhedrons, and core scrapers (e.g., Figure 4). This ‘toolkit’ could have been used in butchering the hippo and the polyhedrons, spheroids and some of the small tools were found in close association with bones. This appears to be a single-context activity area and the assemblage is like others from east Africa associated with butchery. It is in marked contrast to the large stream-side sites, whether of Developed Oldowan or of Acheulian type. The smaller 8F occurrence is a site where, though other activities could be represented, the main one appears to have been the butchery of a partial hippo carcass and, as such, is a single-episode activity set (Clark, 1987).

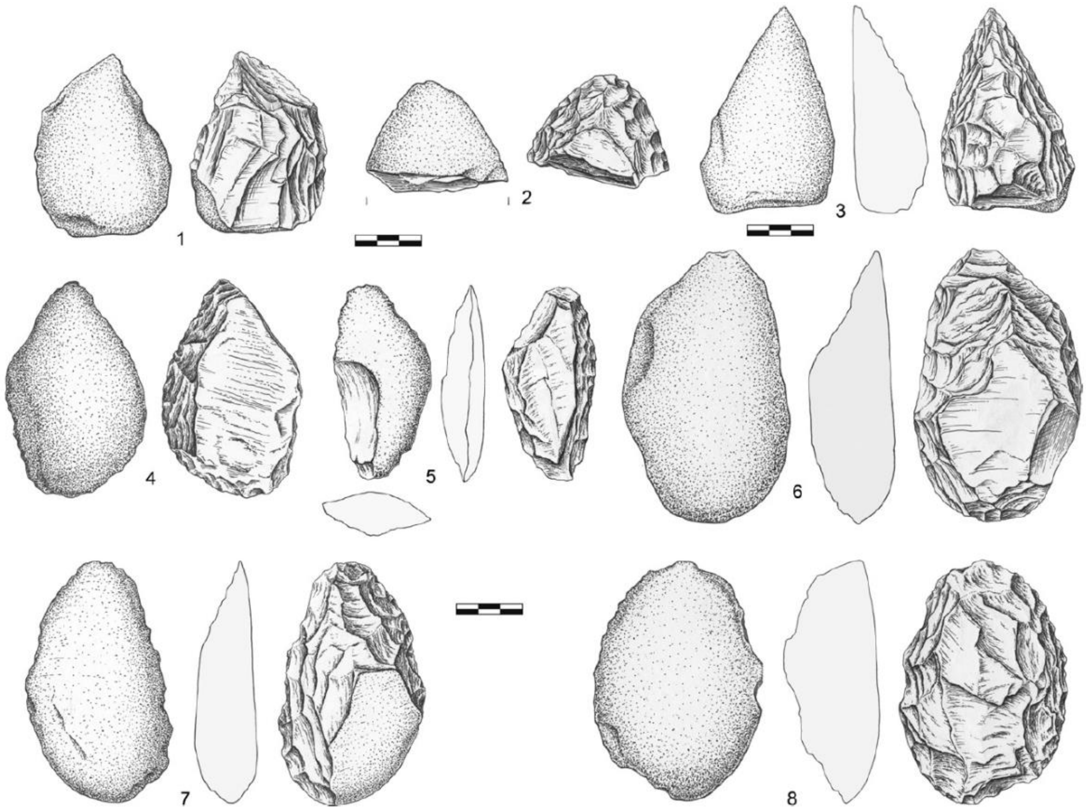


Figure 4: Examples of unifaces from Gadeb 8F (De La Torre, 2011)

2.2.2. Faunal Remains from Gadeb

Faunal remains from Gadeb has been found from different excavated localities (2A, 2B, 2E, 2C, 8D, 8E and 8F) (Clark & Kurashina, 1979b). Although mostly fragmentary, several bovids, hippo, elephant, zebra, and pig were reported in Gadeb 2E and 8D, and the hippo in Gadeb 8F. The faunal remains were said to be associated with the artefacts, but as reported in the literatures the fragmentary state of the bones and their low numbers prevented Clark and colleagues from interpreting further the association of fossils and lithics. The exception was Gadeb 8F, which was considered to represent a butchering episode of a hippopotamus by Developed Oldowan hominins (Clark, 1987; Clark & Kurashina, 1979a). This single-event activity area at Gadeb 8F would contrast with the other localities in Gadeb, which were said to represent “multi-context, multi-component concentrations of high density, most probably reflecting regular re-occupation over an extended period of time” (Clark, 1987). along the banks and channels of shallow streams (Clark & Kurashina, 1979a).

2.3. A Review of Archaeological Sites in Highland Ethiopia

Most Ethiopian Acheulean sites are associated with the rift valley except Gadeb (Clark & Kurashina, 1979a), Chilga Kernet (Todd et al., 2002, 2015), Fanta, Gemeda and Koche (Lanzarone et al., 2021) (Lanzarone et al, 2022), Melka Wakena (Hovers et al., 2021) and Melka Kunture (Chavaillon & Berthelet, 2004). Fanta, Gemeda, and Koche represent some of the few sites documenting early paleoanthropological evidence known from highland contexts. The sites contains a rich assemblage of fossil mammals and Acheulean artifacts dating back approximately 600,000 years and are in a rare high-altitude context (Lanzarone et al., 2016, 2021). Numerus bone fragments were collected from top layer of Fanta and Gemeda sites. Researchers have established a connection between the stone tools and fauna by finding one possible cut-marked bone. Additionally, potential traces of cutmarks have been identified on long bone fragments on Fanta fauna. Based on the zooarchaeological investigation so far done Hippopotamidae fossils are the most abundant at Fanta (Lanzarone et al., 2021).

Melka Wakena which is close to the Gadeb plain is located in the southeastern Ethiopian highlands. A large number of Acheulean artifacts and bovid fossils has been reported from this site complex (Hovers et al., 2021). According to Hovers, and her team (2021) faunal remains at Melka Wakena is not extensive. Most of the specimens were found during excavations at various localities, with some discovered in outcrops along the banks of the Wabe River. Only a portion of the fossil vertebrates found within the archaeological context are well preserved, while the majority are fragmented. The large complex of archaeological and paleontological sites of Melka Kunture is located on the banks of the Upper Awash in the Ethiopian plateau at elevations of 2000-2200m a.s.l. some 60km south of Addis Ababa. The massive area of Melka Kunture consists of a cluster of Pleistocene sites. It is one of a kind archaeological site in Ethiopian Highlands that yielded the long running lithic industry evolution (Altamura, Bennett, et al., 2020; Geraads et al., 2022)

In Melka Kunture Hippopotamus cfr. Amphibius is abundant and represents a third of the whole faunal assemblage. Bovidae is represented by several subfamilies such as Bovinae, Alcelaphinae, Reduncinae and Antilopinae. The presence of this multiple tribes suggests the co-existence of both open and aquatic spaces. Suidae, Giraffidae, Rhinocerontidae and Equidae are among the identified mammalian family in Melka Kunture. In this prehistoric site the presence of carnivores is extremely rare and only two bird remains were recorded

(Chavaillon & Berthelet, 2004; Gallotti et al., 2010). Beside the identified faunal remains at Melka Kunture, in Gombore Gully sequence Altamura and his colleagues (2020) identified Hominins, Bivalves, Herbivores, Hippopotamus, carnivores and undetermined footprints from ichnosurfaces. The fossil tracks reveal a substantial component of small and middle-sized animals.

2.4. A Review of Taphonomic Studies

Taphonomy studies the processes that affect the transition of the remains of past living organisms and their traces into the lithosphere (Holz & Simoes, 2005; R. Lyman, 2010; Stiner, 2008). It involves examining how organic remains become incorporated into the rock record and what happens to these materials after burial (A. K. Behrensmeyer & Kidwell, 1985; Fernandez-Jalvo & Andrews, 2016). Efremov (1940) initially defined taphonomy as the "study of the transition of organic remains from the biosphere into the lithosphere" (A. K. Behrensmeyer & Kidwell, 1985). Analysing bone breakage and other taphonomic data can provide insights into the depositional history of a site (Thompson, 2005).

Taphonomy is a multidisciplinary investigation that aims to reconstruct the past in meticulous detail. The identification of taphonomic processes in the fossil record is based on their effects on fossils, including the biological, chemical, and physical modifications preserved on the specimens. Taphonomy also has implications in biostratigraphy and evolutionary investigations, as well as a wide application in a variety of fields that includes geology, archaeology, palaeobotany, and forensics studies (Fernández-Jalvo et al., 2011; Fernandez-Jalvo & Andrews, 2016). Taphonomy seeks to understand natural processes so that data from the fossil record can be evaluated correctly and applied to palaeobiological and palaeoecological questions (Behrensmeyer et al., 2000). As the study of natural processes of preservation and destruction, taphonomy directly addresses the problem of how fossils represent past organism's evolutionary pattern and important biological events in the past. However, most organisms do not preserve to fossils. The complex effects of preservation must be considered in understanding and interpreting the general ecosystem of the past (Behrensmeyer, 1984).

Taphonomic processes begin when an organism loses control over the organic components of its body, either through death or discard, and extend through the pre-burial interval of exposure and concentration through final burial and diagenesis. Preservation is strongly affected by pre-death circumstances such as habitat, so these can easily become part of a taphonomic study (Behrensmeyer, 1984; Behrensmeyer & Kidwell, 1985). According to (Fernandez-Jalvo & Andrews, 2016) Taphonomic modifications can be identified and interpreted by comparing them with observed processes caused by known agents acting on previously unmodified bones under controlled experimental conditions or through naturalistic monitoring projects.

The taphonomic history of single fossils or of fossils assemblages provides evidence additional to that given by taxonomic identification. Because modifications recorded on fossil bones are the response to organic or inorganic agents that may not fossilize, taphonomic modifications should be seen as processes providing a more dynamic view of the past rather than as destructive processes (Fernández-Jalvo et al., 2011; Fernández-López, 1991). Accordingly, building on the modifications and processes observed on the individual fossils preserved in a fossil assemblage, we reconstruct the extent to which a prehistoric bone assemblage has been altered (Fernandez-Jalvo & Andrews, 2016).

The conceptual framework for taphonomy consists of successive stages of transformation – death, decomposition, burial, fossilization – separated by the processes that take place between each stage (Behrensmeyer, 1984). The fossil assemblage is always affected by the way it was accumulated and preservation processes undergone. Taphonomic agents may act together or may be times successive. Similarly, fossil accumulations may be deposited as a single event, or they may occur over considerable lengths of time, and it is important to distinguish between them.

Earlier accumulations may be subjected to a different combination of taphonomic agents to later accumulating bones, and if the two sets are mixed in the sediment this can give rise to confusion as to the manner of accumulation. Humans, however, are yet another agent of disturbance in terrestrial fossil sites, arising out of their social behaviour, omnivorous diet, versatile living strategies and highly destructive activity at occupied sites all of which produce a final mixed assemblage that needs intensive investigation to distinguish human distortion from ecological occurrence (Fernández-Jalvo et al., 2011).

Fernández-Jalvo and Andrews (2016) listed the main sources of data for taphonomic studies, including fossil faunas, studies of modern analogue faunas, and examining the impact of the methods used for investigating the modifications. Correct identification is crucial to the interpretation of how and why animal bone assemblages accumulate in archaeological and paleontological sites. Equally important is the interpretation placed on these identifications.

One of the many ways for tracing feeding behaviour and carnivore-herbivore interactions is tooth marks and associated damage features inflicted by carnivores on bones. Unlike feeding traces of mammalian carnivore, crocodiles produce distinctive tooth marks including bisected pits and punctures, hook scores that have not been observed in assemblages modified by mammals (Njau & Blumenschine, 2006).

2.4.1. Weathering as Taphonomic Evidence

Bone weathering defined by (Behrensmeyer, 1978), refers to the process which the original microscopic organic and inorganic components of bone are separated from each other. The distraction could be by physical and chemical agents operating on the bone in situ, on the surface or within the soil zone. It is the decomposition and destruction of bones as part of the normal process of nutrient recycling in and on soils. Based on Purdy and Clark (1987) weathering is continuous through time, involves mechanical and chemical changes to a bone's original integrity as a discrete object and occurs in surface and subsurface contexts.

It seems probable that the physical stresses of repeated heating and cooling, and wetting and drying, contribute to the weathering characteristics in addition to microscopic changes in organic components. The relative importance of such physical stress may be affected by the original bone thickness and density and hence by the physical condition of the animal before death. Roots may also cause splitting and fragmentation of buried bones. Buried bones frequently show no sign of weathering even when exposed parts are in stage 4 or 5 (Behrensmeyer, 1978).

Fossilization of bones depends on the intensity and rate of various destructive processes and chance for permanent burial prior to decomposition. Most bones decompose beyond recognition in 10 to 15 years. Bones of animals under 100kg and juveniles appear to weather more rapidly than bones of large animals or adults. Small-scale rather than widespread environmental factors seem to have greatest influence on weathering characters (Behrensmeyer, 1978).

Behrensmeyer (1978) proposed a six-stage descriptive categorization of bone weathering based on experimental observations conducted in Amboseli Park, Kenya. These stages, based on extent of sub-areal exposure of bones are classified from fresh weathering (stage 0) to a complete destruction of a bone texture (stage 5), as shown in figure 6. It should be noted that this weathering classification is applicable only to mammals larger than 5kg body weight, and a similar classification for smaller animals, birds, reptiles, and fish has not been attempted.

When applying weathering stages to fossils, it is important to ensure that surface textures on bones are primary, limiting the usable sample to carefully excavated bones with matrix covering their surfaces that have not been altered by recent erosion.

Figure 5: Examples of bone weathering showing the 6 progressive weathering stage from Weathering stage 0 to 6 (Behrensmeyer, 1978)

Observations of bone weathering in different environments across continents have shown that the textural characteristics of the different weathering stages are generally recognizable. This suggests that the structural features of bones themselves play a major role in weathering characteristics, regardless of external conditions. However, temperature and humidity can exert strong control over the rate of weathering (Behrensmeyer, 1978).

Weathering features on fossils provide valuable insights into the taphonomic processes that bones and bone assemblages undergo. To determine the surface exposure of a bone prior to burial and the accumulation period, distinguishing primary weathering from transport abrasion and diagenetic effects should be considered. Spatial distribution patterns of bones in different weathering stages, variations in weathering within bones from a single animal, and their relationship to sedimentary environments can help discern the relative importance of micro-environmental factors and the duration of accumulation (Behrensmeyer, 1978).

For a fossil assemblage found from sites in Ethiopia (Tappen, 1994) suggests the classification and interpretation of bone weathering stages are relevant not only for eastern African environments but also for other regions, including Ethiopia. The application of weathering stages can aid in the interpretation of weathering characteristics observed in Ethiopian bone assemblages.

2.4.2. Post-Depositional Processes

Post-depositional Processes can have significant morphological effects on bone surfaces. Some of these effects include dendritic etching, pocking, exfoliation, smoothing, and sheen (Thompson, 2005). Thompson, (2005) defines dendritic etching is the presence of branching channels that groove the surface of a bone. These channels can vary in depth, spacing, and density. Pocking, like dendritic etching, involves the obliteration of small, semi-circular patches on the bone surface. Both dendritic etching and pocking can occur in varying degrees of density and depth.

Exfoliation occurs when the bone surface peels away or is removed in sheets. This continuous process can obliterate identification marks on affected areas, making it challenging to discern any surface modifications. Smoothing refers to the rounding of bone contours on a gross level, resulting in a smoother appearance and the potential loss of anatomical features. Features such as foramina, tuberosities, and fossae may become indiscernible. Sheen, on the other hand, describes the degree to which a bone fragment reflects light, indicating a polished or shiny appearance. Various agents, including water, airborne particles, and gastric action, can contribute to the development of sheen on bone surfaces (Thompson, 2005).

