

Review

# Elephant and Mammoth Hunting during the Paleolithic: A Review of the Relevant Archaeological, Ethnographic and Ethno-Historical Records

Aviad Agam \*  and Ran Barkai

Department of Archaeology and Ancient Near Eastern Cultures, Tel Aviv University, P.O.B. 39040, Ramat Aviv, Tel Aviv 69978, Israel; barkaran@post.tau.ac.il

\* Correspondence: aviadkra@post.tau.ac.il

Academic Editor: Maria Rita Palombo

Received: 31 December 2017; Accepted: 6 February 2018; Published: 8 February 2018

**Abstract:** Proboscideans and humans have shared habitats across the Old and New Worlds for hundreds of thousands of years. Proboscideans were included in the human diet starting from the Lower Paleolithic period and until the final stages of the Pleistocene. However, the question of how prehistoric people acquired proboscideans remains unresolved. Moreover, the effect of proboscidean hunting on the eventual extinction of these mega-herbivores was never seriously evaluated, probably because of the lack of acquaintance with the plethora of information available regarding proboscidean hunting by humans. The aim of this paper is to bridge this gap and bring to light the data available in order to estimate the extent and procedures of elephant and mammoth hunting by humans during the Quaternary. This study examines the archaeological evidence of proboscidean hunting during Paleolithic times, and provides a review of ethnographic and ethno-historical accounts, demonstrating a wide range of traditional elephant-hunting strategies. We also discuss the rituals accompanying elephant hunting among contemporary hunter-gatherers, further stressing the importance of elephants among hunter-gatherers. Based on the gathered data, we suggest that early humans possessed the necessary abilities to actively and regularly hunt proboscideans; and performed this unique and challenging task at will.

**Keywords:** proboscidean; hunting strategies; Paleolithic; human-proboscidean interaction

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## 1. Introduction

For over one million years humans and proboscideans have shared habitats across the Old and New Worlds. Elephants and mammoths were not only habitat companions, possibly conceived at times as other-than-human persons [1], but were also included in the human diet. The consumption of elephant fat and meat began with the emergence of *Homo erectus* in Africa some 2 million years ago, spread across the Old and New worlds by different human groups, and persisted up until the final stages of the Pleistocene with the extinction of proboscideans in Europe, America and most parts of Asia [2–5].

However, the question of how prehistoric people procured these enormous animals has remained unanswered. The debate regarding hunting versus scavenging as the two leading strategies of Paleolithic meat and fat procurement has subsided, as evidence of hunting accumulates [6,7]. While human hunting of medium-sized ungulates is commonly accepted in the archaeological research, the procurement of mega-herbivores by hunting is still under debate. Some find it difficult to accept that large mammals were actively hunted by Paleolithic humans and question the efficiency of such an activity [8]. However, it was recently suggested that “it is possible that expanding group sizes prompted Acheulean hominins to become big game hunters (i.e., with more mouths to feed, larger prey

was sought and obtained)" [6] (p. 19). We concur with such hypothesis and claim that the archaeological record suggests active procurement of mega-herbivores during Lower Paleolithic times and onwards. Here we explore the available evidence regarding elephant and mammoth hunting by examining the archaeological, ethnographic and ethno-historical records. The plethora of evidence presented is then used to discuss probable proboscidean procurement strategies in the Paleolithic. We believe that the data presented in this paper, and most specifically the intimacy that characterized past and present human interactions with proboscideans as well as perceiving elephants as other-than-human-persons, sheds new light on human-proboscidean relationships in the Quaternary. Notwithstanding the fact that humans hunted proboscideans at will, we believe it is most reasonable to assume that culling was monitored and executed only following specific rites in order to ensure the continuation of the existence of these two closely related species, human and proboscideans. We suggest that the nature of these special relationships prevented over-hunting of elephants and mammoths throughout the Pleistocene and can serve as a token of human perception of the environment during the Quaternary, as well as an example of the way past and recent hunter-gatherers kept a sustainable life way. This also could serve as a lesson to the human race nowadays.

## 2. Meat and Fat in the Early Human Diet

The role of protein and fat in the Paleolithic human diet has been previously demonstrated [6,9], in addition to the significance of complementary calories gained from vegetal resources [10,11]. Animal meat and fat constitute an excellent source of calories and provide essential amino acids, minerals, vitamins and fatty acids [12,13]. While meat clearly offers a good nutritional option, fat has virtues of its own, as it is the densest form of nutritional energy available in nature [2], providing a much higher calorific gain than either protein or carbohydrates [14,15]. In addition, fat is plentifully present in large herbivores even in times of resource depletion [16], and in some cases, when there is a certain dietary stress, it may even be the only means of survival [14]. Thus, fat, marrow included, must have had an important role in early humans' diet. Fat content has indeed been documented to affect prey selection among recent hunter-gatherers [17,18].

*Homo erectus* (sensu lato) evolved ~2 Ma in Africa, presenting new body proportions, an increased brain volume, new dental characteristics, and possibly a specialized digestive system dependent on enriched foods to successfully maintain the body and brain [16,19]. Fat and marrow were an essential food source for *Homo erectus* in providing for their daily energy expenditure [2,20]. Bone marrow was also demonstrated to be a better source for vitamin C than meat [21]. Thus, it is not surprising that the earliest archaeological sites contain animal bones in direct association with stone tools, demonstrating the consumption of meat, fat and marrow by early humans [6].

However, how did early humans procure animal carcasses? While some scholars were in favour of scavenging the leftovers of big cats [22–24], most current studies suggest otherwise. Studies of bone modifications suggest that early humans had primary access to animal carcasses [7,25,26]. Furthermore, the ability of early humans to design hunting tools is evident [27,28]. Given the important role often attributed to meat and fat in early human diet, it seems unlikely that scavenging was the dominant strategy for animal procurement, as the dependence on animal-based calories must have necessitated active involvement in ensuring a steady supply of prey [7,29]. Moreover, recent research has acknowledged the abilities of early humans to perform complex tasks indicating advanced social and technological capabilities [30].

Additional support for assessing the hunting abilities of early humans comes from the field of primatology, as some basic traits may have been shared by our early ancestors and most common Pan relatives, chimpanzees and bonobos [6]. Chimpanzees have been documented hunting medium and small-sized mammals [31–34] and meat consumption by chimpanzees was demonstrated as highly valuable [35]. Hunting methods applied by chimpanzees include spotting, watching, following and chasing the prey; and one group in Senegal was even observed hunting using wooden spears [36]. These observations suggest a deep, phylogenetically rooted origin of this behaviour in these very

closely related taxa [6], implying that hunting was a trait already practiced by the common ancestor of chimpanzees and humans, a trait that might have evolved as the adaptive role of calories acquired from meat and fat became more important.

### 3. Proboscidean Exploitation by Early Humans

Given the presence of elephant/mammoth remains at many Paleolithic sites worldwide [37–42], and as elephants were by far the largest terrestrial animal available for Paleolithic humans, presenting a unique combination of large quantities of both fat and meat [2], we suggest that elephants played a major role in early humans' diet and adaptation [5,43,44]. Direct evidence of proboscidean consumption is provided by isotopic studies, indicating a significant dependence upon mammoths by early humans in Europe [45,46]. The importance of proboscideans in the Paleolithic diet is further stressed through cases in which selected elephant body parts were carried into Paleolithic caves [38,47,48], implying their high nutritional value.

The issue of prey choice and body part transport is complex and beyond the scope of this paper. However, for example, among the Hadza (Tanzania), for example, animal body parts that are considered high-ranked are more likely to be transported from kill sites to base camps, compared to low-ranked body parts [49]. In the case of elephants, a high nutritional value is attributed to various body parts present at many Paleolithic sites [37], further implying the significance of elephants in human diet and adaptation (however it goes without saying that most probably fat and meat were also transported to these sites, leaving no archaeological signature after being consumed). Recent hunter-gatherer documentations present elephant meat and fat as highly valuable [50], and even as prestigious foods [51,52], while other accounts refer to the abundance of edible tissue in elephant carcasses [53,54] as well as the probable preference in taste for elephant fat and meat [55]. It is also interesting to note that among traditional societies the carcasses of procured animals are usually exploited to their full potential, often out of economic motivations, but often also out of an ontological stand of respecting the hunted animal [15,56,57]. Among the caribou hunters in Greenland, for example, all materials which can be extracted from the hunted caribou are used: antler, fur, meat, fat, sinews, bone fat and marrow [15]. A similar maximization of elephant carcasses was demonstrated in Castel di Guido (Italy), where early humans fractured elephant bones for marrow, and used elephant bones as a material for tool manufacture [58].

