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NONCULTURAL MODIFICATIONS TO MAMMALIAN BONES IN SITES OF MASS DEATHS AND SERIAL PREDATION

ABSTRACT: This paper abstracts some patterns that have emerged from taphonomic field studies over the past 10 years documenting the death and post-mortem processes affecting bones of hundreds of large mammals (about 30 different taxa) in southern Africa, north central Canada, and central Australia. Bone densities are high in both mass-death sites and serial predation loci. Appendicular elements are well-represented; trampling by large mammals spiritually fractures many limb-bones (proportions range from 0% to 62% of the total numbers of bones); false cutmarks (micromarks created by noncultural agencies) are present in some assemblages; toodmarking is uncommon at death sites; bone weathering varies widely even within the same site. These site characteristics are similar to those found in archeological and nonarcheological sites from around the world, such as early hominid sites in Africa.

KEY WORDS: Taphonomy — Noncultural Bone Sites — Mass Deaths — Serial Predation.

INTRODUCTION

This paper briefly reports data from several large noncultural bone sites, all of which were created by the forces of nature since 1973 in National Parks or other protected areas where human activities are nonexistent. Details about the sites are available in several publications, and more descriptions are currently in preparation. All of these bone sites are in or adjacent to stream channels or ponds or are located on floodplains. These sites are not represent a deliberate or partial sampling of any region, but rather the actual discoverable occurrences of all such sites in several large study areas. The sites were located through extensive searches on foot, by four-wheel-drive truck, and in light airplanes.

SITE LOCATIONS

In Zimbabwe (south-central Africa) four very large mass-death sites are currently under long-term study. Hundreds of elephants (Loxodonta africana) died en masse at these sites. At a separate site also in Zimbabwe, 40-50 African buffalo (Syncerus caffer) died on masse after falling over a 30 m high cliff above the floodplain of a second-order stream. Related longitudinal studies involve a serial predation site, Ngamo pan in Zimbabwe, where bones of wildebeest (Connochaetes taurinus) and other ungulates are extremely abundant around a permanent water source in wooded savanna. In Botswana one mass death site is under study along the Chobe River, where 200 buffalo had been drowned, and their carcasses pulled from the water by wildlife authorities. In north central Canada, one mass death site has been found on the north shore of Lake Claire in Wood Buffalo National Park, where 3,000 bison (Bison bison) had been drowned in a flood; and one serial predation site is under continuing study in the Hay Camp Prairies, where a territorial pack of wolves (Canis lupus) preys on wild bison. Recent field studies in central Australia are focusing on mass-death sites of wild horses (Equus asinus) affected by severe drought, and cumulative death sites of wild camels (Camelus dromedarius). For details about most of these sites, see Conybeare and Haynes (1984), Haynes (1983,
of bone inventories), while all serial predation sites were only partially sampled, so total bone counts, MNI's, etc., will be much higher in the entire serial predation sites than reported here.

**NUMBER OF BONES**

The mass death sites were created by large numbers of animals dying during a relatively brief interval of time.

Hence, many carcasses were deposited in a restricted land area very quickly. Such an abundance of carcasses resulted in underutilization of each carcass by carnivores (see Haynes 1982 for a discussion of carcass “utilization”).

The serial predation sites resulted from carnivores killing and eating individual animals from relatively unstressed populations over extended periods of time. Thus, in general carcass utilization was expectably full, as opposed to “light” or “heavy”.

The density of bodies ranged from 1 per 2 square meters to 1 per 153 square meters in mass-death sites, and from 1 per 100 to 1 per 125 square meters in serial predation sites. However, spot clusters of bones often approached 50 per m² in carcass loci, separated by several meters from other clusters. Hence, these average numbers do not indicate how extremely dense bone deposits were in certain parts of the sites.

If the land areas surveyed in mass death and serial predation sites are converted to the same sizes, the typical number of bones per surveyed square meter in mass-death sites would be higher than in serial predation sites. Great variation does not allow generalizing rules or laws to be drawn up.

In mass-death sites, the number of individual animals per surveyed square-meter is much higher than in serial predation sites (the range in mass-death sites = minimum density of 1 individual per 1,378 square-meters, maximum of 1 individual per 21 square-meters; in serial predation sites, range = minimum density of 1 individual per 2,571 square-meters, maximum of 1 individual per 760 square-meters). The densest distribution of individual carcasses is found at noncultural sites dominated by elephant or by African buffalo. Figure 3 shows part of one mass-death site in Zimbabwe; in the photograph, three elephants are represented by bones scattered in a area approximately 50 m². In Figure 4, an area about 100 m² contains bones of at least six elephants.