These morphological effects can provide valuable information for understanding post-depositional processes and evaluating surface modification identification. Reconstructing the taphonomic history of the faunal assemblage, evaluating the role of hominins in assemblage formation, identification of hominin induced modifications in the form of cut-marks, traces of marrow extraction, skeletal element representation. Further variables before burial includes traces of carnivore modification and bone weathering. Skeletal element representation with reference to hydrodynamic sorting, breakage patterns, abrasion together evaluate the formation process of the faunal assemblage (Altamura, Gaudzinski-Windheuser, et al., 2020).

One way of understanding taphonomic history of an archaeological bone assemblage is skeletal part frequency data. Generally, the less nutritious and heavier part (axial skeleton) remain at the animal death sites, while the more nutritious and lighter part of the animal (limbs even whole carcasses of small animal) are transported away from death sites. This pattern is used to tell apart camp site from butcher site (Bunn, & Kroll, 1986).

3. Chapter Three – Materials and Methods

3.1. Materials

The faunal remains used for this study comes from the archaeological localities of Gadeb 2 and Gadeb 8, which were excavated in 1975 and 1977. A total of 854 faunal remains including both cranial and postcranial specimens, were studied.

Postcranial specimens larger than 2 cm (except for micromammals) were considered for bone surface modification analysis following the standardized zooarchaeological methods. All studied samples are currently stored in the collection and laboratory services of Ethiopian Heritage Authority (EHA), where the study was conducted.

3.2. Methods

In this archaeozoological investigation, three specific but interrelated methods of study were employed: curation, taxonomic identification, and taphonomic analysis. These methods followed procedural frameworks that guided the analysis. The study process of the Gadeb faunal assemblage involved the following steps:

3.2.1. Curation

The curation of the Gadeb faunal assemblage followed the methodology devised by (Assefa, 2006). The initial step in the faunal investigation was the curation and documentation of the faunal remains collected during the 1975 & 1977 excavations. Each 854 specimen was carefully cleaned using plain water to remove matrix and have a clear visual of the cortical surface of the specimens. After washing the specimens with water, I left it on the top of the bag to air-dry. In the meantime, stratigraphic and contextual information were recorded. Acetone was applied when necessary to remove hard sediments, vinac was used to strengthen fragile fossils, and glue was used for refitting fresh breaks. Specimens that were damaged in the storage process were photographed before any curation work. Each specimen was assigned a specimen number with the prefix "G" representing Gadeb and recorded in an Excel data sheet. The numbering is random. All specimens were photographed using Nikon DX digital camera. Faunal specimens without proper labelling or no labelling at all are excluded from the study.

3.2.2. Taxonomic Identification

Before taxonomic identification, all the specimens were classified as identifiable (ID) or non-identifiable (NON-ID). Then for the identifiable specimens, I identified each to a particular skeletal element based on morphological and distinct landmarks. Based on the element morphology whenever possible specimens were identified to taxonomic groups. I focused on specimens that are complete or with diagnostic features. Specimens were identified to specific skeletal elements whenever possible. The taxa identification is to a family level but for the Bovidae when the preserved specimens are allowing, I identified to a tribe level. Identification to a tribe level allows to infer habitat types as bovids are known environmental indicators (Alemseged, 2003; Reed et al., 2013; Shipman & Harris, 1988; Spencer, 1997).

Specimens that were too fragmentary to be assigned to a taxonomic or skeletal part category were categorized as non-identifiable (NON-ID). Unidentifiable skeletal parts of mammalian taxa were categorized to only size-based classification i.e., small, medium, and large. Taxonomic and anatomic determination was done based on comparative references of fossils. I was assisted by the comparative collection of modern fauna placed in the EHA comparative collection room. In addition, for identification of skeletal elements and taxonomic determination I referred to (Hillson, 1999) and (Walker, 1985) guide books.

For Size-based identification of a specimen, I followed the protocols of (Bunn, 1982). For calculating taxonomic frequency, all elements assigned to a particular taxon were counted (NISP values), including epiphyses and long bone shaft fragments that were identified to the family level. The NISP represents the total number of Identified specimens, specimens referring to any bone or tooth fragment identified to the anatomical level (Lyman, 2008).

3.2.3. Taphonomic Analysis

The aim of any zooarchaeological study is to reconstruct the taphonomic processes that faunal remains undergo after they are discarded and to identify the agents. These agents could be natural or/and anthropogenic which are responsible for the accumulation of faunal remains in archaeological sites. Once bones are discarded, they sustain natural and biological processes of alteration, and studying the resulting patterning forms the basis for taphonomic investigations into the depositional history of faunal remains at archaeological sites (Lyman, 1994). Taphonomic studies enable zooarchaeologists to distinguish between pre-burial and post-burial signatures within faunal assemblages.

For the entire faunal assemblage from the Gadeb localities excavations, including both identifiable and non-identifiable specimens, I categorized the specimens into two groups based on Fisher (1995): bone modifications by hominins and bone modifications by non-hominin processes. To identify hominin traces of modification on bones, I focused on cortical preservation, bone surface modifications, and bone breakage patterns as outlined by (Bunn, 1982). Thorough examination of surface modifications, including cut marks, percussion marks, tooth marks, and other natural marks, was recorded on all informative specimens.

Each mark was individually scrutinized, and its features were carefully observed according to parameters established through experimental studies on tooth and percussion mark patterns. Percussion marks, cut marks, and tooth marks were identified based on the criteria outlined by (Blumenschine et al., 1996). Additionally, breakage patterns within the bone assemblage were analysed using the protocols already developed (Capaldo & Blumenschine, 1994; Villa & Mahieu, 1991). To estimate the exposure time between the animal's death and its final burial, the six stages of weathering process defined by (Behrensmeyer, 1978), were applied.

During the analysis, each specimen was studied under strong light with the naked eye, followed by examination with a 40x hand lens under strong light conditions. When necessary, Dino Lite USB microscopes (Figure 6a) and Keyence digital microscopes (Figure 6b) were utilized to enhance and capture detailed images of the modifications.

(a)

(b)

Figure 6: (a) Dino Lite USB microscope (b) Keyence digital microscope

4. Chapter Four – Results

4.1. General Faunal composition of Gadeb

The Gadeb fossil assemblage is characterized by a relatively diverse faunal composition (Figure 7). The preservation of the faunal remains is affected by both biological and depositional processes. Damages related to excavation and post-excavation (e.g., storage handling) are also observed. The extent of faunal preservation varies from poorly preserved to well preserved remains that are fitting for bone surface modification study. From both localities (2 and 8), a total of 854 faunal remains were studied. From locality 2, 532 specimens and from locality 8, 322 specimens were analysed. At locality 2, the studied faunal remains are from excavation trenches 2B, 2C, 2D, 2E and some bags are labelled only Gadeb 2. From locality 8 the specimens are recovered from excavation trenches 8A, 8B, 8C, 8D, 8F and, like with locality 2, some bags are labelled only Gadeb 8 without mentioning the specific trench. Majority of the specimens in this study are from Gadeb locality 2E and 8E. On this study the faunas are studied in their locality and not separated by their excavation trenches.

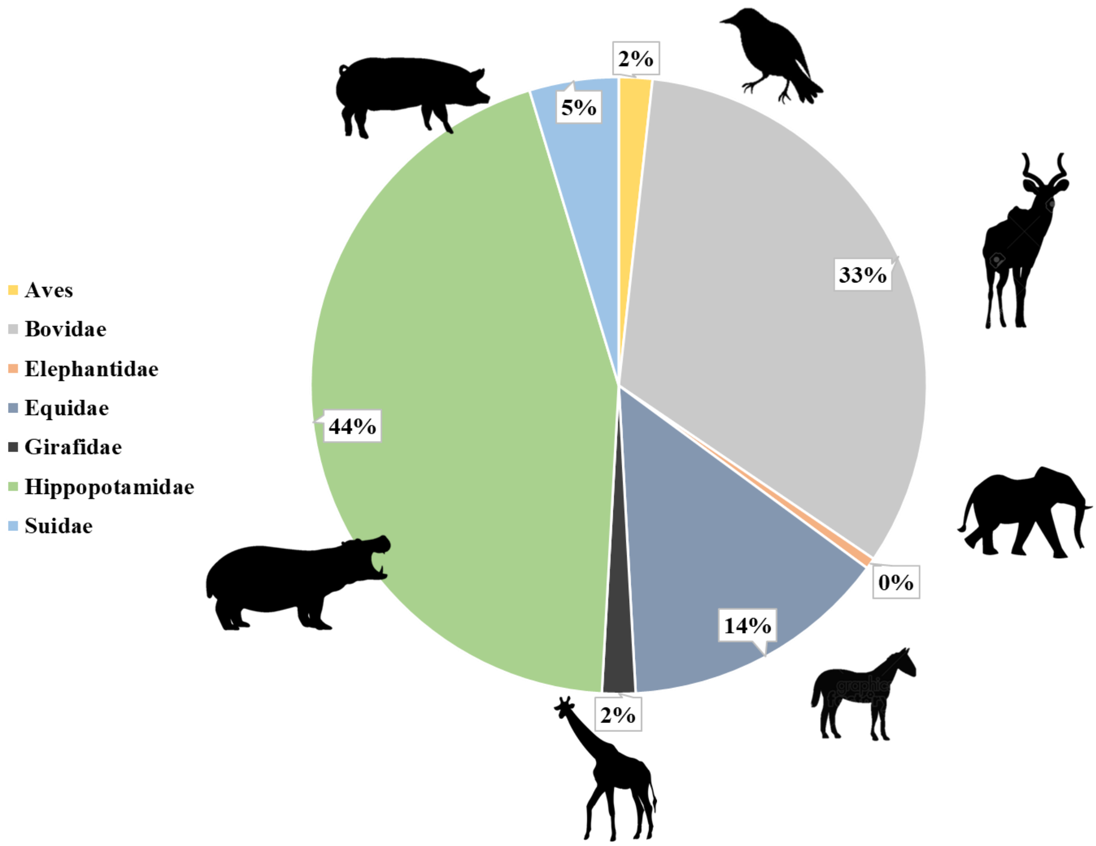


Figure 7: Faunal abundance of Gadeb from both localities 2 and 8

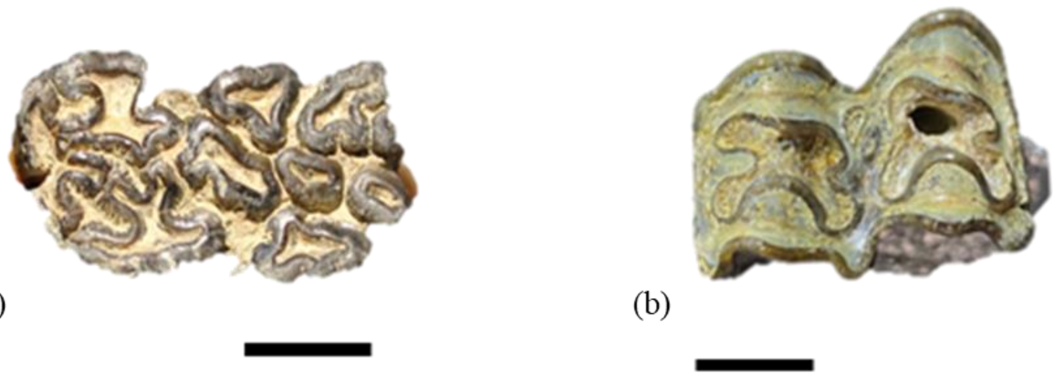
The overall faunal composition of Gadeb is predominantly of Hippopotamidae (44%) and Bovidae (33%) as shown in the figure above (Figure 7). Except for the Hippopotamidae, megaherbivores such as Elephantidae and Giraffidae are rare, while Carnivora is absent. Similarly, birds are very rare from this site. However, micromammals are present in locality 8 but not included in this study. Equids and Suids are moderately represented in the Gadeb faunal spectrum. Results for both taxonomic composition and taphonomic processes are presented below for each locality.

4.2. Gadeb Locality 2

4.2.1. Taxonomic composition and skeletal element abundance

At Gadeb locality 2, 532 specimens studied. 94 are cranial parts, 157 are post cranial parts and 281 are non-identifiable to any part of a skeletal element. Out of the identifiable to both cranial (*n* = 94) and post cranial (*n* = 157) elements, 104 specimens are identified to a family level. The most represented taxa in this locality are Hippopotamidae *(n* = 43). Only six are identified from post cranial elements, while 36 are identified from dental remains.

Bovidae are represented by the same number (*n* = 43), as Hippopotamidae. Of these, 15 specimens are identified from postcranial elements, and 27 of them are cranio-dental elements (isolated tooth, cranial fragments, and horn cores). From the post cranial elements, I was not able to narrow the identification to a tribe level but from the horn core and isolated tooth I was able to identify 10 specimens to a tribe level. These include three Alcelaphini (Figure 8b), two cf. Aepycerotini (Figure 9a and 9b), two Antilopini (Figure 9c), two Aepycerotini, and one cf. Hippotragini (Table 1).



(a) (b)

Figure 8: (a) Suidae molar fragment (b) Alcelaphini upper molar, 1cm scale, from locality 2

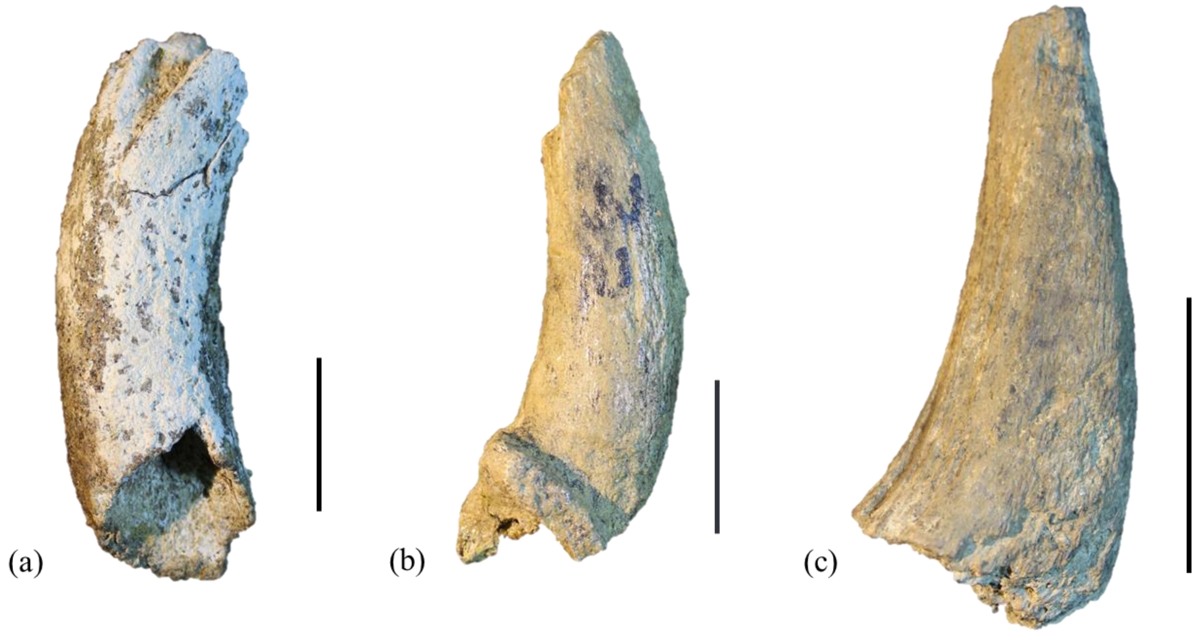


Figure 9: Horn core Bovidae (a) cf. Aepycerotini (b) cf. Aepycerotini (c) Antilopini. 3cm scale, from locality 2

The total number of identified specimens as belonging to the Equidae family in locality 2 assemblage is nine. One metatarsal is identified from the post cranial elements the rest are identified from isolated tooth. Almost the same representation as Equidae, eight skeletal elements are identified as belonging to the Suidae family. Only a complete astragalus is identified as belonging to this family in the post cranial assemblage. The other seven are identified from isolated tooth fragments (Figure 8a). Elephantidae is identified in locality 2 assemblage from molar fragment (Figure 10) and tusk fragment.