Some other incentives for the hunting of proboscideans may be related to technological needs, while others may refer to social considerations. The thick hides of proboscideans could have been used for clothing, containers and shelter; their bones could have been used to produce tools of both practical and symbolic significance. In some cases, for example, elephant bones were used to produce "tools" mimicking the typical iconic Lower Paleolithic handaxes [59]. The bones of elephants could also have been used as fuel for fire [60,61]; and fat produced from their fat deposits, internal organs and bones could have been used for cooking [62]. Tusks were also used for the manufacture of various artefacts, possibly as early as the Lower Palaeolithic [28]. There are also suggestions for the use of mammoth bones for the construction of dwellings [63]. It is true that scavenging natural elephant/mammoth death locations could have provided early humans with some of these materials (apart from broken elephant limb bones used for the production of handaxes and most probably fat as well). We wish, however, to make it clear that the direct procurement of proboscideans by hunting provides early human a series of benefits, besides the major caloric contribution.

Some argue that big-game hunting might have been mostly aimed at gaining prestige and social status [18,64,65]. According to these suggestions, big-game hunting was done primarily for its prestige value, or for other social and political benefits, commonly referred to as "costly signaling", while nutritional considerations played a secondary role.

While the possible motivations for the acquisition of proboscideans are multiple, the strategies applied by Paleolithic groups for elephant and mammoth procurement are still unclear. Binford [66] suggested marginal scavenging as the applied strategy for procuring elephants. In contrast,

the hunting of proboscideans by prehistoric humans has been suggested, mostly based on indirect archaeozoological evidence, from several Middle Paleolithic [43,47] and Upper Paleolithic sites [60,67,68]. In addition, an early work by Johnson et al. [62] has suggested the application of mammoth hunting strategies by the Clovis people of North America, suggesting that “elephants have behavioural mannerisms that, once learned by early man, could lead to maximal predation”. In addition, indeed, elephants are relatively easy to locate due to their repeated use of familiar paths [62,69], their dependency on water sources, and the very clear tracks they leave behind [70].

The issue of the extinction of proboscideans throughout North America and Euroasia during the terminal Pleistocene and Holocene is a matter of debate. The overkill hypothesis, for both North America and Western Europe, first developed by Martin [71,72], was attacked by Grayson and Meltzer [73] and Meltzer [74], who claimed that there is no evidence supporting it whatsoever (but see [75,76] for counter-attacks). Nikolskiy and Pitulko [77] suggest, based on the data yielded from Yana site (Siberia), that the humans that occupied the site hunted mammoths infrequently, and that such a sporadic pattern of hunting cannot be the cause of mammoth extinction. It should be noted that the Yana hunters were targeting mammoths first and foremost for ivory, supplemented by a nutritional use [78]. Frison describes the hunting strategies of the Paleoindians of North America as “systematically opportunistic” [79] (p. 41). However, Frison further explains that “the loss of breeding females to Clovis hunters could have dramatically hastened the extinction of the species, especially at a time when ecological conditions were deteriorating” [79] (p. 43). Surovell and Waguespack [76] claimed by comparing the Clovis record to the Old World record that the number of 14 clear Clovis proboscidean kill sites identified in North America is “in fact a very large number”, suggesting that “in comparison to the Old World record, Clovis peoples seem to have exploited elephants with much greater frequency than in any other time and place” [76] (p. 94). A year later Surovell and Waguespack [80] further claimed the Paleoindians hunters applied specialized large-game predation strategies, providing, in their view, a circumstantial support for the Overkill hypothesis. It seems likely, then, that humans probably played a role in these extinctions, though the exact extent of this role cannot be accurately assessed.

In this study, we present the available archaeological data demonstrating direct and indirect evidence of proboscidean hunting. In addition, we discuss ethnographic and ethno-historical data describing elephant hunting by recent hunter-gatherers and small-scale societies (excluding strategies irrelevant for prehistory, such as the use of guns, swords, horses and vehicles). Hunting by traditional methods but with modern materials (i.e., wooden spears with metal blades) is also discussed, as spears were in use by both prehistoric and contemporary groups prior to the introduction of metal. The gathered data are used to support our contention that elephant and mammoth hunting was within the capabilities of early humans and indeed had been practiced at will.

It should be noted that starting from the mid-16th century a commercial demand for ivory emerged, contributing to increased elephant poaching [8]. Thus, contemporary indigenous groups often hunt elephants for both the commercial value of their ivory and for their fat and meat [51,81] (pp. 134, 498). Hunting large game for commercial purposes is often associated with the use of rifles, rather than traditional methods [82]. Lewis [54], however, reveals a different situation among the BaYaka of the Congo Basin. There, complex social mechanisms are aimed at monitoring elephant hunting for dietary purposes, in addition to limiting the gain of status and prestige of successful hunters. Such variation in the motivations for hunting may affect both the number of elephants hunted and the strategies applied to do so. We believe that the case presented by Lewis, reflecting the practice of elephant hunting mainly for dietary purposes among egalitarian immediate-return societies, offers greater relevance for reconstructing elephant hunting in prehistoric times, when early humans were hunting elephants mostly for nutritional purposes.

We start by presenting archaeological evidence of elephant hunting. We then discuss Upper Paleolithic depictions that may be of relevance, before exploring cases of elephant hunting in the ethnographic and ethno-historical records, listed according to the applied strategy. Finally, we present

the rituals accompanying elephant hunting among contemporary hunter-gatherers, which demonstrate the significance of elephant hunting among those societies, and the role of elephants in the cosmological and ontological conceptions of these groups. Eventually, we discuss the presented data, and conclude.

#### 4. Evidence of Elephant Hunting in the Archaeological Record

Proboscidean remains are found at many Paleolithic sites throughout Asia, Europe, Africa and the Levant [7,41,48]. Such remains are also common in prehistoric sites in late Pleistocene North America [83–85] (but see [86,87]). Furthermore, zooarchaeological data, including age profiles, breakage patterns and bone spatial distribution, provide indirect evidence supporting scenarios of elephant hunting (see below). This chapter describes the current archaeological evidence, direct and indirect, of proboscidean hunting. Representations of proboscideans in Upper Paleolithic cave depictions and as portable objects are also shortly presented and discussed.

##### 4.1. Direct Archaeological Evidence of Proboscidean Hunting

The small amount of direct archaeological evidence of elephant/mammoth hunting is distributed over a wide geographic and temporal range, and is attributed to different members of the genus *Homo*. Worth noting, in this section we also provide evidence of lithic hunting items directly associated with proboscidean remains found in Paleolithic sites, as they imply a connection between the two types of finds, thus further supporting the hunting of these proboscideans.

Most archaeological indications of proboscidean hunting relate to projectiles and thrust implements found embedded in and/or in direct association with elephant remains, or to the identification of injuries caused by thrust/thrown weapons. In the central Siberian Arctic, a ~45,000-year-old carcass of a woolly mammoth was uncovered, bearing several human-induced injuries [88] (but see [89]). Two blows were detected in two ribs, possibly aimed at internal organs and/or blood vessels, and another on the internal side of the left jugal bone. Additional hits were noted on the left scapula, suggesting the use of relatively light throwing spears in addition to a thrusting spear. Pitulko et al. [90] suggest that mammoth hunting facilitated the survival of humans across the northernmost region of the Arctic and their spread within this region.

At the Upper Paleolithic Yana site, dated to 27,000–29,000 years ago [61,77], most of the bones recovered are of mammoths. A tip of a narrow siltstone point was found embedded in the right scapula of a young mammoth. The hit angle implies that the right side of the thorax was hit from the rear and slightly above. A similar pattern was detected on a fragment of another right scapula from a mid-size mammoth. Two additional identical holes caused by projectiles were found on the right iliac bone of the pelvis of a young mammoth and on the right scapula of a juvenile mammoth. Projectiles made of mammoth ivory, ivory foreshafts and preforms suitable for such implements were also recovered [61]. Mammoth hyoid bones were found within the same cultural layer but separated from the main bone accumulation, indicating the transportation and consumption of fresh mammoth organs [77]. The gathered data have been interpreted as evidence of mammoth hunting by early humans, including the hunting of mammoths of specific sizes, ages and sex.

At Krakow Spadzista, an Upper Paleolithic Gravettian site in Poland, backed stone implements were found in large numbers together with the remains of at least 86 mammoths, dated to ~24,000 years ago [40], indicating that mammoths were the favoured prey of Gravettian hunters. Out of the 197 examined implements, 55 presented a characteristic impact, interpreted as the flint parts of thrown weapons. These implements were likely hafted, and possibly used in mammoth hunting. The researchers suggest that these tools were usually taken back by the hunters after the hunt, while fragments of broken points remained inside the mammoth carcasses [40].

