Comment

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No country for old archaeology

Along came primate archaeology. At its inception, it targeted lithic technology, debunking myths about the exclusive 'hominin country club' that accepted only members of our clade as makers of archaeological records. Because of it we learned that non-humans leave behind assemblages that last thousands of years (Mercader et al. 2007; Falótico et al. 2019) and realised there is intra- and inter-species variability in tools used for the same functions by contemporaneous communities of non-human primates (Carvalho et al. 2008; Luncz et al. 2019). We found that unintentional by-products of stone-tool use by monkeys can mimic Oldowan morphotypes (Proffitt et al. 2016). Meanwhile, surveys commenced in older deposits and we discovered that archaeology is older than the Oldowan and that *Homo* is most certainly not the first toolmaker (McPherron et al. 2010, Harmand et al. 2015, but see Carvalho and Beardmore-Herd 2019 for a review).

These discoveries were far-reaching, but the study by Pascual-Garrido and Almeida-Warren remind us that we have barely scratched the surface of primate archaeology's potential. Moreover, their work highlights how we overlooked what most likely was the majority of the hominin toolkit, thus missing the opportunity to understand behaviours that may depict a more complex scenario of our technological evolution. Perishable materials usually do not endure for as long as lithics do (but see Wadley et al. 2020, Pante et al. 2020). After all, we cannot find the Older-than-the-Oldowan until we survey deposits older than 2.6 Ma, and to find organic tools, we must search for them – both in the present and in the past.

The authors' 'archaeology of the perishable' shows that three communities (Mahale, Issa, Gombe) of the same sub-species of *Pan troglodytes*, ranging in different ecological settings, transport and re-use selected organic raw materials, exploiting resources near the tool-use sites, albeit with differences at the most open site, Issa. Even more interesting are the plant removals at the source-sites, which scarify and remain detectable. And, the further you move away from the site, the fewer plant removals found. So, number of removals could be used as an indicator of the distance from tool-source to tool-site. In reality, termite mounds can fossilize (Darlington 2005) and so could some of the more robust, woody vegetal sources from which these removals occur. Hence, if removal patterns are carefully recorded and the neo-taphonomy understood, it may be possible to identify this sourcing and transport in the fossil record.

Meanwhile, as the authors' work reveals, there are important insights about behavioural evolution and technology – as well as some cautionary tales - from observing our closest living relatives using perishable tools to fish for insects. For example, the work presented reaffirms the importance of considering the ecology of culture (as per Koops et al. 2014). At Issa, the most open of the three sites, the lower-density of resources may be altering the cost-benefit balance of this type of tool-use, and hence influencing how far and how often tools get transported. Why carry raw materials long distances if they are widely available? How do we truly know hominin tool transport distances, if we are in the dark about non-lithic technology, and assume transport occurred in a single journey, instead of numerous short bouts? This piece

prompts us to think of the importance of not using a 'one size fits all' when considering transport distances to infer species cognitive skills or complexity, especially if we are inferring skills from the absence of evidence.

Consider the example of the Bossou chimpanzees that use 22 different tool-types, with only one being lithic tool-use (Matsuzawa et al. 2011). At a forest location where stone tool use is customary, 1200 hours of footage were collected over 30 years during *the peak of tool-use season*: it contains an individual average of 7.8% stone tool use time. Now, imagine carrying out an archaeological excavation of Bossou that only recovered lithic records and thus having less than 7.8% of the species' activity budget to consider when reconstructing the group lifeways. You would never know about the pestle pound, ant dip, algae scoop, etc., or the optimisation of resource-use that might include transporting one stone one hundred times over several years. What could this say about technological complexity, foresight and strategies of exploitation of resources? One cannot assume a species' ability from studying *one mode of tool use* or, better said, one cannot *compare skill* based on comparing hominin lithics vs. non-hominin lithics. Only a holistic understanding of overall optimal foraging strategies can unveil such evolutionary pathways.

This piece carves a path that deserves further work. In the absence of early perishable archaeological records, deeper archaeological knowledge of the technological elements of modern species repertoires is fundamental. If we are to find earlier organic records, we must know first how to identify them, how such sites form, what features may last, and develop the analytical methods that will take us further than what we are classically trained to do. There are reasons for hope with the archaeology of the perishable. Just as with termite fishing, other chimpanzee behaviours hold potential for expanding investigations, e.g. tortoise smashing (Pika et al. 2019), crab-processing (Koops et al. 2019), tree-drumming (Babiszewska et al. 2015), accumulative stone throwing (Kühl et al. 2016) or bark peeling (Lapuente et al. 2020).