Figure 10: Elephantidae molar fragment. 3 cm scale, from locality 2

Tribe	*NISP*
Cf. Aepycerotini	2
Aepycerotini	2
Alcelaphini	3
Cf. Hippotragini	1
Antilopini	2
Total	**10**

Table 1: NISP count of Bovidae tribes from Gadeb locality 2

From the total assemblage of locality 2 (n = 532), 94 skeletal elements are identified to cranial, 157 specimens are identified to post cranial elements and 281 bone fragments are non-identifiable skeletal element. From the 94 cranial elements 77 of them are complete and broken parts of isolated tooth. The remaining cranial remains consists of 14 horn core fragments, a cranial fragment (including frontal and orbit part), an auditory bone as well as a mandibular ramus fragment of small to medium size animal. From the specimens identified to post cranial skeletal part (n = 157), 71 are identified to a complete and broken parts of specific skeletal element and 86 specimens are several long bone fragments.

Complete and broken isolated tooth is the most represented (47%) element from the total assemblage identified to a skeletal element part (n = 164). Various vertebra parts and rib fragments are represented in a significant amount (n = 18 and 14 respectively). Vertebra (n = 18), rib (n = 14) and horn core (n = 14) fragments are the second most represented in the assemblage (11%, 9% and 9% respectively) following the most represented dental fragment. 11 specimens are complete and fragmented Metapodial parts. The other skeletal elements identified from this locality are two astragalus, one auditory bone, two carpal/ tarsal bone, one fibula, five phalanx, four humerus, one pelvis, five radius, four scapula, and two tibiae. 86 specimens are not identified to a specific skeletal element but are identified as long bone fragments (Table 2).

Skeletal element	*NISP*
Auditory bone	1
Cranial fragment	1
Mandibular fragment	1
fibula	1
Pelvis	1
Radioulna	1
Astragalus	2
Carpal/tarsal	2
Tibia	2
Scapula	3
Phalanx	5
Humerus	5
Radius	5
Metapodial	11
Horn core	14
Rib	14
Vertebra	18
Isolated tooth	77
Total	**164**

Table 2: skeletal element representation from Gadeb locality 2

4.2.2. Taphonomy

In this part, results from hominin induced marks, bone weathering stages, bone abrasion as well as other post-depositional alteration will be presented. No clearly defined carnivore activity marks such as tooth mark were identified from the bone surfaces and will not be further discussed.

4.2.2.1. Hominin induced marks

From the total assemblage (*n* = 532) of locality 2, about 8% (*n* = 43) of the specimens show hominid induced modification. The most common modification type in this assemblage is green fracture. 28 specimens have spiral shape breakage pattern related to green fracture. Only three specimens showing green fracture are identified to skeletal element level: humerus (Figure 11a and b), rib, and phalanx.

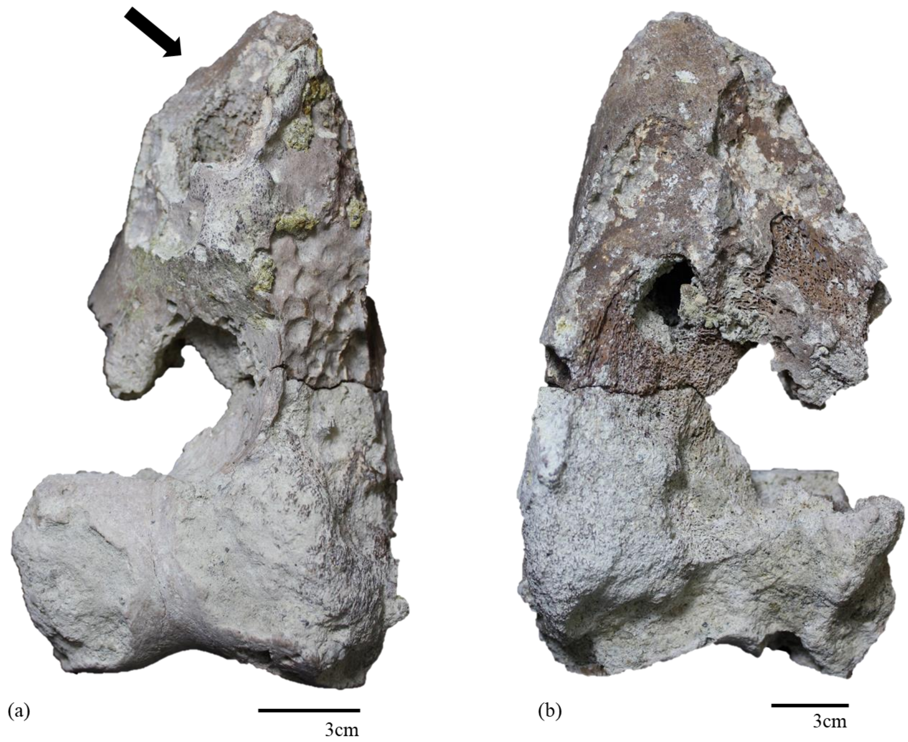


Figure 11: Distal humerus of Hippoptamidae from locality 2 showing effect of corrosion (large pit corrosion), (s) Posterior view the arow showing green fracture (b) Anterior view.

The other common hominin induced mark identified in these assemblages is possible percussion mark. Nine specimens show possible percussion pit. Two of the specimens showing such marks are identified to a skeletal part. Both belongs to a large size mammal, one vertebra fragment (Figure 13a and b) and scapula spine (Figure 12). On the indeterminate vertebra fragment beside possible percussion pit the specimen exhibits irregular linier mark on the cortex of one side. Similarly, the scapula fragments have a green fracture beside the possible percussion pit. The other specimen exhibiting possible percussion pit is a long bone fragment (Figure 16 b and c).

The other four specimens are long bone fragments (e.g., Figure 20 a and b). Only one specimen from locality 2 assemblage exhibits a peeling effect from breakage process (Figure 19).

Figure 12: Scapula fragment; the arrow indicates possible percussion mark. 2cm scale, From Locality 2

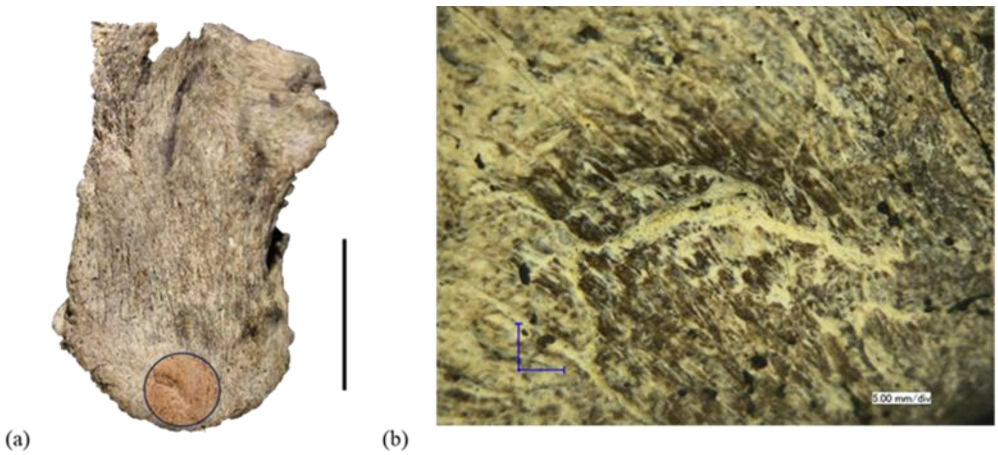


Figure 13: (a) indeterminate vertebra fragment from Locality 2. Scale 2 cm (b) closeup picture of possible percussion pit on the vertebra.

In locality 2 assemblage, possible cut marks are observed on five specimens and other linier marks on three specimens. from the specimens exhibiting possible cut marks one is a large size animal (Bovidae) rib shaft (Figure 14 a, b and c). The specimen has a well-preserved cortical surface and is a whole circumference of a rib near the proximal end. Anatomical position of the mark is on the dorsal surface of the rib shaft. The second specimen exhibiting possible cut mark is medium size mammal long bone fragment near epiphysis. The cortex exhibits two linier possible cut marks. Beside the possible cut mark, this specimen exhibits green fracture.

The third specimen showing possible cut mark is long bone fragment near the epiphysis which belongs to a large size animal (Figure 15 a and b). The incision is positioned near the articular end of the cortex. The fourth specimen exhibiting cut mark is another long bone fragment of a medium size animal (Figure 16 a and b). Additional to possible cut mark, this specimen exhibits possible percussion pits and green fracture. One side has three cluster of possible cutmarks. The fifth specimen showing cut mark is a large size Bovidae radio-ulna (Figure 17 a-d) shaft. This specimen shows possible percussion pit and multiple similarly oriented striations on the caudal side. On the cranial side the cortex exhibited multi oriented shallow incisions. However, this can also be a possible effect of trampling (Domínguez-Rodrigo et al., 2009) or later abrasion of the cutmarks (J. Thompson, 2005). (R. L. Lyman, 1994), explains trampling usually produces marks on bone surface.

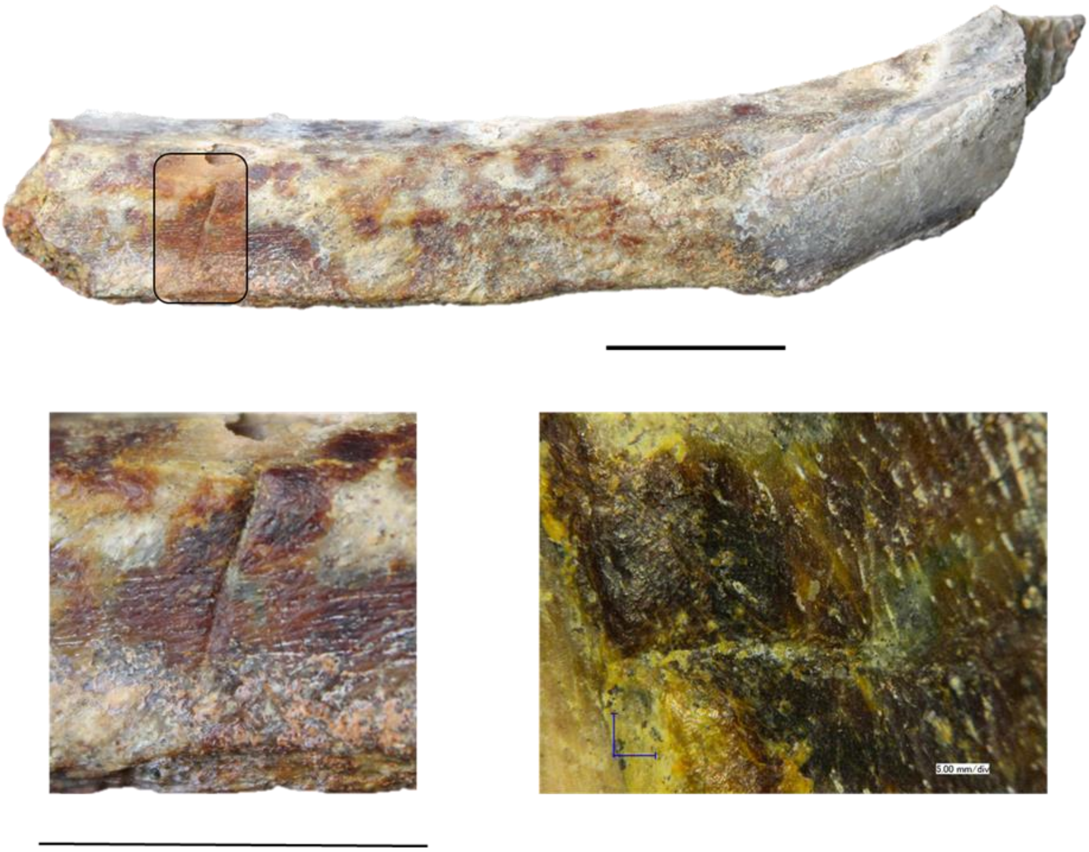


Figure 14: Rib fragment from locality 2 (a) complete picture of the specimen (b) close-up picture of the cut mark with a photo camera (c) close-up picture of the cut mark with a microscope. 2cm Scale.

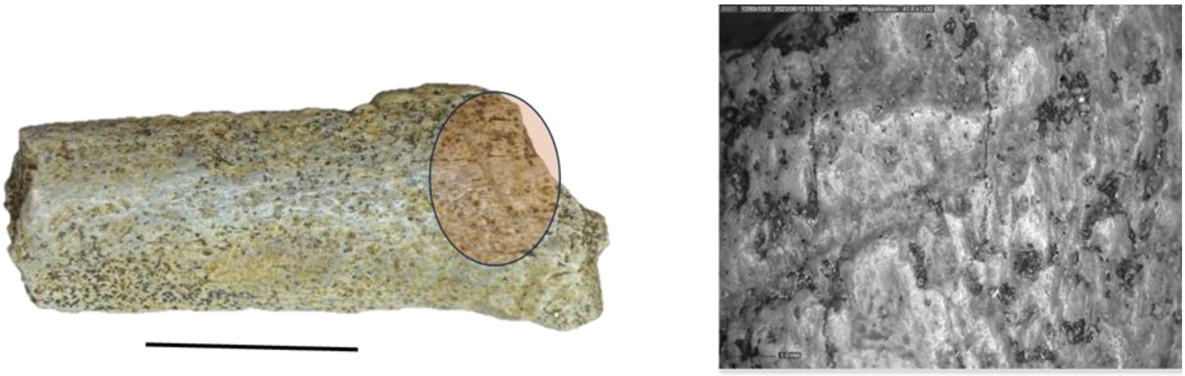


Figure 15: Long bone fragment from Locality 2 (a) complete picture, (b) close-up picture taken using USB Dino light. 2cm scale

