

## Article

# Pike Use in Megafauna Hunting and Antipredator Defense: Historical Techniques and Paleolithic Research

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## Abstract

This paper presents a comprehensive assessment of megafauna confrontation using pikes, as recorded in historical accounts and ethnographic studies depicting techniques of hunter-gatherers, pastoralists, colonial hunters and others. In contrast to the two other basic spear types, the lance and the javelin, the impalement force of the pike is derived from the mass and speed of the charging or lunging animal. The historical data demonstrate that pike bracing was a common and fundamental technique used by spear-wielding individuals challenging megafauna, including ursids, pantherids, suids, bovids, and mounted equids, that confront humans aggressively and are not disadvantaged. In hunting, pikes were used most often in situations where the hunter influenced the animal's behavior to draw a charge, leap or lunge. Braced spears (pikes) were also important for defending against predators and cavalry mounts that attacked in these ways. We examine such variables as animal size, trajectory and momentum, weapon rotation on its base, shaft diameter, frequency of cross bars, and point material (wood, osseous, lithic and metal). Variability in pike use is of significance to numerous archaeological and evolutionary topics that require assessment of human confrontation with Pleistocene megafauna, and approaches to archaeological pike identification are considered.

**Keywords:** paleolithic; lithic pike; megafauna; spear hunting; cross bar; impalement; braced spear; lance; javelin; antipredator

## 1. Introduction

Wooden spears are widely acknowledged as a cornerstone weapon for much of humankind's history, despite the rare preservation of spear shafts archaeologically. Spears are portable shaft weapons usually made of resilient wood and sharp-tipped, used to wound or kill by piercing hide and flesh in vulnerable areas. Three basic types of hunting spears have been recognized since the Roman Empire: the *rumex* or javelin; the *hasta*, a thrusting spear; and the *venabulum*, a robust spear with cross bars specifically used for hunting the most dangerous animals [1–4].

In this paper, we refer to the javelin as a thrown spear, the lance as a hand-thrust spear, and the pike as a heavier spear often used in braced position against aggressive megafauna (this nomenclature has been discussed by Milks [5] and Sargeant [6]). We recognize that any individual weapon might be used in more than one of these ways, even if it is best suited for one of these actions due to its size and other characteristics.

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Much of the archaeological literature on spear hunting in the Paleolithic emphasizes the javelin and lance types of weaponry e.g., [7–11]. Less attention has been paid to the use of pikes or braced weapons. Recently, we made the case that braced weaponry may have played an important role in megafauna hunting and defense in the Late Pleistocene in North America [12]. That study examined the likelihood that long spears tipped with Clovis points served as pikes that provided an effective means for taking down large herbivores (e.g., mammoth, bison, etc.) and for protection against ferocious predators (e.g., *Arctodus*, *Panthera americanus*, and *Smilodon*). Our hypothesis originated from an examination of historical and ethnographic depictions of portable braced shaft weapons used against lions, jaguars, boars, wild carabao (water buffalo), and brown bears in Europe, North and South America, Africa, and Southeast Asia. They also served as weapons of war against charging horses in the Classical World and beyond. These historical records depicted a method of dispatching large and/or threatening animals using long pike shafts tipped with points made from a diverse range of materials (e.g., bone, antler, bronze, and steel) that were firmly braced on the ground. The lethal force of the weapon was predicated on the forward momentum of the animal charging into the sharp pointed pike that ripped through its hide and penetrated deeply into its body. Triggering the animal's charge into the weapon was crucial and may have involved projectiles, dogs, fellow hunters, or even fire.

In our previous paper, we examined whether the distinctive fluted Clovis points produced from fine-grained lithic material may have tipped long-shafted wooden pikes that people used across North America about 13,050–12,650 BP. We showed that Clovis-pointed pikes had a much greater force of impact (measured as kinetic energy) for hide penetration, cutting tissue, and breaking bones compared with atlatl-propelled darts, lances or javelins. We noted that Clovis points were often associated with osseous rods in some Late Pleistocene sites. We hypothesized that the lithic points and osseous rods may have served as pike tip components. We undertook a series of experiments using replicas of Clovis points and beveled rods to evaluate how well our pike splint foreshaft model penetrated wet cow hide at different levels of kinetic energy. We also assessed various lashing arrangements of the Clovis pike tip and evaluated the crushing force of the Clovis weapon during impact with bone (or, in our experiment, an oak plank), finding that a lashing sufficient for hide penetration could rupture on impact with bone to allow point detachment before breakage. Our investigation supported the idea that Clovis points and beveled rods may have served as key elements of effective braced weapons used by Native Americans in the Late Pleistocene. We concluded that Clovis-tipped pikes should be considered as one of the weapons they used for hunting and defense along with possible thrusting spears and throwing darts.

The purpose of this sequel paper is to consider the broader use of braced weaponry beyond Pleistocene North America. Long-shafted pikes are an effective weapon for hunting and defense that could be employed in many different cultural and temporal contexts. In contrast to javelins and lances, where the potency of the weapon is based on brute human energy, the impalement force of the pike is derived from the mass and speed of the charging or lunging animal. Consequently, pikes could be used by almost anyone who could plant them solidly in the ground or against a tree or boulder to receive the animal's charge. These weapons might be used to take down megafauna that could feed a small community, remove a bear from a cave before a ceremony, or as a defensive weapon by gathering groups in exposed places. Furthermore, the long wooden shafts could be employed in a variety of domestic activities when not used as a weapon (e.g., tent poles, drying racks, and a travois when travelling).

This paper presents a comprehensive assessment of megafauna hunting using pikes recorded in historical accounts and ethnographic studies, adding 200 documentary textual

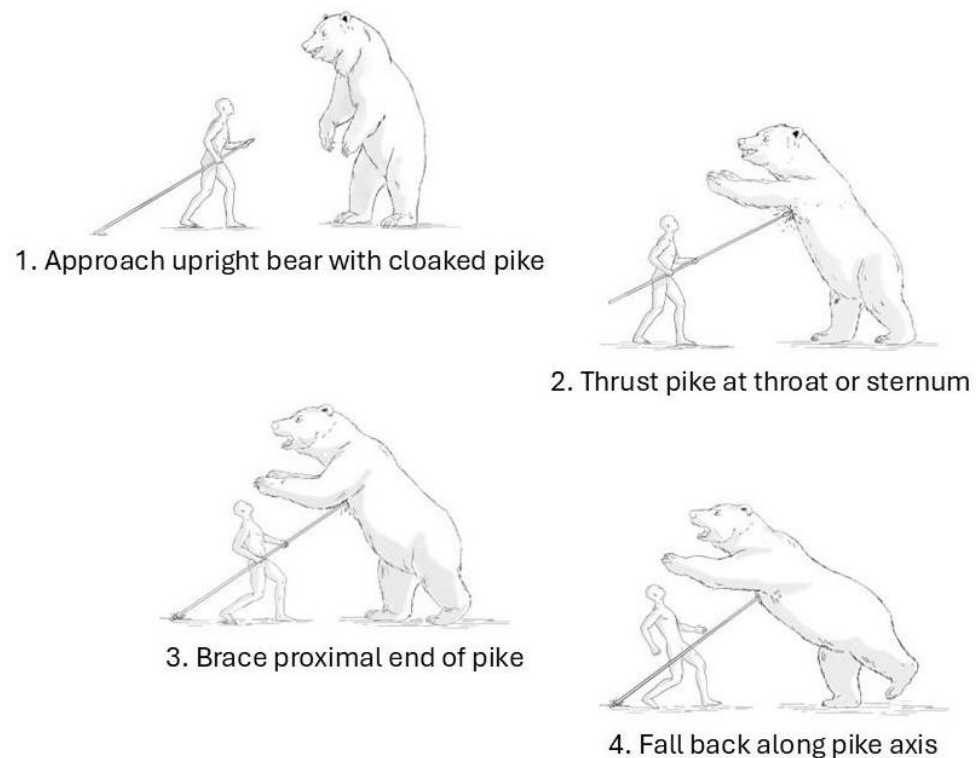
accounts and images to our previously identified sources. (Not all depictions in our 2024 paper meet the criteria for inclusion in the current dataset.) These records document the diverse range of animals and cultural contexts associated with braced weaponry, which has implications for its use in more ancient times. We consider how these narratives of braced spear use may relate to Paleolithic archaeological questions by examining such factors as animal size, trajectory and momentum, weapon rotation on its base, shaft diameter, frequency of cross bars, point size, and material (esp. lithic and non-metal examples).

## 2. Materials and Methods

Anthropologists have long noted the astounding strength of braced weapons in comparison with thrust or thrown spears. Portrayals of braced spear hunting of pantherids and ursids date to anthropology's early years [13], appearing in early anthropological texts [14,15]. Based on his research with the Alutiiq, William Laughlin [16] recognized that impaling with a braced spear has allowed humans to hunt the largest terrestrial megafauna, well over ten times their size, using a wooden spear. F.E. Zeuner observed that commonly the thrusting spear "has only the energy of the man behind it," while in hunting with a braced weapon the "energy there is provided by the animal" [17] (p. 321). Astley Goodwin discussed Maasai lion impaling [17] (p. 322), as did Adamson Hoebel [18] (p. 146), who also noted that braced spears could have been used against large animals in the Middle Paleolithic. That perspective was shared by Robert Wenke [19] (p. 103) based on observations of brown bear hunting with braced spears in North America. Wenke contrasted the pike technique with a disadvantaging technique as two possible modes of Middle Paleolithic megafauna spear hunting. The latter involved restricting an animal's mobility by driving it into vulnerable, confined places—such as swamps, box canyons, or enclosures—where hunters could deliver a fatal strike with one or more spears.

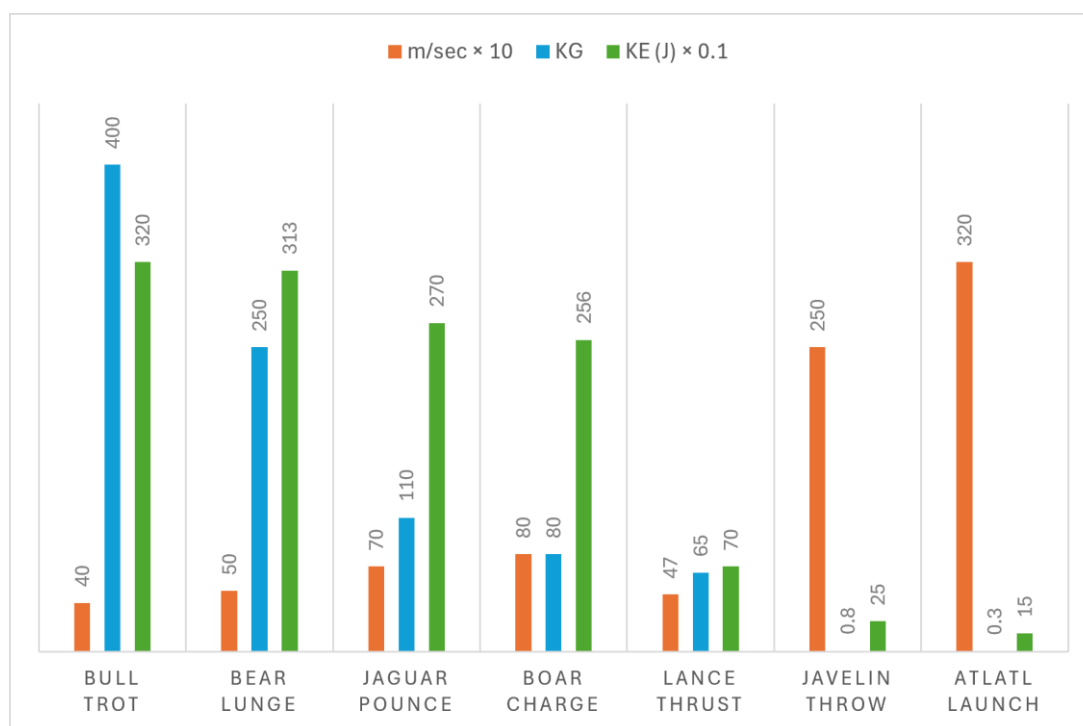
Despite these observations, twentieth century archaeological assessment of Paleolithic weapons rarely included the possibility of braced spears and charge reception (but see [20] (p. 608)). Early in this century, the archaeologists McLaren et al. [21], working on early Holocene bear cave sites on the Northwest Coast of the Americas, proposed that foliate points near caves were from hunters using these to tip braced spears, citing De Laguna's and Hallowell's ethnographies.

Force in Paleolithic spear action is usually assumed to be human power, central to both thrusting and throwing the spear [10,11,20,22]. Milks et al. [23] have emphasized that gravity also contributes to acceleration in thrown javelins, with velocity increasing as the projectile descends from the apex of its trajectory. The momentum of the targeted megafauna whose hide is pierced by the spear point is a much more powerful force, and the braced pike opposes this in the inert, axial force of the shaft with its base embedded in a resilient substrate or some other inert mass, such as a tree or boulder. If the shaft is sturdy and planted solidly and the megafauna has substantial momentum, the result may be deep impalement, stoppage, and immediate disablement (see Figure 1).



**Figure 1.** Illustration of brown bear pike hunting steps, often preceded by provocations such as a projectile strike. Step 2 is omitted in many instances.

The three spear types are not exclusive, but in most cases the kinetic energy generated at the tip of the weapon is comparatively light for the javelin, greater for the lance, and much greater for the pike, often by an order of magnitude. In each case this kinetic energy (KE) is equal to one half of the weapon's mass multiplied by its velocity squared. Kinetic energy imparted is expressed in Joules (J), mass in kilograms and velocity in meters per second. Figure 2 shows the relative contributions of mass and velocity in the deployment of pikes, where the animal provides the momentum, in comparison with the lance, javelin and dart. Only with the lance and the javelin is human force the source of the piercing momentum. Note that the megafauna mass, even at moderate velocity, provides far greater force than the human-powered spears can provide.



