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RESEARCH REPORTS

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Observations Regarding the Cerutti Mastodon

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ABSTRACT

It has been argued that the Cerutti Mastodon site in southern California contains evidence of human activity 130,000 years ago. A brief examination of the materials did not support the claim of cultural artifacts or of bone processed by hominins. The assemblage from the site can be much better explained as a natural deposit, likely disturbed by other mastodons soon after the death of their comrade. Given the brevity of our study, it is important that future studies examine the data, fossils, and lithics to test the initial hypothesis. Additional excavations are also recommended.

KEYWORDS

Cerutti mastodon; peopling of the Americas; Paleoindians; bone tool technology; unknown hominin

1. Introduction

The Cerutti Mastodon (CM) site was discovered in 1991 by paleontological monitors during freeway construction in an area of known fossil deposits near San Diego in southern California. About 50 per cent of the site had previously been destroyed by a housing project, about 25 per cent was excavated between 1992 and 1993, and about 25 per cent remains intact (T. Deméré, personal communication 2017). The excavated portion of the CM site contained the fragmentary remains of a single juvenile mastodon (*Mammut americanum*) found in association with purported stone tools. Two concentrations of bone including molar fragments and fractured femora were found. Each concentration was associated with a stone argued by Holen et al. (2017) to have been an anvil, used to percussively fragment the bones to obtain marrow and/or to remove some of the resulting splinters to another location to modify into bone tools. The site was dated to ca. 130,000 years ago by ^{230}Th/U radiometric analysis and was attributed to the presence of a heretofore unknown species of hominin (Holen et al. 2017, 479).

Following the publication of the Holen et al. (2017) paper, we, like many of our colleagues, followed with interest the lively debate regarding the site. The original interpretation was supported by Boëda, Griggo, and Lahaye (2017) and Gruhn (2018), criticized by Braje et al. (2017), Ferraro et al. (2018), and Haynes (2017a, 2018), and rebutted by Holen et al. (2018a, 2018b, 2018c).

Holen and colleagues' interpretation of the CM site as anthropogenic in origin is based primarily on their supplemental experimental study demonstrating that humans can fracture modern elephant bone in a way that resembles the fracture patterns at the CM site. Human involvement is one possible explanation, but not a necessarily accurate one. A number of other explanations could account for the for the bone breakage patterns at the CM site. This issue of equifinality is a concerning flaw with Holen et al.'s interpretation of the site, and one which we believe necessitates a detailed taphonomic study of the CM bones.

Given our proximity to the site and the collections (located at the San Diego Museum of Natural History), we contacted Dr Thomas A. Deméré at the Museum about examining the material. Two of us (Sutton and Rosen) are California archaeologists (with some 100 years of archaeological experience between us), and one of us (Rosen) had briefly worked at the site during the excavations. The other one of us (Parkinson) is a zooarchaeologist experienced in bone taphonomy, especially as related to hominin use of large mammals, and has worked on faunal remains from hominin sites in East Africa as well as on proboscidean sites in North America for more than 15 years.

We attended a lecture by Dr. Deméré on the CM site sponsored by the San Diego County Archaeological Society in San Diego on 28 November 2017. In that talk, Dr. Deméré bemoaned the lack of independent analysis of the material. We met with Dr. Deméré

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immediately after his lecture and discussed the possibility of examining the site materials. He agreed that such an assessment would be welcome.

We visited the San Diego Museum of Natural History on 9 February 2018 to get an initial look at the site materials in anticipation of further study. We observed some items (purported artifacts, the vertical tusk, and some other bones) that were displayed in exhibit cases and were shown examples of the other faunal remains, including the second tusk, in the storage area of the museum. We discussed with Dr. Deméré the possibility of conducting a detailed and systematic study of the remains, and a research design to guide such a study (requested by Dr Deméré) was subsequently submitted. A few days later, we were told that our study would have to be delayed since the original analysis was not yet complete (despite the fact that conclusions were already published (Holen et al. 2017)). In March 2018, Ruth Gruhn visited the museum, observed the items on display, was shown some of the faunal remains in storage, and published a brief report on her observations (Gruhn 2018). Given the unspecified delay in conducting a detailed study, we report here our observations and thoughts on what we were able to see at the museum during our brief visit.

