A CHRONICLE OF HOMINIDS & AUROCHS

ORIGINS OF AUROCHS AND CATTLE
HOMINID HUNTING & SCAVENGING
BISON WILD BURGERS

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Ever wonder how humans and cows first connected and how people came to eat beef steaks? We’re giving you the first look at the long line of evolutionary history between cows and humans that finally led to Big Macs.

It could be argued that the single most important animal domestication event in human history was taming *Bos primigenius* (common name: aurochs). Of the world’s medium to large sized mammals, the global cattle population, 1.355 billion, (FAO 2007) is second only to humans, 6.67 billion (United Nations 2008:11). Cattle occupy 30% of the earth’s land mass and supply humanity with 85% of its milk and dairy products, 65% of its leather, and 24.2% of the world’s meat (FAO, 2007).

Long before aurochs domestication and present day economic importance, hominids and aurochs have maintained an extensive co-evolutionary chronicle as each genus disseminated from their geographic

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**Figure 1.** Wild and domesticated species within the tribe Bovini (family Bovidae, subfamily Bovinae), adapted from (Gallagher et al. 1999).

<table>
<thead>
<tr>
<th>Tribe</th>
<th>Genus</th>
<th>Wild Species</th>
<th>Domesticated Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bovini</td>
<td>Bos</td>
<td><em>Bos primigenius</em> Aurochs (extinct)</td>
<td><em>Bos taurus, Bos indicus</em> (Domesticated Cattle)</td>
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<td></td>
<td></td>
<td><em>Bos javanicus</em> Banteng</td>
<td><em>Bos banteng</em> (Bali Cattle/ Madura Cattle)</td>
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<td></td>
<td></td>
<td><em>Bos guarus</em> Guar</td>
<td><em>Bos frontalis</em> (Mithan/ Gayal/ Drung Ox/ Dulong)</td>
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<td></td>
<td></td>
<td><em>Bos sauveli</em> Kouprey</td>
<td><em>Bos grunniens</em> (Domestic Yak)</td>
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<td></td>
<td></td>
<td><em>Bos mutus</em> Yak</td>
<td><em>Bubalus bubalis</em> (Domestic water buffalo)</td>
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<td></td>
<td>Bison</td>
<td><em>Bison bison</em> American bison</td>
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<tr>
<td></td>
<td></td>
<td><em>Bison bonasus</em> European bison</td>
<td></td>
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<tr>
<td></td>
<td>Bubalus</td>
<td><em>Bubalus arnee</em> Wild Asiatic buffalo</td>
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<td></td>
<td></td>
<td><em>Bubalus mindorensis</em> Tararaw</td>
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<td></td>
<td></td>
<td><em>Bubalus depressicornis</em> Lowland Anoa</td>
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<td></td>
<td></td>
<td><em>Bubalus quarlesi</em> Mountain Anoa</td>
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<tr>
<td></td>
<td>Syncerus</td>
<td><em>Syncerus caffer</em> African Buffalo</td>
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</table>
origins in Africa and subsequently encountered one another throughout Africa and Eurasia. Archaeological evidence indicates that hominids actively hunted aurochs, particularly during the upper Pleistocene and were almost certainly responsible for their decline and eventual extinction during the Holocene.

**EVOLUTIONARY ORIGINS OF AUROCHS AND CATTLE**

Figure 1 depicts a generally accepted phylogeny of wild and domesticated species of cattle (*Bos*), bison (*Bison*) and buffalo (*Bubalus and Syncerus*) within the Bovini tribe. Worldwide, 897 breeds of cattle are recognized (FAO 2007). By far, the most economically important cattle breeds originated from two species/subspecies: *Bos taurus* and *Bos indicus* which were domesticated from *Bos primigenius* starting ~ 11 ka (Edwards et al. 2004; Edwards et al. 2007; Loftus et al. 1994, MacHugh et al. 1997).

The considerable genetic divergence between zebu (*Bos indicus*) and taurine (*Bos taurus*) cattle indicates that two distinct subspecies of aurochs were independently domesticated (Ibeagha-Awemu et al. 2004; Loftus et al. 1994; MacHugh et al. 1997). Zebu cattle likely were domesticated in the Indus Valley, Pakistan (Meadows 1993) and later introduced to Africa (Bradley et al. 1998; Ibeagha-Awemu et al. 2004), whereas taurine cattle were domesticated in the Near East (Edwards et al. 2004; Edwards et al. 2007) and Africa (Hanotte et al., 2002; Ibeagha-Awemu et al. 2004).