**Figure 2.** Graph of variation in force (KE) involved in different megafauna encounters with pikes (1–4), lance (5), javelin (6), and dart (7). KE is derived from animal momentum for pike encounters, from human power for the lance, and from human power and gravity for the javelin. Mass and velocity values are within the range for each species, adjusted for its attack mode. Lance, javelin and launched dart data are approximated from [24,25]. See the description for Table 2 in [12] for further explanation of KE estimates. This graph assumes that the contact point is a weapon tip of the same size for each encounter. Key impact variables that are not shown include weapon diameter (and sharpness and resilience) relative to hide resilience, target contact angle, motion, and bone structure.

Table 1 contrasts the characteristics and deployment of the three spear types. In general, javelins are more gracile and shorter, pikes more robust and longer, and lances are somewhere in between. The javelin is the most portable, such that more than one might be carried by a single person, while the pike is the most robust but can still be carried by a person or via a dog travois. Each spear type has distinctive implications regarding the wielder's safety in a megafauna encounter. The javelin maintains distance from the target animal, the thrusting lance (lance B) allows mobility for dodging and repeated strikes (especially if the megafauna is otherwise disadvantaged), and the rigid-stance-held lance (lance A) counters animal momentum up to the lance-wielder's stance and grip capacity. (Note that charge reception with a rigid stance and the lance held horizontally, as depicted by Sabatius [26] Oehrl [27] and others, is not the focus of this study.) The pike is generally in end-braced position when the animal is wounded (or immediately following wound initiation), but the wielder can move outside the exposed position once the prey is pierced, as the animal's momentum decreases. If the shaft base remains anchored, the impaled animal is more exposed to attacks from other hunters.

**Table 1.** Spear type dynamics based on deployment technique and related attributes and actions in use against targeted megafauna.

|                                 | Pike       | Lance (A)         | Lance (B)   | Javelin     |
|---------------------------------|------------|-------------------|-------------|-------------|
| Deployment Techniques           | End braced | Rigid stance held | Hand thrust | Hand thrown |
| Shaft Strength, Mass (Relative) | High       | Medium/high       | Medium      | Low         |

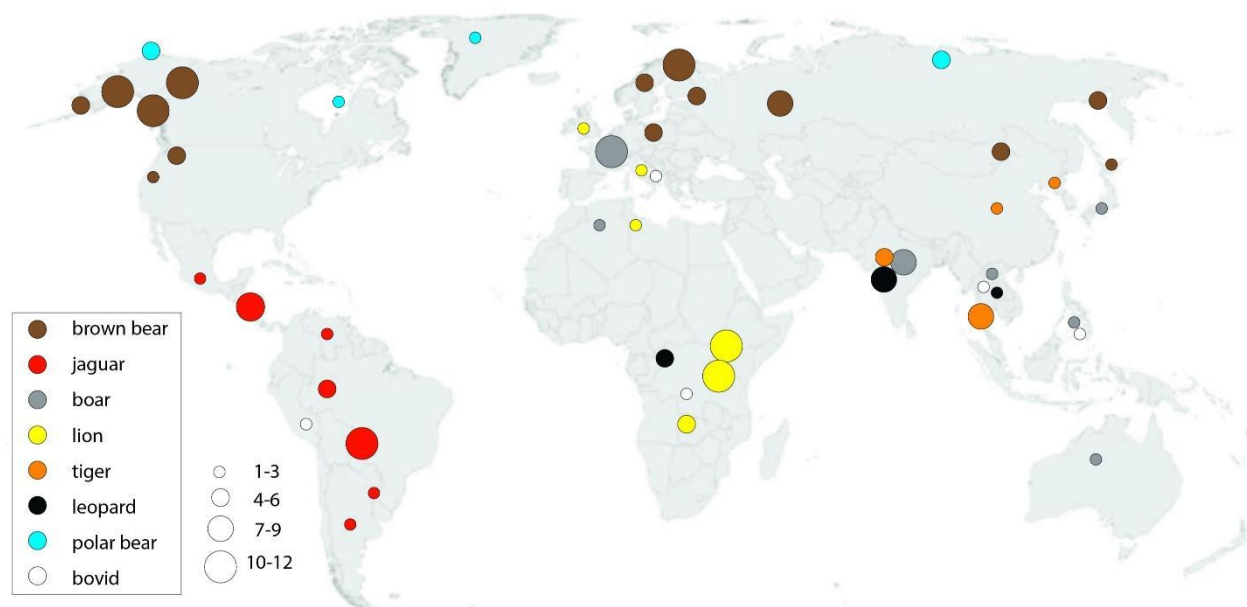
| Cross Bar to Limit Penetration | Often present                              | Often present                                      | Uncommon                                           | Very rare                            |
|--------------------------------|--------------------------------------------|----------------------------------------------------|----------------------------------------------------|--------------------------------------|
| Target Motion                  | Charge/lunge/leap                          | Charge/lunge/leap                                  | In motion or at rest                               | In motion or at rest                 |
| Target Contact                 | Ventral                                    | Ventral                                            | Lateral, dorsal or ventral                         | Lateral, dorsal or ventral           |
| Contact Force (Estimated)      | 2000 J to >8000 J: target momentum         | <2500 J: target momen. to max. stance hold         | <700 J: weapon momentum maximum                    | <200 J: weapon momentum maximum      |
| Weapon Force                   | Inert mass (ground surface, tree, etc.)    | Human stance & grip over ground surface            | Human motion over ground surface                   | Human motion & gravitational descent |
| Locus of Force Application     | Proximal shaft end                         | Shaft span (grip)                                  | Shaft span (grip)                                  | Shaft span (grip)                    |
| Piercing Termination           | Weapon stops or diverts target momentum    | Weapon stops or diverts target, or stance collapse | Target density stops weapon momentum               | Target density stops weapon momentum |
| Rotation & Oblique Force       | Massive: base pivot redirects impact force | Moderate: grip leverage expands wound or redirects | Moderate: grip leverage expands wound or redirects | Limited, e.g., anchored shaft wobble |

Each weapon is limited by shaft resilience and positioning, making intergenerational knowledge transfer a critical aspect of successful deployment of the system. If the shaft breaks or the wound is not in its vulnerable core the animal may be only partially disabled and its momentum may continue, leaving the hunter exposed. If the pike bracing angle is too low, the base may lose purchase, and if it is too high or wide to the left or right, tip deflection may result. In comparison with the end-braced pike, the lance may be quickly overwhelmed by larger and fast-moving megafauna, and the javelin may have little penetration depth relative to the mass of the large animal.

The ethnohistorical sources depicting braced pike use in this paper have been identified in digital text and image searches of databases, including the Internet Archive, Canadiana, the Library of Congress, Google Books, eHRAF, the Hathi Trust and museum archives. Many were digitized in recent years. Boolean search terms such as “braced spear” “boar spear,” and “animal was impaled” were entered with the goal of identifying clear depictions of historical braced spear hunting. In Google Books, semantic search was also deployed based on these search term sets. Both taxon-specific and nonspecific search terms were used (for example, using *animal* or *beast* in addition to *lion* or *buffalo*). Nearly all searches were conducted in English, but in some cases translations from other languages have been included. Only those accounts that indicate proximal end bracing were included; stance-held charge reception is not in the dataset. Depictions of kneeling to receive the animal’s charge with spear raised are included as examples of weapon bracing.

The results from these searches are presented in Appendix A, and specific text or images that comprise each depiction appear in the Supplemental Materials. A table of weapon characteristics based on the 219 ethnohistorical depictions is presented in Appendix B. This body of ethnohistorical data has the potential to grow substantially as researchers review the literature in languages other than English and documents not currently available digitally or worded differently than those presented here.

Ethnographic and historical accounts of pike use against megafauna begin with ancient Greek and Roman boar hunting and defense against charging warhorses, continuing into the late 19th and early 20th centuries with Arctic and subarctic bear hunting, lion hunting in East Africa, boar and bovid hunting in Eurasia and Africa, tiger and leopard hunting in Asia, and jaguar hunting in Latin America (see Figure 3 for locations of pike use by animal type).



**Figure 3.** Map showing generalized regional frequency of ethnohistorical depictions of pike hunting for each of the megafauna taxa represented in this study.

The Appendix A data are organized by megafauna taxon and region. Table 2 summarizes the contextual information for the 219 documentary accounts, and Table 3 summarizes the elements of weapon deployment and related actions. Depictions with no information for a given column are left blank.

**Table 2.** Contextual data summary.

| Count   | Brown Bear Eurasia<br>n=47 |    | Brown Bear N. America<br>n=38 |    | Polar Bear<br>n=9 |   | Boar<br>n=23 |    | Jaguar<br>n=33 |    | Lion<br>n=33 |    | Tiger<br>n=14 |   | Leopard<br>n=14 |    | Bovids<br>n=8 |   |
|---------|----------------------------|----|-------------------------------|----|-------------------|---|--------------|----|----------------|----|--------------|----|---------------|---|-----------------|----|---------------|---|
| Region  | N. Europe                  | 17 | AK Inuit                      | 12 | Alaska            | 4 | Europe       | 11 | Mato Gros.     | 11 | E. Africa    | 21 | SE Asia       | 7 | India           | 7  | Roman         | 3 |
|         | Slavic                     | 14 | AK others                     | 12 | Canada            | 2 | India        | 9  | Cent. Am.      | 8  | C. Africa    | 5  | India         | 4 | Africa          | 5  | SE Asia       | 2 |
|         | NE Asia                    | 12 | Yukon                         | 8  | Russia            | 1 | SE Asia      | 2  | Amazon         | 5  | N. Africa    | 1  | China         | 2 | SE Asia         | 2  | Africa        | 2 |
|         | W. Europe                  | 2  | W. N. Am.                     | 6  | Greenland         | 1 | Japan        | 1  | Venezuela      | 3  | Africa       | 2  | Korea         | 1 |                 |    | Peru          | 1 |
|         | Other                      | 2  |                               |    | Arctic            | 1 |              |    | Argentina      | 3  | Europe       | 3  |               |   |                 |    |               |   |
| Century |                            |    |                               |    |                   |   | 2000s        | 1  |                |    |              |    |               |   |                 |    |               |   |
|         | 1900s                      | 22 | 1900s                         | 21 | 1900s             | 4 | 1900s        | 6  | 1900s          | 18 | 1900s        | 27 | 1900s         | 5 | 1900s           | 10 | 1900s         | 2 |
|         | 1800s                      | 21 | 1800s                         | 18 | 1800s             | 5 | 1800s        | 9  | 1800s          | 14 | 1800s        | 4  | 1800s         | 8 | 1800s           | 4  | 1800s         | 3 |
|         | 1700s                      | 1  |                               |    |                   |   | 1600s        | 2  | 1700s          | 1  | 400s         | 2  | 1700s         | 1 |                 |    | 2-400s        | 3 |
|         | 1600s                      | 1  |                               |    |                   |   | 1500s        | 2  |                |    |              |    |               |   |                 |    |               |   |
| Source  | 1500                       | 2  |                               |    |                   |   | 400s         | 1  |                |    |              |    |               |   |                 |    |               |   |
|         |                            |    |                               |    |                   |   | 0-100ce      | 1  |                |    |              |    |               |   |                 |    |               |   |
|         | eth./oral                  | 14 | eth./oral                     | 25 | hunting           | 3 | hunting      | 12 | naturalist     | 10 | hunting      | 14 | hunting       | 4 | colonial        | 3  | image         | 3 |
|         | hunting                    | 12 | naturalist                    | 8  | eth./oral         | 4 | historical   | 4  | hunting        | 6  | unspec.      | 4  | arena         | 3 | hunting         | 4  | eth./oral     | 2 |
|         | image                      | 8  | journalist                    | 3  | geologist         | 1 | image        | 3  | Colonial       | 5  | colonial     | 1  | colonial      | 2 | eth./oral       | 2  | arena         | 1 |
|         | naturalist                 | 5  | hunting                       | 3  | image             | 1 | journalist   | 2  | journalist     | 7  | eth./oral    | 6  | eth./oral     | 3 | military        | 3  | naturalist    | 1 |

|            |   |            |   |  |       |   |           |   |            |   |       |   |       |   |         |   |
|------------|---|------------|---|--|-------|---|-----------|---|------------|---|-------|---|-------|---|---------|---|
| historical | 7 | historical | 2 |  | other | 2 | eth./oral | 4 | other      | 4 | other | 2 | other | 2 | hunting | 1 |
| journalist | 1 | image      | 1 |  |       |   | literary  | 1 | naturalist | 3 |       |   |       |   |         |   |