**BONE REPRESENTATION**

The averaged number of surface bones per individual animal ranges from about 21 in a site where lions killed nearly all the animals represented (mainly medium size ungulates), to about 7 in a site where starvation killed all the animals (nearly all are large

FIGURE 1. Locations and types of bonesites under study.

FIGURE 2. African elephants congregating at a wilderness water source, the site of mass die-offs in drought years. Note elephant bones in foreground.

FIGURE 3. Sable antelope (Hippotragus niger) seeking water at the same site shown in Figure 2. Note bones of at least three elephants on the ground.

FIGURE 4. Bones of at least six elephants at another water source in Zimbabwe, Africa. These animals died during severe drought years (1982 - 1983).
herbivores), (Tab. 1). Note that in the sites where scavenging killed the animals, heavy elephant trampling and digging buried many bone elements. Thus, the true number of bones per individual is undoubtedly much higher than the surface inventory indicates. Innominate and skulls are the best-represented elements in both mass-death and serial predation sites in Africa, while in North America sacra and skulls are best represented. Patterns of bone representation in the Australian sites are similar to those in Africa.

Upper limb elements (i.e., scapula, humerus, femur) are better represented than lower limb elements (i.e., radius, ulna, tibia); foot elements are always very poorly represented. Ribs and vertebrae are also not well represented at any cumulative or mass-death site.

**BONE MODIFICATIONS**

Fresh-bone fracturing is very common in mass-bone assemblages, due to trampling especially. In mass-death sites, up to 82% of limb elements are spirally fragmented. The higher proportions are found in sites where elephants died in muske due to drought.

In serial predation sites, prior to trampling by large ungulates, the proportion of spirally fractured limb elements may be as high as 100% for animals weighing up to 450 kg. In some cases, distal limb bones (i.e., metapodials, tibia, radius, ulna) may be completely fragmented even before skin and flesh have been eaten off the thoracic cage and upper limb elements.

Well known trampling incisions were introduced to the literature by Fricke (1884), but were first illustrated by Haynes and Stanford (1984). They were brought to the attention of many paleoanthropologists by Behrensmeyer et al. (1986), Andrews and Cook (1985), and others since then. These fake cutmarks are caused by animals (a) stepping on upper bone surfaces; or (b) pressing the bone’s lower surface on the ground and sliding it over sediment; a third cause is (c) manipulation by animals using the foot – very commonly seen with elephants, which push, position, kick, turn over, or soccer-ball dribble bones.

The marks caused by (a) are generally on ridges or flat surfaces (Figure 5); the marks skip over depressions, and are found as parallel sets or single incisions. Marks caused by (b) are in the same places, but the incisions may follow into depressions; they may be single, parallel, or in several sets (Figure 6). Marks caused by (c) have unusual locations or surfaces. For example, on the back of the skull (Figure 7), or tusk alveoli. They are usually parallel or subparallel.

**TABLE 1. Averaged Numbers of Bones (Including Fragments) per Individual Animal at each Site (latest counts)**

<table>
<thead>
<tr>
<th>Site Name</th>
<th>No. of Bones</th>
<th>MIN (all taxa)</th>
<th>Averaged Representation Averages</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Mass-Deaths)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shibui Main Locus</td>
<td>&gt;1000</td>
<td>43</td>
<td>23 bones/individual</td>
</tr>
<tr>
<td>Shibui Main Basin</td>
<td>49</td>
<td>8</td>
<td>6 bones/individual</td>
</tr>
<tr>
<td>Lembeba Pothole</td>
<td>48</td>
<td>5</td>
<td>10 bones/individual</td>
</tr>
<tr>
<td>N'chimba Main Basin</td>
<td>171</td>
<td>19</td>
<td>9 bones/individual</td>
</tr>
<tr>
<td>Lake Mbae North Shore</td>
<td>440</td>
<td>49</td>
<td>9 bones/individual</td>
</tr>
<tr>
<td>(Cumulative)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hay Camp Prairie</td>
<td>39</td>
<td>5</td>
<td>8 bones/individual</td>
</tr>
<tr>
<td>Nguno South Area</td>
<td>720</td>
<td>35</td>
<td>21 bones/individual</td>
</tr>
</tbody>
</table>