At the 13,500-year-old Upper Paleolithic site Lugovskoye (Siberia), a wound caused by a projectile was detected in a mammoth vertebra, with quartzite inserts embedded in it [91]. The point itself had either been removed or fallen out of the wound. Based on the absence of healing marks, it seems that death occurred immediately upon injury. The site is located within a natural occurrence of fossil



megafauna, indicating a possible tendency of Paleolithic humans to locate their sites near localities where mammoths were known to gather (e.g., watering places, salt flats).

At the Upper Palaeolithic Nikita lake site (~13,800–13,600 years ago, Arctic Siberia), a stone tool fragment was detected within a mammoth rib, suggesting the hunting of that mammoth [82]. At the Upper Paleolithic site of Kostenki (Russia), another flint tip was found embedded within a mammoth's rib [92,93].

The use of spears was suggested for the ~125,000-year-old site of Lehringen (Germany), where a wooden spear was found in direct association with a straight-tusked elephant, supposedly between the ribs of the elephant (however such an association was never decisively demonstrated, see [94,95]). Thieme et al. [96] contended that the spear had been carefully scraped of bark, indicating that significant efforts were involved in its preparation. It was suggested that hunters usually took the spear back with them after the kill, while at Lehringen the spear was embedded in the elephant carcass and left at the kill site [95]. At the near-by Gröbern (Germany, 130,000–115,000-year-old), a possible point made from a cervid tibia splinter was found in an elephant carcass, along with several flint flakes [95]. It is of note that at Schöningen (Germany) several wooden spears were also found dated to ~300,000 years ago [97]. These rare finds provide the oldest evidence of the systematic hunting of large herbivores using spears [97], indicating that this technology was known and in use by humans already by the end of the Lower Paleolithic, and possibly even earlier. As elephant remains bearing cut marks were recently recovered at the Schöningen site [98], and future studies may provide additional information regarding its procurement.

In North America, proboscideans were found at several Clovis and pre-Clovis sites in direct association with bone points and Clovis stone projectiles [99]. Such artefacts were documented as being capable of killing modern elephants [100].

At the Manis Site (Washington) a tip of a projectile made of a mastodon bone was found embedded in a rib of a mastodon dated to 13,800 years ago [101]. It should be noted, though, that this interpretation was questioned by several scholars, mainly due to the lack of other clear anthropogenic finds in association with that evidence [102,103].

In western Utah several Haskett projectiles were found, dated to 12,000–13,000 years ago [104]. One of these projectiles has been shown positive to elephant antiserum through a protein-residue analysis, implying proboscidean hunting, most likely a mammoth. Duke [104] suggests that Haskett projectiles were probably used as sophisticated throwing/thrusting spear tips aimed at proboscideans.

At the Lehner site (Arizona, ~11,000-year-old), the remains of 13 mammoths were found, as well as of other animals, in direct association with 13 Clovis fluted spear points [105]. These remains have been interpreted as representing several hunting events carried out by Clovis hunters over a relatively short period of time.

At Naco (Arizona, ~11,000–10,000 years ago), the remains of a mammoth were found in direct association with eight stone points [106]. The setting was interpreted as an evidence of mammoth hunting by hurling these eight stone tipped spears into it. Interestingly, while variable in size, the spear points were all of the same type, known as the "Clovis fluted type".

The data presented above describe the main finds known today demonstrating proboscidean hunting by prehistoric humans. While such examples are indeed uncommon (mostly due to issues of preservation and visibility of prehistoric hunting localities), their broad geographic distribution, as well as the prolonged gaps between cases, demonstrate that past societies independently practiced proboscidean hunting whenever these mega-herbivores were available, making their hunting a significant human trait during Paleolithic times.

#### 4.2. Indirect Archaeological Evidence of Proboscidean Hunting

Age profiles are commonly used to identify patterns of proboscidean procurement. These profiles generally indicate the preference for young individuals (but see [107]). At Lower Paleolithic Terra Amata (France), for example, taphonomic analysis indicated a selective procurement of young

individuals [108]. At the Acheulian site of Holon (Israel) most of the elephant bones found were of juveniles [109]. At the post-Acheulian cave site of Bolomor (Spain), all the elephant bones yielded were of young or juvenile animals [110]. At the Middle Paleolithic Spy Cave (Belgium), it seems that the new-born mammoth calves brought to the site and consumed had been killed soon after birth [47]. Svoboda et al. [111] suggested, based on mammoth age profiles in Mid-Upper Palaeolithic Central Europe, that the selective predation of juveniles and sub-adults can be inferred. At the Upper Paleolithic 27,000-year-old site of Krems-Hundssteig (Austria), the mammoth assemblage is dominated by juveniles and subordinate adults [68]. Juveniles were also preferred at Pleistocene cave sites in China [112]. This repeated pattern of young proboscidean procurement suggests that age played a significant role in their selection, possibly due to nutritional considerations and the relative ease of procurement (under specific conditions, such as the lack of protection by mature females due to separation from the herd) and transportation. Another possible consideration is that of taste, implying that young proboscideans tasted better and provided specific nutrients due to their high concentrations of specific fat deposits, tenderer meat and the presence of higher quality fat in certain organs [55,113].

Based on the accumulated tusks at the Yana site, it was suggested that the adult mammoths hunted were mostly females [78]. This pattern implies a preference for the procurement of tusks as straight in shape as possible, suitable as performs to produce rods. Female tusks are relatively thin, long and straight, thus perfectly suitable for this purpose. Sub-adults and juveniles were also hunted, but mainly as food.

At Pavlov I (Moravia) age profiles have suggested the use of two different proboscidean hunting strategies, one targeting subadult and adult individuals, and the other targeting young and subadult individuals [67]. This was suggested to imply that hunting was the main, or even sole, strategy of mammoth procurement at the site.

Regarding North America, experiments have demonstrated the ability of Clovis points hafted in spears or atlatls to penetrate the body of an African elephant, producing a lethal wound [79] (pp. 58–59). While some scholars question the function of Clovis points as projectiles, as well as their role in proboscidean hunting [102], others point to a strong association between Clovis projectiles and proboscideans detected at several Clovis sites, implying that proboscidean hunting was a common trait during Clovis times [76].

In Middle Paleolithic La Cotte de St Brelade (Jersey) an interesting strategy of mammoth hunting was implied. It was initially suggested that the two mammoth bone heaps detected at the site, with dozens of individuals in each, represent mammoth drive events [114]. However, several decades later, Scott et al. [115] contended that the terrain surrounding the site prevented such drives, and instead suggested a strategy of hunting individual mammoths in the valley beneath the fissure, followed by the transportation of selected mammoth body parts uphill to the site [42]. Whatever the strategy used, it is agreed that the hunting of large numbers of mammoths by Neanderthals took place at La Cotte.

#### *4.3. Probable Evidence of Proboscidean Hunting in Upper Paleolithic Depictions*

Mammoths appear in Upper Paleolithic zoomorphic representations (roughly 35–15 ka), in cave depictions and as portable symbolic/ornamental artefacts [116], demonstrating the significant place of proboscideans in these early humans' lives and symbolic sphere. In total, there are over 500 representations of mammoths in Paleolithic cave depictions. These representations often appear in the form of paintings and engravings on walls and ceilings, and as engraved and sculpted ivory pieces. The motivations behind their creation are yet unknown (however, see [1]). Nonetheless, these depictions seem to stem from complex social sets of behaviours, and to reflect beliefs, worldviews, cosmologies and the nature of human/other-than-human interactions [117,118]. The depictions could also be related to social systems of knowledge transmission and initiation [119,120]. Within this context, mammoth depictions could provide some indication regarding human-mammoth interactions, including hunting.

Representations of animals in cave depictions were suggested by some to be related to hunting magic [121,122]. Such suggestions are based on claims that most animals represented in Paleolithic depictions were hunted for dietary purposes. These claims are partially supported by documentation of hunting magic in the ethnographic records [123]. However, this theory is often criticized in claims of misuse of ethnographic data and of mismatch between the frequency of animals in depictions and their frequency in Paleolithic faunal assemblages [121].

Several Upper Paleolithic mammoth representations include elements which might be related to hunting. In the Font-de-Gaume cave (France), a remarkable depiction was detected [124] (p. 145), presenting the outline of a mammoth on which a unique pattern was superimposed, interpreted as a trap. Nikolskiy and Pitulko [77] analysed two Upper Paleolithic mammoth images, from Rouffignac Cave (France) and from El Pindal (Spain), and inferred both depictions as indicating mammoth hunting. They suggest that a concentration of linear marks in the heart area of the Rouffignac image may represent a cluster of spears, and that a heart-shaped stain in the middle of the image from El Pindal represents the area of a serious wound inflicted by hunters.