**Table 3.** Summary of variability in documentary accounts of pike use in megafauna confrontations.

| Count        | Brown Bear Eurasia |    | Brown Bear N. America |    | Polar Bear |   | Boar      |    | Jaguar    |    | Lion      |    | Tiger     |    | Leopard   |   | Bovid     |   |
|--------------|--------------------|----|-----------------------|----|------------|---|-----------|----|-----------|----|-----------|----|-----------|----|-----------|---|-----------|---|
|              | n=47               |    | n=38                  |    | n=9        |   | n=23      |    | n=33      |    | n=33      |    | n=14      |    | n=14      |   | n=8       |   |
| Attack       | Lunge 1            | 24 | Charge                | 15 | Charge     | 4 | Charge    | 18 | Leap      | 22 | Leap      | 19 | Leap      | 13 | Leap      | 7 | Charge    | 8 |
|              | Lunge              | 6  | Lunge1                | 10 | Lunge1     | 1 | Unspecif. | 5  | Charge    | 5  | Charge    | 10 |           |    | Charge    | 2 |           |   |
|              | Lunge 2            | 7  | Lunge2                | 5  | Lunge2     | 2 |           |    | Unspec.   | 5  | Lunge     | 1  |           |    | Lunge2    | 1 |           |   |
|              | Charge             | 5  | Lu. or Ch.            | 3  | Lunge      | 1 |           |    | Lunge     | 1  | Unspec.   | 3  |           |    |           |   |           |   |
|              | Lu. or Chg.        | 3  | Leap                  | 4  | Leap       | 1 |           |    |           |    |           |    |           |    |           |   |           |   |
|              | Unspec.            | 2  | Unspec.               | 1  |            |   |           |    |           |    |           |    |           |    |           |   |           |   |
| Action       | Provoc.            | 34 | Provoc.               | 24 | Provoc.    | 4 | Provoc.   | 13 | Provoc.   | 18 | Provoc.   | 20 | Provoc.   | 8  | Provoc.   | 7 | Provoc.   | 3 |
|              | Defense            | 1  | Defense               | 2  | Defense    | 3 | Defense   | 1  | Defense   |    | Defense   | 4  | Defense   | 4  | Defense   | 1 | Defense   |   |
|              | Cloaking           | 6  | Cloaking              | 1  | Cloaking   |   | Cloaking  |    | Cloaking  | 2  | Cloaking  | 3  | Cloaking  | 1  | Cloaking  |   | Cloaking  |   |
|              | Rotation           | 7  | Rotation              | 3  | Rotation   |   | Rotation  | 1  | Rotation  | 5  | Rotation  | 1  | Rotation  | 4  | Rotation  | 1 | Rotation  |   |
| Group        | ≥1 hunter          | 22 | ≥1 hunter             | 6  | ≥1 hunter  | 4 | ≥1 hunter | 6  | ≥1 hunter | 9  | ≥1 hunter | 15 | ≥1 hunter | 7  | ≥1 hunter | 2 | ≥1 hunter | 5 |
|              | dog(s)             | 7  | dog(s)                |    | dog(s)     | 2 | dog(s)    | 7  | dog(s)    | 13 | dog(s)    |    | dog(s)    |    | dog(s)    | 1 | dog(s)    |   |
| Other Weapon | Firearm            | 15 | Arrows                | 7  | Spears     | 4 | Firearm   | 4  | Blade     | 7  | Spear     | 12 | Spear     | 5  | Bayonet   | 2 | Spear     | 3 |
|              | Blade              | 8  | Spears                | 2  | Firearm    | 1 | Spears    | 2  | Firearm   | 5  | Firearm   | 3  | Firearm   | 3  | Firearm   | 2 | Blade     | 1 |
|              | Spears             | 5  | Firearm               | 3  | Arrows     | 1 | Blade     | 2  | Spear     | 4  | Blade     | 1  |           |    | Spear     | 1 |           |   |
|              | Arrows             | 3  | Blade                 | 1  |            |   |           |    | Arrows    | 2  | Bayonet   | 1  |           |    | Arrows    | 1 |           |   |
|              | Projectile         | 2  |                       |    |            |   |           |    | Bayonet   | 1  |           |    |           |    |           |   |           |   |

### 3. Results

#### 3.1. Pike Use Context

Appendix A data table columns are discussed here with one exception. In the fifth column (Assessment) we have coded each entry to assess the relative reliability and inherent biases of these accounts systematically. Any book or article classed as nonfiction may still lack representational constraints, some being subject to dramatization, for example. However, the overall consistency in the combined nonfiction accounts provides ethnohistorical strength. The braced pike technique is depicted across centuries and around the world, involving a wide range of species being hunted by people from diverse walks of life and cultural origins. To address reliability, we differentiate the source material into six distinct categories of records. Within each category there are two to three tiers involving derivation, specificity and other characteristics.

Ethnographic and oral tradition sources are most common in the dataset, together representing 28% of the entries. Although we did not identify in-depth anthropological studies of pike hunting, multiple instances of this weapon strategy are discussed by Hallowell [28], Fedje et al. [29], and Simon [30]. Our tabulation draws from these and several other ethnographic accounts of braced spear hunting, including multiple Saami studies [31–33], three from Frederica De Laguna's [34,35] Tlingit ethnographical work, three Nunamiut studies [36–38], two each from the Nanai [39,40] and Guato [41,42], and several others [43–53]. These range geographically from the Pantanal in Paraguay to the tributaries of the Yukon, and from Siberia and northern Europe to East Africa, India and Southeast

Asia. Published oral tradition narratives provide further testimony from indigenous hunters, defenders and storytellers [54–58].

The second most common source for these accounts is big game hunting and fur trade narratives, primarily from the nineteenth and early twentieth centuries. In the company of indigenous spear hunters, such as the shikari in India, cattle herders in East Africa, and seminomadic subarctic peoples, European and American big game hunters often observed the effectiveness of the braced spear at times when their guns jammed or bullets and musket balls were ineffective in facing a tiger, lion or bear (e.g., [59–62]). They often hired guides proficient in the pike technique, and several rifle hunters and fur traders recorded observations of indigenous pike hunting.

We also found that naturalists and conservationists depicted pike hunting of large animals [63–68]. Journalist accounts were numerous, and these often reiterate narratives from interviews, memoirs and published volumes. Some journalists participated in hunts [69–71]. We have omitted journalist accounts that appear to be derived from other published sources that have been inventoried here. Pike hunting is represented in European artwork beginning in the 2nd century CE (Figure 4). In the Supplemental Materials, thumbnails of several of these images are included. Parenthetically, the digital searches also identified hundreds of depictions of defensive braced spear use in 19th and 20th century fiction, in the work of authors such as Edgar Rice Burroughs [72,73], likely influenced by the aforementioned hunting literature and journalism. These novels and scripts have not been included in this study, although rare early literary accounts such as that of Lucian [74] from ancient Greece do hold information relevant to pike research.

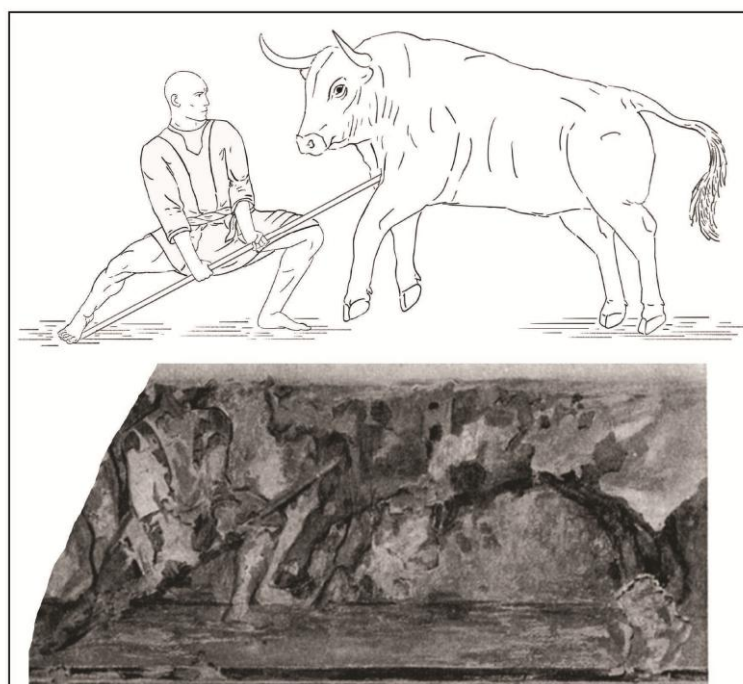
Historical accounts of pike hunting are primarily from the 1800s (40%) and early 1900s (52%). This coincides with the rapid spread of print media and steam-powered international travel, as well as expanding European, Euroamerican and Russian colonial occupation and extractive resource development. The rise of big game hunting as sport following the development of the metal cartridge was also a factor, though due to their high cost and other factors affecting their availability, newer ammunition and firearms remained rare in many areas well into the 20th century. Lastly, salvage ethnography was practiced in many parts of the world in the early 20th century.

Descriptions of the use of pikes against charging cavalry horses and war elephants in military contexts are quite numerous [2–4,75–78]. In contrast to pike hunting studies, military pikes have been well documented by historians and strategists for decades, and therefore depictions of battlefield use are not included in Appendix A or this paper's tables. In warfare, horses charge, but they can rear as well in these confrontations. So too may elephants used in warfare, and these were driven to trample soldiers wielding pikes [7] (p. 71) and [78] (p. 226). The braced pike was often used against charging cavalry, as its greater strength was needed to stop charging mounted equids [79].

Some military pikes were used for hunting, and hunting pikes could be used by soldiers [2] (p. 69) and [80]. Firearms reduced the military use of pikes, but until metal cartridges became common after the 1870s, most rifles had to be reloaded through the muzzle after each shot. In the 18th and 19th centuries, muskets were often outfitted with bayonets and could be braced toward cavalry charges after the weapon's round had been fired [81] (p. 100). Muzzleloaders with bayonets were also used as pikes during hunting. The Norwegian historian Oyvind Flatnes observes that hunters used firearms and pikes together into the latter 19th century:

*"Shots from muzzle-loaders were usually fired at point-blank range. There was no time to reload in the event of a misfire or being faced by a wounded bear and many hunters carried a long birch spear, tipped with a sharp metal point or knife, as a backup. An injured or provoked bear would instinctively get up on its hind legs and attack. Instead of running, the hunter would get down on his knees and plant the spear in the ground*

in front of him, with the tip pointing towards the bear. As the bear attacked, the hunter calmly aimed the spear at the bear's chest and held his ground until it ran onto the spear" (Flatnes [82]).



**Figure 4.** Artist's sketch (above) based on a 3rd century C.E. Roman archaeological painting identified by Shear [83] (p. 452) at the theater in Corinth. Shear observed of the bull: "With his tongue protruding and his forelegs in the air he has rushed to transfix himself on the point of a long spear which is held by a crouching gladiator who has supported the other end of the spear in the sand of the arena with his right foot".

Many jaguar hunters eschewed firearms altogether, preferring the braced spear over a musket or rifle because of its reliability, to preclude the consequences of misfires and because an animal even mortally wounded by a bullet may still carry out its attack [66] (p. 259) [84].

### 3.2. Represented Species

We have identified pike hunting accounts involving brown bears (*Ursus arctos*), polar bears (*Ursus maritimus*), wild boar (*Sus scrofa*), jaguars (*Panthera onca*), lions (*P. leo*), tigers (*P. tigris*), leopards (*P. pardus*), and various bovids. These taxa or close antecedents were present in the Pleistocene, and therefore the historical accounts are likely also relevant to Paleolithic confrontation with extinct taxa such as cave bear, *Arctodus*, European jaguar, *Smilodon*, American lion, cave lion, and several wild bovids, among others.

Historically, megafauna hunting with pikes held special significance for cultures through much of the world. Brown bears were hunted for prestige by Athabaskan chiefs in the Yukon and the Saami of Scandinavia, and for subsistence and pelts by Athabaskans, Inuit, Tlingit, Gilyak, Tungus and Ainu hunters of the northern Pacific Rim, as well as by Russians, Norwegians and Fins. Europeans and Russians used pikes to hunt brown bears for furs and sport. Boars were hunted for meat and for sport among elites, and many boar hunters relied on pikes from the earliest written records through to the modern day in parts of Eurasia. Braced spear hunters include the shikari and Donghurs of India, the Lahu of Laos, tigreros of Latin America, Maasai cattle herders, and the Tiger Spear Division of the Ming and Qing dynasties. East Asian and South Asian tiger hunters with pikes

pursued aggressive animals near populated areas, and Latin American tigreros used pikes to hunt jaguar that killed livestock or, more rarely, threatened people. The Guato in South America hunted jaguars with pikes as a rite of passage, and lion hunting, often with a braced spear, was a rite of passage for pastoralists of East Africa. Braced spears are still a reliable defense against predatory megafauna attacks in some regions. Below we provide more details about the pike hunting of specific animals commonly described in the literature. Most of the tabulated accounts depict taxa hunted within their historical range, but a handful involve species confronted well outside their native range, such as a bull in Peru, an African lion in London, and a boar in Australia.

BROWN BEARS instinctively rise up on hind legs to assess changing situations, and, based on historical accounts, brown bears were especially predictable in their response to hunters, often attacking from this position. Once the bear was standing upright the pike could either be moved to braced position below and to the front of the bear, anticipating the direction of its lunge, or it could be thrust into the bear's chest and then braced as the bear counterattacked. In either case the bear's weight is received on the braced pike point as the animal descends from an upright position, moving forward to attack the pike wielder.

Brown bears account for 41% of the depictions of pike hunting that we have compiled. These are split between accounts from Eurasia and North America, representing much of the historical range of this species. Black bears (*Ursus thibetanus* and *Ursus Americanus*) do not appear to have been regularly hunted with braced weapons, though they were sometimes hunted with spears by groups such as the Magori of Japan. The difference is likely due to the tendency for black bears to flee human hunters and because they rarely rise onto two legs when they do attack [30]. Brown bears are common in Middle and Upper Paleolithic faunal assemblages, and historical hunting of this species may provide the closest analog to hunting strategies used for now-extinct cave bears and short-faced bears as well. The greater size of the extinct species means that lower-powered lance and javelin techniques were probably less effective against these.

POLAR BEARS represent 4% of the documented accounts. These were often encountered in open settings on Arctic ice, and variation between these accounts and brown bear hunting partly reflects differing contexts. The species would have been encountered less often during the portion of the Pleistocene when Arctic settings were rarely occupied by humans.

BOARS are perhaps the most widely depicted prey of spear hunters, among those animals that charge the hunter. Dog baying and brush beating were both frequently used in boar hunting. Like other pike hunter prey, boars have a propensity to attack when threatened. Today boars account for approximately 7% of the global wild land mammal biomass [85], and they are common in archaeological faunal assemblages dating back to the Middle Paleolithic.

AFRICAN LION. The historical range of the lion was much more extensive than it is today and included parts of Eurasia inhabited by different species. Most depictions of lion hunting with braced spears involve pastoralists such as the Maasai of Kenya and other tribes in East Africa, though accounts from other parts of Africa are also recorded (see Figure 5). In the 19th and early 20th centuries, accounts portray a solo lion hunt as part of the process of becoming a Maasai *murrān* (warrior). Accounts indicate that this rite of passage changed to group hunts, then was suspended as the pastoralists increasingly prioritized lion conservation efforts. Lions were normally isolated from their pride before they were targeted, probably because they might otherwise attack as a group [86].



"LONE SPEARMAN TO FIGHT IT OUT, MAN AND BEAST TOGETHER."

**Figure 5.** Carl Akeley's [87] sketch of a Nandi spearman with shield, facing a lioness. One of the man's knees is on the ground and the other braces the shield, while the proximal end of the spear is planted to receive the weight of the attacking lioness.