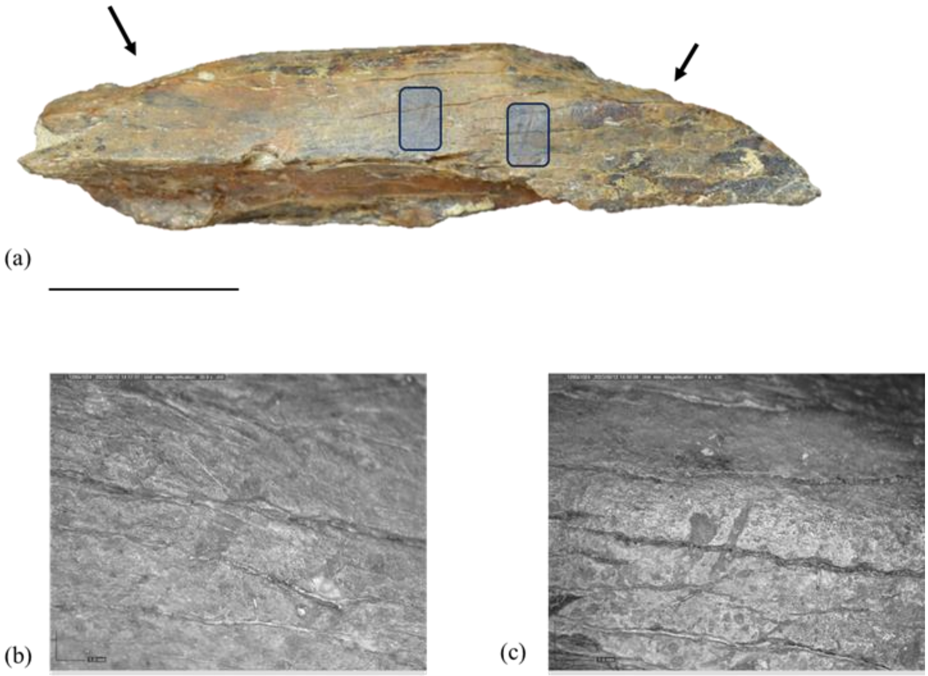


Figure 16:(a) long bone fragment the arow indicating green fracture. 2cm scale. From locality 2. (b) close-up picture 30x magnification of a possible percussion mark (c) a close-up picture of percussion mark 40x magnification

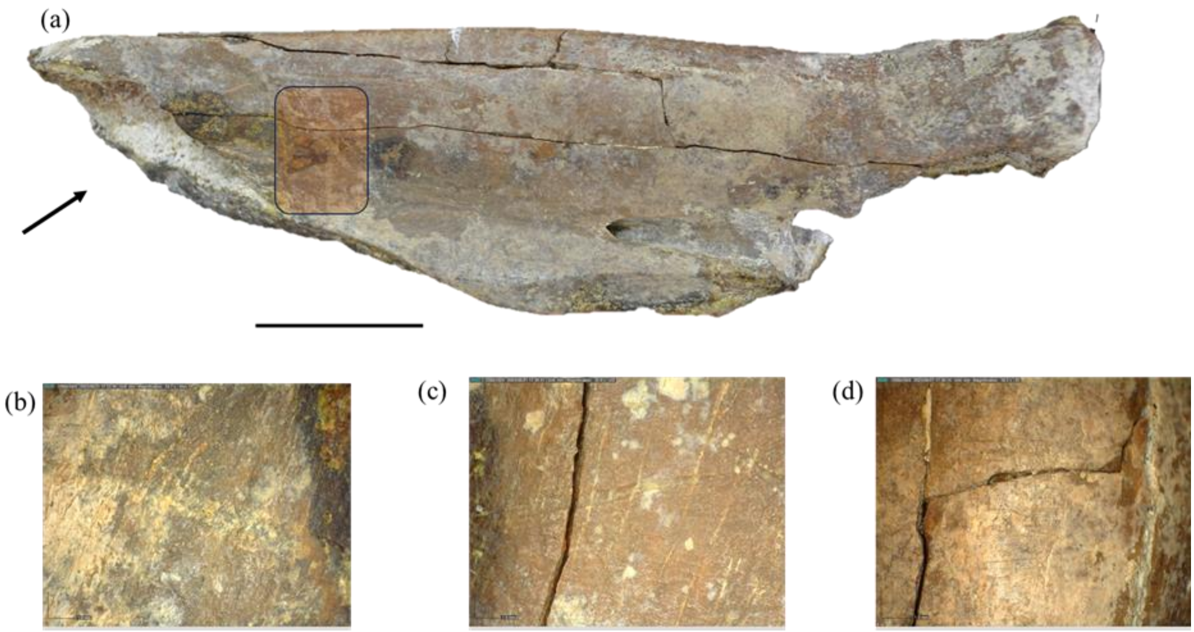


Figure 17: (a) Bovidae radio-ulna. 3cm scale. from Locality 2. The arrow indicates a green fracture. (b) and (c) Dino-pictures: cutmarks and (d) unidentified marks.

From the specimens showing linier marks, one is non-identifiable bone fragment (Figure 18 a and b). The linier mark is exhibited on the cortical surface of the specimen near the broken end. The other specimen is a long bone flake. The mark is on the cortical surface near the broken end. The third specimen exhibiting linier mark is nonidentifiable bone fragment. similar to the other specimens, the mark is on the cortical surface near the broken end. Only one specimen from locality 2 assemblage shows peeling effect from breakage process (Figure 19). This bone fragment is non-identifiable to any specific skeletal element.

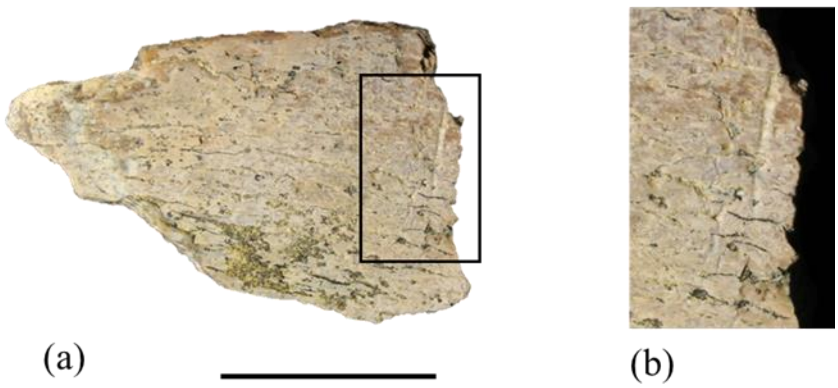


Figure 18: (a) non-id bone fragments with linear mark (b) a close-up picture of the linear mark. 2cm scale. From locality 2.

Figure 19: non-id bone fragment. the arrow indicating a pilling effect. 2cm scale. From locality 2

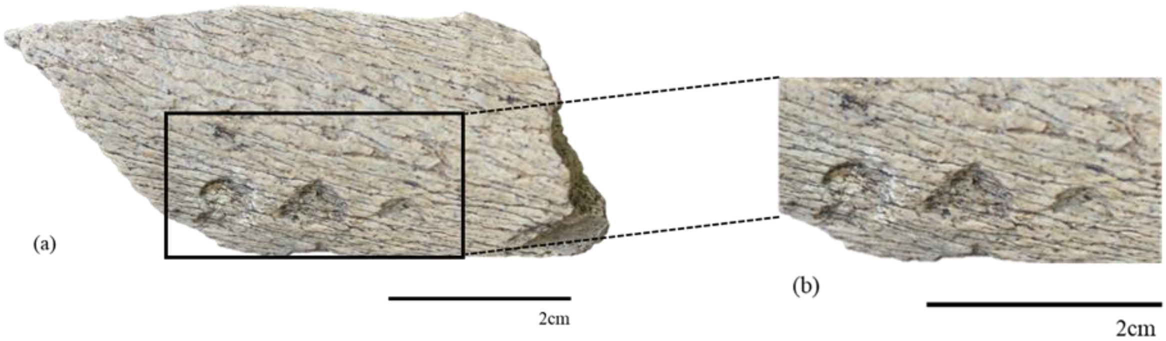


Figure 20: (a) cortical surface of a long bone fragment (b) close picture of the possible percussion pit

In addition, possible bone tool is identified at locality 2. An elephant tusk from this locality exhibits possible used damages on both surfaces and sides (Figure 21). However, to confirm if this specimen was used as a tool, use wear analysis must be done.

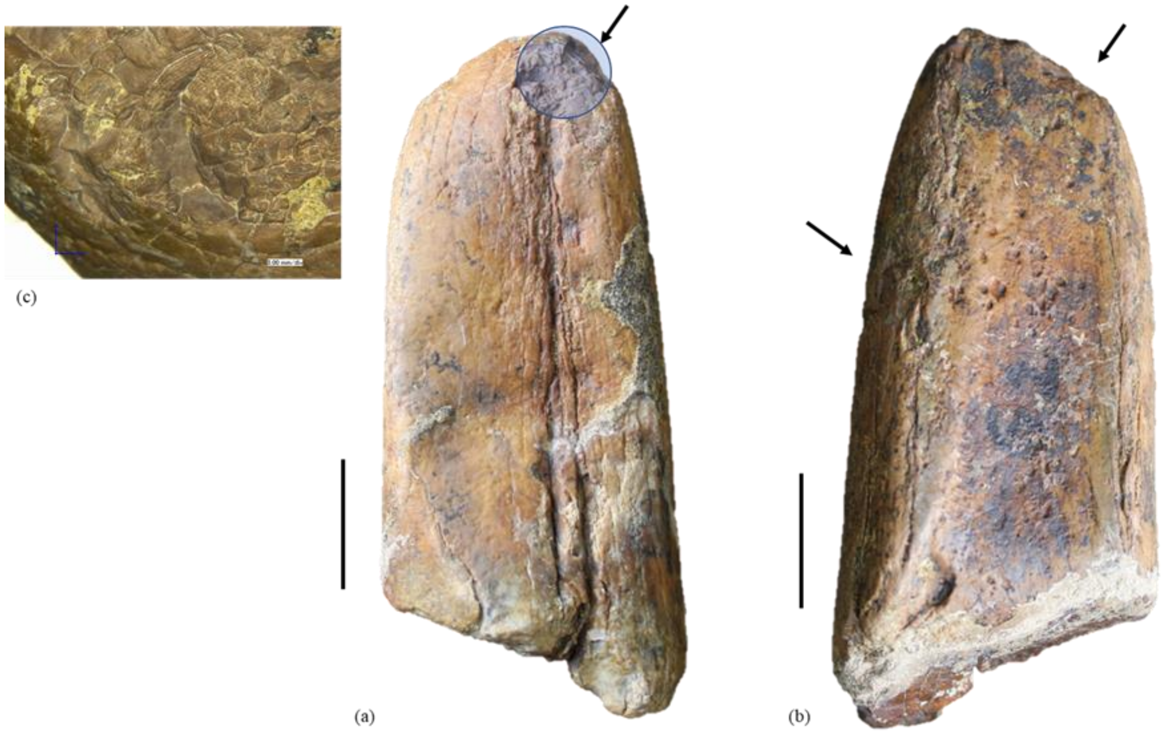


Figure 21: 'possible tool' (a) one side the arrow indicating possible use damage (b) one side the two arrows indicating possible use damage. 2cm scale. From locality 2 (c) microscope picture of the circled part in picture (a)

4.2.2.2. Weathering

301 specimens are evaluated for the six stages of weathering. Most of the specimens fall within weathering stage 1, 61% (*n* = 183) followed by weathering stage 2 which are 31% (*n* = 93). Only 4% (*n* = 14) show weathering stage 3, whereas weathering stages 4 and 5 were not observed in this collection. This indicates a relatively quick burial of the assemblages that probably due to active water transport (A. K. Behrensmeyer, 1978; R. L. Lyman, 1994). Figure 22 shows the various weathering stages recorded for this locality.

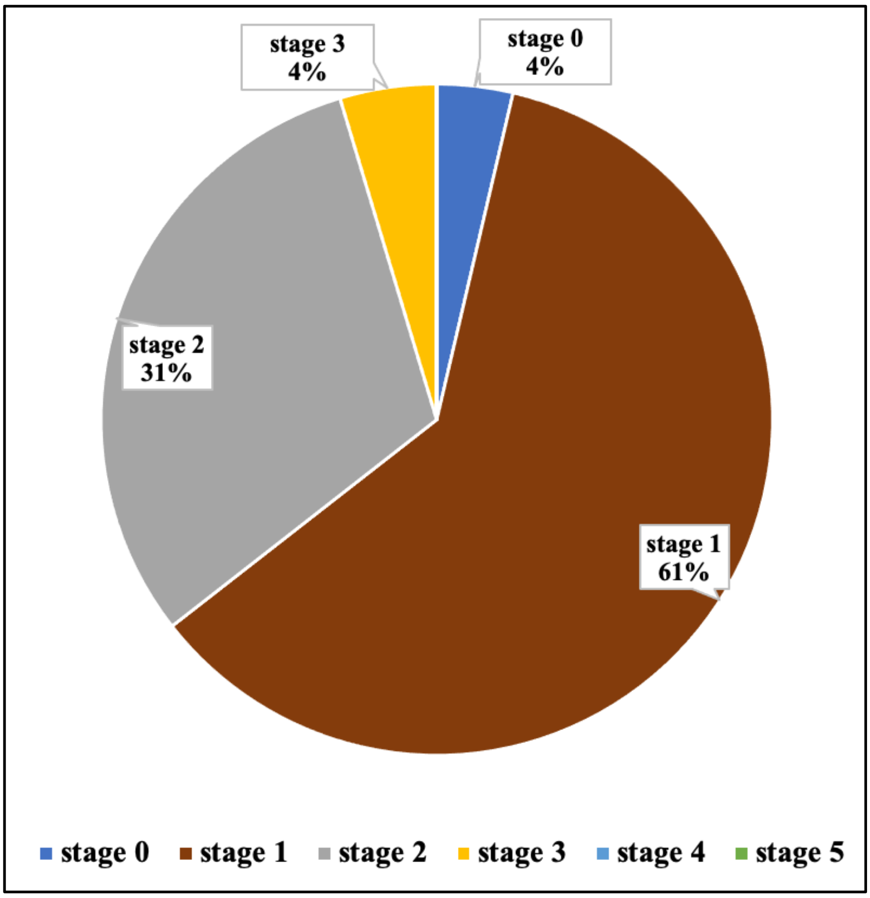


Figure 22: Weathering stages (n = 301) of specimens from locality 2

4.2.2.3. Post-depositional Alterations

Abrasion, corrosion, and cortex exfoliation are the common post depositional alterations observed from Gadeb locality 2 faunal assemblage. From the total (*n* = 532) assemblage 70 specimens exhibits the above three post-depositional alterations. Corrosion represents the most common alteration. 54 specimens are affected by large pit (Figure 12 a and b) and small pit of corrosion (Figure 23). 16 specimens are affected by cortex exfoliation. In some cases, complete destruction of the cortical surface is noted. The absence of the cortical surface influenced to detect any kind of bone surface modification if there was any. Only one specimen exhibits possible trampling effect.

Figure 23: (a) Long bone flake cortical surface affected by corrosion (an arrow indicating green fracture), (b) the green fracture side, (c) medullary cavity showing effect of corrosion. 3cm scale. From locality 2

From the total locality 2 faunal assemblage 385 specimens are studied for the four abrasion stages. 39% (*n* = 150) of the specimens are in stage 3, which is highly abraded. 30% (*n* = 117) are in stage 2, which is moderately abraded and 28% (*n* = 108) are in stage 1, which is slightly abraded. Only 3% (*n* = 10) are in fresh condition (Figure 24).