Some portable artefacts might also be related to mammoth hunting. Two spear-throwers shaped like mammoths were found at Canecaude I (Aude) and at Abri Montastruc (Tarn-et-Garonne), two Magdalenian sites in France [116], suggesting an association between the hunted animal and the hunting weapon. At the Yana site an engraved mammoth tusk was found, presenting anthropomorphic figures interpreted either as hunters or as dancers [125]. In the Geissenklösterle, an Upper Paleolithic cave site in Germany, a figurine of a mammoth was found, decorated with signs and dots of red ochre [126], possibly related to hunting. At Vogelherd, an Upper Paleolithic cave in Germany, several figurines made of mammoth ivory were found [127]. One mammoth figurine features irregular crossing lines on its soles, suggested to represent the wrinkles that exist on mammoth soles, possibly reflecting a deep knowledge and familiarity with the traits of proboscideans, enabling their tracking during the hunt. The Upper Paleolithic site of Sunguir (Russia, ~24,000 years ago), revealed the burial of a boy and girl. Among the grave goods, long spears made of straightened mammoth tusks were found, and some ivory artefacts [128]. Again, an ontological association between a hunting weapon made of mammoth tusks and the hunted animal could be envisioned.

It is of course necessary to be extremely cautious regarding such interpretations, as we are still far from understanding the nature of the Paleolithic symbolic systems (but see [129] for a possible interpretation concerning the variability in Paleolithic representations of proboscideans). Nonetheless, the role of mammoths in Upper Paleolithic cosmology and symbolism cannot be ignored.

## 5. Evidence of Elephant Hunting among Contemporary Indigenous Groups

Ethnographic accounts describing the application of elephant hunting by recent indigenous groups are presented in this section, listed according to the applied hunting strategy (Table 1).

### 5.1. Hunting with Spears

The use of spears (Figure 1) is strongly associated with the hunting of large animals [27,130]; and indeed, the use of spears in elephant hunting appears in several ethnographic documentations.

Lewis [54,131] studies the Mbendjele BaYaka of northern Congo-Brazzaville, who occasionally hunt elephants using spears, an act which requires “secret knowledge [ . . . ] in addition to an intimate knowledge of one’s fellow hunters and the prey’s habits, precision in aim and movement and a significant dose of courage” [54] (p. 22). Hunters also need to develop the skills of tracking and stalking elephants. The hunting of elephants among the Mbendjele is accompanied by spirit-plays performed before, during and after the hunt, aimed at regulating the hunt and ensuring its success, as well as the sharing of the carcass among group members.

The use of spears in hunting elephants is also mentioned by Köhler [52], Hayashi [53] and Yasuoka [132] regarding the Baka pygmies, and by Terashima [133] regarding the Mbuti pygmies, both from Congo.



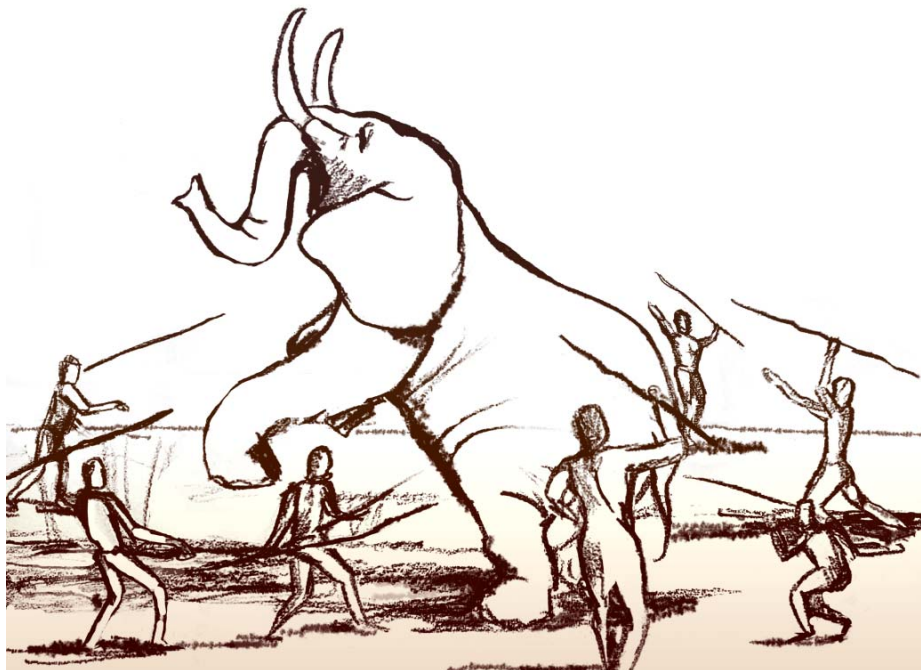
Howell [51] contends the Nuer relied on agility, personal courage and skill in spear-throwing during their elephant hunting. They did not rely on stealth, but, rather, attacked the elephant from all sides, using spears, while shouting war cries [51] (pp. 95–96). It should be noted that the Nuer exploited elephant carcasses for both meat and ivory, from the latter of which they would produce bracelets. Only a limited amount of ivory was traded.

Another elephant hunt procedure, performed by a single spear-wielding hunter, is described by Janmart [134] regarding the pygmies of the Ituri forest (Congo). According to Janmart, “the hunter sneaks underneath the standing elephant and thrusts the spear upward into its soft belly with a lightning-quick movement” [134] (p. 146). He then immediately slips out from underneath the elephant, taking advantage of the elephant’s momentary confusion. If the hunter has enough time, he adds another jerk to the lance, enlarging the wound (see Figure 2). A similar strategy is later described by Duffy [50] (p. 156) regarding the same group. Several cases of elephants killing people have been noted in the literature, usually during hunting ([50] (p. 143) [135], demonstrating the danger involved in approaching these huge animals.

Another procedure, using poisoned spears, is applied by the Bakalongwewanzofu (Zambia). According to Marks [136] (p. 63), the group used weighted spears to injure the elephant. They then aligned themselves in two lines parallel to the expected trajectory of the elephant’s escape and speared it until it died.

Marks [136] describe another strategy involving the use of poisoned spears, applied by the Bashimunina of Zambia. An experienced member of the group climbed a tree whose branches hung across known elephant trails, while other members drove the elephants toward this tree. When an elephant passed underneath, the hunter threw his heavy spear, aiming for the animal’s shoulder blades (see Figure 3).

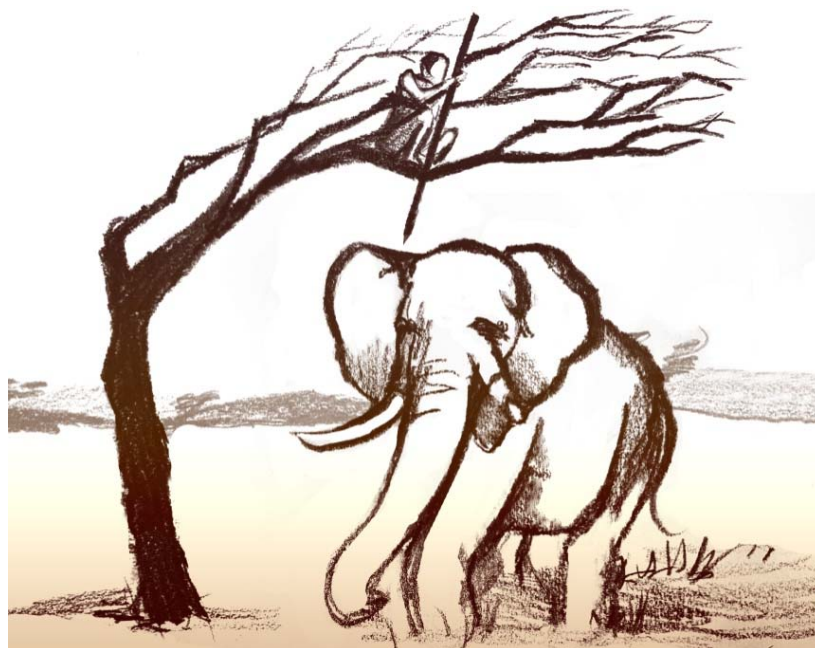
In a study surveying 96 contemporary hunting groups, Churchill [130] identified an association between the use of hand-delivered spears, whether thrust or thrown, and the hunting of large prey, including elephants. He claims that “this may be because spears are the best tool for dispatching large animals or because the hunting techniques required to take game with hand spears generally work better with larger prey” [130] (p. 19). In some of the following examples spears are also used, combined with other methods. In these cases, we note the place of spears in the procedure.



**Figure 1.** An illustration of elephant hunting using spears. Courtesy of Dana Ackerfeld.



**Figure 2.** An illustration of elephant hunting by a single hunter, stabbing it in the belly. Courtesy of Dana Ackerfeld.



**Figure 3.** An illustration of elephant hunting by a single hunter, stabbing it from a tree hung across known elephant trails. Courtesy of Dana Ackerfeld.