Contemporary European taurine cattle breeds maintain a lineage that reflects genetic admixture with African cattle (Anderung et al. 2005; Beja-Pereira et al. 2006; Ibeagha-Awemu et al. 2004) and little (Achilli et al. 2008; Anderung et al. 2005; Beja-Pereira et al. 2006) or no (Edwards et al. 2007) introgression from wild aurochs. The earliest African cattle were *Bos taurus*, whereas contemporary African zebu cattle are an admixture of *Bos indicus* and *Bos taurus* with differing levels of zebu genes (Hanotte et al., 2002; Ibeagha-Awemu et al. 2004).

Aurochs and modern cattle breeds are members of the Bovinae Subfamily which evolutionarily diverged from the Bovidae Family 12.0-14.3 Ma (Hassanin & Douzery 1999). Within the Bovini Tribe, Bubalus and Syncerus genera diverged 6.9-7.7 Ma, whereas *Bos/Bison* diverged 3.3-4.8 Ma (Hassanin & Douzery 1999). Other Bovini phylogenetic analyses using microsatellites rather than mtDNA suggest more recent divergence estimates (Ritz et al. 2000). However, calibration of the molecular clock in both mtDNA and microsatellite evolution is notoriously difficult and complicated by variability in mutation rates (Bradley et al. 1998).

Recent morphometric analyses of fossil Bovini skulls suggest that *Bos primigenius* evolved from a Late Pliocene African precursor (*Pelorovis turkanensis*) and an Early Pleistocene form (*Pelorovis oldowayensis*, *Pelorovis sensu stricto*), found in Africa and the Middle East (Martinez-Navarro et al. 2007). This interpretation is more plausible than previous hypotheses for an Indian source of *Bos primigenius* from either *Bos acutifrons* (Pilgrim 1939) or *LeptoBos falconeri* (Duvernois 1990). The origin for the putative Indian ancestors has not been precisely dated within the Upper Siwalik, *Equus sivalensis* Interval-Zone (2.6- 0.6 Ma), wherein *Bos acutifrons* and *LeptoBos falconeri* first appear (Nanda 2002). In contrast, the chronology of the Shungura D formation in the Turkana Basin
where *Pelorovis turkanensis* fossils were unearthed has been more exactly dated to 2.52–2.40 Ma (Hernández Fernández & Vrba 2006). Accordingly, *Bos acutifrons* and *LeptoBos falconeri* may significantly post-date the African emergence of *Pelorovis turkanensis*. A reworked analysis of the *Pelorovis* genus indicates its close anatomical resemblance to *Bos* (Gentry & Gentry 1978). Further, the oldest unequivocal record of *Bos* dates to the 600–800 ka specimen from Ethiopia (Gerards et al. 2004) rather than India. Compared to Indian fossils, older and more precise dates for *Bos primigenius*’s first appearance outside of Africa occur in Italy (~500–600 ka) (Cassoli et al. 1999) and Spain (~700 ka) (Estévez & Saña 1999). Collectively, these data support an East African origin for *Bos* from *Pelorovis* during the Late Pliocene, contemporary with the emergence of *Homo* (Martínez-Navarro et al. 2007).

**GEOGRAPHIC DISTRIBUTION OF AUROCHS**

Figure 2 depicts the range of three purported subspecies of *Bos primigenius*. *Bos primigenius namadicus* likely became the domesticated *Bos indicus* (Loftus et al. 1994; MacHugh et al. 1997; Meadow 1993), whereas *Bos primigenius* became the domesticated *Bos taurus* (Edwards et al. 2004; Edwards et al. 2007). *Bos primigenius opisthonomus* probably represents the North African distribution of *Bos primigenius* rather than a discrete subspecies (Gautier 1988). Genetic evidence supports this interpretation and also indicates an independent domestication for the North African version of *Bos primigenius* separate from its Near Eastern counterpart (Hanotte et al., 2002; Ibeagha-Awemu et al. 2004). Following their probable East African origin, aurochs spread to Europe where they are first known from fossils in Spain (~700 ka) (Estévez & Saña 1999) and Italy (~500–600 ka) (Cassoli et al. 1999). Human and aurochs remains from the late Middle Pleistocene have been unearthed together at the Bau de l’Aubesier site in southeastern France (Lebel et al. 2001).

In the UK aurochs occupied England by the Hoxnian Interglacial of the late Middle Pleistocene but did not inhabit Ireland (Schreve & Bridgland 2002). Aurochs reached central Europe (Germany) by ~275 ka – an exceptionally warm interglacial period between the Elster and Saale ice ages (Van Vuure 2005:36).