JAGUAR ranged historically throughout South America and Central America and into North America. The jaguar hunting practices of tigreros protecting livestock are well known, and these pike techniques appear to have their origins with numerous indigenous groups such as the Carib, Tlapaneco, Kokama and Guato (See Figure 6). The widely used Inca pikes may have also been used for jaguar hunting at times. While mostly encountered individually, multiple jaguars were sometimes confronted by pike hunters [69] and [88] (p. 120).



**Figure 6.** Tigrero preparing to receive jaguar's attack on a braced pike [84] (p. 498).

TIGERS of South Asia and East Asia are quite large, particularly in the north, where their thick hide adapted to freezing conditions made them more difficult to kill with a spear. In Indonesia and China, they were captured and later released for confrontation with multiple pike wielders in arena settings. There are also limited accounts of hunters

using braced spears and triggering a tiger's attack, but this is not as widely reported as in lion or jaguar accounts.

LEOPARDS were hunted with braced spears in South and Southeast Asia and in Sub-Saharan Africa, where they sometimes attacked people or livestock [66]. Like jaguars, leopards frequently attack prey from above, leaping from trees with paws spread apart, making them vulnerable to braced spear use.

BOVIDS. Unlike pantherids, most bovids today are domesticated. At least three of the eight depictions of pikes impaling bovids are likely performance-related, at a *plaza de toros* and Roman coliseums, the others for subsistence. Though intensive bovid hunting with pikes is not demonstrated in any region, the practice appears to have been widespread, involving carabao (*Bubalis kerabau*), gaur (*Bos gaurus*), auroch (*Bos primigenius*), and cape buffalo (*Syncerus* sp.). Additionally, historical and ethnographic accounts depict unspecified spear use in hunting bison, wisent, and musk ox. There are many historical depictions of bovid spearing with pikes from horseback in North America and in Eurasia, such as the Spanish picadors, but these have not been tabulated in the current study.

One account not tabulated appears to describe pike hunting of unspecified cervids (Zeuner in [17]), and another refers to pike use against moose [50]. There is a single account of a colonial big game hunter using a braced spear to stop a charging elephant in *musth* condition [89] (p. 408):

*"On my return to camp on this occasion, I found that my elephant had gone musth and was running amok among my tents. He ran at me as I stood in the door of the tent, but, as I had a spear in my hand, I placed the butt against my foot and let him run on to the point. He did not appear to like this, for he stopped and then left my camp and went off into the jungles."*

### 3.3. Pike Deployment Patterns

Table 3 summarizes the variability in pike deployment and related animal attack behavior, associated actions, hunting group makeup, and additional weapons used in conjunction with pikes. Each of these is discussed below.

#### 3.3.1. Megafauna Attack Mode

Animal approach speed and posture are factors in the braced pike user's impalement strategy. Quadrupedal megafauna attack behavior varies between taxa. We distinguish a charge as approaching with all four legs on the ground, a lunge with hind limbs on the ground and both forelimbs free, and a leap as an approach with all limbs airborne at the time of contact. In Table 3 we distinguish Lunge 1 as the standing approach to the weapon tip, Lunge 2 as met with spear thrust and brace, and Lunge as unspecified in this distinction. In this scheme, charging may be overrepresented because the term was sometimes used for any approach. Brown bears sometimes charge, but they often rise on hind limbs to assess danger, and numerous accounts depict them attacking spear wielders from this position, with lunges being much more common than charges in historical accounts from Eurasia (the difference may relate to the larger average size of *U. arctos* in North America).

Pantherids usually leap to attack on descent but sometimes charge close to the ground with a late leap or lunge [66]. Tigreros observed that cats that pounce with forelimbs spread, such as the jaguar, are much less likely to parry the spear than those, such as the puma, that reportedly cross their forelimbs as they leap. The bounty for puma was twice what they received for a jaguar because of this, and it is not clear if pike bracing was used in puma hunting [90] (p. 363) and [91]. Larger animals such as lions often come into contact with the pike wielder, even when impalement is successful, and this may be a factor in the East African use of shields in lion hunting with braced spears.

Bovids and boars charge and can cause deadly wounds with their horns or tusks, or by trampling. Each may use its greater mass to overwhelm smaller and slower adversaries, and the boar sometimes uses its sharp tusks to slice a much larger attacker. A surprising number of accounts depict hunters attempting rigid-stance lancing (lance A in Table 1), only to be thrown down by the boar and trampled or mauled by its tusks. After having survived such an encounter, the hunter Robert Baden-Powell [92] (p. 673) noted, "... a good boar weighs 300 lb.; and this multiplied by the impetus of his pace, amounts to I don't know how many foot-tons by the time he reaches his object." For larger boars, the pike technique appears to have been much more reliable than rigid-stance lancing, though charging boars were challenging to stop with a spear in any case (see Figure 7).



**Figure 7.** Drawing by Baden-Powell [92] showing his effort to maintain a braced pike position as the impaled boar shifts in its efforts to gore the hunter.

Horses also charge at pikes when mounted, in battle. We have not identified depictions of wild equid hunting with pikes, but there is extensive information about warhorses being impaled from the front when charging. The kneeling infantry position in response to the "prepare for cavalry" command in the British military is preparatory to such confrontation. Horses also rear for defense, which leaves them vulnerable to the thrust and brace technique. This likely applies to other equids as well. A form of attack not documented but hypothesized is swinging of horns, tusks or trunk laterally toward the hunter, as we hypothesized for Clovis spears used against mammoths or bison [12].

### 3.3.2. Associated Actions and Group Composition

To better understand these historical megafauna confrontations, we have tabulated descriptions of provocation, weapon cloaking, defensive pike use, group composition and use of additional weapons (Table 3). Although most megafauna documented ethnohistorically are aggressive toward the smaller pike wielder at the time of impalement, the animal's aggression is usually brought on by human provocation, which is clearly indicated in 60% of the historical accounts. Pike-wielding hunters provoked animals with their dogs; weapons such as firearms, spears or bows and arrows; noise harassment; den invasion; surrounding; and threatening approach. Once an animal is provoked, an individual hunter might display vulnerability in order to encourage the animal's aggressive

approach toward the hunter to ensure pike alignment and suitable positioning. In addition to provocation, animal sounds were sometimes mimicked to attract prey and set up pike confrontations [37,50,88]. Retaliatory hunting following attacks on humans or livestock is indicated in several accounts.

Antipredator defensive pike use is much less common at 5% of the accounts of megafauna pike use, though defensive use is common in military accounts. The exception is polar bear encounters. Although the sample size is small, the ratio of defensive use of pikes against polar bears is comparatively high relative to instances of hunters provoking a polar bear charge or lunge. Other defensive examples include pike use against a boar in India and a lion experiencing starvation due to ungulate die-off in Central Africa [62,89,93–97]. Women were sometimes involved in pike hunts. Children and elderly hunters who had lost use of their legs were known to hunt or defend themselves with braced pikes [97] p. 107, [34,56,86,95,98] p. 365, [99] p. 127. Antipredator defensive use of braced spears may have been more common during millennia when predators were larger and more numerous.

Cloaking the pike is often key to avoiding parrying of the weapon, especially for brown bears and big cats that attack with their paws (see Appendix A for examples of parrying). Cloaking can involve the hunter standing with the braced spear mostly to the rear and sliding back as the lunging bear is about to make contact (as shown previously in Figure 1). Leaping cats approach more quickly, so cloaking may involve covering the spear in fabric so that it looks like the arm of the hunter, or maintaining aim directly toward the animal, making the spear less visible [13,100]. Spears can also be positioned just below the top of a bush or a portable branch or shield that is between the cat and the hunter. A related strategy for many pike hunters is to threaten, wound, or harass the megafauna at the time of engagement so that it comes on with such urgency that it does not notice the pike tip.

### 3.3.3. Rotation

Pike impalement does not always cause immediate death or disablement of megafauna, but if the base of the spear remains anchored in the ground and the weapon stays intact, the hunter may remain unharmed as the wound continues its effects. Initially we assumed that impalement solely involved linear (axial) immobilization. Yet many accounts indicate the animal remains somewhat mobile, its force redirected as it pivots over or around the anchored base of the spear, trying to reach the hunter while the wound deepens. As the animal's forward momentum is directed toward the pike, some of the energy will be absorbed by the shaft's upward or lateral rotation, unless the shaft breaks or the animal stops with no redirection. Upward rotation in the vertical plane of approach is described in several accounts. Rotation is key to using a short to moderate-length spear as a pike, protecting the hunter and reducing strain on the shaft by dispersing the impact force. We hypothesize that flexing in longer pike shafts served some of the same purpose. In the tabulated accounts, rotation to an overhead position is sometimes described, and in some cases the animal's momentum and pike resistance cause the animal to completely vault over the hunter during impalement. Transverse animal movement may also reduce spear wound depth [22] (p. 222). Given these scenarios, a more nuanced look at rotational force in pike use may be critical to differentiating lithic pike points from projectile points, the latter primarily encountering axial resistance, an observation discussed below.

The presence of multiple hunters (e.g., Figure 8) has been tabulated where indicated in Table 3. Any of the pike hunts could be attempted by a solitary pike wielder, and sometimes this is preferred to keep the animal's attention on the pike wielder alone to maintain its trajectory. Additional hunters are frequently mentioned as using other weapons for provocation and/or follow-up attack after the animal is impaled. In some cases, the pike

immobilizes the animal, allowing attack from different directions, but it is also common for a second hunter to stand behind the pike wielder. Secondary weapons include rifles, muskets, bows and arrows, lances, javelins, clubs, and blades such as machetes, swords, axes and knives. For brown bear or boar, three pike hunters are sometimes depicted, with the center hunter taking the lead or commanding the animal's attention. For jaguar hunting there are often two hunters, the one in front holding one or two braced spears. Even later firearms that penetrate as deeply as a fixed pike were often seen as less likely to stop the animal from coming into contact with the hunter if fired at from close range [70,82,101]. A bullet that mortally wounds a springing tiger does little to slow the pantherid's momentum toward the hunter once the cat is airborne. In contrast, the pike offers stoppage at a short but survivable distance and often causes disabling injury even if the animal's vulnerable core is missed.



**Figure 8.** Two of four pike wielders in a Tlapaneco hunting group in Mexico impaling a jaguar leaping from a ledge using fire-hardened oak pikes. Journalist Harry Dunn [69] was present, and he later worked with illustrator W.R.S. Stott to render this image.

A group baying or ringing target megafauna was common. Often a pursued animal will stop fleeing if it finds a reasonably defensible position when being surrounded by baying dogs and/or hunters. Ringing often involves finding an isolated animal in the open and broadly surrounding it, then gradually tightening the circle, the hunters recognizing that the animal may charge or try to leap over the hunters in one part of the ring. In many lion hunts, an individual would move in from the ring and approach the animal, drawing the charge, leap or lunge which could be received on this individual's weapon. Other hunters would then attack the impaled animal by throwing or thrusting spears or wielding clubs or blades.

Dogs play a key role, often scent-tracking the prey and then baying or harrying and pursuing the animal toward hunters waiting with pikes. This is typical for boar hunts. Baying is also typically used for the jaguar, whom the hunter then approaches, crouching and bracing the weapon at the moment the cat leaps forward. In some encounters, dogs provide valuable distraction, but in other cases the pike hunter prefers to be the sole focus of the megafauna attack. In most polar bear encounters, dogs were present for sled transportation and/or hunting, and this is reflected in the hunting strategy and bear response.

### 3.4. Pike Attributes

Attributes depicted ethnohistorically in 108 of the 219 accounts are tabulated in Appendix B, with shaft length and diameter averages shown in Table 4. In some cases, attributes are estimated from images. Shafts are typically quite robust, and points are often broad and thick. Some braced spears are designated with the name of the target species, such as the tiger spear, bear spear, boar spear and jaguar spear. Materials often used are resilient hardwood, such as ash, yew, assegai and acacia. Birch shafts are common in northern regions. Some pikes were curated for decades, while others were expedient. Shaft reliability was key to survival of the pike hunter, and size and weight were limited due to the need for maneuverability and portability. Pikes require a shaft of a suitable length, diameter, straightness and resilience. A chopping tool such as a large stone flake, ground adze, machete or metal axe may be needed to harvest and sharpen the pike stave, and fire-hardening is reported for tapered wooden tips. Some shafts took months of planning and preparation to make them reliable enough for bracing against a massive, charging animal [58]. Strength testing, temper sequencing, tapering, and checking for cracks were all done. However, there are also ethnohistorical examples of long staves being harvested expediently and sharpened the day of the hunt, especially where machetes could be used to harvest pike staves and sharpen their tips.

The length of pikes in the tabulated depictions ranges from 1.5 m to over 3 m (Table 4, Appx. B). Pikes with a higher proportion of metal (e.g., at the tip and base), such as the Maasai lion spear and Roman venator weapons, may have been narrower than those with more wood, and some metal-tipped spears were almost swordlike in the distal segment. Proximal metal ferrules and back spikes were common on East African spears and some Roman venabulae. The accounts indicate that hunting pike shafts sometimes had more mass near the tip, as with a javelin [23]. This may be because additional mass was needed nearest the point of entry to pierce the hide in opposition to the oblique momentum of rotational animal contact.

**Table 4.** Shaft attributes from ethnohistorical depictions in Appendix B.

|                                                |     |
|------------------------------------------------|-----|
| Shaft Length in Meters ( <i>n</i> = 39)        |     |
| Avg                                            | 2.5 |
| St. Dev.                                       | 0.5 |
| Shaft Diameter in Centimeters ( <i>n</i> = 20) |     |
| Average                                        | 5.1 |
| St. Dev.                                       | 1.0 |

Pike diameter ranged from just under 4 cm to over 7 cm, and some shafts were tapered. The type of wood was likely a factor in thickness, as was the mass and momentum of the attacking animal the pike was to be used for. Thicker shafts are needed for pikes compared with the lance or javelin because compression and oblique force from rotation are far greater for the pike. The large diameter of historical pike shafts required proportionally large points or blades at the tip. These range from fire-hardened, tapered shaft tips to wrought iron or copper daggers lashed in place with hide or sinew. Documented

hafted pike points are most often metal, but there are several accounts of bone or antler points, including the Koyukon point made from the forearm of a bear, and caribou antler points. Flaked stone points are noted in some instances, but these were not in use at the time or location these records were made. Hide or sinew lashing is commonly used, but there is only one instance describing mastic being used for a braced spear, though chewed sinew provides its own mastic.