### 5.2. *Hunting Using Pitfalls*

The use of pitfalls (Figure 4) in elephant hunting is combined with the use of spears. Although the Khwe (Namibia) no longer hunt elephants [137] (p. 339), their forefathers did hunt them. One farmer quoted a story told by his forefathers, describing the use of pitfalls with sharp objects in them.



**Figure 4.** An illustration of elephant hunting using pitfalls and dogs. Courtesy of Dana Ackerfeld.

The use of pitfalls is also mentioned by Lee and Guenther [138] regarding the early Ghanzi bushmen, and by Sikes [139] relating to the Ituri forest pygmies in Congo. Sikes reports that the pygmies captured an elephant in a pitfall and killed it using short stabbing spears.

### 5.3. *Hunting with Axes*

Axes are rarely mentioned in association with elephant hunting. One such example, however, is provided by Marks [136], applied by the Bamutemakwangwa (Zambia). In this strategy, the hunters concealed themselves among the vegetation surrounding the elephant paths and attacked the passing elephants with poisoned axes, slashing the tendons of their feet.

### 5.4. *Hunting with Traps*

Sikes [139] describes the use of a trapping technique for elephant hunting employed by village hunters in Central Africa. They use “a typical trap consisted of a woven ring of sharp thorns, dosed with cortisone from the *Strophanthus* vine, and weighted with a heavy drag log” [139] (p. 219).

### 5.5. *Hunting Using Arrows*

Lee [140] refers to a strategy of hunting using arrows, attributed to the !Kung. He quotes a story according to which a northern !Kung can kill an elephant by shooting a poison arrow into its foot, “the only point where an arrow will penetrate the tough hide” [140] (p. 234). However, he adds that this story has not been verified.

### 5.6. *Hunting Using Fire*

The hunting of elephants by ringing them with fire was noted by Lee [140] regarding the !Kung. Lee explains that fire is lit on one side while the !Kung arrive from the other and they all spear the elephants. Lee further explains that an “essential factor in hunting elephants appears to be the ability to coordinate many hunters in a single game drive...” [140] (p. 234).

### 5.7. Hunting Using Dogs

The use of dogs during hunting has been suggested in some archaeological cases, starting as early as the Upper Paleolithic [141]. Dogs have also been used in some of the above-mentioned elephant hunting practices performed by recent indigenous groups.

For example, the elephant hunting of the Bakalongwewanzofu combined the use of dogs with the use of spears [136]. After the leader had speared an elephant with a poisoned spear, the rest followed and chased the wounded elephant using dogs [136] (p. 63). Other cases are noted during events of mass elephant slaughter, in which dogs assist in driving the elephants towards the desired area [138,140].

**Table 1.** A summary of groups and applied elephant hunting strategies from ethnographic sources.

Group	Strategy	Number of Participants	Dogs	References
Mbendjele Bayaka	spears	multiple	–	[54,131] (p. 170)
Bakalongwewanzofu	poisoned spears	multiple	+	[136] (p. 63)
Bashimunina	poisoned spears	multiple	–	[136] (p. 63)
Mbuti	spears	multiple	–	[52,53,133] (p. 73)
Baka pygmies	spears	multiple	–	[132]
Congo Pygmies	spear	one	–	[134]
The Khwe	pitfalls	?	–	[137] (p. 339)
the early Ghanzi Bushmen	pitfalls	?	–	[138]
the Ituri Forest Pygmies	pitfalls	?	–	[139] (p. 223)
The Bamutemakwangwa	poisoned axes	?	–	[136] (p. 63)
village hunters in Central Africa	woven Traps	multiple	–	[139] (p. 219)
the !Kung	poisoned arrows	?	–	[140] (p. 234)
the !Kung	use of fire	multiple	+	[140] (p. 234)

## 6. Ethno-Historical Accounts of Elephant Hunting

Ethno-historical sources are less reliable than archaeological and ethnographic accounts, particularly as they have been reported by travelers, adventurers or missionaries. Such writings pay less attention to methodological considerations and tend to be based on personal impression and the agenda of the writer (although academic writers too are influenced by their own personal experience and agenda). Nonetheless, while such ethno-historical sources should be treated with cautious, they may also provide interesting and useful notions regarding the issue examined here. This part of the study explores the available documentations regarding elephant hunting from ethno-historical sources, listed according to the applied strategy (Table 2). The provided accounts refer to indigenous groups only, but also contain cases in which the main reason for hunting was the procurement of ivory for trade. Only traditional methods are presented.

### 6.1. Hunting with Spears

Wood [81] describes elephant hunting with spears by a South-African group (not mentioned by name), in which several hunters get close to the elephant and simultaneously spear it. Afterwards, the hunters attempt to isolate the wounded animal, spearing it again and again.

Wood describes another method using a spear, which involves one hunter, equipped with a heavy spear and some rope [81] (p. 498). The hunter attaches heavy stones to the shaft of the spear. He then ties one end of the rope to the spear and selects a suitable tree to climb. When an elephant passes underneath, the hunter drops the weighted spear and it starts to cut its way deeper into the animal's vital organs, until it dies from loss of blood.

Another group, the Dôr, is also mentioned by Wood [81] (p. 498) as using lances for elephant hunting. In this case, the hunters surrounded the elephant and each one hurled his spear in turn into the animal. The Dôr and Baer tribes were also documented spearing elephants from trees [142].



The Fans, a Bantu group, applied another approach to elephant hunting, using a weighted spear tied to a branch under which the elephant was expected to pass, released using a string tied to a trigger [81] (p. 597).

Carrington [124] mentions an elephant-hunting method involving only one person, wielding a heavy-bladed spear. The hunter is naked, and covered in dung to conceal his scent. He then “stalks his chosen animal [ . . . ] until he is within at most three or four yards of the creature’s head. Then, at a single bound, he strikes, plunging his spear either into the belly or the neck of the astonished animal [ . . . ] Surprise is the essence of the attack, and the spear must also be accurately placed in a vital part” [124] (pp. 149–151). Carrington adds that the Congo pygmies, as well as other groups, use a similar method but in groups of three or four.

Schweinfurth [143] (p. 124) describes a strategy applied by a group in south-western Sudan, involving the use of a strong lance. According to the story, provided by a secondary source, group members had crept underneath the belly of an elephant, and stabbed it dexterously from below. In that case, the hunt was claimed to be aimed at the procurement of ivory for trade.

Native hunters in Africa are described by Carrington [124] as taking advantage of elephants crossing rivers, hunting them using spears. These hunters “attach a weight to a spear by a piece of rope and then spear the trunk from their canoes. The weight drags the trunk down and the unfortunate animal drowns. Some eight hours later the gases inside the carcass cause it to float, when it is recovered by the natives for food” [124] (pp. 69–70).

According to Neumann [144], only a few of the Ndorobos of East Equatorial Africa hunt, but that they do occasionally kill an elephant or two, either by harpooning them or by using poisoned javelins [144] (pp. 79–80).

### 6.2. *Hunting Using Pitfalls (with Spears)*

The strategy of hunting using pitfalls is described as “a pit with smooth sloping sides [that] is dug across a path frequented by the quarry, and covered with branches and a layer of earth [ . . . ] The pit is usually about 10 to 12 feet long by 6 feet broad at the top, and the sides converge to a point some 14 feet below ground level. The way the pit is shaped causes the legs of the trapped elephant to be pinned together so that its movements are hampered, and escape becomes virtually impossible” [124] (pp. 143–144).

Carrington [124] (p. 144) also mentions a variant of this strategy, consisting of a rectangular or circular pit. This pit contains one or more sharpened stakes pointing upwards and on which the animal is impaled.

Wood describes the elephant-hunting routines of several South-African groups, with the occasional use of pitfalls constructed for the capture of individual animals, including elephants [81] (p. 134). These pits are large but not very deep, because the size and weight of the captured animals prevent them from escaping. In addition, a sharpened stick is placed in the middle of the pit, so that the animal falling upon it is impaled. Interestingly, Wood adds that “the elephants are so crafty that they soon learn caution from the fate of their comrades, and it is difficult to catch an elephant in a pitfall as it is to catch an old rat in a trap” [81] (p. 134). The use of pitfalls for elephant hunting by indigenous villagers in Central Africa is also mentioned by Selous [145] (p. 138). These pitfalls are located on the paths trodden by these animals and concealed with dry grass.

### 6.3. *Hunting with Axes*

Wood [81] describes elephant hunting using an axe and involving two persons. One hunter takes an axe while the other takes no weapon. After they locate an elephant, the one without the weapon starts to make a noise, attracting the elephant’s attention, while the axe-man steals up on the elephant from behind and with a single blow severs its leg tendon. After that, “the animal is helpless [ . . . ] and the hunters can [ . . . ] leave it there and go after another, being quite sure that they will find the lamed animal in the same place” [81] (p. 405).