The purported artifacts, the vertical tusk, and some of the bones were locked in a display case on exhibit, and so we were not able to closely examine or make any detailed measurements. Some of the other bone material in storage was very briefly examined but no detailed measurements or observations were possible. We were not able to examine any of the specimens under magnification. Thus, our impressions of the CM material derive from in-person visual observations and from the descriptions and photographs in Holen et al. (2017).

2. Questions

As we understand it, there are a number of questions regarding the original interpretation of the site. These include: (1) whether the purported artifacts are actually artifacts; (2) the geographic origin of the stone that constitutes the purported artifacts; (3) whether there is any evidence that any bone was broken by humans using the purported artifacts; (4) whether there is any evidence of human modification of the bone; (5) the reason the femoral heads were found together; (6) the reason a tusk was in a vertical position; and (7) the possibility that the breakage of the stone and bone was the result of mechanical damage from construction equipment.

2.1. Artifacts?

Associated with the mastodon skeleton were five stone cobbles reported as artifacts, including two anvils (of andesite) and three hammerstones (one of pegmatite and two of andesite), plus several flakes detached from an anvil or hammerstone. The original interpretation is that the femora were placed on an anvil and struck with a hammerstone, resulting in the breakage of the bone and the detachment of flakes from the anvil due to the force of the impact. Several of the stone flakes were refitted to the anvils.

We did not observe any traits on the anvils that stood out to us as characteristic of artifacts. The flake scars on the cobbles appeared quite rough (although the stones are macrocrystalline). The flakes from the purported anvils would have been detached from the parent rock by percussion, with the hammerstone striking the bone which in turn struck the stone and detached the flakes. As such, none of the flakes would have been purposefully detached to manufacture any type of stone tool and so would not be expected to have any of the characteristics of cultural debitage.

Of note is the lack of unambiguous formal tools at the site. Haynes and Klimowicz (2015, 26) argued that "only the presence of stone artifacts or some other unambiguous feature such as hearths or artwork can be universally applied to many of the simpler proboscidean sites to solidly distinguish human from nonhuman origins." Others (Holen 2006, 2007a, 2007b; also see Johnson 2006, 2007) have argued that even in the absence of stone tools, the presence of spiral fractures, bone-flaking, and impact marks could also be used to determine whether a site was anthropogenic. This latter set of criteria was used for the CM site by Holen et al. (2017).

2.2. Geographic origin of the purported artifact stone material

The purported artifacts are of an igneous stone, the presence of which was suggested to be inconsistent with the low energy sediments of the site (Holen et al. 2017, 479), and so leading to the interpretation that they were brought to the site by humans. There are a number of other possible explanations for the presence of such cobbles at the site, including upslope alluvial fans (Ferraro et al. 2018, E1) or even transport of the stone to the site by mastodons. African elephants have been observed picking up large rocks and logs with their trunks to throw at other individuals during fights (Holdrege 2003, 54). "Tool use" in elephants has not been well studied, but elephants have also been documented modifying branches to use as fly switches and for scratching (Chevalier-Skolnikoff and Liska 1993; Hart et al. 2001). Given that elephants pick up objects in their environment and manipulate them, it is possible that mastodons could have picked up the stones and transported them from a short distance away. Past these possibilities, we cannot add anything to explain the presence of the igneous cobbles at the site; but we would not assume human manipulation as the sole possibility.

2.3. Evidence of bone breakage

The original interpretation (Holen et al. 2017, 479) noted the presence of spiral fractures on the femora. We saw at least one of these bones and did observe what appears to be a spiral fracture, suggesting perimortem breakage. The absence of defleshing marks on the femur suggests the possibility that it had been exposed long enough to skeletonize but not long enough for the marrow to decay and the bone to become brittle. Indeed, in such large animals, the long bones can remain "green" for several years (Haynes 1991). It also seems possible that the animal may have broken its leg during life (e.g., Haynes 1988a), perhaps even contributing to its death.

The bone flakes and notch illustrated by Holen et al. (2017, figure 2) do resemble diagnostic hominin percussion damage. The thin flakes with bulbs of percussion, wide arcuate notches, and incipient flake in the medullary cavity of specimen CM-340 are all features that result from dynamic loading of bone during hard-hammer percussion as described originally by Capaldo and Blumenschine (1994). However, percussion pits that are typically associated with these features (Pickering and Egeland 2006) are notably absent on the CM bones. A number of the bone fragments were found in association with the purported anvils, and it was argued that they were produced by people breaking the femora on the stone anvils using hammerstones. Some of the bone fragments were refitted, supporting their association with the anvils.