Breakage or point loss on impact with bone may be less detrimental with braced pike use because animal momentum is massive and sustained, allowing the pike to penetrate and decelerate target mass even with less tip sharpness. Longer sword-like iron spear tips like the assegais used by the Maasai against lions sometimes bent during impalement of a springing lion. But even when the tip was damaged during impalement the braced weapon could still cause severe injury and absorb much of the force of the attack. (Like spears, shields of stiff rawhide may have Paleolithic origins.) Impalement continues until animal movement is stopped or if the modulus of elasticity of the shaft material is exceeded into permanent, non-elastic deformation and failure during axial compression.

Cross bars of varying materials are explicitly depicted in over 24% of the historical pikes that are described in the textual accounts or shown in images, and they were likely present on several of the pikes that were not described in detail. Cross bars were very effective at limiting impalement depth to protect the hunter and allow weapon withdrawal prior to breakage, and for subsequent use during the encounter. The need for a wound depth-limiting element on many braced spears underscores how much more powerful the pike technique is relative to thrusting and throwing spears, as illustrated in the following 19th century account [102] from Malaysia:

*“... the tiger has sprung upon the point of a spear held in rest by a kneeling Malay, and, the spear, passing completely through the beast’s body, the tiger has come down on the man’s back and killed him. The old men say it is because, regardless of the wisdom of their ancestors, fools now face a tiger with spears unguarded, whereas in the olden time it was always the custom to tie a crosspiece of wood where blade joins shaft to prevent the tiger ‘running up the spear’ and killing his opponent.”*

Most cross bars were positioned near the base of the metal, bone or antler pike point. In some cases these were integrated into the cast metal tip just above the socket that held the distal mainshaft end. In other cases they were attached to the shaft with lashing. The antler-tipped Gwich’in bear spear has a phalange in place of a crosspiece. Cross bars that are not metal are described as antler, bone, ivory or wood. Among subarctic peoples, wrought iron or cold hammered copper knives had a wide hilt that served as the cross bar when used in the spear configuration [103] (p. 289) and [104].

In addition to the extraordinary depth of the pike wound relative to other megafauna spear use, pike bracing typically involves frontal attack that allows the spear to enter vulnerable ventral areas where bone is less dense. The sternum and costal cartilage portions of ribs are less dense bone and, in general, ribs present a smaller cross-sectional aspect from the front than the laterally flared proximal ribs, scapula, and vertebral processes that are likely to be in the path of weapons striking the animal from the side or dorsal region. Cross bars helped to keep the weapon from penetrating deeply enough that the point hit these areas from inside the chest cavity.

#### 4. Discussion

The ethnohistorical data demonstrate that pikes were used in a variety of situations where humans influenced megafauna behavior to bring forth a charge, leap or lunge. Braced spears were also effective in antipredator defense from carnivores that attacked in these ways without provocation. It is therefore likely, though not proven, that since the

Middle Paleolithic or earlier, humans made use of braced weapons for reliable megafauna hunting and defense, from sharpened wood staves to hardwood poles with stone or osseous points held in place with strong lashing.

The pike technique could have allowed a Paleolithic hunting strategy that made diverse megafauna taxa highly accessible with handheld weapons. Pleistocene hunters could have used provocation and braced pikes to obtain large prey present in nearby settings without the need for long-distance pursuit. They could have used the technique to take kills from big cats or bears, or to defend their own kills without the need for fire brands or large numbers of humans present. It may be that using pikes for defense meant humans could more readily inhabit regions dominated by Pleistocene predators and megafauna prey. Faunal assemblages show that from the early Pleistocene humans were competing with megacarnivores and consuming a wide range of megafauna, including many that would be difficult to kill with thrusting spears or javelins alone [105–107].

It is also relevant to Paleolithic weapon studies that the assembled ethnohistorical accounts show that complex projectiles did not replace the spear for hunting of several aggressive large mammal taxa even by the early twentieth century in parts of the Americas, Eurasia and Africa, and in many instances the bow and arrow or firearms were ancillary to pike deployment. Thus, there is no reason to conclude that large megafauna would have been inaccessible to Paleolithic hunters who lacked complex projectiles.

Here we suggest possible approaches to identifying evidence for braced pike use during the Pleistocene, building on our archival research and previous experimental work and assessment of megafauna hunting with Clovis points and beveled osseous rods.

#### 4.1. Pleistocene Faunal Remains

Hunting lesions provide direct evidence of weapon use in human confrontations with megafauna [108]. Given the ethnohistoric depictions of attack modes and pike impalement, hunting lesions on megafauna remains indicative of ventral contact and massive compressive force at loci of weapon tip contact may suggest pike use.

Although hunting lesions are not common prior to the Upper Paleolithic, early examples of ventral weapon tip contact have been discussed in archaeological reports, including cave lion [109,110] and mammoth reports [111]. Animals with ventral lesions found in Upper Paleolithic sites include a horse from La Garma [112] and two bears killed in cave settings with evidence of ventral neck or chest wounds [113]. Interpretations of these assemblages could be reconsidered in light of the ethnohistorical evidence for pike use. We have presented approaches to such associations at numerous North American Clovis sites, considering possible pike weaponry associated with mammoth remains at sites such as Naco and Blackwater Draw [12].

#### 4.2. Paleolithic Artifacts

Paleolithic wooden spears from the Schoningen, Clacton, and Lehringen sites in Europe have been assessed as possible lances or javelins, but given the ethnohistorical information presented here, the possibility that one or more of these was used as a braced pike should also be considered. This might be indicated by shaft length and diameter, the resilience of the wood species, and potentially wear patterns. Given that pikes are often much more robust than most other spears, segments of archaeological pike shafts in other assemblages may have been mistaken for tent poles, drying racks or other wooden structural remains, necessitating review of these artifacts where present in Paleolithic collections.

The possibility of archaeological lithic and osseous pike points and wood or osseous cross bars can also be considered. Given the combination of large shaft diameter and massive compression with rotation, Paleolithic archaeological pike points are likely to be those

that most effectively convert massive oblique force to axial force in the shaft, those with greater resilience under compression, and those sufficiently wide to provide wound entry for a wide diameter shaft with a thickly lashed haft. We have considered force dampening in pike point hafting elements to reduce point fracture, but rigid haft designs should also be considered. The fire-hardened wood shaft tips and hafted osseous points indicated in the ethnohistorical literature may prove to have been resilient as pike tips. The wound enhancement many lithic points are known for may be of less importance in a braced weapon so powerful that it often requires a cross bar to limit wound depth.

The ethnohistoric findings have several implications for replication and experimentation involving archaeological types.

- (1) Shaft diameter range is distinctive. Most replication and experimentation assume projectile or thrusting action and involve spear shafts less than 30 mm diameter, which is much smaller than known ethnographic and historical pikes used in megafauna hunting. In addition to wider main shafts, assessing pike use may require correspondingly wide lithic points, osseous points, and fire-hardened wood shaft tips for experiments.
- (2) Mastic is rarely mentioned in ethnohistorical pike hafting accounts, yet it is nearly ubiquitous in hafted lithic point experiments conducted by experimental archaeologists. The widespread use of robust lashing at the haft in documented pikes allows for strength without mastic and expeditious removal and replacement of points. Omitting mastic in replication also provides for a measure of elasticity in the haft, allowing dampening and/or detachment, which could play a role in the adjustment of some weapons to compression and rotation to reduce the likelihood of fracture (see [12]). Unlike human-powered lance and javelin use, pike impalement involves deep weapon penetration despite a thicker shaft and more robust perimeter lashing.
- (3) As we showed in 2024, momentum experiments can involve much greater mass to replicate axial compression produced by fast-moving megafauna against a braced pike. Cross-bar position indicates that impalement well into the chest cavity was common, and several accounts depict ursids, suids and pantherids being completely transfixes when a cross bar was not present or was attached well below the pike tip. Experiments should employ the momentum necessary for a large diameter shaft to penetrate to such depths.
- (4) Experiments can involve pike rotation to assess the degree to which different point types and hafts more often convert oblique force to axial force without breakage or collapse under high compression with changing force direction. Among large points, some may be more stable, or hafts may be more flexible to allow for the oblique-to-axial force conversion necessary to initiate and maintain impalement of the forward moving target.
- (5) It may be productive to experiment with different wood types and fresh vs. seasoned wood to address variability such as force absorption through bending of longer shafts vs. rotation of shorter shafts. Are expedient shafts able to withstand impalement compression, or is seasoning necessary for a given wood species?
- (6) Replication and experimentation with wood and osseous hafted cross bars may lead to the identification of diagnostic wear patterns or materials, sizes and shapes that may be identified in archaeological specimens.

There may be other archaeological indications of Paleolithic pike use, such as identification of ventral spear injuries in megafauna depicted in rock art. As the topic is further explored, these approaches can be expanded upon.

## 5. Conclusions

We have considered recently digitized text and imagery from the past two millennia, expanding the dataset on braced pikes to 219 individual depictions [2,13–19,26–29,31–71,82–102,114–253]. This cross-cultural, multi-taxon dataset has been examined systematically, though largely filtered by the use of English-language search terms. Although we have not interviewed former pike hunters or observed people hunting megafauna with pikes, several ethnographers and other observers documented pike use, and we have compiled and analyzed these depictions. We have taken a comparative technological approach, considering weapon efficiency in varying contexts and modeling the pike as one of three basic spear types used for millennia in geographically diverse settings. Using variables such as target animal behavior, kinetic energy (focusing on mass in addition to velocity in momentum), force application in weapon positioning, and weapon compression and rotation, we have distinguished the pike from the lance and javelin.

We infer from this analysis that there has been widespread and variable use of braced pikes against several megafauna species for millennia, including but not limited to ursids, pantherids, suids, equids and bovids. This inference is limited by the historical decline of pike use, yet the recurrence of specific techniques in widely varied documentary accounts lends strength to our hypothesis. The accounts are far-reaching, suggesting a much more extensive historical and ethnographic record than we have been able to explore. We speculate that pike use may have been common in the Pleistocene when these or similar megafauna taxa were predominant as apex predators or foraging herbivores. Spear use of some kind is presumed by archaeology for much of the Paleolithic, and there may be ways to identify likely pike use in the archaeological record.

For megafauna encounters, the braced pike was arguably the most powerful handheld hunting weapon prior to the development of advanced firearms in the 19th century, yet pikes are no more technologically complex than other handheld wooden spears. Unlike other spears, the pike can reciprocate the force of a charging large animal in the hands of both small and large people, even juveniles and elderly individuals with limited mobility, and it was often used in conjunction with other weapons, including projectiles. Given its effectiveness for hunting and defense, pike use is potentially relevant to several cultural and evolutionary topics involving megafauna, from reliance on large herbivore hunting to coexistence with megacarnivores. Modeling pike use archaeologically may lead to new interpretations of known assemblages and artifact types, shedding light on many millennia of human adaptation in habitats dominated by Pleistocene megafauna.

**Supplementary Materials:** The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/quat9040056/s1>.

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## Appendix A. Ethnohistorical Pike Accounts Dataset

Each of the entries in the table below is based on a corresponding text passage or image appearing in the Supplementary Materials. Most of these data are summarized in Tables 2 and 3, and addressed in Section 3 of the main text.

Assessment of Reliability (Asmnt): Ob = Observer accounts; Ob-1 involves first-hand observation; Ob-2 is indirect with the source specified; Ob-3 is a vaguer generalization of the observed technique. P = Practitioner's statement of hunting technique; P-1 is testimony of the pike wielder; P-2 is indirect, usually a recounting of the pike wielder's statements.

OT = Oral tradition: retelling of longstanding cultural practice, often as myth or lore. OT-1 is specific, OT-2 is generalized or source-unspecified.

E = Ethnographic; E-1 is systematic ethnographic assessment based on a researcher's extended cultural interaction; E-2 is less specific or incidental and includes non-research depictions.

H = Historical; H-1 historical text or image, often supported by other records; H-2 includes less representational text such as early missionary accounts or archaeological images such as Roman mosaics; H-3 is text from a legend or derivative historical depiction.