**TABLE 2. Densities of Bones and Individual Animals at the Sites**

<table>
<thead>
<tr>
<th>Site Name</th>
<th>No. of Bones</th>
<th>MIN</th>
<th>Area</th>
<th>Approx. Bone Density</th>
<th>Approx. Density of Individuals</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Mass-Deaths)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shibui Main Locus</td>
<td>&gt;1000</td>
<td>43</td>
<td>150 x 50 m</td>
<td>1 per 7 m²</td>
<td>1 per 174 m²</td>
</tr>
<tr>
<td>Shibui Main Basin</td>
<td>49</td>
<td>8</td>
<td>20 x 20 m</td>
<td>1 per 8 m²</td>
<td>1 per 50 m²</td>
</tr>
<tr>
<td>Lembeba Pothole</td>
<td>48</td>
<td>5</td>
<td>12 x 12 m</td>
<td>1 per 3 m²</td>
<td>1 per 20 m²</td>
</tr>
<tr>
<td>N'chimba Main Basin</td>
<td>171</td>
<td>19</td>
<td>20 x 20 m</td>
<td>1 per 2 m²</td>
<td>1 per 21 m²</td>
</tr>
<tr>
<td>Lake Mbae North Shore</td>
<td>440</td>
<td>49</td>
<td>2.7 km x 20 m</td>
<td>1 per 153 m²</td>
<td>1 per 1578 m²</td>
</tr>
<tr>
<td>(Cumulative)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hay Camp Prairie</td>
<td>39</td>
<td>5</td>
<td>95 x 40 m</td>
<td>1 per 100 m²</td>
<td>1 per 760 m²</td>
</tr>
<tr>
<td>Nguno South Area</td>
<td>720</td>
<td>35</td>
<td>3.0 km x 30 m</td>
<td>1 per 125 m²</td>
<td>1 per 2573 m²</td>
</tr>
</tbody>
</table>

* (note: 1 widely separated specimen left out of count)

**FIGURE 5. Sharply incised trampe-mark on an elephant vertebra, created by animal's hoof sliding over the exposed bone surface.**

**FIGURE 6. Incised elephant rib fragment, marked by being trampled against a silty sand substrate.**

**FIGURE 7. Manipulation marks on the rear of an elephant's skull, created by a curious elephant using its feet.**

Results from scavengers quarrying bones or harvesting nutrients from the defleshed skeletons.

The degree of bone weathering varies widely in any kind of site. For example, I have found differentially weathered *Camelus* phalanges over 2 decades old, in the very arid, hot Australian semi-desert; weathering on one phalanx from a single foot was stage 5, while weathering on another phalanx from the same foot was stage 1 - 2 (Figures 8 - 9). Such differences in weathering of bones from one carcass are extremely common in Africa, as well as in North America. One of the factors differentially affecting bone surface deterioration is fire: during the early rainy season in Zimbabwe, lightning-strikes set off brush fires that burn through bone deposits. Dry bones may be carbonized or scorched, or in other cases may be calcined from high heat. Greasy bones may be selectively burned where the most oil remains, and dried soft tissue may burn or smolder when the rest of the dry bone does not burn. Hence, patches of burnt bone are created on elements that are otherwise little affected. Some patches may be blackened, but the carbonized tissue crumbles away or is blown and washed off in rains or due to animal trampling (Figures 10 and 12). About 2 - 3 years after a grass fire, bones that were lying in the grass may not clearly appear to have been burnt anymore. However, parts of the assemblage may appear to be weathered to stage 5 (Behrensmeyer 1978), while other parts remain in stages 1 or 2.

**FIGURE 8. Two Camelus phalanges from a single animal that died 29 years before the bones were photographed in central Australia. The bone on the left has suffered from weathering far more than the bone on the right.**

**FIGURE 9. View of the proximal articular surfaces of the same two camel phalanges as in Figure 8, showing extreme differences in weathering 25 years after death.**

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Department of National Parks and Wildlife Management; R. Lewis; R. Redhead; G. Masson and the Wardens of Wood Buffalo National Park, Canada. Janis Klimowicz prepared the manuscript. Funding was provided mainly by the National Geographic Society, and also by the National Science Foundation. I thank Dr. H. Ullrich for inviting me to the symposium in Zagreb.

REFERENCES


ACKNOWLEDGEMENTS

I gratefully acknowledge the crucial assistance of the Zimbabwe Department of National Parks and Wildlife Management, and Parks Canada (which has undergone several name changes over the past few years). I thank D. Cumming; R. Martin; A. Conybeare; M. Jones; the Wardens, Rangers, and Scouts of the Zimbabwe