2.4. Evidence of human modification of the bone

There appears to be no indication that the mastodon was killed or butchered by humans, and no cut marks have been observed on any of the recovered bones (Holen et al. 2017, 482). This suggests that the mastodon died a natural death and if humans were involved, it would have been as scavengers. Holen et al. (2017, 482) suggested that humans took the femoral shafts and some molars and broke them into fragments, some of which would have been removed to a separate location for later modification into tools. This interpretation would account for the absence of evidence of any actual bone modification and the absence of other cultural indicators of carcass processing, such as stone tools, flakes, or hearths. While we might not expect to find stone tools or butchery marks, we would expect to find hammerstone percussion marking associated with the impact notches on the spirally fractured bones, but this evidence appears to be absent.

Indeed, our examination of a portion of the faunal material found no evidence of bone processing. No cut marks were seen, and no tools that might have been used to modify bone were present. We cannot address whether bone splinters were removed from the site as such a hypothesis would be very difficult to test, perhaps even to the point of being untestable and so invalid.

2.5. Adjacent femoral heads

The discovery of the two detached femoral heads adjacent to one another has been interpreted by Holen et al. (2017, 481) as the result of purposeful placement. The detached femoral heads did not appear broken from our initial examination, but were separated from the femoral shafts because their epiphyses were unfused. In natural settings, unfused long bone epiphyses detach from their metaphyses once the bone is desiccated. A "side by side" spatial patterning of the femoral heads would also be expected given that they are in close proximity in an articulated skeleton. This is not considered diagnostic of hominin activities. In a context such as the CM remains, natural factors are the most parsimonious explanation for the location of the femoral heads.

2.6. A vertical tusk

Another important datum in the original interpretation of the site being archaeological was the presence of a vertical tusk, proposed to have been purposefully placed in the ground by humans (Holen et al. 2017, 481), perhaps to mark the location of the carcass. It does appear to be unusual for a tusk to naturally settle in a vertical position, and it would be common to adopt a cultural interpretation of such features if found in an established archaeological site (e.g., Iakovleva 2015). However, this feature alone does not indicate human intervention because elephants are commonly interested in the skulls and ivory of the carcasses of their family group (McComb, Baker, and Moss 2006; also see Douglas-Hamilton et al. 2006). It is quite plausible that other mastodons may have interacted with the bones, trampling and moving them. Such disturbance would be a more parsimonious explanation of the origin of the tusk position.

2.7. Mechanical damage?

The CM site was discovered when a construction machine hit the top of the vertical tusk, severely damaging its distal tip. Given this obvious mechanical damage, it was suggested by critics (e.g., Haynes 2017a, 196, 2018) that the bones and putative artifacts at the site may have been broken by soil pressure from construction equipment. However, it is clear that surfaces of the bone spiral fracture and the broken surfaces of the purported artifacts are covered in what was described as "pedogenic carbonates" (Holen et al. 2017, supplemental material) that must have formed prior to any mechanical disturbance. In addition, it does not appear that any of the other bones were recently broken. Thus, we see no evidence that the site materials (other than the distal tip of the upright tusk) were broken by construction equipment (also see Gruhn 2018).

3. Discussion

There are several points of disagreement among the various researchers regarding the CM remains. From our brief examination, we agree with Holen et al. (2017) that (1) on the one femur we saw, there is a spiral fracture that suggests the bone was broken while "green"; and (2) other than the broken distal tip of the vertical tusk, there is no evidence of mechanical damage on any of the bones or stones (also see Gruhn 2018). We are not able to add any further insight on the origin of the exotic stones at the site. While the presence of fractured bone and stone is clear, the mechanism(s) through which those items were broken is ambiguous at best and remains at the heart of the pro and con arguments for hominin involvement.

Holen et al. (2017, 480) ruled out trampling contemporaneous with the death of the animal or imminent burial as a fracture agent, arguing that if the remains were trampled, one would expect that smaller bones would be more extensively broken. However, based on personal observation (by Parkinson) on modern bone assemblages of larger mammals in East Africa, trampling damage varies based on the duration and number of animals involved in the trampling. If an assemblage is not heavily trampled, trampling damage may be found on only a small subset of bones regardless of bone size. Trampling resulting in the differential breaking of "smaller bones" has not been demonstrated experimentally so far as we know. Theoretical modeling suggests bone shape (disc, sphere, blade, rod), along with the substrate, will exert a tremendous influence on whether or not a particular bone is fractured by post-depositional processes such as trampling (Darwent and Lyman 2002).