#### 6.4. Hunting with Traps

Wood [81] (p. 596) explains that the Fans use special wild-growing vines to weave a net-like barrier. They then scare the elephant, chasing it into the trap. After the animal is trapped, they surround it and spear it from all directions. A similar description of the same group is mentioned by Du Chaillu [146] (p. 82).

Du Chaillu further describes another hunting strategy applied by the Fans involving traps. The hunters take a heavy piece of wood, attach a sharp point to it and hang it from a high tree. When the elephant springs the trap the piece of wood shoots into its back, the sharp point injures it and the heavy weight breaks its spine [146] (p. 85).

Another strategy depicted by Wood refers to a specific case he had heard from a secondary source. According to the story, the hunters discovered that three elephants frequently use a certain part of the forest. The hunters fenced that part, leaving just one opening. The elephants entered the fenced area willingly, unaware of the danger. "So certain were the hunters that their prey was safe", Wood says, "that they did not even take the trouble to close the openings through which the animals had entered [...] [the elephants] came in [...] and they remained. The whole thing is a mystery" [81] (p. 605).

Lagercrantz [142] describes a hunting strategy which was commonly used throughout Africa, called "the harpoon down-fall", applied mainly for elephants and hippopotamus. According to Lagercrantz, a harpoon, occasionally smeared with poison, weighted with a heavy log, is employed suspended from a tree branch or from a pole fixed up horizontally between two trees, directly above a known path of the hunted animals. When the animal passes below it, it springs the trap, and the spear strikes the animal on its head, neck or its back.

Lagercrantz [142] further mentions a strategy applied by the Chinga, involving the use of trapped pits. They dig a pit about 1 m deep, and half a meter wide, covering it with a mat. Once an elephant steps on the mat, its foot goes through it, and a harpoon is set off and fall on the elephant.

#### 6.5. Elephant Mass Killing

Some groups have been documented as driving elephants towards a controllable terrain, where they could be slaughtered as a group.

Regarding the early Ghanzi bushmen, several strategies of elephant hunting were noted, including the use of "game drives, game fences (that could be several miles in length), and rows of staked pit falls running through dry river beds" [138] (p. 215).

Lyell [147] noted that native groups used to drive herds of elephants into swamp lands, quicksand or quagmire, where the immense weight and powerful struggles of the elephants only sank them deeper. These groups "used to drive herds into such ground and killed the anchored animals at their leisure with spear stabs in the soft abdominal region." [147] (p. 46). He further contends that this method "was probably a much more effective way of killing them than in circles of grass and bush fires" [147] (p. 46). The motivation for the hunt is not mentioned.

Lagercrantz [142] also mentions the application of organized elephant drives executed throughout Africa. In this strategy, elephants are headed towards trees on which hunters await, and when they pass underneath, spears are being thrown at them.

#### 6.6. Hunting Using Arrows

The Kamba (Kenya) hunted elephants for meat until the late 18th century, before their transition to the long-distance ivory trade [148]. The demand for ivory then led to a change in the Kamba hunting repertoire. It is suggested that the use of small bows and poisoned arrows had made the early Kamba hunters effective predators of elephants [148]. The use of poisoned arrows for elephant hunting in Africa is also mentioned by Carrington [124] (p. 151) as a method employed in the past but no longer used.

### 6.7. Hunting Using Fire

The use of fire for elephant hunting, applied by several villages, is described in Baker’s book [149]. The hunters take advantage of the tall grass surrounding the elephant herding territories, form a circle of roughly two miles in diameter around them and simultaneously set fire to the grass. Once the elephants start to panic and suffocate, “the unfortunate animals charge recklessly through the fire, burnt and blinded to be ruthlessly speared by the bloodthirsty crowd awaiting this last stampede. Sometimes a hundred or more elephants are simultaneously destroyed in this wholesale slaughter” [149] (p. 45). The motivation for the hunt is not mentioned.

Schweinfurth [143] (p. 24) describes the hunting of elephants by Azande people in Sudan with the use of fire and lances. According to Schweinfurth, the elephants are driven towards patches of grass that were left by steppe burning, where the crowd burn the grass around them. Badly affected by the smoke and fire, the elephants became an easy prey to the hunters, who stab them repeatedly with the lances.

### 6.8. Hunting Using Dogs

The use of dogs during elephant hunting has also been noted in the ethno-historical sources. In one case, the use of dogs is described during elephant hunting with spears, aimed at distracting the elephants from the hunters [75].

**Table 2.** A summary of groups and applied elephant hunting strategies from ethno-historical sources.

Group	Strategy	Number of Participants	Dogs	References
Unnamed South-African group	spears	multiple	+	[81] (pp. 134–136)
Unnamed South-African group	spears	1	–	[81] (p. 498)
The Dör	spears	multiple	–	[81] (p. 498)
The Fans	spears	?	–	[81] (p. 597)
native hunters in Africa	heavy spear	1	–	[124] (pp. 149–151)
native hunters in Africa	spears	multiple	–	[124] (pp. 69–70)
a group in south-western Sudan	strong lance	1	–	[143] (p. 124)
The Ndorobos	poisoned javelin	?	–	[144] (pp. 79–80)
The Nuer	spears	multiple	–	[51] (pp. 95–96)
native hunters in Africa	pitfalls	?	–	[124] (pp. 143–144)
South-African group	pitfalls	multiple	–	[81] (p. 134)
hunter-gatherers in Central Africa	pitfalls	?	–	[145] (p. 138)
The Fans	weaved trap	multiple	–	[81] (p. 596), [136] (p. 82)
The Fans	heavy wood trap	multiple	–	[146] (p. 85)
Throughout Africa	“the harpoon down-fall”	?	–	[142]
The Chinga	Trapped pit	?	–	[142]
Unknown South-African group	fenced area	multiple	–	[81] (p. 605)
South-African group	axe	2	–	[81] (p. 405)
the early Ghanzi bushmen	elephant mass killing	multiple	–	[138] (p. 215)
African groups	elephant mass killing	multiple	–	[147] (p. 46)
The Kamba	poisoned arrows	?	–	[148]
African groups	poisoned arrows	?	–	[124]
native hunters in Africa	mass killing by fire	multiple	–	[149] (p.45)
Azande people	mass killing by fire	multiple	–	[143] (p. 24)
Tribes throughout Africa	Mass killing	multiple	–	[142]

## 7. Elephant Hunting Rituals and Cosmology

Many Hunter-gatherers groups conceive of animals as “non-human persons” or “other-than-human-persons” [56,150], thus perceive the hunt differently than as envisioned by Western societies. Recent hunter-gatherer societies world-wide are practicing ceremonies and rituals aimed at negotiating the divide between the appreciation of animals as equal co-dwellers of the world on the one hand, and the hunting of the same animals on the other [57,151]. These rituals are oriented, in many cases, both towards negotiating with the specific “Lord of animals” regarding the hunt and for maintaining social order, equality and personal autonomy within the group. A brief reference to the human-animal interface and its reflection in hunting rituals is therefore in order.

According to Lewis [54] “Immediate-return hunter-gatherers achieve relative equality between camp members by [ . . . ] employing levelling mechanisms such as teasing and avoidance to deal with attempts by others to claim status or impose themselves” [54] (p. 2). Within this context, rituals act as “a levelling mechanism that strengthens community spirit and mediates power evenly between individuals and subgroups” [152] (p. 197). Thus, it is not surprising that hunting in general, and elephant hunting specifically, is bound by rituals and spirit-plays performed before, during and after the hunt, and which “must be rigidly followed” [51] (p. 98).

Rituals and spirit-plays are often affiliated with the environment. Among the Baka (Cameroon), for example, rites and their components are strongly related to the forest [153]. According to Lewis [154], the BaYaka perform spirit-plays and songs to establish a relationship of care and concern between humans and the forest, by means of which they expect the forest to share on demand its wealth (the animals in it, in the case of hunting).

Among the Mbuti pygmies, before the hunt of an elephant, the group members sing songs to the forest to ensure a successful hunt [50] (p. 143). Special dances take place as well, during which some play the hunters and others the elephants. In those dances, the hunters always win and hunt the elephant.