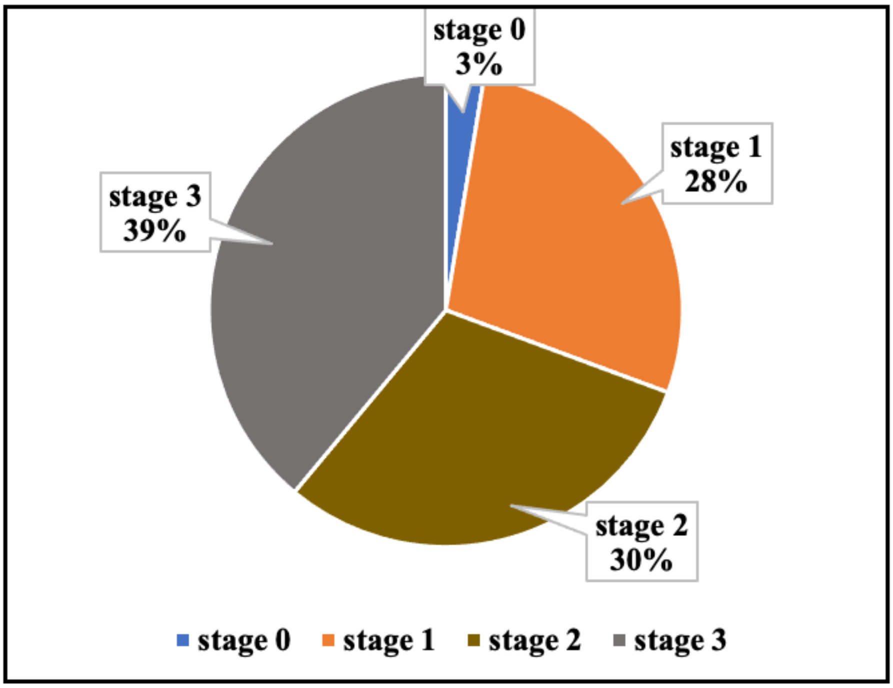


Figure 24: Abrasion stages (n = 385) of specimens from locality 2

4.3. Gadeb Locality 8

4.3.1. Taxonomic Composition and Skeletal Element Abundance

At Gadeb locality 8, 322 specimens are studied. 73 are identified to complete and fragmented isolated tooth, 84 are post cranial parts and 165 specimens are non-identifiable. 65 specimens are identified to a different taxonomic group (family level). The most represented taxon in locality 8 assemblage is Hippopotamidae (*n* = 31). Three were identified form post cranial elements and 28 were identified from isolated tooth and tooth fragments (Figure 25). The second most represented taxa are Equidae and Bovidae (*n* = 15 and 14 respectively). Three of the Equidae are identified from post cranial elements, 11 were identified from isolated tooth and one is identified from a nearly complete mandible (Figure 26). Nine of the Bovidae are identified from isolated tooth, two are identified from horn core fragments and the other three are identified from post cranial elements.

Figure 25: Hippopotamidae molar. 2cm scale. From locality 8.

From the 14 specimens identified to a Bovidae family, six specimens were identified at a tribe level. Those are Aepycerotini, Alcelaphini, Antilopini and Bovini (Table 3).

Tribe	***NISP***
Aepycerotini	1
Alcelaphini	2
Cf.Alcelphini	1
Antilopini	1
Bovini	1
Total	**6**

Table 3: NISP count of Bovidae tribes.

The other taxa identified in locality 8 assemblage include Giraffidae and Aves. Giraffidae is identified from three post-cranial elements but not from the cranial elements. Aves is identified from three post cranial elements.

From the total faunal assemblage analysed at locality 8 (*n* = 322) ,84 specimens are identified to a post cranial skeletal part and 73 specimens are identified to cranial skeletal part. From both cranial and post cranial skeletal parts 101 specimens are identified to a specific skeletal element. The rest are long bone fragments. Of these, majority (*n* = 70) of the specimens are dental remains (complete and fragments of isolated tooth). Like locality 2, dental fragment is the most represented in the identified assemblage (69%). One specimen is a nearly complete mandible of Equus (Figure 26). In addition, two horn cores fragments of Bovidae were also recovered from this locality.

Figure 26: nearly complete Equidae mandible. 4cm scale. From locality 8

Postcranial elements are also represented significantly (*n* = 84). From the 84 specimens identified to post cranial skeletal part, only 31 specimens are assigned to a particular skeletal element. The other 52 specimens are identified to a long bone fragment. The most identified element from this assemblage belongs to rib (*n* = 10, 10%). The other skeletal parts identified from locality 8 are one astragalus, three femur, one 1^{st} phalanx, two horn cores, three metapodial, three pelvis, one radioulnar, two radius, one scapula, and one thoracic vertebra. Some elements are complete, and some are fragment parts (Table 4).

Skeletal element	*NISP*
Mandible	1
Astragalus	1
Phalanx	1
Humerus	1
Radioulna	1
Scapula	1
Vertebrae	1
Tibio-tarsus	1
Honr core	2
Radius	2
Femur	3
Metapodial	3
Pelvis	3
Rib	10
Isolated tooth	70
Total	**101**

Table 4: skeletal element representation from locality 8

4.3.2. Taphonomic Results

Hereafter hominin induced marks, post depositional alterations, abrasion and weathering stages will be presented. The same as Gadeb locality 2, no confirmed carnivora induced marks like tooth mark was found from this locality.

4.3.2.1. Hominin induced marks

From the total assemblage studied at locality 8 (*n* = 322), 30 specimens show possible hominin induced marks. Much like locality 2, green fracture is the most frequent mark in locality 8 faunal assemblage. 20 specimens exhibit spiral shaped breakage green fractures due to percussion activities. Six of them are identified to large mammal skeletal elements which are pelvis, rib, femur and metatarsal. The remaining skeletal parts belong to medium and large size animal limb bones. The other frequently exhibited mark in this locality is a possible percussion mark. Five specimens exhibit peeling effect. Four of them are identified to a skeletal element part: metapodial, vertebra (Figure 27), radio-ulna and rib of large animal. Only one linier mark has been identified and no cut mark has been recognized from locality 8 assemblage.

Figure 27: Thoracic vertebra of Giraffidae, the arrow indicates the pilling effect. 3cm scale. From locality 8

One of the specimens (Figure 28) showing possible percussion mark is a medium size animal long bone fragment near the epiphysis. It exhibits a percussion point, percussion striation and green fracture. The anatomical position of the mark is on the proximal shaft near the epiphysis. The other specimen (Figure 29) is a mid-shaft long bone flake. The percussion point is on the cortical surface. The other specimen (Figure 30) is a radius of a Giraffidae. This long bone fragment is proximal to diaphysis and has a green fracture. The percussion point is on the proximal end near the epiphysis. The other specimen is unidentified bone fragment.

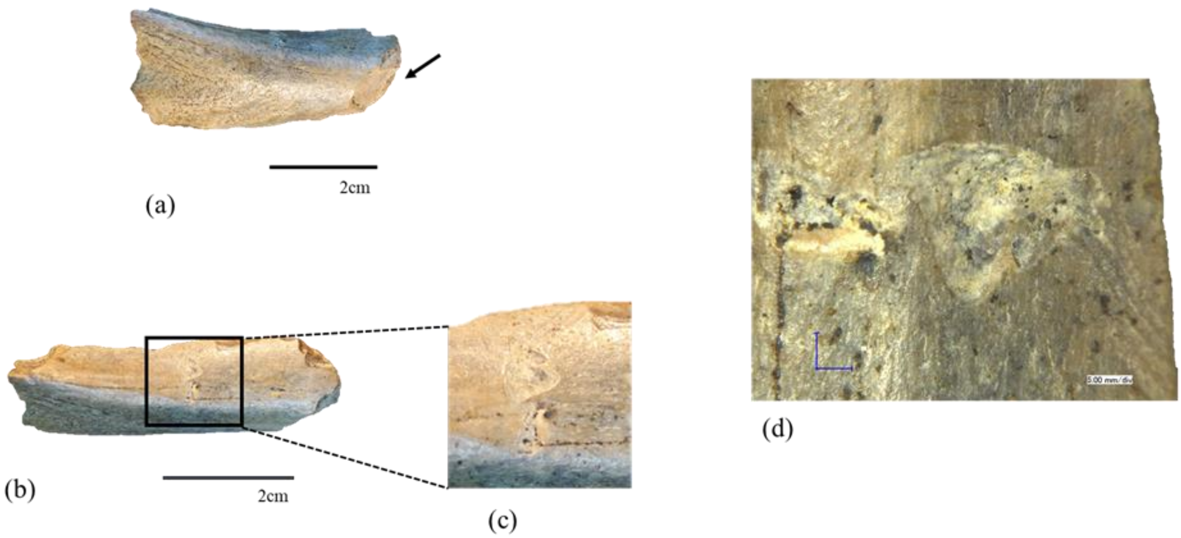


Figure 28: (a) Long bone fragment the arrow showing green fracture (b) a cortical surface showing possible percussion pit (c) close-up picture of the percussion pit (d) close up picture of the percussion pit and percussion striation. 2cm scale. From locality 8

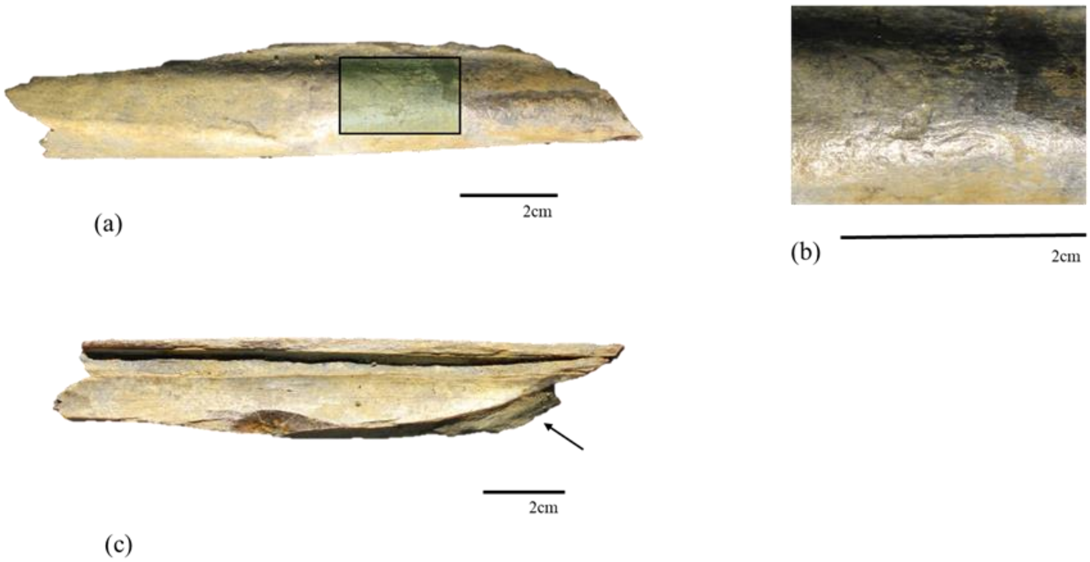


Figure 29: (a) cortical surface of long bone fragment (b) close-up picture of the possible percussion pit and striation (c) medullary cavity side, the arrow showing green fracture. 2cm scale. From locality 8

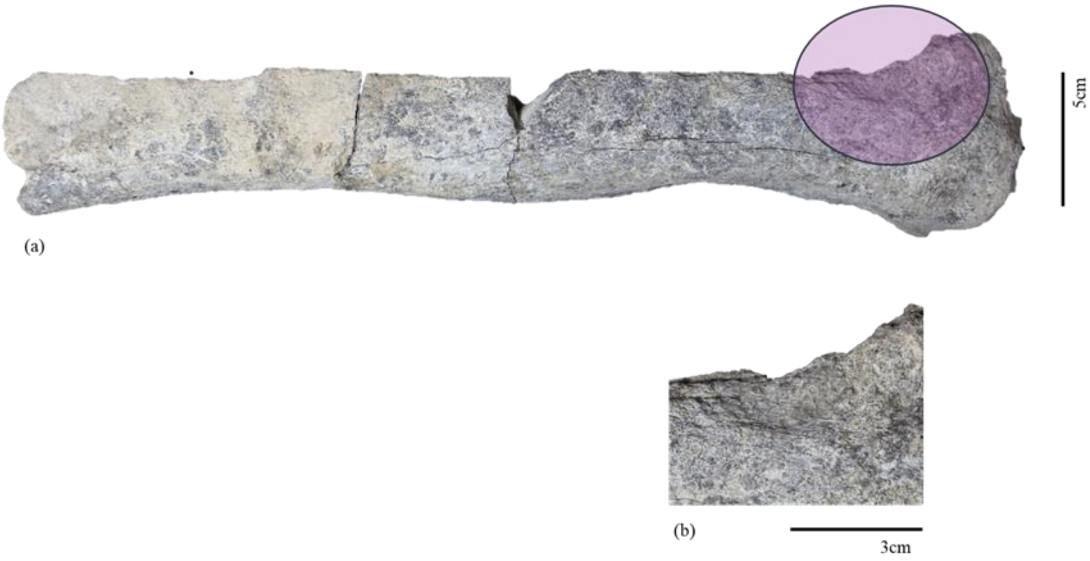


Figure 30: (a) proximal to distal radius of Giraffidae showing possible percussion mark (b) close-up picture of possible percussion pit. From locality 8

Only a single specimen from locality 8 exhibits linear mark. This specimen is a medium size animal rib fragment. The anatomical position of this linier mark is placed on the ventral side of the rib (Figure 31).

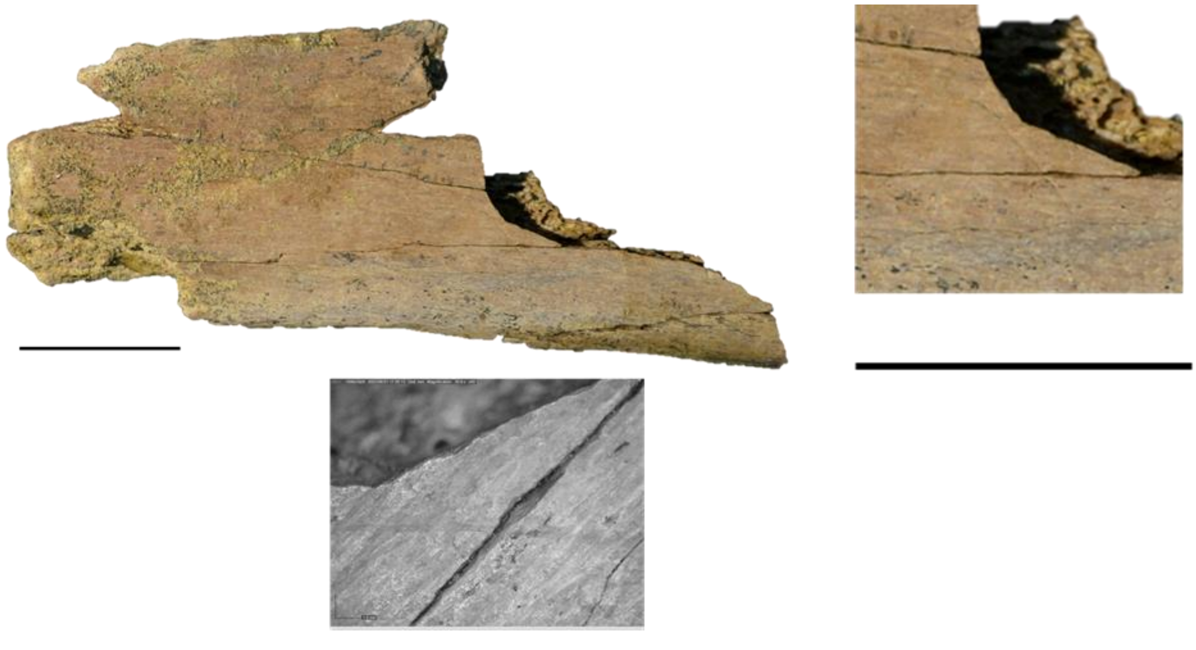


Figure 31: (a) a rib shaft (b) a close-up picture of the linear mark and (c) dino-light picture of the linear mark. 3cm scale

From Gadeb locality 8F, a Hippopotamida lower canine fragment resembling a bone tool (Figure 32) were observed. Even though, it needs further analysis the breakage pattern looks like it was intentionally flaked, with percussion points and polished edge similar to bone tools reported elsewhere (e.g., (Backwell & d'Errico, 2005; Pante et al., 2020).