L = Literary. There is no tier 1 in this category. L-2 indicates early era of use and/or an account that is well informed based on parallels with other documentary records.

| Region/Group                                         | Period | Rec. Type     | Ref # | Asmnt | Attack  | Initial | Other    | Hntrs | Dogs | Add. Weap.   |
|------------------------------------------------------|--------|---------------|-------|-------|---------|---------|----------|-------|------|--------------|
| <b>Brown Bear (<i>Ursus arctos</i>) n = 63 (41%)</b> |        |               |       |       |         |         |          |       |      |              |
| Europe: Saami                                        | 1900s  | Image         | 65    | E-1   | Lunge   | Prov    |          |       |      | Rifle        |
| Europe: Saami                                        | 1900s  | Image         | 65    | E-1   | Lunge   | Prov    | Cloaking |       |      |              |
| Europe: Saami                                        | 1900s  | Ethnographic  | 51    | E-1   | Lunge 1 | Prov    |          |       |      |              |
| Europe: Saami                                        | 1900s  | Zoologist     | 65    | E-1   | Lunge 1 |         | Cloaking |       |      |              |
| Europe: Saami                                        | 1900s  | Ethnographic  | 33    | E-1   | Lunge 1 |         | Cloaking |       |      |              |
| Europe: Saami                                        | 1800s  | Ethnographic  | 31    | E-1   | Lunge 2 | Prov    |          |       |      |              |
| Europe: Saami                                        | 1800s  | Ethnographic  | 32    | E-1   | Lunge 1 | Prov    |          | Yes   |      | Spears       |
| Europe: Saami                                        | 1900s  | Ethnographic  | 114   |       | Lunge 1 | Prov    | Parry    | Yes   |      | Spears       |
| Europe: Saami                                        | 1700s  | Historical    | 115   | H-1   | Lunge 1 | Prov    |          | Yes   |      | Muskets      |
| Europe: Saami                                        | 1800s  | Image         | 116   | H-3   | Lunge   | Prov    |          | 1     |      | Rifle, knife |
| Europe: Finland                                      | 1800s  | Historical    | 117   | H-1   | Lunge 1 | Prov    | Parry    |       |      |              |
| Europe: Norway                                       | 1900s  | Historical    | 37    | H-1   | Lunge 1 | Prov    | Rotation |       |      | Projectiles  |
| Europe: Norway                                       | 1900s  | Naturalist    | 118   |       | Lunge 2 | Prov    |          |       |      |              |
| Europe: Norway                                       | 1900s  | Historical    | 119   | H-1   | Lunge 1 | Prov    |          |       |      |              |
| Europe: Norway                                       | 1800s  | Historical    | 82    | P-2   | Lunge 1 | Prov    |          |       |      | Rifle/musk.  |
| Europe: Norway                                       | 1900s  | Historical    | 120   | H-1   | Lunge 1 | Prov    | Cloaking |       |      |              |
| N. Europe                                            | 1800s  | Historical    | 121   |       | Lunge 1 |         |          |       |      |              |
| W. Europe/medieval                                   | 1500s  | Image         | 122   | H-2   | Lunge   | Prov    |          | 2     | 4    |              |
| W. Europe/medieval                                   | 1500s  | Image         | 123   | H-2   | Lunge   | Prov    |          | 2     | 4    | Pike, sword  |
| Russia/Slavic                                        | 1900s  | Image         | 124   | H-2   | Lunge 1 |         |          | 1     |      | Rifle        |
| Russia/Slavic                                        | 1800s  | Image         | 125   | Ob-2  | Lu or C |         |          | 6     | 5    | Axe, rifle   |
| Russia/Slavic                                        | 1900s  | Image         | 126   | H-2   | Lunge   |         |          | 1     | 1    | Rifle        |
| Russia/Slavic                                        | 1800s  | Hunting acct. | 61    | Ob-1  | Lunge 1 | Prov    | Rotation | 2     |      | rifle        |
| Russia/Slavic                                        | 1800s  | Hunting acct. | 127   | Ob-3  | Lunge 1 |         |          |       |      | Pistol       |
| Russia/Slavic                                        | 1800s  | Hunting acct. | 128   | Ob-1  | Lunge 1 | Prov    | Rotation | 2     |      | Rifle, spear |
| Russia/Slavic                                        | 1800s  | Hunting acct. | 129   | Ob-2  | Lunge 1 | Prov    |          | 1     |      | Guns, sword  |
| Russia/Tver                                          | 1900s  | Hunting acct. | 130   | Ob-1  | Lunge 1 | Prov    |          |       | 2    | Axe          |
| Russia/Slavic                                        | 1900s  | Hunting acct. | 131   | H-2   | Lu or C |         |          |       |      |              |
| Russia/Slavic                                        | 1800s  | Hunting acct. | 71    | Ob-1  | Lu or C | Prov    |          | Yes   |      | Musk., kni.  |
| Russia/Slavic                                        | 1800s  | Hunting acct. | 132   | Ob-3  |         | Defen   |          | 2     |      |              |
| Russia/British                                       | 1800s  | Hunting acct. | 133   | Ob-1  | Lunge 1 | Prov    | Rotation | Yes   |      |              |

|                         |       |                |     |      |         |       |          |     |     |              |
|-------------------------|-------|----------------|-----|------|---------|-------|----------|-----|-----|--------------|
| Russia/St. Petersburg   | 1800s | Hunting acct.  | 134 | Ob-2 | Charge  | Prov  | Rotation | Yes |     | Rifle        |
| Belarus/Naliboki Forest | 1600s | Naturalist     | 135 | H-3  | Lunge 2 | Prov  |          |     | Yes | Sword        |
| Siberia/Evenki          | 1800s | Ethnographic   | 136 | E-1  | Charge  |       |          |     |     |              |
| Altai/Tatars            | 1800s | Hunting acct.  | 137 | Ob-2 | Charge  | Prov  |          |     |     | Rifle        |
| Ural Mtns/Bashkirs      | 1800s | Hunting acct.  | 138 | Ob-2 | Lunge 2 |       |          |     |     |              |
| NE Asia; Evenk          | 1900s | Ethnographic   | 53  | E-1  | Lunge 2 | Prov  |          |     |     |              |
| NE Asia: Yakut          | 1900s | Journalist     | 99  | OT-2 |         | Prov  |          | 1   |     |              |
| NE Asia: Even           | 1900s | Zoologist      | 139 | E-1  | Lunge 2 | Prov  |          |     | Yes |              |
| NE Asia/Kamchatka       | 1800  | Naturalist     | 140 | E-3  | Lunge 2 | Prov  |          |     |     | Knife        |
| NE Asia; Ainu           | 1900s | Ethnographic   | 141 | E-1  | Lunge 1 |       | Par/Clo  |     |     |              |
| NE Asia; Ainu           | 1800s | Ethnographic   | 142 | E-2  | Lunge 1 | Prov  |          | 2   |     | Arro., kni.  |
| NE Asia; Ainu           | 1800s | Ethnographic   | 49  | E-1  | Charge  | Prov  |          | Yes |     | Arrows       |
| NE Asia: Amur R.        | 1850s | Ethnographic   | 143 | E-1  | Lunge 1 |       |          | 2+  |     | Yes, unspec. |
| NE Asia: Gilyak         | 1900s | Ethnographic   | 45  | E-1  | Lunge 1 | Prov  | Par/Clo  | Yes |     | Pikes        |
| Amur R.; Nanai          | 1900s | Ethnographic   | 39  | E-1  | Charge  | Prov  | Rotation |     |     |              |
| Amur R.; Nanai          | 1900s | Ethnographic   | 40  | E-1  | Lunge 1 | Prov  | Rotation | 2+  |     | Arr., musk.  |
| Alaska: Kuvvanmiut      | 1900s | Ethnographic   | 43  | E-1  | Lunge 1 | Prov  | Parry    |     |     |              |
| Alaska: Inupiat         | 1900s | Naturalist     | 144 | E-2  | Lunge 1 | Prov  | Parry    |     |     | Spear        |
| Innuitt/Kuskokwim       | 1900s | Historical     | 145 |      | Charge  | Prov  |          |     |     |              |
| Alaska: Innuitt         | 1800s | Naturalist     | 146 | E-2  | Lunge 1 | Prov  |          |     |     |              |
| Alaska: Innuitt         | 1900s | Naturalist     | 147 | Ob-2 | Charge  |       |          |     |     |              |
| Alaska: Innuitt         | 1900s | Image          | 148 | H-3  | Lunge 1 |       |          |     |     |              |
| Alaska: Nunamiut        | 1900s | Ethnographic   | 38  | E-1  | Lunge 1 |       |          |     |     |              |
| Alaska: Nunamiut        | 1800s | Ethnographic   | 36  | E-1  | Lunge 1 | Prov  |          | 1–2 |     | Arrows       |
| Alaska: Nunamiut        | 1900s | Ethnographic   | 37  | E-1  | Lunge 1 | Prov  | Rotation |     |     | Arrows       |
| Alaska: Agulimuit       | 1800s | Oral history   | 54  | P-2  | Lunge 1 | Prov  |          |     |     |              |
| Alaska: Indigenous      | 1900s | Oral history   | 149 | OT-2 | Lunge 2 | Prov  | Rotation |     |     |              |
| Innuitt/Athabaskan      | 1900s | Naturalist     | 68  | E-2  | Charge  |       | Parry    |     |     |              |
| Alaska: Koniag          | 1900s | Ethnographic   | 16  | E-1  |         |       |          |     |     |              |
| Alaska: Alutiiq         | 1800s | Journalist     | 150 | Ob-2 | Lu or C | Prov  |          |     |     |              |
| Alaska: Tanana          | 1800s | Ethnographic   | 151 | E-1  | Charge  |       |          |     |     |              |
| Alaska: Tanaina         | 1900s | Naturalist     | 152 | OT-1 | Charge  | Prov  |          |     |     |              |
| Alaska: Tanaina         | 1800s | Oral tradition | 153 | OT-2 | Charge  | Prov  |          |     |     |              |
| Alaska/St. Elias        | 1800s | Journalist     | 154 | E-2  | Charge  | Prov  |          |     |     | Musket       |
| Alaska/St. Elias        | 1800s | Ethnographic   | 155 | E-1  | Charge  | Prov  |          |     |     | Arrows       |
| Alaska/St. Elias        | 1800s | Ethnographic   | 34  | E-1  | Lu or C | Defen |          |     |     |              |
| Alaska: Yakutat         | 1900s | Ethnographic   | 34  | E-1  | Leap    |       |          |     |     |              |
| Alaska: Tlingit         | 1900s | Hunting acct.  | 156 | OT-3 | Charge  |       |          |     |     |              |
| Alaska: Tlingit         | 1900s | Ethnographic   | 56  | OT-1 | Leap    |       |          |     |     |              |
| Alaska/Denali NP        | 1900s | Naturalist     | 157 | E-2  | Charge  | Prov  |          |     |     |              |
| Yukon; Kuitichin        | 1900s | Journalist     | 158 | E-2  | Lu or C | Prov  |          |     |     |              |
| Yukon; Kuitichin        | 1800s | Ethnographic   | 159 | OT-2 | Leap    |       |          |     |     |              |
| Yukon; Kuitichin        | 1900s | Oral tradition | 160 | OT-2 | Charge  | Prov  |          |     |     | Arrows       |
| Yukon: Han              | 1800s | Ethnographic   | 50  | E-1  | Lunge 2 | Prov  |          | 2   |     | Other pikes  |
| Yukon: Koyukon          | 1800s | Ethnographic   | 48  | E-1  | Lunge 1 | Prov  |          |     |     |              |
| Yukon: Koyukon          | 1900s | Oral history   | 58  | OT-1 | Lunge 2 | Prov  | Rotation | 2   |     |              |
| Yukon: Koyukon          | 1900s | Oral history   | 58  | Ob-2 | Charge  | Prov  |          |     |     | Blunt arrows |
| Yukon: Gwich'in         | 1800s | Ethnographic   | 55  | E-1  | Lunge 2 | Prov  |          | Yes |     | Arrows       |
| Tla-o-qui-aht           | 1800s | Ethnographic   | 46  | E-1  | Leap    | Prov  | Cloaking | Yes |     | Arrow        |
| Canada; Indigenous      | 1900s | Ethnographic   | 19  | E-2  | Charge  | Prov  |          |     |     |              |
| Canada: Nakoda          | 1800s | Ethnographic   | 161 | E-2  | Lunge 1 | Prov  |          |     |     | Ax, gun      |
| Western U.S.            | 1800s | Hunting acct.  | 162 | Ob-2 | Lunge 2 | Defen |          | 1   |     |              |
| Oregon/Modoc            | 1800s | Hunting acct.  | 163 | Ob-2 | Charge  |       |          |     |     |              |