3.1. Earliest bone tools?

If an unknown species of hominin at the CM site was processing bone for tool use at 130,000 years ago as suggested by Holen et al. (2017), this would be the earliest occurrence of bone as a raw material in the archaeological record. The earliest standardized bone tool technology is found in Africa in the Middle Stone Age at approximately 75,000 years ago (d'Errico and Henshilwood 2007; Henshilwood et al. 2001; Yellen et al. 1995). Bone technology became widespread in Europe following the arrival of anatomically modern humans approximately 40,000 years ago. Examples of bone tools are found in Châtelperronian assemblages in Europe and are attributed to Neanderthals, but it is debated whether Neanderthals made these assemblages. The late date of these assemblages suggests this technology could have been transmitted to Neanderthals from Upper Paleolithic modern humans (Soressi et al. 2013). Although some very early evidence suggests opportunistic use of bones as tools at sites in South Africa (d'Errico and Backwell 2009), the majority of archaeological evidence suggests the use of worked bone technology is a behavior associated with modern *Homo sapiens*.

3.2. Which hominin species would have been present?

Which species of *Homo* might have been in the New World at 130,000 years ago? Holen et al. (2017, 482) proposed an unidentified species of *Homo*. The dating suggests it must have been either *H. erectus*, Neanderthals, Denisovans, or archaic *H. sapiens*. However, there is no evidence in the archaeological record that any of these species used bone technology, apart from Neanderthals (but Neanderthal use of bone raw material postdates the CM site by nearly 90,000 years). Secondly, if hominins were processing the Cerutti Mastodon for marrow, the archaeological traces widely recognized as evidence of bone marrow processing are lacking (notably percussion pits with striae). Finally, there is no unequivocal evidence of any human presence in the Americas prior to about 16,000 years ago, despite a number of such claims (e.g., Budinger 2004; Leakey, Simpson, and Clements 1968).

3.3. Equifinality

A major flaw in the argument presented by Holen and colleagues, as noted by Haynes (2017a), Braje et al. (2017), and Ferraro et al. (2018), is the issue of equifinality. Simply because humans *can* cause breakage patterns like those seen at the CM site (as claimed by

Holen et al. (2017), based on experiments) does not mean that humans *did* cause the bone breakage at the site. Holen et al. (2017) have not ruled out, and may not be able to rule out, other agents of bone breakage.

Other ways in which spiral fractures and other bone breakages could occur include mastodons trampling on the carcass, a known elephant behavior (Haynes 1991; McComb, Baker, and Moss 2006; also see Douglas-Hamilton et al. 2006). Haynes (1983) has documented spirally fractured bones resulting from trampling and dust wallowing in modern free-ranging bison and moose. Myers, Voorhies, and Corner (1980) demonstrated over three decades ago that green-bone breakage alone is not a reliable indicator of human activity, as several Miocene and Pliocene paleontological localities in North America clearly predating human arrival show evidence of spiral fracturing on large mammal bones likely due to trampling. Other proboscidean sites in the Americas with no evidence of human involvement also contain spirally fractured bone, including the 11,600-year-old Java Mastodon site, New York (Hodgson et al. 2008), the 24,000-year-old Inglewood Mammoth Site, Maryland (Haynes 2017b), and the ca. 60,000-year-old Waco Mammoth site (Ferraro et al. 2018).

Another possibility, even in the absence of observable tooth marks, is that the bones were broken by a large carnivore such as a short-faced bear (*Arctodus* spp.; e.g., Voorhies and Corner 1986). Haynes (1983) argued that *Arctodos* "could have levered off shaft fragments of bones in an effort to get at marrow inside long bones and created flakes or flakelike spalls that lacked tooth marks." This is a possibility, although unlikely given the amount of effort a carnivore would have had to exert to break large proboscidean bones. Lyman (1984) documented that even volcanic eruptions can produce spiral fractures. Finally, it is possible that such a fracture could have occurred post-fossilization, as it appears that fossil proboscidean bone can sustain "green bone" spiral fractures (Haynes 2017b; also see Wiest, Esker, and Driese 2016). Given that multiple mechanisms can produce spirally fractured bone, the spirally fractured bone present at the CM site is not particularly unexpected and does not conclusively and unequivocally demonstrate anthropogenic origin.