Figure 2. The geographic distribution of aurochs subspecies during the Pleistocene. **Gray:** *Bos primigenius*, primigenius. **Black:** *Bos primigenius namadicus*. **Mottled Gray:** *Bos primigenius opisthonomus*, adapted fom (Van Vuure 2002.)
During cold glacial periods aurochs withdrew to Mediterranean refugia and then expanded northward during warm interglacials (Sommer & Nadachowski 2006). The most northerly Bos primigenius fossils were discovered at 60° N near Saint Petersburg Russia (Gromova 1931). Aurochs remains have been commonly found in the Middle East, but not in the Arabian Peninsula or Southeast Asia (Van Vuure 2005: 44, 45). Relatively few finds of Bos primigenius namadicus are known from India; additionally their Pleistocene chronology in India is uncertain (Van Vuure 2005:45).

Aurochs fossils have been uncovered in North and Central China limited to the Late Pleistocene and Holocene (Zong 1984), but not in Indo China, suggesting that Bos primigenius entered China via a northern route (Van Vuure 2005:46).

**HOMINID HUNTING/SCAVENGING OF AUROCHS AND THEIR PREDECESSORS**

Before the emergence of Homo and Bos, hominids likely intermingled with Pelorovis turkanensis as evidenced by stone tool processing of bovid bones dating to 2.5 Ma in the Middle Awash Valley, Ethiopia (de Heinzelin et al. 1999). It is unclear if these butchered Alcelaphine bovid remains were scavenged or hunted, nor which hominin species did the butchering.

Nonetheless, this evidence suggests that other Bovini, including Pelorovis, may have been exploited by hominids, as these fauna appear together in the Hata Member of the Bouri Formation where processed Alcelaphine fossils were discovered (de Heinzelin et al. 1999). The earliest global emergence of Homo occurs 2.4 Ma in the Baringo region of Kenya, whereas in the Turkana Basin Homo appears ~ 2.4 Ma in Shungura Member E (Hill et al. 1992). Accordingly, Homo would have co-existed in the Turkana Basin with Pelorovis turkanensis, which materializes slightly earlier in the Shungura Member D (Hernández Fernández & Vrba 2006). Abundant fossil evidence indicates that early Homo in East Africa processed and consumed meat and marrow of bovids (Plummer 2004); however direct evidence for Pelorovis turkanensis exploitation remains elusive.

The first skeletal evidence of Homo outside of Africa occurs at Dmanisi in the Republic of Georgia 1.75 Ma (Lordkipanidze et al. 2006). Because, no precisely dated Bos or Pelorovis fossils are known from Eurasia at this time, hominid interaction with Pelorovis was likely limited to Africa. In Europe, aurochs fossils first appear ~700 ka in Spain (Estévez & Saña 1999) and in Italy by ~500 – 600 ka (Cassoli et al. 1999), whereas early Homo remains have been uncovered in Northern Spain dating to 1.1 – 1.2 Ma (Carbonell et al. 2008) and to ~ 800-900 ka in Italy (Ascenzi et al. 2000). Accordingly, early Homo likely inhabited geographic locales overlapping chronologically with aurochs.
Still, the fossil record neither corroborates nor refutes aurochs scavenging or hunting at this early juncture.

The earliest hominid presence in Northern Europe dates to ~700 ka at 52° N in the UK (Parfit et al. 2005), whereas the first aurochs fossils appear in the UK during the late Middle Pleistocene (Schreve & Bridgland 2002). Similar to aurochs, early hominids in Europe were forced to retreat southward during glacial periods but returned to more northerly latitudes during interglacials. Consequently, encounters between Bos and Homo at specific chronologies and latitudes were dependent upon long term climatic conditions. In addition to climatic limitations to hunting aurochs by hominids, a critical degree of behavioral and technological sophistication would have been necessary to hunt and kill these large, dangerous beasts. The first hominids occupying Europe 1.1 – 1.2 Ma (Carbonell et al. 2008) and 700 – 800 ka (Achilli et al. 1996; Parfit et al. 2005) utilized Oldowan lithic technology, whereas later hominid species associated with fossil finds from Boxgrove in the UK (~500 ka) and Mauer (~400 ka) in Germany employed Acheulian tools (Dennell & Roebroeks 1996; Roberts & Parfitt 1999).

In addition to bifacial hand axes, these hominids crafted tapered wooden spears that appear in Germany by 400 ka (Thieme 1997). A putative puncture wound in a deer scapula uncovered at Boxgrove and dated to ~500 ka (Roberts & Parfitt 1996) suggests that sharpened wooden spears may have been frequently employed to kill mid to large sized mammals.