The spirit-plays accompanying elephant hunting stress its great economic and social value and are aimed at ensuring the success of the hunt, eliminating any claims to special status by the hunters, and at monitoring the hunt by the women and at the sharing of the elephant by the whole group and neighbouring groups [54]. Among the BaYaka, for instance, prior to the departure of men to an elephant hunt, women sing Yele songs and enter a state of trance, “flying” over the forest. When they spot an elephant during the “fly”, “they ‘tie up’ the elephant’s spirit” [54] (p. 22). The following morning the women tell the men where to find it. In effect, the women “catch” the elephant first [54]. This is also why an elephant hunting trip is called “a women’s hunting trip”, even though no women join it in person. In the case of the Baka pygmies (Cameroon) it is believed that if the dances are performed in perfect harmony with the singers and drummers, the hunt will succeed [155]. Joiris [153] later describes an amulet called a *simbo*, worn by hunters, with a small bell that allegedly jingles whenever a potential prey approaches. This bell is considered to have great hunting powers, originating in the call of a specific species of bird that tends to perch on elephants’ backs. It is said that this bird’s call informs the hunter that an elephant is close by, even before the hunter sees the elephant. A Baka elephant hunt is preceded by spirit-plays summoning the forest spirits to bring about a successful hunt [156]. Furthermore, a forest spirit called *jengi* is known to guide the hunters to places where there is prey, while also protecting them from the perils of the forest. Among the Nuer, a specific ceremony is performed before the hunt by a magician who is familiar with the ways of elephant “calling” [51]. The Nuer believe that there is a spiritual bond between elephants and humans. This connection is stressed by a myth about the origin of elephants, in which the daughter of Loh, one of the original Nuer, became an elephant and told her people that they will want to kill her for her “huge teeth” and because her meat is “fat and sweet”. She further says that they may do so, if they obey her words: “You shall never throw the first spear, and when I am dead you shall cut flesh from off my back and eat it raw” [51] (pp. 96–97). Joiris [153] also points to a cosmological and ontological connection between humans and elephants, expressed through several rituals referring to the animal’s relationship with humans and with the environment.

Rituals and spirit-plays also take place during the hunt. Among the BaYaka, the women’s deep trance continues while the men are out hunting [54]. The women rock rhythmically back and forth while singing Yele songs. This state proceeds until the forest spirit *Moshunde* flies through the forest and tells them that the men have hunted, taking them to the place of the kill. At the kill site, additional spirit-plays are performed. After the hunt, a spirit-play called *Malimbe* takes place, in which the spirit can demand whatever it desires from the wife of the elephant hunter—usually a share of the meat [54]. After dusk, a forest spirit named *Eya* is summoned to mark the death of the elephant. This spirit-play involves humoristic, sexually explicit and vulgar dialogue. During the feasting, songs

are sung, celebrating the abundance of meat. These spirit-plays and feasting continue until most of the meat has been consumed [54]. Among the Baka pygmies, after an elephant hunt, some of the young boys play the spirits of the forest who make the dying of the elephant known to the people [156].

Certain rules and taboos accompany the hunting of elephants, as well as the distribution and consumption of the elephant's meat and fat after the kill. It is a known taboo among the Nuer, for example, to kill an elephant by stealth. Rather, they must directly confront it, otherwise "the elephant will kill them in the combat or later through the agency of its spirit" [51] (p. 96), or it will cause "disasters, sickness and famine to the people" [51] (p. 98). To succeed in future hunts, a Baka hunter who is the first to spear an elephant must not eat even a single piece of the meat, and the same goes for his paternal and maternal families [132]. This custom was suggested by Sato [157] to be a levelling mechanism, with the hunter and his older relatives being absent from the festive feast during which the elephant is consumed [156]. Among the Bayaka, certain foods, such as the meat of prey animals, must be carefully distributed among all present, following a series of strict rules [54]. If these rules are not followed, the hunter will incur bad luck and future hunts will fail. Thus, meat is always distributed initially in camp before being cooked and redistributed again by the women, who send plates to the men's area in the centre of the camp and to their female friends and relatives. Furthermore, rather than gaining prestige, those men who hunt too often, are mocked and teased. Consequently, they will prefer to stop hunting for a while, rather than being cursed or exiled. Interestingly, this mechanism is monitored by the women, who may refuse to cook meat provided by such a hunter, thus forcing him in effect to leave the camp. Lewis [54] demonstrates this with the case of a successful elephant hunter who was exiled because he refused to stop his frequent hunting. Among the Nuer there was no monitored distribution of the elephant meat [51]; rather, everyone could eat as much as they liked, with no discrimination in favour of the hunters.

The rites and spirit-plays described above are aimed at negotiating with the spirits of the forest, ensuring the proper conduct of the hunt and its success, regulating the hunt and enforcing the sharing of the carcass among group members as well as neighbouring groups. The importance of these ceremonies demonstrates the dietary significance of elephant hunting and the sharing of elephant fat and meat, as well as the role of elephant hunting and sharing within the inter- and intra-group social discourse. These insights illuminate the dual roles, both practical and social/cosmological, of elephants among recent hunter-gatherers.

## 8. Discussion

Proboscideans and humans have shared habitats across the Old and New Worlds for hundreds of thousands of years. Notwithstanding the assumption that both prehistoric humans and the more recent hunter-gatherers conceived of elephants and mammoths as habitat companions and as other-than-human-persons, the archaeological evidence stress the dietary use humans made of these mega-herbivores, and the ethnographic data further supports these claims. The dual conception of proboscideans as equal co-residents of the world as well as an essential food source for humans, demonstrated above, is part of a much wider cosmological belief system and ontology of recent hunter-gatherers (a belief sometimes termed animism, or even new-animism, see [158,159]) and perhaps also of early humans, and pertaining to every component in the world, not only proboscideans. In the case under discussion, it has been argued previously that the physical, social and behavioural resemblance between proboscideans and humans must have highlighted the "personhood" of elephants and mammoths and the human relationships established with them [1,15]. The available ethnographic and ethno-historical evidence suggests that elephants have been hunted by recent hunter-gatherers wherever they naturally occurred. This pattern, we believe, is also likely regarding prehistoric times too. Direct evidence in the form of lithic implements embedded within proboscidean bones supports the use of projectiles for proboscidean hunting during prehistory. Other hunting strategies, such as the use of pitfalls and traps, are more difficult to find, as they occurred outside of the archaeological sites typically excavated, while most excavations take place at base camps,

or butchering sites. Generally, the signal left by past societies is not always visible in the archaeological record, especially when discussing activities which have taken place off-site [160]. Indeed, many of the strategies presented above would not leave a trace within archaeological sites chosen to be excavated. Thus, we believe that in order to improve our understanding of proboscidean hunting strategies during the Paleolithic, excavations should go outside the base-camps, identifying and exploring the kill sites.

Several hypotheses in respect to possible proboscidean procurement strategies applied by prehistoric societies have been posited in the past. Hannus [161] suggested several scenarios regarding the New World, which can also be applied to the Old World: the surrounding/entrapment of proboscideans; the exploitation of proboscideans trapped in marshy sediments; the wounding of proboscideans (probably by spears) in the abdominal area, and tracking them; the stampeding of a herd towards bluffs; and the opportunistic scavenging on weakened or dead animals.

The list of scenarios suggested by Hannus lacks many of the possible strategies presented above. The archaeological, ethnographic and ethno-historical records demonstrate a wide variety of strategies that were applied in both the distant and recent past in elephant/mammoth hunting, including the use of spears, axes, traps, pitfalls, arrows and fire.

The use of dogs by recent hunter-gatherers for elephant hunting, as already described, might correspond with the appearance of canids at certain Upper Paleolithic sites in Eurasia featuring mammoth remains. Shipman [141] suggests that several Eurasian archaeological sites dated to between 40,000 and 15,000 years ago, and bearing a large quantity of mammoth bones, reflect two different phenomena: the development of a complex projectile technology and the domestication, or partial domestication, of canids. The remains of large canids have been found at those sites, suggesting, in her opinion, the use of dogs during mammoth hunting. A similar suggestion was posited by Fiedel [162] regarding North America, contending that dogs provided the earliest settlers with assistance in tracking, hunting and transportation, and thus also played a part in mammoth hunting. Interestingly, a study using stable isotopic tracking of bone collagen at the Gravettian (29,500–31,500-year-old) site of Predmostí I (Moravian Plain), indicated that while Pleistocene wolves were more inclined to eat horse and possibly mammoth, the large canids at the site relied mostly on reindeer and muskoxen as prey [46]. These results were interpreted as implying that Gravettian hunters, who themselves relied heavily on mammoth fat and meat, controlled to some extent the diet of these canids and did not feed them with mammoths.

Additional indirect data implying the feasibility of elephant hunting by early humans is provided by Haynes [70]. Based on an analysis of elephant dung, Haynes suggested that “A clever tracker can examine dung boluses to estimate (1) how large the animal was; (2) how long ago the dung was passed and how fast the animal was traveling—hence, how far ahead the animal may be—and (3) the animal’s relative health, appetite, and feeding preferences. All these clues would improve the efficiency of human foraging, thus reducing the cost in time and energy needed to hunt elephants”. Sikes [139] (p. 220) demonstrated that elephant tracking can indeed be performed by using their droppings as an indicator. The familiarity of hunters with the behaviour of elephants has been demonstrated in several other ethnographic and ethno-historical accounts as well ([81] (pp. 134–136, 498), [131] (p. 170), [136] (p. 63), [156]), further supporting the importance of accumulated and shared knowledge in proboscidean hunting. Remarkably, the tracking and hunting of elephants can take up to two weeks, with elephant hunting expeditions reaching as far as 50 km away from their village [156].