Figure 32: Hippopotamida canine possibly 'flaked?' (a) dorsal side and (b) ventral side. 3cm scale. From locality 8

Locality 8 F 'Butchery site'

From Gadeb locality 8 site 8F or the 'butchery site' 20 specimens were analysed. Four of them are isolated tooth fragments and three belongs to Hippopotamidae (Figure 34) and one upper molar identified to Bovidae family. One of the Hippopotamidae canine mentioned above seems flaked intentionally (Figure 32). Out of the 16 specimens identified to a post cranial part, two are identified to element level: a nearly complete scapula of Hippopotamidae (Figure 33) and large mammal rib. The remaining specimens are two bone flakes, five long bone fragments and seven unidentified bone fragments.

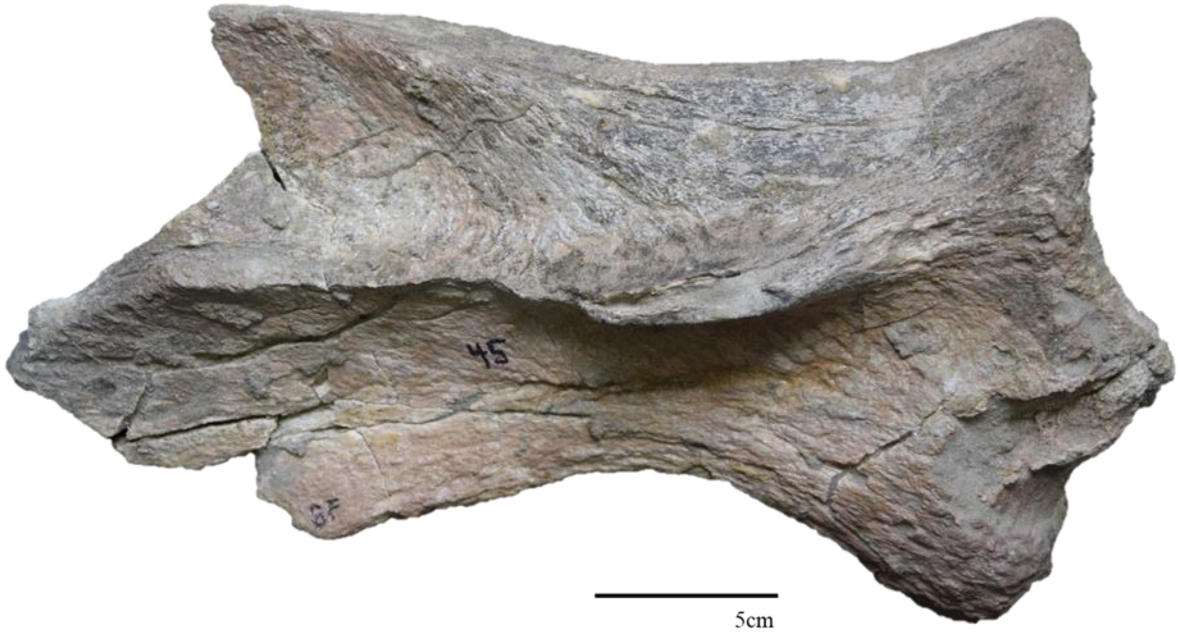


Figure 33: lateral view of Hippopotamidae scapula. From locality 8F

Figure 34: lower canine of Hippopotamidae

From the total post cranial specimens (n = 16) eight specimens exhibit anthropogenic and post depositional modification. Four specimens exhibit green fracture, one specimen has possible percussion mark, three specimens show partial cortex exfoliation, and four specimens show root etching marks (Figure 35).

Figure 35: (a) long bone fragment showing root mark (b) close up picture of the root mark.

4.3.2.2. Weathering

From the total assemblage of locality 8 (n = 322), 126 specimens are studied for six stages of weathering. In a similar pattern like locality 2, 58% (n = 73) are in stage 1 condition, whereas 23% (n = 29) are in stage 2 and 14% (n = 18) are in stage 3 (Figure 36). In addition, like locality 2, no specimen was identified to weathering stages 4 and 5, indicating a short sub-areal exposure of the bone surfaces.

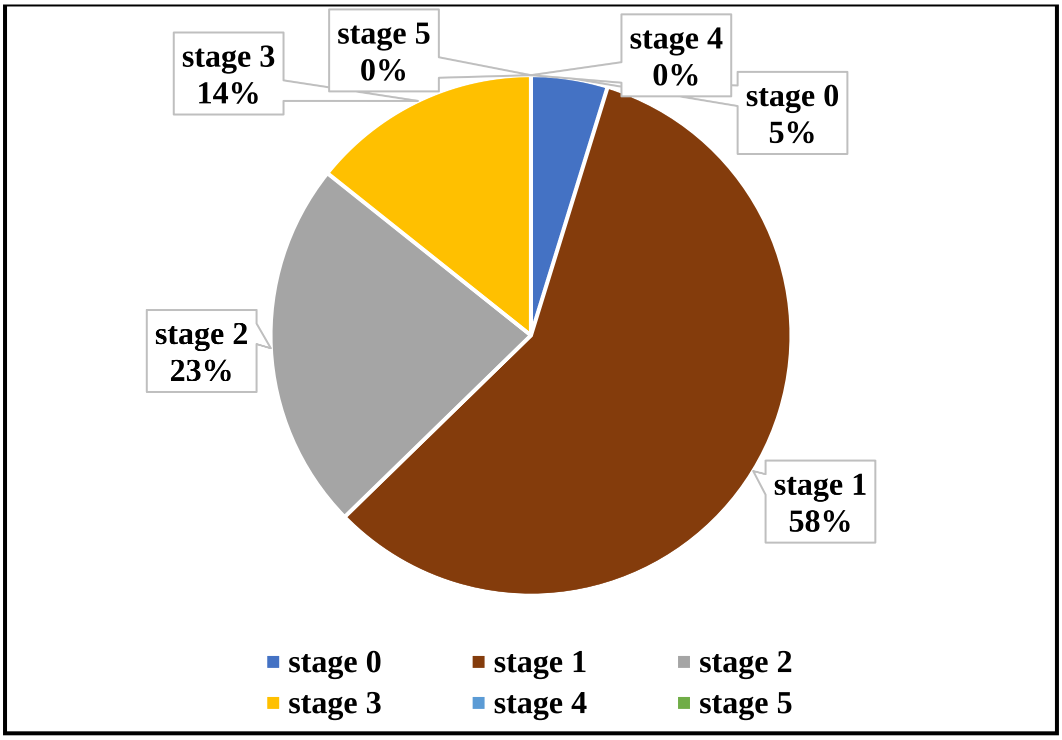


Figure 36: percentage of the weathering stages

4.3.2.3. Post depositional alterations

At locality 8, on the 322 specimens analysed for taphonomy effects, 46 specimens are affected by post depositional alterations. Three types of alterations are recoded at this locality. The most common alteration is exfoliation which is a total or partial removal of cortical surfaces of a bone (e.g., Figure 37). A total of 30 specimens shows complete and partial cortex exfoliation. Compared to the total assemblage except for the cranial elements (n = 249), only 10% are affected by cortex exfoliation.

Figure 37: long bone fragment showing cortical surface exfoliation and the arrow shows green fracture. 3cm scale. From locality 8

The other post-depositional alteration observed from this locality assemblage are corrosion (Figure 38) and root marks also called dendric etching (J. Thompson, 2005). 10 specimens are affected by small and large pit corrosion and five specimens exhibit root mark.

Figure 38: non-id bone fragment exhibiting small pit corrosion. 3cm scale. From locality 8.

For the different abrasion stages, 230 specimens are analysed from locality 8 assemblages. 43% (*n* = 98) are in stage 3 condition, which is highly abraded. 35% (*n* = 81) show moderate abrasion (stage 2) and 15% (*n* = 35) are in stage 1 condition. Only 7% (*n* = 16) of the specimen are in a fresh stage with no impact of abrasion (Figure 39).

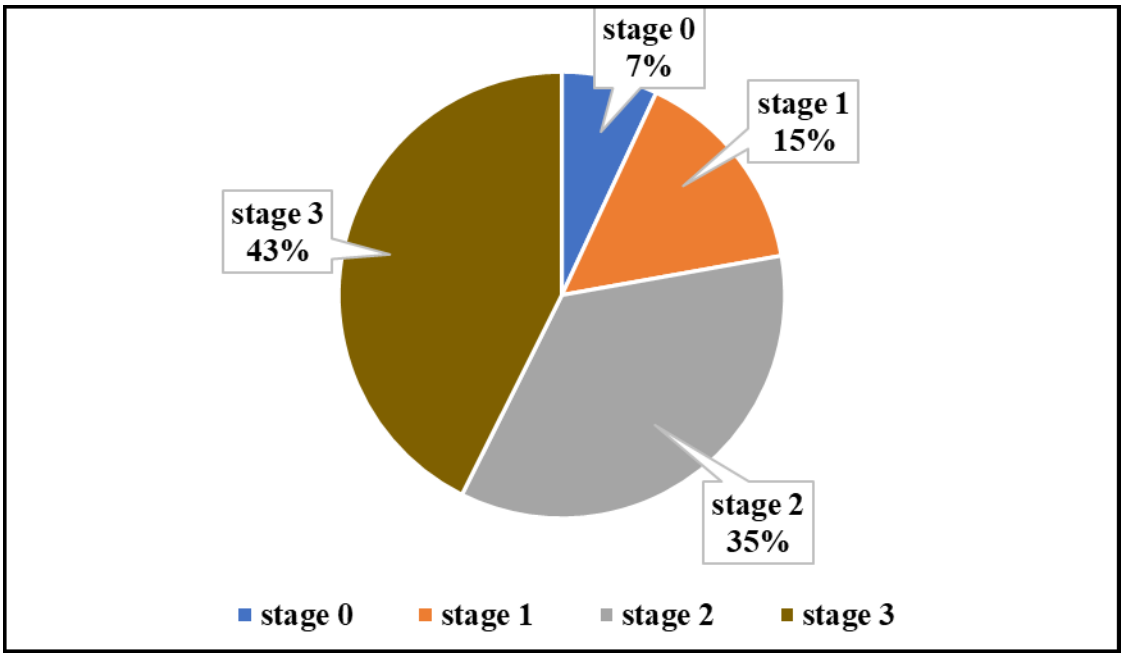


Figure 39: abrasion stages of locality 8 assemblage (n = 230)

5. Chapter Five – Discussion

5.1. Taxonomy abundance comparison between Gadeb localities

Assorted fauna families have been identified from both localities of Gadeb (*n*= 169) (Figure 8 and Figure 40). Hippopotamidae, Equidae and Bovidae are represented in both localities with a great abundance. Elephantidae and Suidae are identified in locality 2 assemblage but not in locality 8. Aves and Giraffidae are identified only from locality 2 assemblage, but they are not represented in locality 8 (Figure 40). Non identified bone fragments and most of the long bone fragments (*n* = 369 from locality 2 and *n* = 221 from locality 8) could not be attributed to family level, specific skeletal element part or size classes due to their high degree of fragmentation and lacking diagnostic features.

A comparison of faunal composition between these two localities shows a high abundance of Hippopotamidae on both sites followed by Bovidae (Figure 40). However, at Gadeb locality 8, Bovidae are generally represented less than at Gadeb locality 2. The other difference comes from the relative high abundance of Equidae at locality 8 than locality 2. This could indicate the presence of an open environment near a water body for locality 8, while relatively mixed condition for locality 2. This could be further discussed using bovid tribes as they are known to be habitat specific taxa (e.g., (Bobe et al., 2007; Reed, 1998; Vrba, 1980). Bovids have been described as sensitive indicators of environment because of the extreme resource partitioning practiced by this group and extensive division of the use of plant resources. Bovids have been sensitive to their habitat for at least the last 4 Mya (Kingdon, 1982; Spencer, 1997).

Suides are environmentally informative (Alemseged, 2003) but the identified suides in Gadeb are only to a family level. The isolated tooth fragments are too fragmentary for narrowing the identification to a species level.

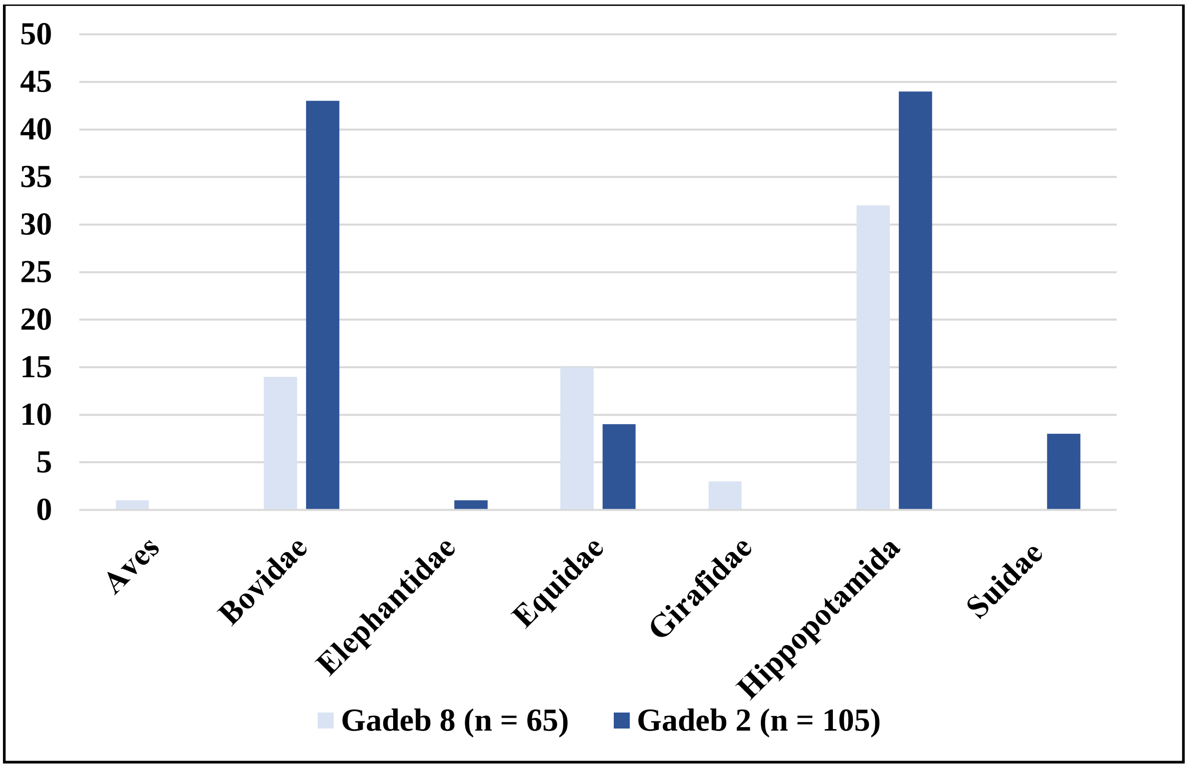


Figure 40: Taxa composition of Gadeb locality 2 and 8

From both localities, 16 bovids are identified to a tribe level. While Bovini is identified only from locality 8, cf. Hipotragini is only identified in locality 2. Antilopini, Alcelaphini and Aepycertini are identified in both localities (Figure 41). Aepycerotini is the most represented in locality 2 and Alcelaphini is the most represented in locality 8. Aepycerotini is known as flexible that could dwell on both open and wooded environments. For instance, modern Aepyceros (impala) inhabits on varied environmental condition with dietary behaviour that ranges from grazing on open habitat to browsing (Cerling et al., 2015). Whereas Alcelaphini prefers open and dry environments. Modern Alcelaphini, for instance are an obligate grazer on dry and open habitats (Bobe & Eck, 2001; Cerling et al., 2015).