|                                                        |       |               |     |      |         |       |          |     |                |
|--------------------------------------------------------|-------|---------------|-----|------|---------|-------|----------|-----|----------------|
| Calif./Nisenan                                         | 1800s | Ethnographic  | 44  | E-1  | Charge  |       |          |     |                |
| <b>Polar Bear (<i>Ursus maritimus</i>) n = 10 (6%)</b> |       |               |     |      |         |       |          |     |                |
| Alaska: Inuit                                          | 1800s | Ethnographic  | 95  | E-1  | Leap    | Defen |          |     |                |
| Alaska: Inuit                                          | 1800s | Ethnographic  | 164 | E-2  | Charge  | Prov  |          |     | Arrows         |
| Nunavuk:Inuit                                          | 1900s | Hunting acct. | 165 | Ob-2 | Charge  | Prov  | 2        | 3   | Spears         |
| Inuit                                                  | 1900s | Geologist     | 166 | E-2  | Charge  | Prov  | 2        |     | Spear          |
| Hudson Bay                                             | 1900s | Oral history  | 167 | E-2  | Lunge 1 |       |          |     |                |
| Arctic; whalers                                        | 1800s | Image         | 168 | Ob-3 | Lunge   |       | 2        |     | Pikes, rifles  |
| Greenland                                              | 1800s | Whaler        | 169 | Ob-2 | Charge  | Defen |          |     |                |
| Chukchi, Inuit                                         | 1800s | Fur trade     | 170 | H-2  | Lunge 2 | Prov  | Yes      | Yes | Spears/pikes   |
| Alaska; Inupiaq                                        | 1900s | Ethnographic  | 171 | E-1  | Lunge 2 |       |          |     |                |
| <b>Boar (<i>Sus scrofa</i>) n = 14 (9%)</b>            |       |               |     |      |         |       |          |     |                |
| Western Europe                                         | 1600s | Image         | 172 | H-2  | Charge  | Prov  | 2        | 5   | Bident spear   |
| Western Europe                                         | 1500s | Image         | 173 | H-2  |         | Prov  |          | Yes |                |
| Western Europe                                         | 1600s | Image         | 174 | H-3  | Charge  | Prov  | Yes      | Yes | Spears         |
| Balkans: Illyrians                                     | 50 CE | Historical    | 2   | H-1  | Charge  |       |          |     |                |
| W. Europe: Portugal                                    | 1500s | Historical    | 175 | P-2  |         |       |          |     |                |
| India: Musahur                                         | 1800s | Hunting acct. | 97  | Ob-1 | Charge  | Defen | Rotation |     |                |
| India; Colonial                                        | 1900s | Hunting acct. | 176 | Ob-1 | Charge  |       |          | 2   |                |
| India: Colonial                                        | 1900s | Hunting acct. | 177 | P-1  | Charge  |       |          |     |                |
| India                                                  | 1800s | Hunting acct. | 178 | Ob-1 | Charge  | Prov  | 3        |     | Rifles         |
| India: Colonial                                        | 1800s | Hunting acct. | 92  | P-1  |         |       |          |     |                |
| India: Colonial                                        | 1800s | Hunting acct. | 179 | P-1  | Charge  | Prov  | 1–2      |     |                |
| Indian; Colonial                                       | 1900s | Hunting acct. | 180 | P-2  |         |       |          |     |                |
| India; Colonial                                        | 1900s | Hunting acct. | 181 | Ob-1 | Charge  | Prov  |          |     |                |
| India; Colonial                                        | 1800s | Hunting acct. | 182 | P-2  |         |       |          |     |                |
| Indonesia/Dayak                                        | 2000s | Hunting acct. | 183 | P-1  | Charge  | Prov  |          | 1   | Rifle          |
| Phillipines/Kalinga                                    | 1800s | Ethnographic  | 47  | E-1  | Charge  | Prov  |          |     |                |
| W. Europe                                              | 1800s | Hunting acct. | 184 | H-2  | Charge  | Prov  |          |     |                |
| W. Europe                                              | 1800s | Literary      | 185 | L-2  | Charge  | Prov  |          |     | Sword          |
| Europe; Roman                                          | 400s  | Historical    | 186 | H-2  | Charge  |       |          |     | Sword          |
| Europe: Ardennes                                       | 1800s | Hunting acct. | 187 | Ob-1 | Charge  | Prov  |          | Yes | Rifle          |
| Europe/German                                          | 1900s |               | 188 | Ob-3 | Charge  | Prov  |          | Yes |                |
| Europe/German                                          | 1900s | Historical    | 75  | H-3  | Charge  |       |          |     |                |
| Japan/Kuunan                                           | 1900s | Journalist    | 189 | Ob-2 | Charge  | Prov  | 2+       | Yes | Rifle          |
| <b>African Lion (<i>Panthera leo</i>) n = 20 (13%)</b> |       |               |     |      |         |       |          |     |                |
| E. Africa: Maasai+                                     | 1900s | Ethnographic  | 18  | E-2  | Leap    |       |          |     |                |
| E. Africa: Maasai                                      | 1900s | Oral history  | 190 | Ob-1 | Leap    | Prov  | 2+       |     | Spears         |
| E. Africa: Maasai                                      | 1900s | Ethnographic  | 17  | E-2  | Leap    |       |          |     |                |
| E. Africa: Maasai                                      | 1900s | Unspecified   | 63  | E-2  | Leap    | Prov  |          |     |                |
| E. Africa: Maasai                                      | 1900s | Hunting acct. | 191 | Ob-2 | Charge  | Prov  |          |     | Spears, rifles |
| E. Africa: Maasai                                      | 1900s | Hunting acct. | 192 | Ob-2 | Leap    |       |          |     |                |
| E. Africa: Maasai                                      | 1900s | Hunting acct. | 193 | Ob-1 | Charge  | Prov  | Yes      |     | Spears         |
| E. Africa: Maasai                                      | 1900s | Ethnographic  | 194 | E-2  | Leap    | Prov  | Yes      |     | Spears         |
| E. Africa: Maasai                                      | 1900s | Hunting acct. | 195 | Ob-3 | Leap    |       |          |     |                |
| E. Africa: Maasai                                      | 1800s | Ethnographic  | 196 | Ob-2 | Leap    | Prov  | Cloaking | Yes | Spears         |
| Laikipia: Maasai                                       | 1900s | Hunting acct. | 197 | Ob-3 | Leap    | Prov  |          | Yes |                |
| E. Africa; Maasai                                      | 1900s | Hunting acct. | 198 | Ob-1 | Charge  | Prov  | Yes      |     | Rifle          |
| Tanganika/Maasai?                                      | 1900s | Unspecified   | 199 | H-3  |         | Defen |          |     |                |
| E. Africa; Zulu                                        | 1900s | Hunting acct. | 200 | Ob-1 | Charge  | Prov  |          |     |                |
| Somalia; Nandu                                         | 1900s | Colonial      | 201 | Ob-1 | Charge  | Prov  | Parry    | Yes | Rifle          |
| Kenya; Nandi                                           | 1900s | Ethnographic  | 87  | Ob-1 |         |       |          |     |                |
| Kenya: Kalenjin                                        | 1900s | Hunting acct. | 202 | Ob-2 | Leap    | Prov  | Yes      |     | Spears         |

|                                                   |       |                 |     |      |        |       |            |     |   |               |
|---------------------------------------------------|-------|-----------------|-----|------|--------|-------|------------|-----|---|---------------|
| Kanya; Nandi                                      | 1900s | Zoologist       | 203 | E-2  | Charge | Prov  |            | Yes |   | Spears        |
| E. Africa                                         | 1800s | Naturalist      | 204 | E-2  | Leap   | Prov  | Cloaking   | Yes |   | Spears        |
| Africa                                            | 1900s | Hunting acct.   | 205 | Ob-2 | Leap   | Prov  |            | 1   |   | Rifle         |
| Ethiopia                                          | 1800s | Hunting acct.   | 60  | Ob-2 | Leap   | Prov  | Rota/Cloak |     |   |               |
| Zimbabwe: Ndebele                                 | 1800s | Hunting acct.   | 206 | Ob-1 | Leap   | Prov  |            |     |   | Rifle         |
| Zimbabwe: Shona                                   | 1900s | Unspecified     | 207 | E-2  | Leap   |       |            |     |   |               |
| Darfur;Zaghawa                                    | 1900s |                 | 208 | Ob-2 | Charge | Prov  |            | Yes |   | Spears        |
| Sudan; Arab                                       | 1900s | Hunting acct.   | 209 | Ob-2 | Charge | Prov  |            | 1   |   | Javel., sword |
| Angola                                            | 1900s | Hunting acct.   | 101 | E-2  | Leap   | Defen |            | 1   |   | Spear         |
| Sudan; Omdurman                                   | 1900s | Hunting acct.   | 96  | H-3  | Charge | Defen |            |     |   |               |
| C. Africa                                         | 1900s | Biographical    | 94  | Ob-1 | Leap   |       |            |     |   |               |
| C. Africa                                         | 1900s | Conservationist | 67  | E-2  | Lunge  | Prov  |            | Yes |   |               |
| C. Africa                                         | 1900s | Hunting acct.   | 86  | Ob-1 | Leap   | Defen |            |     |   |               |
| Africa: Angola                                    | 1900s | Missionary      | 101 | Ob-1 | Leap   | Defen |            | Yes |   |               |
| Roman: England                                    | 400s  | Image           | 210 | H-2  | Charge |       |            |     |   |               |
| Roman                                             | 400s  | Historical      | 176 | H-1  |        |       |            |     |   |               |
| England; colonial                                 | 1900s | Journalist      | 211 | P-2  | Leap   | Prov  |            |     |   |               |
| <b>Jaguar (<i>Panthera onca</i>) n = 17 (11%)</b> |       |                 |     |      |        |       |            |     |   |               |
| Nicaragua/Nahua                                   | 1800s | Milit./mining   | 212 | E-2  | Leap   |       |            | 1–2 | Y | Gun, ar, bla. |
| Nicauragua; Carib                                 | 1800s | Hunting acct.   | 213 | Ob-2 | Leap   | Prov  |            | Yes |   |               |
| Mato Gros./Guato                                  | 1900s | Ethnographic    | 42  | E-1  | Leap   | Prov  |            |     |   | Arr.,         |
| Brazil/Mato Grosso                                | 1900s | Image (video)   | 214 | P-2  | Leap   |       |            |     | Y | Spe., mach.   |
| Brazil/Mato Grosso                                | 1900s | Ethnographic    | 41  | E-1  | Charge | Prov  |            |     |   |               |
| Mato Gros.; Guato                                 | 1800s | Zoologist       | 84  | P-1  | Leap   | Prov  |            | 2   |   | Spears        |
| Brazil; Indigenous                                | 1900s | Ethnographic    | 215 | E-1  |        |       |            |     |   |               |
| Brazil                                            | 1900s | Hunting acct.   | 216 | Ob-2 | Leap   | Prov  |            |     | Y | Revolver      |
| Brazil                                            | 1900s | Hunting acct.   | 217 | Ob-2 | Charge | Prov  |            |     |   | Gun           |
| Brazil/Mato Grosso                                | 1900s | Hunting acct.   | 218 | Ob-1 | Charge | Prov  |            |     |   |               |
| Brazil/Mato Grosso                                | 1900s | Journalist/bio  | 219 | P-2  | Leap   | Prov  | Rotation   |     | Y | Rifle, bayo.  |
| Brazil/Guato                                      | 1900s | Hunting acct.   | 220 | P-1  | Leap   | Prov  |            | 1   | Y |               |
| Brazil; So. Forests                               | 1900s | Zoology         | 221 | Ob-1 | Leap   |       | Rotation   |     | Y |               |
| Matto Grosso                                      | 1900s | Zoology         | 222 | E-2  | Leap   | Prov  | Rotation   |     | Y |               |
| Columbia:Tupi-Gua                                 | 1800s | Zoology         | 223 | E-2  | Leap   | Prov  |            |     |   |               |
| Venezuela/Guajira                                 | 1800s | Journalist      | 70  | Ob-1 | Leap   |       |            |     | Y |               |
| Venezuela/Orinoco                                 | 1800s | Colonial        | 224 | P-2  | Charge | Prov  |            | Yes |   | Musket        |
| Japura R.: Macusi.                                | 1900s | Museum          | 88  | P-1  | Leap   | Prov  | Rotation   | Yes |   | Spears        |
| Peru: Amazon                                      | 1800s | Journalist      | 100 | Ob-2 |        |       |            |     |   |               |
| Amazon; Kokama                                    | 1900s | Journalist      | 225 | Ob-2 |        |       |            |     |   |               |
| Amazon                                            | 1969  | Naturalist      | 226 | E-2  | Leap   | Prov  |            |     |   |               |
| Argentina/Tucuman                                 | 1800s | Naturalist      | 64  | E-2  | Leap   |       |            |     | Y |               |
| Argentina/Huarpe                                  | 1700s | Colonial        | 227 | H-2  | Charge | Prov  |            | 2   |   |               |
| Uruguay;                                          | 1800s | Hunting acct.   | 228 | Ob-3 |        |       |            |     |   |               |
| Mexico; indigenous                                | 1900s | Naturalist      | 229 | E-2  | Leap   | Prov  |            |     |   |               |
| Mexico; Tlapeneco                                 | 1900s | Journalist      | 69  | Ob-1 |        |       |            |     |   |               |
| Honduras: Indigen.                                | 1900s | Colonial        | 230 | E-2  | Leap   | Prov  |            | 1   |   | Machete       |
| Nicaragua                                         | 1800s | Ethnographic    | 13  | E-1  | Leap   |       | Cloaking   |     | Y | Machete       |
| Costa Rica/Nicarag                                | 1800s | Colonial        | 90  | Ob-2 | Leap   | Prov  |            | 1   | Y | Machete       |
| Costa Rica/Nicarag                                | 1800s | Journalist      | 91  | Ob-2 | Leap   |       |            |     | Y | Mach, spear   |
| S Amer.: Tucuman                                  | 1800s | Zoology         | 231 | E-2  | Leap   |       | Rotation   |     | Y |               |
| Amazon/Napo R                                     | 1800s | Literary        | 232 | L-2  | Leap   |       | Cloaking   |     |   | Machete       |
| S Amer.: Pantanal                                 | 1900s | Naturalist      | 66  | E-1  | Lunge  |       |            |     |   |               |
| <b>Tiger (<i>Panthera tigris</i>) n = 11 (7%)</b> |       |                 |     |      |        |       |            |     |   |               |
| India                                             | 1900s | Ethnographic    | 14  | E-1  | Leap   |       | Rotation   |     |   |               |