In summary, by at least 400 ka hominids inhabiting Europe maintained an arsenal of weapons capable of bringing down large mammals, including aurochs (Marean 1998; Roebroeks 2001).

DEFINITIVE HOMINID AND AUROCHS INTERACTION

Although circumstantial evidence suggests that early (~400-700 ka) European hominids may have encountered and scavenged or hunted aurochs, direct fossil evidence for these actions appears later and is attributed to Homo neanderthalensis and sapiens. Numerous archeological sites in Europe and the Levant show that Neanderthals frequently exploited Bos primigenius. Cut marks on faunal remains from Biache-Saint-Vaast in France dating to ~200-240 ka indicate Neanderthals placed an emphasis upon adult aurochs (Auguste 1995).

Detailed taphonomic analyses of Misliya Cave in Israel reveal that aurochs were hunted by Neanderthals during the early Middle Paleolithic (>200 ka) (Yeshurun et al. 2007), but were of greater importance at nearby Hayonim Cave (ca. 140-220 ka) (Stiner 2005) and at Kebara Cave during the late Middle Paleolithic (Speth & Tchernov 1998). Recent excavations near the mouth of the river Somme in France have uncovered aurochs and other large fossilized mammal (elephant and rhinoceros) bones with flint cut marks made during butchery and dated to ~125 ka (Antoine et al. 2007).

By analyzing staple isotopes of various elements in fossilized hominid bones and contrasting these signatures to prey animal isotopes, the relative proportion of prey animals in the predator’s diet can be estimated (Balter & Simon 2006; Bocherens et al. 2005). Isotopic analysis of a 35,000 year old Neanderthal specimen from France indicated that Bovinae flesh (except reindeer, but including aurochs) comprised 58% of the consumed meat (Balter & Simon 2006). Collectively these data along with the taphonomic information represents definitive evidence for aurochs consumption by Homo neanderthalensis; however, it is unclear whether aurochs were hunted, scavenged or both.

Since Neanderthals were known to hunt other megafauna including elephants by plunging spears into the chest cavity (Movius 1950), it is likely that other large mammals including aurochs were hunted (Marean 1998; Roebroeks 2001; Stiner 2005).

As modern humans dispersed from Africa they had the opportunity to hunt or scavenge aurochs...
wherever they were encountered. Fossilized *Bos primigenius* bones exhibiting cut marks or other evidence demonstrate aurochs were frequently targeted prey by modern humans during the upper Paleolithic and Holocene (Bar-Oz *et al.* 2008; Benecke 1999: 123; Goring-Morris & Horwitz 2007; Hüster-Plogmann *et al.* 1999; Legge & Rowley-Conwy 1988:94; Noe-Nygaard 1973; Prummel *et al.* 2002; Street 1990; Steppan 1999).

A particularly graphic example is the “Vig Aurochs” unearthed in Denmark and dating to 10.6 ka. This animal was wounded on two separate occasions by Upper Paleolithic hunters. The first wound to the right scapula was caused by a flint spearhead that lodged in the bone and eventually healed. Two abdominal wounds at a later date proved fatal and were the result of flint arrowheads which remained lodged between the ribs (Noe-Nygaard 1973).

In addition to the archeological evidence, there are numerous historical accounts illustrating and describing aurochs hunting. King Ramses II (1197 – 1165 BC) of Egypt hunted aurochs in Northern Mesopotamia, as did the Assyrian king Senacherib (704-681 BC) (Extinction website 2008). Julius Caesar describes aurochs hunting in 53 BC by tribes people in the German Black Forest (McDevitte & Bohn 1869), and in France, Charlemagne hunted these formidable animals in 802 AD (Extinction website, 2008).

**HOW THE KILLING WAS DONE**

Clearly, no single procedure was employed to hunt and kill prey by Paleolithic hominids. Hunting and killing procedures would have varied by prey size, intelligence, ferocity and other physical attributes in conjunction with available weapons technology (Churchill 1993; Shea 2006).

Table 2 lists the advent of the most common weapons used by Stone Age hominids. Until the development of hafted stone tipped spears, the most effective weapons for killing large animals likely were sharpened wooden spears, whereas smaller animals could have been clubbed, stoned, speared, strangled or violently thrust upon the ground or other hard objects.