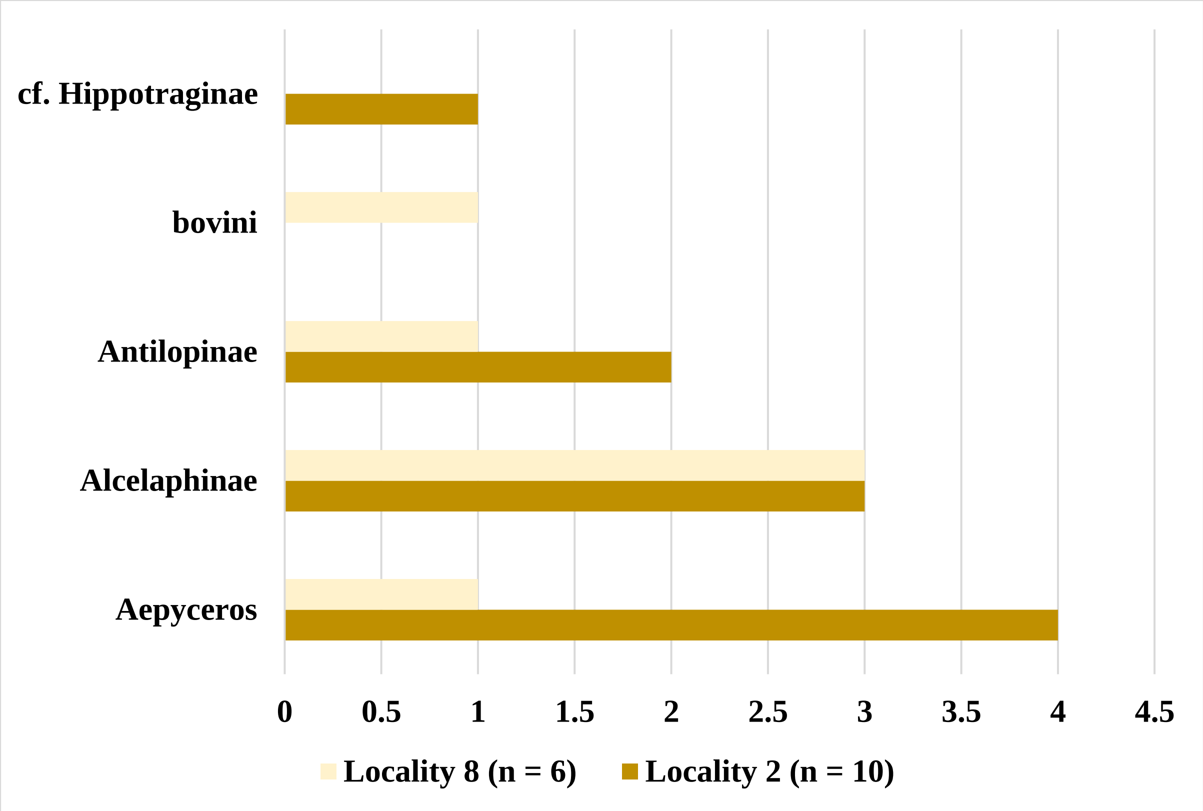


Figure 41: identified Bovidae tribes from locality 2 and 8

5.2. Ecological context of Gadeb Localities

Based on species ecological tolerances of the identified taxa at Gadeb localities, the paleoenvironment during the whole sequence is a composition of several microenvironments. Following taxon-based (phylogenetic) approach the presence of browsers and mixed feeders suggest some form of woodland in the vicinity. The water dependent taxa, hippopotamus indicate the presence of a nearby permanent water source either a lake or river. But the presence of Bovids, mostly (Alcelaphini) and Equids indicate the presence of open grasslands (Bobe & Eck, 2001; Cerling et al., 2003; Cerling et al., 2015). Assuming the elevation of the area has not changed much since the time of deposition (Williams et al., 1979), the Abundance of Alcelaphini and Equids in both localities indicate the presence of highland grassland habitat. Modern representative from the tribe Alcelaphini prefer semi-arid grasslands. The giraffe implies the presence of some trees (Geraads et al., 2022). Suidae and Equidae also support the presence of some local grasslands (J. C. Thompson et al., 2015).

Sample sizes of identified taxa were too small to surely distinguish between the different localities of Gadeb and sub localities. To calculate the accurate number of the actual population that contributed to the recovered assemblage Gadeb is not reliable. This is mainly due to the context of the site. De La Torre (2011) study indicates that materials from some of the trenches are not in their primary context. Clark and Kurasshina (1980) claim that based on the abrasion stage of the lithic materials the assemblage in some of the trenches are in a secondary context. But the materials are deposited not far from the primary context. The third reason is that the storage condition of the material since the excavation time is not ideal. There are several specimens that are damaged, misplaced, unlabelled, and as a result excluded frum this study.

In the provisional faunal identification work by D. Geraards and S. Edwards (reported on Clark and Kurashina, 1979b) they reported identifying post cranial elements of Elephantidae in the collection. Based on my work there is only one tooth fragment of Elephantidae. There is no hominin, carnivore and aquatic animal remain recovered from both localities of Gadeb. My evaluation of paleoenvironment indication is suggested from Hippopotamus, Bovid, Equid and Suide assemblages. Similarly to Gadeb, Hippootamidae is the most common large mammal represented in Fanta (Lanzarone et al., 2021) and in Melka Kunture (Chavaillon, & Piperno, 2004).

Similar to Hippos, Bovids are most represented in Melka Kunture. Alcelaphini is the most represented Bovidae tribe followed by a few specimens identified as Bovini, Reduncini and Antilopini (Chavaillon, & Piperno, 2004). According to Chavaillon and Piperno (2004), in Melka Kunture the complete lack of Tragelaphines, the almost complete lack of Reduncines, and the striking dominance of Alcelaphines and Antilopines strongly suggest that the environment (at Garba IV) was dry and open.

5.3. Depositional environments of Gadeb localities

Analysis of skeletal element representation allows to understand the type of depositional environments, mainly related to riverine systems (Alemseged, 2003; Behrensmeyer, 1988). The identified skeletal elements represented in both localities does not show similarity (Figure 42). One auditory bone, carpal/tarsal element, cranial fragment, fibula, humerus, and tibia are identified only from Gadeb locality 2. Femur, pelvis, and Radio-ulna are identified only from locality 8.

Body part representation for the mammals shows over-representation of dental fragments on both localities. Complete isolated tooth and fragments are most represented in both localities (Figure 42). The hardest substance of the body part preserves well in the fossil record.

Skeletal part representation is one of the prominent ways for determining agents influencing a site formation history. An abundance of shaft fragments with no proximal or distal ends are considered an indicator for a carnivore assemblage with the carnivores chewing off the ends of the bones.

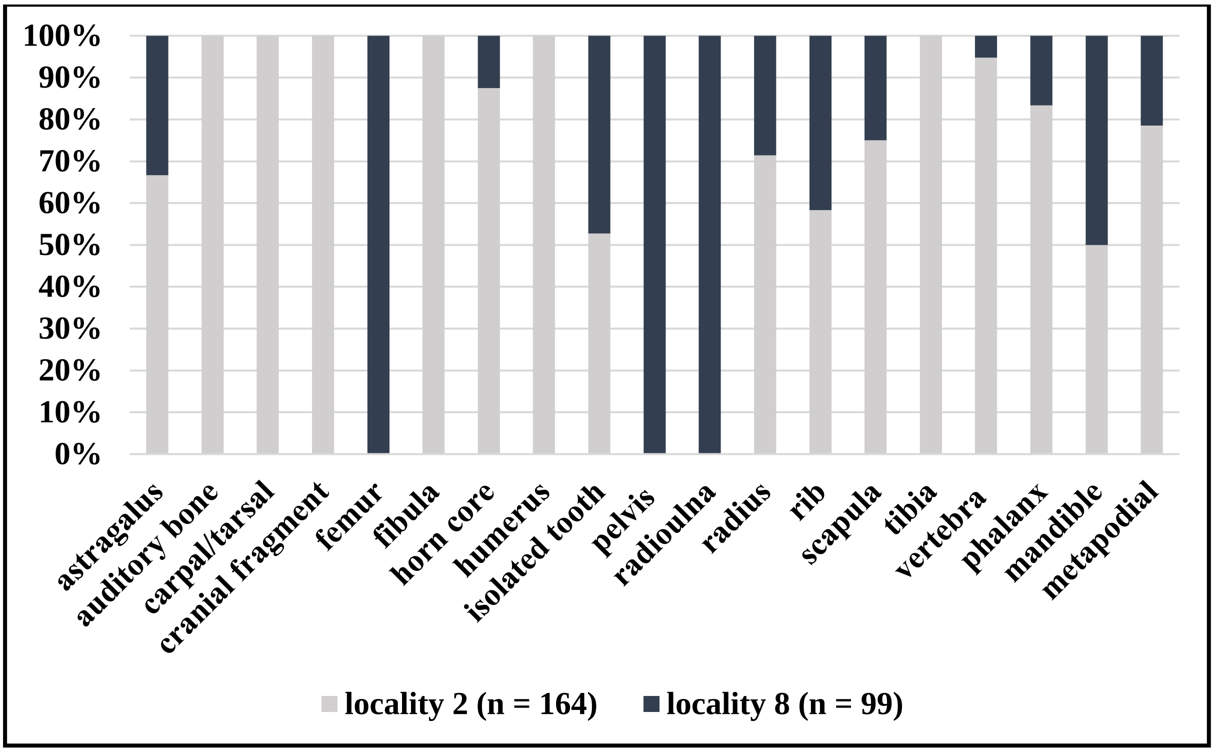


Figure 42: percentage representation of skeletal elements at Locality 2 and 8

In all the Gadeb assemblages, no carnivore tooth mark was found despite significant number of the long bones exhibited green fractures. A hominin assemblage would rather display proximal and distal ends of bones and would lack shaft fragments due to hammerstone breakage. Overall, the skeletal part representation tips in favour of a hominin manipulated assemblage. Thus, generally, hominin activity and hydraulic effect are important taphonomy factors.

Weathering stage data show that the two localities produced fossils with relatively similar exposure histories. Assemblage from both localities doesn’t fall into stage 4 and 5 weathering stages. Out of the total (*n* = 301) assemblage studied for the different weathering stages from locality 2, 92% is only slightly weathered and falls within stage 1 and 2. For locality 8 assemblages (*n* = 126), 81% is slightly weathered. Like locality 2 these assemblages are in stage 1 and 2 categories. These faunal remains are characterized by cracking along the long axis of the bone while the cortex is still preserved.

To assess the degree of fluvial alteration, abrasion stage of the bone fragments has been recorded. In both localities several specimens are moderately abraded (stage 3 and 2). From the total assemblage (locality 2 n = 385 and locality 8 n = 230) studied for abrasion categories 69% from locality 2 and 78% from locality 8 is stage 1 and 2 category. This could relate to moderate energy flow of the river carrying sediments slightly affecting the sorting of skeletal elements (Behrensmeyer, 1988).

Gadeb could have been an ideal place for hominid occupation with an available water resource, large mammals, and raw material for lithic production. The presence of hominid bone surface modification in most of the layers support the statement Gadeb was not a seasonal occupational site. The taxa and skeletal element abundances were not specifically quantified, most identified specimens were fragments of post cranial elements rather than individual diagnostic specimens. This suggests a high degree of fragmentation rather than a large minimum number of individuals (Madgwick & Broderick, 2015; Marean, 1991; Thompson, 2005). The overall distribution of long bone midshaft portions is dominant in Gadeb fauna assemblage. According to (Capaldo, 1997) experimental work and archeofauna study from Olduvai (FLK 22) this indicates that long bone fragmentation was concentrated in the nutritive phase of site formation.

5.4. Traces of Hominin Butchery activities at Gadeb

Bone surface modification on bones from archaeological assemblage contains crucial evidence for understanding the role of hominid behaviours and non-hominid taphonomic processes on a site formation (Fisher, 1995).

Possible cut marks are only identified from Gadeb locality 2 assemblages but not from locality 8, not even in the hippo ‘butchery site’. The other hominid induced modifications: green fracture, linear mark, peeling effect, and possible percussion marks are found in both localities in different concentration. This indicate the feasting of mega faunas by the hominins. Analysis from the Gadeb assemblage revealed that no carnivore modification was identified. Fossil remains of carnivorans are not identified too.

5.4.1. Comparison with other sites

The taxonomic composition of Gadeb is similar with other sites in East Africa and sites located in the highland areas of Ethiopia (Table 5). According to Geraads et al., (2022) in Melka Kunture hippos, bovids and equids are common large mammals. Suidae, Giraffes and Elephants are quite rare. Most of the bovids belong to the tribe Alcelaphini, and only a few specimens are identified to Bovini, Reduncini and Antilopini. Carnivorae and Primate are extremely rare.

The results from Gombore II-2 in Melka Kunture, suggest that many of the bones were fragmented when still fresh and that biotic agents were responsible for most of the bone damage. Fracturing due to diagenetic or burial and/or post-burial processes to a considerable extent is not evident. These results underline the above suggestion that the faunal assemblage shared a relatively homogeneous burial (Altamura, Gaudzinski-Windheuser, et al., 2020).The presence of this marks indicates the occupation of hominids in the highland during the Plio-Pleistocene time

Site name	**Age (Ma)**	**Hominid activities**	**Taxa represented**	**Reference:**
Melka Kunture	1.4-0.7	Cutmark	Hippo	Altamura, 2020
Konso	~1.4	Cutmark, bone tools	Hippo, bovids and other medium to large mammals	Sano *et al*., 2020; Echassoux, 2012
Olduvai Gorge (Bed II-IV)	1.4-08	Cutmark, bone tools	Various medium to large mammals including bovids	Blumenschine 1995; Dominguez-Rordigo et al 2002; Pante et al 2020; Organista et al, 2017, 2023
Koobi-Fora Fm (Okote)	~1.5	Cutmark, percussion	Hippo, bovids, and other medium to large mammals	Bunn, 1994; Pobiner 2008, Merritt, 2017
Shungura Fm. (Member L)	~1.2	Cutmark, percussion, bone tool(?)	Hippo, Bovidae, Proboscidea, Fish, Turtle	Redae, 2022
Buia, Danakil depression	~1	Cutmarks	Hippo, Bovidae, crocoilia	Fiore *et al.*, 2004
Gadeb	~1.4-07	Cutmarks + percussion + bone tools?	Medium to Large size Mammals	This study

Table 5: table showing late early Pleistocene (1.5-0.7 Ma) sites with Megafauna butchery evidence in eastern Africa.