Certainly, even when practicing elephant hunting on a regular basis, scavenging too could occur if a group of humans or an individual, for example, were to stumble upon a dead elephant [51]. Furthermore, it was demonstrated by Capaldo and Peters [163] that cases of natural deaths by mass drowning during the wet season in Tanzania can provide scavengers with an abundant supply of meat. Such a supply would be relatively predictable if it involved climatic seasonal and spatial repetition. However, such events are uncommon and tend to occur only in specific geographic areas [25]. Thus, the usually sporadic and infrequent nature of such cases implies that it could not have acted as a main trajectory in the procuring of such a key component in the early human diet.



Regarding *Homo erectus* (sensu lato) and the Acheulian cultural complex, there is a lack of direct evidence in respect to the strategy employed for elephant procurement. However, it is our contention that the required cognitive abilities, including team work, social cooperation, communication skills and the production of a wide array of tools suitable for hunting (mostly made of perishable material such as wood), were all integral components of their abilities (see [28,97] for supporting data). Such abilities have already been suggested regarding the occupants of the Acheulian site of Gesher Benot Ya'akov, ~780,000 years ago [30,164], who are known to have procured and eaten elephants [165]. Furthermore, the large quantities of fat and meat associated with elephants may imply the existence of some form of food sharing between group members and possibly between different groups, and/or preservation, as well as the existence of cooperative acquisition strategies [7]. Preservation of meat of medium and large game indeed was documented among recent hunter-gatherer groups, allowing it to be preserved for several days and even longer periods of time [15,166]. Preservation of elephant meat is described in the case of the Mbuti pygmies, by smoke-drying it, and the sharing of it by several bands for several weeks [50] (pp. 144, 163). Meat could have also been preserved without the use of fire, by sun-drying [167,168], or by burying it in an anaerobic environment, underground or underwater [169,170]. Similar abilities could have been a part of the *Homo erectus* behavioural repertoire, enabling them to cope with the great amount of meat and fat provided by an elephant carcass, thus making the effort involved in obtaining it worthwhile. Moreover, we believe that the important role of elephant meat and fat in the diet of Acheulian hominins necessitated an active approach in the procurement of elephants, further supporting the various hunting scenarios. Additionally, based on a bio-energetic model, together with the cultural transformations known to have taken place in the late Lower Paleolithic Levant, an explanation has been offered to account for the demise of *Homo erectus* and the appearance of a new, locally-evolved, post-*Homo erectus* hominin lineage at ~400,000 years ago in the Levant [2]. The model suggests that the disappearance of elephants from the human diet in the Levant around this time triggered a selection process in favour of those who were better adapted for hunting larger numbers of smaller, faster animals with a high fat content. It is of note that no elephants have been found in Levantine post-Acheulian sites—i.e., this significant part of the Acheulian life and diet does not feature in post-Acheulian sites. Additionally, meat consumption has known and generally accepted ceilings, with fat contributing a compulsory component in the human diet to provide sufficient daily energy expenditure (with elephants constituting an outstanding package of fat, see [2]). The habitual use of fire for roasting and cooking and the new lithic technologies practiced at that time in the Levant can be listed here as two of the important new cultural elements related to this transformative biological and socio-economic landscape [171,172].

During the Middle Paleolithic in Europe, the picture is even clearer. The diet of Neanderthals was shown by stable isotope studies to include a substantial component of animal resources [45], dominated by large and medium-sized herbivores, including mammoths, rhinoceroses, deer and horses [43,173], along with a complementary exploitation of small animals [110] and plant materials [174]. It is not surprising therefore that evidence of the Neanderthals' complex hunting abilities in general [175,176], and their hunting of mammoths specifically [47,115] is abundant. Furthermore, Rendu et al. [177] identified the practice of communal hunting by Neanderthals and of storage strategies for future consumption. These findings indicate the existence of a social organization, including high technical and cognitive abilities, communication and cooperation. The findings from this study also demonstrate their ability to cope with the great quantity of meat and fat provided by mammoth carcasses by storing and preserving it for future use (although direct evidence of this remains to be demonstrated).

## 9. Conclusions

This study reviews the available archaeological evidence and the reported anthropological and ethno-historic observations regarding elephant-hunting strategies among ancient and contemporary societies. It also explores the possibility that proboscidean hunting was executed by Paleolithic groups. While acknowledging the fact that extinct elephants and mammoths existed in different landscapes,

and in different climatic conditions, and thus were probably different to some extent, it is our contention that the significant similarities between them allow us to suggest the projection of the accumulated data on all species of ancient proboscideans.

Indeed, Carrington noted that although “the techniques employed by our early ancestors for hunting the mammoth, the mastodon, and the elephant can never be exactly known [ . . . ] they probably resembled those of the [ . . . ] elephant hunting tribes of the recent past” [124] (p. 143). Notwithstanding the naivety and methodological flaws embedded in this statement, some similarities in hunting techniques might indeed exist. It is true that the Paleolithic archaeological record is limited in its ability to reflect hunting strategies. It is also true that only few findings can be clearly associated with such an activity. However, the ethnographic and ethno-historical data provide several cases and strategies of elephant hunting, presenting a set of abilities that we believe might existed in early humans as well, notwithstanding that certain materials (such as metals) were not available to these Paleolithic societies, and that some motivations (such as the ivory trade) are not relevant. As at least some of the items mentioned in the data provided above were also manufactured and used by prehistoric groups (e.g., spears and projectiles), and given the technological and cognitive abilities attributed to Lower and Middle Paleolithic populations, and as the profits which could have been yielded from an elephant carcass were abundant and significant, we strongly believe that at least some of the above-presented strategies were also applied by prehistoric people. Furthermore, although some claim that the hunting of large-sized prey was too costly in terms of cost-benefit, compared to that of small game, making such large prey “inefficient choices” [8], it is our contention that elephants played a main role in the Paleolithic diet, providing an abundant supply of meat and fat, in a way unparalleled by any other prey [16], and, hence, were hunted and procured when available and needed.

As Sikes [139] describes it, hunting elephants in prehistory was probably an experience filled with “exhilaration, surprise, and frequent exhaustion felt by those who followed these strong, yet generally gentle, giants” [139] (p. 225). It is not surprising, then, that such hunts are often accompanied by rituals, myths and taboos [51,54,178]. It is our view that early humans possessed the necessary abilities to actively and regularly hunt elephants and, indeed, that they performed this unique and challenging task at will. However, it is our contention that the available data presented in this paper strongly supports the notion that the influence of hunting on elephant and mammoth populations must have been rather limited, due to the impression that past and present hunter-gatherers treated proboscideans as other-than-human-persons and hunted these mega-herbivores following a set of regulated behaviours and rituals, while taking into account the relationships people had with these animals. Moreover, it appears that a group of hunter-gatherers could have sustain to a relatively substantial period of time following the hunt of a single mega herbivore, and thus such hunt was not carried out rather frequently. Notwithstanding the probability that hunting might have contributed to other factors influencing the extinction of elephants and mammoths in Quaternary times, it is our view that it was not a dominant factor in this process.

When the Mbuti pygmies of the Ituri forest hunt an elephant, they move their entire camp to the kill site, celebrating for weeks with singing and dancing—and no hunting ([50] (p. 144), [179] (p. 138)). Among prehistoric groups, as among recent hunter-gatherers, the successful hunting of a proboscidean was probably a significant event, a real cause for a celebration. While the effort, risk and time invested in such a complex activity were clearly considerable, we suggest that the nutritional, economic and social benefits of such hunting were greater still, making all the effort and exertion involved fully worth it.

**Acknowledgments:** We thank Dana Ackerfeld for the wonderful illustrations she contributed for this paper. We also thank Ruth Blasco, from the Centro Nacional de Investigación sobre la Evolución Humana, Jordi Rossel, from the Institut Català de Paleoeologia Humana i Evolució Social, and Naomi Paz, from Tel-Aviv University, for reading early versions of this manuscript, and for their constructive comments and suggestions, which greatly improved this paper. Finally, we would like to thank the three anonymous reviewers who provided their insightful comments, helping us to clarify and improve this manuscript.

**Author Contributions:** The data presented was collected and analysed by both authors, and they wrote the manuscript together.

**Conflicts of Interest:** The authors declare no conflict of interest.

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