|                                                    |       |                |     |      |         |       |          |     |                |
|----------------------------------------------------|-------|----------------|-----|------|---------|-------|----------|-----|----------------|
| Korea                                              | 1900s | Hunting acct.  | 233 | P-1  | Leap    | Prov  | Rotation | 0   |                |
| Malaysia/Perak                                     | 1800s | Colonial       | 102 | Ob-2 | Leap    | Prov  |          | Yes |                |
| Malaysia                                           | 1800s | Colonial       | 234 | Ob-2 | Leap    | Prov  |          | Yes | Rifl., bayo.   |
| Indonesia/Javanese                                 | 1800s | Arena acct.    | 235 | Ob-2 | Leap    | Prov  |          | Yes |                |
| Indonesia/Javanese                                 | 1900s | Arena acct.    | 236 | Ob-3 | Leap    | Prov  |          | Yes | Spears         |
| Thailand/Hill Tribes                               | 1900s | Ethnographic   | 52  | E-1  | Leap    | Prov  |          | Yes | Spears         |
| Thailand/Hkaren                                    | 1800s | Missionary     | 93  | OT-1 | Leap    | Defen |          |     | Stake          |
| Laos; Lahu                                         | 1900s | Ecologist      | 237 | P-2  | Leap    | Defen |          |     |                |
| China/ Qing                                        | 1700s | Arena acct.    | 238 | H-2  | Leap    | Prov  |          | Yes | Pikes, stakes  |
| China/ Qing                                        | 1800s | Hunting acct.  | 239 | E-2  | Leap    |       | Cloaking |     | Spears, rifle  |
| India/Gujarat                                      | 1800s | Hunting acct.  | 62  | Ob-2 |         | Defen |          | 9   |                |
| India/Shikari                                      | 1800s | Hunting acct.  | 59  | Ob-2 | Leap    | Prov  | Rotation |     | Rifle          |
| India/Kolhan                                       | 1800s | Oral tradition | 240 | OT-1 | Leap    | Defen | Rotation |     |                |
| <b>Leopard (<i>Panthera pardus</i>) n = 8 (5%)</b> |       |                |     |      |         |       |          |     |                |
| Nigeria/Hill Tribes                                | 1900s | Colonial ofc.  | 241 | L-2  | Leap    |       | Rotation |     |                |
| Ghana/Ashanti                                      | 1900s | Oral narrative | 57  | OT-1 | Leap    |       |          |     |                |
| Ghana/Ashanti                                      | 1800s | Hunting acct.  | 242 | Ob-1 |         |       |          |     |                |
| Zimbabwe: Shona                                    | 1900s | Unspecified    | 207 | E-2  | Leap    |       |          |     |                |
| Africa                                             | 1900s | Hunting acct.  | 243 | P-1  |         | Prov  |          | Yes | Spears         |
| India/Shikari                                      | 1900s | Hunting acct.  | 179 | P-1  |         | Prov  |          |     | Arrows         |
| India; Colonial                                    | 1900s | Military       | 244 | P-1  |         |       |          |     |                |
| India; Colonial                                    | 1800s | Military       | 245 | P-2  | Leap    | Prov  |          |     |                |
| India/Colonial                                     | 1900s | Hunting acct.  | 89  | P-1  | Leap    | Prov  |          |     | Y              |
| India/Colonial                                     | 1800s | Military       | 246 | Ob-1 | Charge  | Prov  |          | Y   | Guns           |
| India/Colonial                                     | 1900s | Colonial       | 247 | Ob-2 | Lunge 2 | Prov  |          |     | Bayon., rifles |
| India/Colonial                                     | 1800s | Colonial       | 248 | Ob-1 | Charge  | Prov  |          |     | Bayon. Rifles  |
| Thailand/Hill Tribes                               | 1900s | Ethnographic   | 249 | E-2  | Leap    | Defen |          |     |                |
| Laos; Lahu                                         | 1900s | Ecologist      | 237 | P-2  | Leap    |       |          |     |                |
| <b>Bovids n = 8 (4%)</b>                           |       |                |     |      |         |       |          |     |                |
| Philli.; Kalinga buff.                             | 1890s | Ethnographic   | 47  | E-1  | Charge  |       |          |     |                |
| Lima, Peru, bull                                   | 1800s | Arena acct.    | 250 | Ob-1 | Charge  |       |          | Yes | Swords, spe.   |
| Ugan./Acholi, buff.                                | 1900s | Naturalist     | 251 | E-2  | Charge  | Prov  |          | Yes | Pikes          |
| Africa; unspecified                                | 1800s | Hunting acct.  | 252 | Ob-1 | Charge  | Prov  |          | Yes | Spears         |
| Thai.Hill Tribes, gaur                             | 1900s | Ethnographic   | 52  | E-1  | Charge  | Prov  |          | Yes |                |
| Roman: Cyprus, bull                                | 400s  | Image          | 253 | H-2  | Charge  |       |          |     |                |
| Roman Corinth, bull                                | 200s  | Image          | 83  | H-1  | Charge  |       |          | 1   |                |
| Rome/Borghese, bull                                | 300s  | Image          | 26  | H-1  | Charge  |       |          |     |                |

## Appendix B. Pike Attributes Table

This table presents data from a subset of the ethnohistorical accounts in this study that depict pike shaft characteristics. Shaft length and diameter are in centimeters, and averages appear in Table 4.

| Region/Group                                    | Ref # | Length | Diam. | Tip           | Cross Bar | Other Description              |
|-------------------------------------------------|-------|--------|-------|---------------|-----------|--------------------------------|
| <b>Brown Bear (<i>Ursus arctos</i>) Eurasia</b> |       |        |       |               |           |                                |
| Europe: Saami                                   | 51    |        |       | 12 in., metal |           | Very stout, thickest at distal |
| Europe: Saami                                   | 65    | 2      |       |               |           |                                |
| Europe: Saami                                   | 65    | 2      |       |               |           | Antler disguise/cloaking       |
| Europe: Saami                                   | 65    | 2      |       |               |           |                                |
| Europe: Saami                                   | 116   | 3      | 4     |               |           |                                |
| W. Europe/Medieval                              | 122   | 2      | 5.5   | 7–10 cm wide  | Yes       |                                |

|                                                       |     |     |     |                  |        |                            |
|-------------------------------------------------------|-----|-----|-----|------------------|--------|----------------------------|
| W. Europe/Medieval                                    | 123 | 2   | 5.5 | Metal            | Yes    | Thins to base, branch nubs |
| N. Europe                                             | 121 |     |     |                  | Yes    |                            |
| Russia/Slavic                                         | 124 | 2.4 | 5   | Metal            | Yes    | Pointed base               |
| Russia/Slavic                                         | 125 | 2   | 5   | Metal            |        |                            |
| Russia/Slavic                                         | 126 | 2   | 6   | Metal            | Yes    | Lashing                    |
| Russia/Slavic                                         | 61  | 2.4 |     | 2 ft. iron blade | Yes    |                            |
| Russia/Slavic                                         | 127 |     |     | Metal            | Yes    |                            |
| Russia/Slavic                                         | 128 |     |     | Metal            | Yes    | Seasoned hardwood          |
| Russia/Tver                                           | 130 | 1.8 |     | Forked           | Forked | Birch pole—rogatina        |
| Russia/Slavic                                         | 131 |     |     | Forked           | Forked | Rogatina                   |
| Russia/Slavic                                         | 132 |     |     | Iron             | Yes    | Seasoned, sinew lash.      |
| Russia: British                                       | 133 |     |     |                  | Yes    |                            |
| Siberia/Evenki                                        | 136 | 1.8 |     | Iron tip         | Yes    | Bar lashed on with strap   |
| Belarus/Naliboki For.                                 | 135 |     |     |                  |        |                            |
| Urals/Bashkirs                                        | 138 |     |     |                  | Yes    |                            |
| Altai/Tatars                                          | 137 | 2.4 | 7.5 | Metal            | Yes    | Sapling, rawhide lashing   |
| NE Asia: Evenk                                        | 53  | 1.8 |     | Leaf-shaped      |        | Thrust and brace           |
| NE Asia/Kamchatka                                     | 140 |     |     |                  |        | Thrust and brace           |
| NE Asia: Ainu                                         | 141 |     |     | Spiked           |        | Lift with cord             |
| NE Asia: Ainu                                         | 49  |     |     |                  |        | Poison and bracing         |
| NE Asia: Amur R.                                      | 143 |     |     |                  |        | Spiked head, lifted w/cord |
| NE Asia: Gilyak                                       | 45  |     |     |                  | Yes    | Attached by thong          |
| NE Asia: Nanai                                        | 40  |     |     |                  |        | Spoon-shaped; 45 degrees   |
| NE Asia: Sakha Yakut                                  | 99  | 1.8 |     |                  |        |                            |
| <b>Brown Bear (<i>Ursus arctos</i>) North America</b> |     |     |     |                  |        |                            |
| Alaska: Innuait                                       | 146 |     |     | Caribou          |        |                            |
| Alaska: Tlingit                                       | 34  |     |     | Barbs, tether    |        |                            |
| Alaska: Inupiat                                       | 144 |     |     | Bone-tipped      |        | Stout spear                |
| Alaska: Nunamiut                                      | 38  | 2.4 |     | Flint, bear bone |        |                            |
| Alaska: Nunamiut                                      | 37  |     |     |                  | Yes    |                            |
| Alaska: Agulimuit                                     | 54  |     |     |                  |        | Stout                      |
| Alaska: Koniag                                        | 16  |     |     |                  | Yes    | Attached with lashing      |
| Alaska: Alutiiq                                       | 150 |     |     |                  |        | “Long spear”               |
| Alaska: Tanana                                        | 151 |     | 4   | Steel            | Yes    | Sinew-wrapped birch        |
| Alaska/St. Elias                                      | 154 |     |     |                  |        | Long, heavy, strongly made |
| Alaska/St. Elias                                      | 155 |     |     |                  |        | Longer spear               |
| Alaska/St. Elias                                      | 34  |     |     |                  |        | Blade can free in animal   |
| Alaska: Yakutat                                       | 34  |     |     | Long knife       |        |                            |
| Yukon: Kuitchin                                       | 158 | 2.1 |     |                  |        |                            |
| Yukon: Kuitchin                                       | 159 |     |     | Chipped stone    |        | Stout shaft of birch       |
| Yukon: Han                                            | 50  | 1.8 |     | Caribou horn     |        | Point lashed to shaft      |
| Athabaskan                                            | 145 | 1.7 |     | 8” caribou horn  |        |                            |
| Athabaskan                                            | 103 |     |     | Y-shaped copper  |        | Dagger used as point       |
| Yukon: Koyukon                                        | 58  |     |     | Bear bone        | Yes    | Hide lashing no mastic     |
| Yukon: Koyukon                                        | 58  | 1.6 | 6   |                  |        | Tapered birch shaft        |
| Yukon: Gwich’in                                       | 55  | 3   |     | Antler 6 × 9 cm  | Flange | Hide lashing               |
| Yukon: Kutchin                                        | 160 | 1.8 |     | Steel            |        | Large blade                |
| Canada: Nakoda                                        | 161 | 2.1 |     |                  |        | Length included blade      |
| Europe: Saami                                         | 32  |     |     | Iron             |        | Long spear                 |
| Nootka/Tla-o-qui-aht                                  | 46  | 1.2 |     | 1 ft. Bone       |        | Birch                      |
| <b>Polar Bear (<i>U. maritimus</i>)</b>               |     |     |     |                  |        |                            |

|                                     |     |     |     |                   |                             |
|-------------------------------------|-----|-----|-----|-------------------|-----------------------------|
| Alaska: Innuait                     | 95  |     |     | Long knife        | Pole with fastening         |
| Alaska: Innuait                     | 164 | 3.3 |     |                   |                             |
| Nunavuk: Inuit                      | 165 |     |     | 2.5 ft.           |                             |
| Innuait                             | 166 | 1.8 |     | Jade or copper    | Bear harpoon, 14in. knife   |
| Greenland                           | 169 |     |     |                   | Whale lance                 |
| <b>Boar (<i>Sus scrofa</i>)</b>     |     |     |     |                   |                             |
| Western Europe                      | 172 | 1.8 | 4   |                   | Yes                         |
| Western Europe                      | 174 |     | 4.5 |                   |                             |
| Western Europe                      | 173 |     | 4.5 |                   |                             |
| Balkans: Illyrians                  | 2   |     |     |                   | Venabulum                   |
| India: Colonial                     | 176 |     |     |                   | Long spear                  |
| Indonesia/Dayak                     | 183 |     |     | Metal             |                             |
| Phillipines/Kalinga                 | 47  |     |     | Barbed            |                             |
| Europe: Ardennes                    | 187 |     |     |                   | Sword braced like pike      |
| Euro.: Germany                      | 188 |     |     |                   | Long spear                  |
| Japan/Kuunan                        | 189 |     |     |                   | Torch pike of bamboo        |
| <b>African Lion (<i>P. leo</i>)</b> |     |     |     |                   |                             |
| E. Africa: Maasai                   | 63  |     |     | Metal             |                             |
| E. Africa: Maasai                   | 193 |     |     | Metal, long, flat | Metal ends; also thrown     |
| Laikipia: Maasai                    | 197 | 1.8 | 5   | Metal             | 2.5 ft. blade               |
| E. Africa                           | 204 |     |     |                   | Ostrich plume for cloaking  |
| Zimbabwe: Ndebele                   | 206 |     |     | Blade             | Long assegais               |
| Sudan; Arab                         | 209 |     |     | Shovel-headed     | Long spear                  |
| C. Africa                           | 94  |     |     |                   | Elephant spear              |
| Sudan: Omdurman                     | 96  |     |     |                   | Huge lion spear             |
| Tanganika/Maasai?                   | 199 |     |     |                   | Long spear                  |
| <b>Jaguar (<i>P. onca</i>)</b>      |     |     |     |                   |                             |
| Nicaragua/Nahua                     | 212 | 3   |     | Wood              | Hardwood                    |
| Mato Grosso/Guato                   | 42  |     |     | Hollow femur      |                             |
| Braz., Mato Grosso                  | 214 | 2   | 5   | 12 in. steel      | From video images 1954/1994 |
| Braz., Mato Grosso                  | 41  |     |     | Bone w/socket     |                             |
| Brazil/Indigenous                   | 215 |     |     | Wood              | Bow also used as pike       |
| Brazil                              | 216 |     |     |                   | Long handled spear          |
| S Amer.; Mato Grosso                | 219 | 1.8 | 5   |                   |                             |
| Matto Grosso/Guato                  | 220 | 2.1 | 4   |                   | yes                         |
| Venezuela/Guajira                   | 70  | 2.1 | 5   |                   | Hard, heavy wood            |
| Mexico: Tlapaneco                   | 69  | 3.7 | 7   | Wood              | Oak, fire-hardened          |
| Nicaragua                           | 13  |     |     |                   | Long, stout lance           |
| Costa Rica/Nicaragua                | 90  |     |     |                   | Long spear                  |
| Costa Rica/Nicaragua                | 91  | 2.1 | 5   |                   |                             |
| S Amer.: Tucuman                    | 231 |     |     |                   | Long, strong spear          |
| Uruguay                             | 228 |     |     | Metal             | Resembles whale lance       |
| Amazon/Napo R                       | 232 |     |     | Fired wood        | Short spear; guaiacum       |
| Argentina/Huarpe                    | 227 | 1.7 |     | Iron              | Iron tip                    |
| Honduras: Indig.                    | 230 |     |     |                   | Long spear                  |
| Mato Grosso: Guato                  | 84  | 2.7 |     |                   |                             |
| <b>Tiger (<i>P. tigris</i>)</b>     |     |     |     |                   |                             |
| Malaysia/Perak                      | 102 |     |     | Blade             | Wood Lashed to shaft        |
| Thailand/Karen                      | 93  |     |     | Wood              | Girl kneels by wood stakes  |
| <b>Leopard (<i>P. pardus</i>)</b>   |     |     |     |                   |                             |
| India/Pradesh                       | 244 | 3   |     |                   | "Hog spear"                 |

**Bovids**

|                     |     |     |                 |     |           |
|---------------------|-----|-----|-----------------|-----|-----------|
| Phillipines/Kalinga | 47  |     | Metal           |     | Barbed    |
| Lima, Peru          | 250 |     | Metal           |     |           |
| Uganda/Acholi       | 251 | 2.7 | Metal tip, base |     |           |
| Europe/Roman        | 26  | 4   | Metal           | Yes | Venabulum |

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