There is no crocodile remain or mark in Gadeb. The same goes for carnivore remain and carnivore induced mark. As a result, mimicked cut marks are ruled out and the possible cut marks identified from locality 2 can be confirmed as hominid induced marks. The location and frequency of cut marks on different skeletal parts can be used in conjunction with a knowledge of animal anatomy to identify patterning in the butchering techniques of present and part humans (Bunn, & Kroll, 1986). Diagnostically valuable contextual clues include the orientation of the mark with respect to a specimen's long axis, the number of marks present on a specimen, and the mark's location on a specimen in relation to anatomical landmarks, fracture features, and other marks (e.g., (Bunn, 1991, 1982; Capaldo, 1998; Selvaggio, 1994; Shipman & Rose, 1983).

The linier marks identified form locality 2 are on specimens non-identified to a skeletal element. As a result, they are not confirmed as a possible cut mark. Additionally, the incisions are shallower, and the anatomical placement of the mark is unknown. The single specimen from locality 8 exhibiting linier mark is debatable for a possible cut mark. The incision is located on the ventral side of the rib. According to Pickering et al., (2013) the position of the mark indicates the process of butchering to access the organs covered by the rib cage. Bone breakage patterns are consistence with marrow accessing.

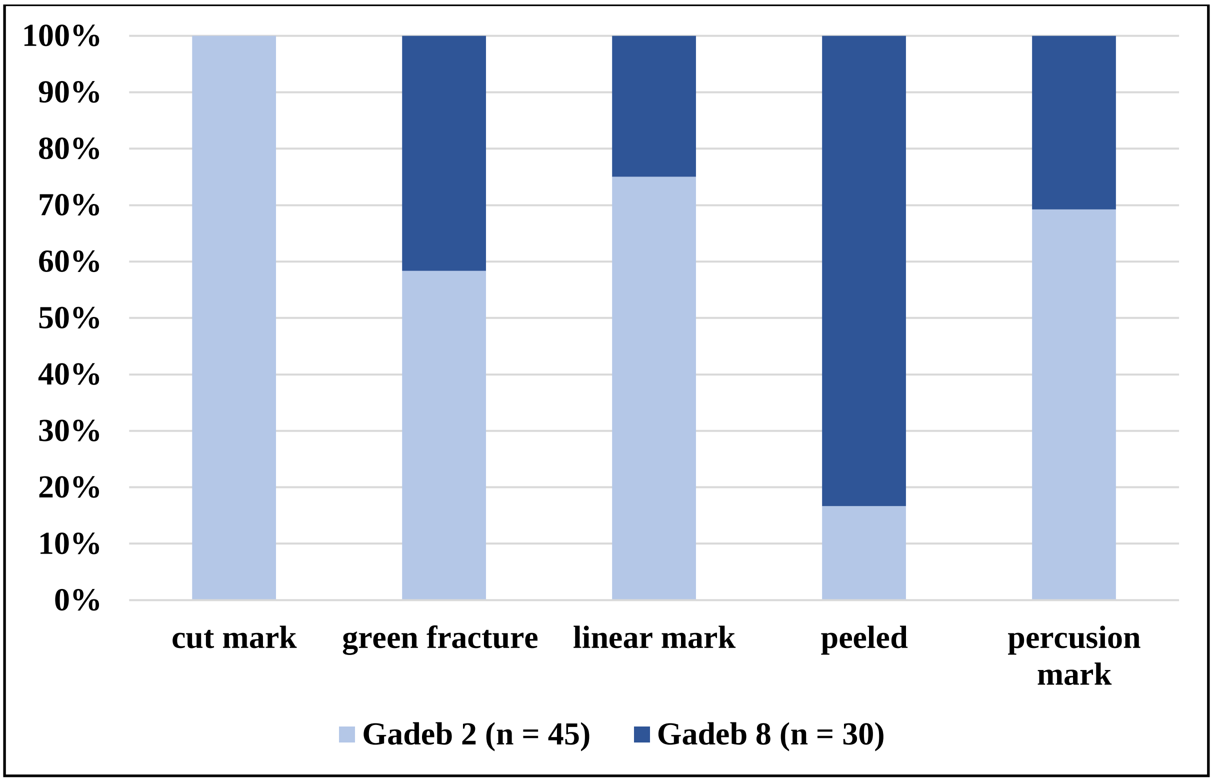


Figure 43: bone surface modification from Locality 2 and 8

Beside taxa composition to reconstruct past environment, additional information on the structure of the fossil environment can be achieved by studying the process of bone degrading before fossilization (Kaiser, 2000). Major taphonomic processes involved in the modification of the material are weathering, abrasion, root etching, corrosion, and cortex exfoliation. All these bone surface degrading agents are a barrier to observe a possible bone surface modification. Corrosion is characterized by groves with smooth u shape. To better understand the agent for corrosion microscopic SEM analysis is recommended.

Post-depositional alteration intensity in both localities is different. Root mark is only exhibited in locality 8 excavation trench 8F. Assemblages from locality 2 are the most affected by corrosion. Assemblages from locality 8 are the most affected by cortical exfoliation.

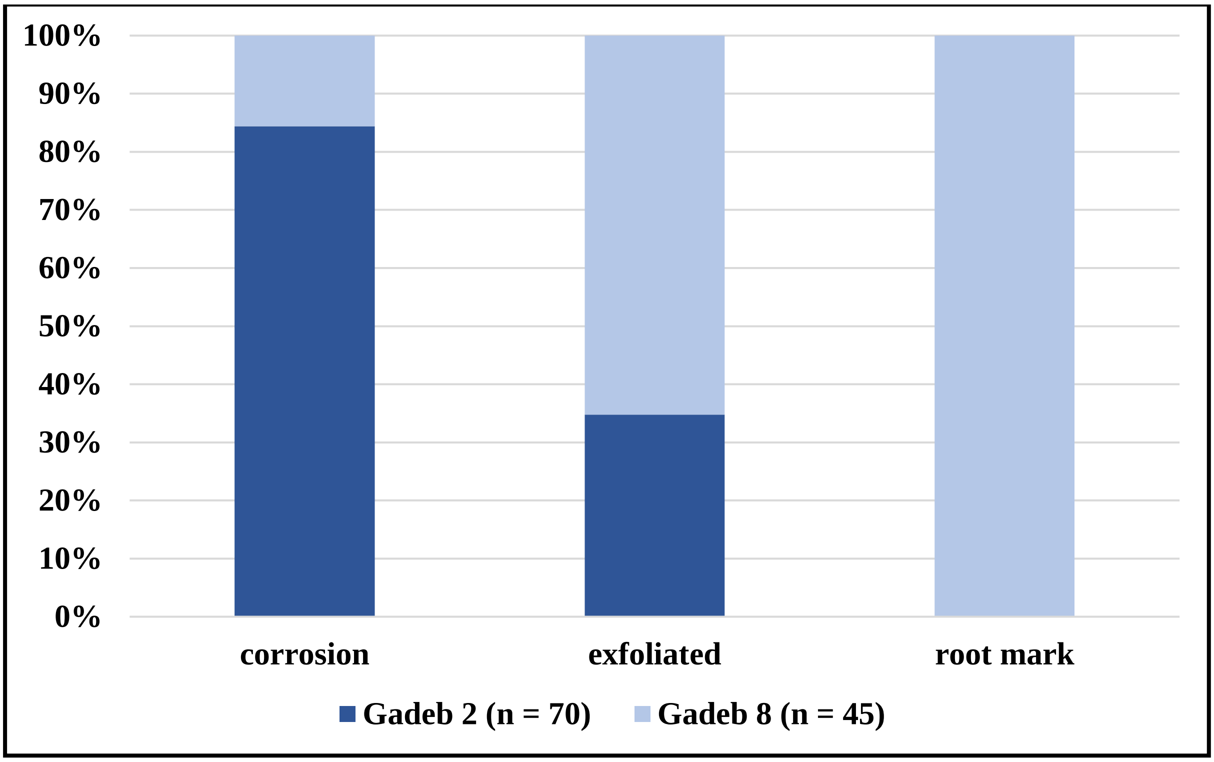


Figure 44: post depositional alteration of Locality 2 and 8

The contextual link between the lithic material and bone fragments is represented by cutmarks and percussion marks. Only 26 specimens from the total Gadeb assemblage exhibited bone modification that was diagnostic of certain accumulators. This is excluding specimens showing green fracture (n = 20 from Gadeb 8 and n = 28 from Gadeb 2). According to (Marean, 1991; Thompson, 2005), the scarcity of surface modification does not translate to a lack of confirmation for any agent, rather the number merely represents a low level of preservation and extended post depositional alteration at the site. The bones recognized as exfoliated, corroded and abraded highlight this preservation status as a barrier to identify bone surface modification Regardless several surface modifications did occur. This bone surface modification information indicates the hominids occupying the Gadeb highland between 1.5 to 0.7 Mya acceded the carcass of large faunas.

Another determination of accumulating agent is long bone breakage pattern defined by (Villa & Mahieu, 1991). Oblique fracture angles are the most common in Gadeb assemblage and they represent fresh, green bone fracture. 33% of the total identified as part of long bones from Gadeb locality 2 (n = 84) exhibit green fracture breakage. 38% of the total identified as part of long bones from Gadeb locality 8 (n = 52) exhibit green fracture breakage. This indicates intensive marrow extraction and the hominids exploiting beside carcass. Villa and Mahieu (1991) defined dried bone breaks having a transverse fracture outline. To identify the timeline of a bone breakage on a long bone the morphologies of the breakage and fragmentation indices are evidence (Villa & Mahieu, 1991). Bone breakage patterns seen in Gadeb assemblage are consistent with marrow accessing activity.

The result from this study supplements the preliminary statement about the fauna by Clark and Kurashina (1979a). Remains of different taxa are found on this site and butchering was commonly practised by the hominids. Gaebe is generally close to or in stream courses, as elsewhere in East Africa and Ethiopia. The Gadeb assemblages show generally close similarities, though with local variation, with those Plio-Pleistocene sites from east Africa.

5.4.2. Possible bone tools

In east Africa Plio-Pleistocene context bone tools have been discovered from Konso (Sano et al., 2020) and Beds II-IV, Olduvai Gorge (Pante et al., 2020). From both sites bone tools have been identified from skeletal elements belonging to Hippopotamidae family. The bone handaxe from Konso is the oldest known extensively flaked example from the Early Pleistocene.

Studies from Beds II-IV, Olduvai Gorge using microscope digital image and references of prehistoric knapping stated the confusion between natural occurrence and hominid intervention on tooth remains. Chipping and battering were interpreted as natural damage. Which could also be a natural modification produced during the lifetimes of the animals during feeding, digging, or through use in intraspecific competition (Pante et al., 2020).

The incisor found at Olduvai has a possible polished and worked area (Pante *et al*., 2020). However, they identified the specimen as a natural occurrence. (Haynes, 1991) stated that hippopotamids and Proboscidean incisors have a tool-like appearance even when unmodified. These dental elements are prone to polish at their tips and are typically striated owing to abrasion that occurs during an animal's lifetime.

Based on the evidence from Konso and Olduvai Gorge, the hippo canine fragment from locality 8F is eligible to be a bone tool. To identify if hominidn modified the bone or if it was a natural phenomenon further investigation must be conducted using microscope and use wear analysis. If there are any micro flake scars, were polish and edge rounding is present. The same is for the Elephantidae tusk from locality 2. Further analysis must be done to identify if it was used as a tool, or the edge scars are part of the taphonomic/microwear process.

5.4.3. Is Locality 8F a 'Butchery site'?

The criteria to recognize sites exhibiting early hominin hunting and butchering practices includes the co-occurrence of stone tools and bones (Shipman & Rose, 1983). However, breakage patterns, skeletal representations, and faunal representations provide additional information (Brain, 1981). According to (Bunn, & Kroll, 1986) identifying butchery site from camp site is the frequency of skeletal part. Generally, the less nutritious and heavier part remain at the animal death site while the more nutritious and lighter part of the animal are transported. At Gadeb locality 8F, out of the 20-specimen found only 25% is identified at a family level and 20% are Hippopotamidae. Bovidae is represented by one isolated tooth. Only 20% show spiral shape breakage and only 1 specimen has percussion mark. 56% (n = 16) of the specimen is moderately abraded. As bone surface preservation is highly affected by hydraulic transportation in this site, butchery marks become difficult to identify. Five of the specimens are long bone fragments and 2 are rib and scapula. Long bones, ribs and scapula are very nutritious elements.

Gadeb 8F was considered to represent a butchering episode of a hippopotamus by Developed Oldowan hominis (Clark & Kurashina, 1979b). This single-event activity area at Gadeb 8F would contrast with the other localities in Gadeb, which were said to represent "multi-context, multi-component concentrations of high density, most probably reflecting regular re-occupation over a longish period of time" (Clark, 1987) on the banks and channels of shallow streams (Clark & Kurashina, 1979a). One of the earliest pieces of evidence of "single-carcass butchery site" is from Gombore II located in a half-graben depression of the Upper Awash

Valley in Ethiopia, 2000 masl. This site is dated to ≈ 0.7 Ma. (Altamura, Gaudzinski-Windheuser, et al., 2020).

5.5. Conclusion

The Gadeb site provides valuable evidence for examining hominin interactions with the paleoenvironment and associated faunas in the highland Ethiopia during Pleistocene time. Though hominin remains were not discovered in Gadeb, evidence of hominin presence is confirmed based on the faunal assemblage. After analysis of the collected data, I found these remains exhibited characteristic traits of hominins as an accumulation agent. Hominin activity is demonstrated through the presence of percussion marks, cut marks, breakage patterns and skeletal part representation. The presence of hominin manipulated marks in diverse levels indicates the site was not seasonally occupied.

No carnivore modification or carnivore remain were found at Gadeb. Sediment attrition, to some extent, post depositional chemical deterioration and not well-preserved cortical surface become a barrier to identify bone surface modification on Gadeb assemblage. Despite the fragmentary state of the fauna, which hinders precise taxonomic identification and bone surface modification the fauna from Gadeb is quite interesting. There is an abundance of fragmentary teeth, with a predominance of Hippopotamidae. From an anatomical point of view, these bone fragments include fragments of pelvis, vertebrae, ribs, and limbs. Several fragments of horn have been retrieved and some have been identified at a tribe level. There is a predominance of hippopotamus, with frequent Bovidae and a substantial number of Equidae. This taxa composition indicates the presence of several microenvironments which includes a water body, grassland, and forest.

The results of this study allowed me to highlight on tentative remarks that Hominins at this time had access to large animal carcasses. This study reveals that hominins manipulate the assemblage and latter it was highly affected by fluvial activity and corrosion. The hominin involvement was determined based on the presence of cut mark, hammerstone percussion mark, specific skeletal part representation and the major representations of certain breakage patterns.

5.6. Recommendation

Future study on this site is not possible since the area is now under water due to the construction of Melka Hydroelectric power dam in the 1980s. Further work on this site can only be done through comparing to adjacent sites like Melka Wokana and refining of the samples already stored in the laboratory of the EHA. For instance, future work can be done through isotope analysis and micro wear studies on the dental remains to better understand the dietary ecology of the ungulates and to refine paleoenvironment context of the localities.

Furthermore, unidentified skeletal elements, especially those with bone surface modifications could be further investigated to taxonomic level through the analysis of cortical thickness measurements. This could be achieved through comparative analysis of the measurements to either conducting experiments or to an existing experimental data.

In addition, bone surface modifications should be studied through further quantitative measurements such as the use of geometric morphometric analysis (Courtenay et al 2019). This will allow to better characterize the shape and size of the cutmarks and compare to already known experimental data (e.g., Souron et al 2019; Redae, 2022). Gadeb has the potential to understand human evolution history during middle to late Pleistocene, in particular early adaptations to highland environments.

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