The fossil record suggests that sharpened wooden spears may have been used by hominids to kill mid to large sized mammals by at least 400-500 ka (Roberts & Parfitt 1999; Thieme 1997). A wooden spear penetrating the thorax of any mammal regardless of its size is eventually fatal in most instances. The most deadly spearing occurs if the heart or any of its major arteries are pierced. Death ensues within minutes from severe hemorrhaging. Similarly, if both lungs are penetrated by a single spear transversing the thorax or from multiple spearings on both sides of the thorax, death occurs rapidly because of the ensuing bilateral tension pneumothorax causing lung collapse which in turn triggers ventricular fibrillation and death.

A spear entering a single lung and not severing any major arteries would not necessarily be immediately fatal; however it would weaken the animal, cause blood loss and make it vulnerable to continued attacks. Spears entering the abdominal cavity would be generally lethal if they pierced the liver, however wounds to the gut would not cause death immediately. It is not entirely clear if sharpened wooden spears were thrown or primarily used as thrusting weapons.

Contemporary experiments with thrown wooden
spears indicate that they are largely ineffective at penetrating large mammal hides except at close ranges (< 8 meters); hence their primary use may have been as thrusting weapons (Churchill 1993; Shea 2006). In this regard, hominids would have had to approach aurochs at near point blank range to kill them with sharpened wooden spears. During the Upper Paleolithic with the advent of the atlatl and bow and arrow, killing could have been accomplished at safer long distances.

Indeed, these technological advances may have hastened the extinction of aurochs.

AUROCHS EXTINCTION

Over the course of their ~ 800 ka or greater presence in Africa and Eurasia aurochs survived numerous cyclical glacial and interglacial climatic changes. Although the fossil record is incomplete, the bulk of the evidence indicates the extinction of aurochs started during the Holocene. In Europe the disappearance of aurochs began in England and ended in Poland in 1627 AD.

Table 1 lists the last known occurrence of aurochs in Europe and the Middle East. Acknowledgements I extend my cordial gratitude to Professor Bienvenido Martínez-Navarro for generously reviewing an initial draft of this manuscript.

Table 2. Timeline of various weapon/killing technology by Stone Age hominids (Churchill 1993; Movius 1950; Semaw et al. 2003; Shea 2006; Thieme 1997)

<table>
<thead>
<tr>
<th>Weapon</th>
<th>Possible Advent</th>
<th>Direct evidence</th>
</tr>
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<tbody>
<tr>
<td>Physical assault (strangulation, hand/foot</td>
<td>2.6 Ma</td>
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<tr>
<td>blows, body slams)</td>
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<tr>
<td>Stone, boulder and stick throwing</td>
<td>2.6 Ma</td>
<td></td>
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<tr>
<td>Wooden or bone clubs</td>
<td>2.6 Ma</td>
<td></td>
</tr>
<tr>
<td>Unsharpened wooden spears</td>
<td>2.6 Ma</td>
<td></td>
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<tr>
<td>Sharpened wooden spears</td>
<td>2.0 – 2.6 Ma</td>
<td>400 ka</td>
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<tr>
<td>Fire hardened wooden spears</td>
<td>&gt; 300 ka</td>
<td>125 ka</td>
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<tr>
<td>Stone or bone arrowheads hafted</td>
<td></td>
<td></td>
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<tr>
<td>to wooden spears</td>
<td>&lt; 250 ka</td>
<td>60 ka</td>
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<tr>
<td>Sling</td>
<td>~ 20 ka</td>
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<tr>
<td>Atlatl</td>
<td>&lt; 50 ka</td>
<td>18 ka</td>
</tr>
<tr>
<td>Bow and arrow</td>
<td>&lt; 50 ka</td>
<td>11 – 12 ka</td>
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</table>
**PRIMAL IN THE KITCHEN**

**BISON WILD BURGERS**

- 2 Tbs. extra virgin olive oil
- 1 medium yellow onion, diced
- 1 fennel bulb, fronds removed, cored and diced
- 2 medium tomato, seeded and diced
- 1 1/2 pounds ground bison
- 1 omega 3 egg
- 4 large Bibb or butter lettuce leaves
- 1 large red heirloom tomato, thickly sliced

Preheat oven to broil.

Heat oil in a cast iron skillet over medium flame. Add onion and fennel and sauté for five minutes. Toss in diced tomato and continue to sauté for three minutes. Remove from flame and set aside to cool for ten minutes. Place mixture in food processor and lightly blend until ingredients appear slightly chopped.

Combine bison with egg and mix thoroughly. Add onion mixture to bison and shape into four equal patties. Place patties on wire rack and broil for twenty minutes, turning at the halfway point. Place patties in large Bibb or butter lettuce leaves, and top with tomato slices and the paleo condiments of your choice.

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