

Tool-marked bones from before the Oldowan change the paradigm

Domínguez-Rodrigo et al. (1) critiqued our paper (2), which provided the earliest evidence for stone tool use and animal tissue consumption as evidenced by bones bearing tool-induced marks found at DIK-55 (Dikika, Ethiopia) and dated to 3.39 Ma. Applying a configurational approach, they questioned the bones' context and without examining or conducting new analysis on the original fossils, argued that all of the Dikika marks resulted from trampling, because a small subset of these marks superficially resembled a small subset of experimentally trampled specimens. Furthermore, they argued (1) that stone tool use and meat consumption before the current consensus dates requires finding manufactured stone tools in situ at the same or similarly dated localities as the tool-marked bones. Also, in their view, the modified bones should be found in situ and completely without additional marks that could fall within the variation of non-stone tool-inflicted marks. If these conditions are not met, they argued that marks that would otherwise be interpreted as stone tool-inflicted (e.g., DIK-55—two marks, A1 and A2) must also be rejected.

We identified the provenience of the bones as a 1.5-m-thick sand layer from a well-documented and dated stratigraphic section that is older than 3.24 Ma, compared them with experimental collections and the published literature, submitted the marks to independent blind tests, used secondary electron imaging and energy dispersive X-ray spectrometry to show the antiquity of the marks and the presence of a stone chip embedded in a mark, and published state of the art documentation, including ESEM micrographs (2). Despite a sample of hundreds of experimentally produced trample marks, Domínguez-Rodrigo et al. (1) were unable to produce a single case that remotely resembles the deep V-shaped, long, parallel marks of DIK-55-2-A1 and -A2. The best interpretation is still that these marks were stone tool-inflicted (1).

The challenge here is for paleoanthropologists to break from the current paradigm in which stone tool use before stone tool manufacture is considered surprising. Our nearest primate relatives both consume meat and use tools (3), and *Australopithecus*

afarensis had the necessary manual dexterity to manipulate tools (4). It is unknown how frequent tool use may have been, but if hominins initially used tools other than intentionally flaked stone, then discovering this will require new field methods that conduct intensive surface modification analysis of all fragments. Furthermore, even in the period from 2.5 to 2.0 Ma, there are still only a few claimed stone tool-modified bones (5), nearly all are surface finds, their marks are not as well-documented as the Dikika marks, and their stratigraphic control is similar or inferior to that of the DIK-55 bones. Domínguez-Rodrigo et al. (1) agreed that DIK-55-2-A1 and -A2 would likely be accepted as genuine cut marks in a less contentious context, but we think that it is the paradigm, not the evidence, that makes the context contentious. It is time to consider a new paradigm and test new hypotheses in which stone tool use and meat consumption predate stone tool manufacture.

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1. Domínguez-Rodrigo M, Pickering TR, Bunn HT (2010) Configurational approach to identifying the earliest hominin butchers. *Proc Natl Acad Sci USA* 107:20929–20934.
2. McPherron SP, et al. (2010) Evidence for stone-tool-assisted consumption of animal tissues before 3.39 million years ago at Dikika, Ethiopia. *Nature* 466:857–860.
3. Pruett JD, Bertolani P (2007) Savanna chimpanzees, Pan troglodytes verus, hunt with tools. *Curr Biol* 17:412–417.
4. Marzke MW (1997) Precision grips, hand morphology, and tools. *Am J Phys Anthropol* 102:91–110.
5. Braun DR, et al. (2010) Early hominin diet included diverse terrestrial and aquatic animals 1.95 Ma in East Turkana, Kenya. *Proc Natl Acad Sci USA* 107:10002–10007.

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