Revised taphonomic perspective on African Plio–Pleistocene fauna

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A recent article in PNAS by Sahle et al. (1) entitled “Hominid butchers and biting crocodiles in the African Plio–Pleistocene” is an important contribution to our theoretical and methodological approaches to human origins research. It emphasizes the problem of equifinality in prehistoric studies (different agencies producing the same or similar results or end products), cutmarks from stone tools and toothmarks from crocodiles on fossil bones in this case.

The pioneering taphonomic work of Brain (2, 3) in South Africa was a brilliant combination of experimental work, such as feeding carcasses and bones to carnivores (hyaena and leopard) and rodents (porcupine); actualistic studies examining animal bone remains of Hottentot settlements (modified by humans and their dogs); and examination of fossil bone assemblages from paleoanthropological fossil sites (Swartkrans, Sterkfontein, Makapan, and Kromdraai). This has set a methodological standard for paleoanthropologists to strive for and refine.

In the mid-1980s, Tim White and I undertook a world survey of bone surface modification of hominid fossils from Africa, Europe, and Asia to evaluate evidence of possible hominid aggression and/or cannibalism. We encountered a myriad of marks on hominid bones that appeared to include those produced by carnivore toothmarks, stone tool cutmarks, rodent gnaw-marks; “random striae” (marks with little patterning that suggested modification from trampling/sediment abrasion); and postfossilization modification of bone from excavation, preparation, and the use of measuring tools (e.g., metal calipers and craniometers). This was well before any major appreciation of the potential role that crocodile predation and feeding could have on bones. We did suggest, however, a possible equivalence between toothmarks produced by mammalian carnivores and those that could be produced by teeth of hominids themselves (4).

An Appreciation of Crocodile Modification

The pioneering work of Njau (5–7) in feeding carcasses and bones to crocodiles and examining the patterns of modification that they produce (toothmark striations and pits, as well as breakage patterns) and comparing these patterns with assemblages of fossil bone from sites at Olduvai Gorge, Tanzania, has revolutionized our interpretation of marks on fossil bones. We now realize that besides mammalian carnivore modification of bones, we need to appreciate the possible modification of bones by crocodilian carnivores as well (in contexts where crocodiles or alligators were present), and that these carnivorous reptiles could produce marks that might be misinterpreted as marks left by stone tools.

Sahle et al. (1) acknowledge that fossil bones from the Middle Awash of Ethiopia (Asa Issie, ca. 4.2 Ma; Maka, ca. 3.4 Ma; and Bouri, ca. 2.5 Ma) bear marks on their surface consistent with crocodile toothmarks, and that some of the Bouri specimens’ marks originally interpreted as stone tool cutmarks (in the absence of in situ stone artifacts) are now are interpreted as the product of crocodile modification. This realization that crocodiles can produce marks on bone surfaces that mimic those produced by the sharp edges of stone tools has been a major game changer in zooarchaeological studies of African Plio–Pleistocene sites.

Some researchers have suggested that the marks on fossil bones from Dikika, Ethiopia, ca. 3.3 Ma (8), are not, in fact, marks produced by stone tool-using hominids (again, a locality with no in situ stone artifacts) but, rather, marks produced by trampling (9). In recent research, Pante et al. (10, 11), using advanced 3D microscopy, have claimed that quantitative data produced by this technique can discriminate between stone tool cutmarks, mammalian carnivore toothmarks, and crocodile toothmarks at a 98% confidence level, and have proposed that the Dikika marks are crocodile modification.

The 3.3 million-year-old flaked stone artifacts reported from Lomekwi, Kenya (12), have also come under question, as to whether these artifacts are truly in situ (9). This is critical to substantiate, as would be this the only site greater than 2.6 Ma, presumably at an australopithecine-grade stage of evolution. In my opinion, one cannot use the possible evidence of flaked stone artifacts at Lomekwi to argue that the marks on the Dikika bones were produced by stone tool-using hominids or vice versa; they are independent circumstances with independent sets of...
Evidence. There is no a priori reason why hominids older than 3 Ma could not have made flaked stone artifacts, however. Studies teaching bonobos (“pygmy chimpanzees,” Pan paniscus) to make stone tools have demonstrated that these African apes have the cognitive and biomechanical capabilities to produce flaked stone tools by employing stone-on-stone percussion and to use the sharp stone flakes produced for cutting activities (13, 14). It is likely that any ape or early hominid with a cranial capacity of 400 cm or larger had such capabilities to make stone tools.

Interestingly, even in the case of a large Oldowan faunal assemblage with well-preserved bone (the FLK “Zinjanthropus” site in Bed I, Olduvai Gorge, Tanzania, ca. 1.84 Ma), there can be a wide range of interpretations pertaining to early hominin procurement and modification of animal carcasses, from a perspective of scavenging the remains left by other predators (15–17) to the early-access procurement of complete or nearly complete animal carcasses by confrontational scavenging or hunting (18, 19). Interestingly, with the exception of the FLK “Zinj” site, it has been reported that other Olduval Bed I sites with the association of stone artifacts with well-preserved faunal remains, including DK at the base of Upper Bed I, ca. 1.85 Ma, have little or no evidence of hominin accumulation and modification (19).

**Future Priorities**

Now that we have a much greater appreciation of the potential contribution of crocodiles to the taphonomy of fossil faunal assemblages, I would suggest the following priorities for paleoanthropologists in the future:

i) As Sahle et al. (1) suggest, many more large-scale excavations of Plio–Pleistocene fossil-bearing sites with excellent faunal preservation, ideally in a fine-grained sedimentary context and with a large sample of fossil fauna, to increase our sample sizes for analysis

ii) More actualistic studies (experimental and observational) of bone modification by carnivorous mammals [e.g., from a striped hyena den (20)], carnivorous reptiles, birds of prey, and rodents, as well as more experimental work on bone modification from the use of stone tools

iii) Development of more refined analytical techniques (especially microscopic ones) to better differentiate between marks made by different agencies

iv) Open sharing of high-resolution cast replicas of prehistoric and experimental marks on bones to serve as reference collections

v) Rigorous blind testing by zooarchaeologists using modified bones of known agencies

vi) Analysis of well-excavated paleontological assemblages in contexts that preclude hominid involvement [e.g., the Miocene of North America (21)] to see if there might be any “false positives” of fossil bone surface modification or breakage patterns that might be misinterpreted as being the result of stone tool-using hominids.

All of us in paleoanthropology are working toward the same goal: to accurately identify biological, behavioral, adaptive, and ecological patterns that emerged during the course of human evolution, and to try to evaluate the driving forces of these patterns. The appreciation that crocodiles could be major players in the modification of fossil faunal remains is another step in this direction.

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