Holen et al. (2017, 480) argued that some linear striations on the bones were the result of scraping across an anvil. These striae are more likely the result of trampling. During our brief examination of the CM bones, we observed bone surface features that did resemble trampling damage, although a detailed microscopic examination, which we were not given permission to do, would be necessary to identify these marks more confidently. Holen et al.'s photo of these marks (2017, extended data figure 4 h) is insufficient to demonstrate they are anvil striations, and their discussion does not rule out other taphonomic agents that can produce such linear striations (trampling, carnivore gnawing, rodent gnawing, and root etching, to name a few). The criteria necessary to confidently identify linear striations/abrasions on bone produced by various agents have been discussed at length in the literature, particularly as they pertain to distinguishing hominin-produced butchery marks from other marks (e.g., Andrews and Cook 1985; Behrensmeyer, Gordon, and Yanagi 1986, 1989; Courtenay et al. 2018; Domínguez-Rodrigo et al. 2009, 2010; Fiorillo 1989; Marin-Monfort, Suñer, and Fernández-Jalvo 2018; Olsen and Shipman 1988; Pante et al. 2017). In order to accept Holen et al.'s identification of these marks as anvil marks, they would need to present a more detailed analysis rather than a superficial identification. Until a detailed analysis is produced, the most parsimonious interpretation of these marks is that they resulted from trampling. Also of note is that the sedimentary context of the mastodon bones was sandy silt, samples of which we observed during our visit to the museum. This is a sedimentary context where trampling marks would likely occur if the remains were trampled (Fiorillo 1984). Further, Haynes (1988b) documented spirally fractured bone and trampling marks as a common occurrence at modern elephant death sites and has argued that these modifications are virtually indistinguishable from culturally modified proboscidean bone.

The archaeological criteria typically required to demonstrate that a site is anthropogenic have traditionally included: (1) the presence of unambiguous formal tools, (2) clear association of tools and faunal remains, and (3) unquestionable evidence of human modification of faunal remains. These criteria have been around for a long time. They were described by William H. Holmes (1893, 1897) and reiterated by Hrdlička et al. (1912), and are often restated when these types of controversial sites come under scrutiny. At sites in East Africa where human involvement with large mammal carcasses is suggested, the standard for acceptance is significantly higher and includes unequivocal, shaped stone tools, and butchery or percussion marks for an assemblage to be recognized as culturally modified (e.g., Domínguez-Rodrigo, Barba, and Egeland 2007). This type of evidence, which is known to be associated with hominin butchery sites going back nearly two million years, is lacking at the CM site. What we do not know is whether other ancient processes, such as trampling, could have caused the bones to spirally fracture, or what other processes may have created what Holen and colleagues interpret as anvil damage. Trampling by proboscideans is a more logical explanation than postulating an unknown hominin in the Americas without any other solid archaeological indications.

4. Conclusion

In sum, we see no evidence that would lead us to believe the assemblage from the CM site could not be much better explained as a natural deposit, likely disturbed by other mastodons soon after the death of their comrade. Postulating a heretofore unknown North American hominin using a never-described bone technology at 130,000 years ago – 110,000 years before currently accepted dates of humans arriving in the New World – is difficult to accept given the data so far presented from the CM site. What is needed now is for others to have access and to examine the data, fossils, and lithics to test the initial hypothesis and that additional excavations be conducted.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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Jennifer Parkinson is a zooarchaeologist and paleoanthropologist interested in the archaeological record related to human diet and evolution. Specifically, her work has examined the importance of meat in the diet of early genus *Homo* and taphonomic evidence related to butchery. She has over 15 years of experience conducting fieldwork on early hominin sites in East Africa and has conducted extensive experimental modeling of carnivore and hominin bone surface damage. She is currently an Assistant Professor of Anthropology at the University of San Diego, and also a Research Associate at the Smithsonian's National Museum of Natural History. She has previously held a postdoctoral fellowship in the Department of Cell Biology and Anatomy at the University of South Carolina School of Medicine.

Martin D. Rosen earned his M.A. in Anthropology from UCLA in 1977. He worked as a CRM consultant before and after a 30-year stint as an archaeologist for the California Department of Transportation (Caltrans). His primary areas of research have focused on Southern California prehistory, hominin evolution, and peopling of the New World. He has published on faunal and lithic analyses, and shell bead manufacturing, trade, and exchange. He currently serves on the Boards of two local museums in San Diego, where he lives with his wife in a historically designated 1921 Craftsman Bungalow.

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