Notably, in an era in which analysing mega-data sets at the computer is commended, this piece speaks to the importance of carrying out systematic, robust field work. The comparison between the three chimpanzee communities entailed remarkable efforts – and would not be possible to attain using camera traps! We need more empirical studies that bring back natural history. It is urgent to look at technological and cultural evolution in broader taxonomic and ecological contexts, especially in highly-endangered species and populations. Finally, to investigate technological evolution we need to make use of… evolution. Not linear, not deterministic, but evolution in a mosaic fashion. The work by these archaeologists of the perishable is helping us to step away from the lithic-mania and allowing the mosaic to take shape.

References cited:

Babiszewska, Magdalena; Schel, Anne Marijke; Wilke, Claudia; Slocombe, Katie E. (2015), Social, contextual, and individual factors affecting the occurrence and acoustic structure of drumming bouts in wild chimpanzees *(Pan troglodytes)*. American Journal of Physical Anthropology, 156: 125-134. doi:10.1002/ajpa.22634

Carvalho, Susana, Eugenia Cunha, Claudio Sousa, and Tetsuro Matsuzawa. 2008. *Chaine operatoires* and resource strategies in chimpanzee nut-cracking (*Pan troglodytes*). *Journal of Human Evolution* 55:148-163.

Carvalho, Susana, and Megan Beardmore-Herd. 2019. Technological origins: Primate Perspectives and Early Hominin tool use in Africa. In *Oxford Research Encyclopedia of African History*. Thomas Spear, ed. Oxford: Oxford University Press.

Darlington, Jo P. E. C. 2005. Distinctive fossilised termite nests at Laetoli, Tanzania. *Insectes Sociaux* 52(4):408–409.

Falotico, Tiago, Tomos Proffitt, Eduardo B. Ottoni, Richard A. Staff, and Michael Haslam. 2019. Three thousand years of wild capuchin stone tool use. *Nature Ecology and Evolution* 3 (7): 1034-1038. https://doi.org/10.1038/s41559-019-0904-4.

Koops, Kathelijne, Wrangham, Richard W., Cumberlidge, Neil, Fitzgerald, Maegan A., L. van Leeuwen, Kelly, Rothman, Jessica M., Matsuzawa, Tetsuro. 2019. Crab-fishing by chimpanzees in the Nimba Mountains, Guinea, *Journal of Human Evolution* 133: 230-241.

Koops, Kathelijne, Visalberghi, Elisabetta, and van Schaik, Carel P.. 2014. The ecology of primate material culture. *Biology Letters* 10: 20140508.

Kühl, Hjalmar S., Kalan, Ammie K., Arandjelovic, Mimi, Aubert, Floris, D'Auvergne, Lucy, Goedmakers, Annemarie, Jones, Sorrel, Kehoe, Laura, Regnaut, Sebastien, Tickle, Alexander, Ton, Els, Schijndel, Joost van, Abwe, Ekwoge E., Angedakin, Samuel, Agbor, Anthony, Ayuk, Ayimisin, Emmanuel, Bailey, Emma, Bessone, Mattia, Bonnet Matthieu, Brazolla, Gregory, Ebua, Buh, Valentine, Chancellor, Rebecca, Cipolett, Chloe, Cohen, Heather, Corogenes, Katherine, Coupland, Charlotte, Curran, Bryan, Deschner, Tobias, Dierks, Karsten, Dieguez, Paula, Dilambaka ,Emmanuel, Diotoh, Orume, Dowd, Dervla, Dunn, Andrew, Eshuis, Henk, Fernandez, Rumen, Ginath, Yisa, Hart, John, Hedwig, Daniela, Heegde, Martijn Ter, Hicks, Thurston Cleveland, Imong, Inaoyom, Jeffery, Kathryn J., Junker, Jessica, Kadam ,Parag, Kambi Mohamed, Kienast, Ivonne, Kujirakwinja, Deo, Langergraber, Kevin, Lapeyre, Vincent, Lapuente, Juan, Lee, Kevin, Leinert, Vera, Meier, Amelia, Maretti, Giovanna, Marrocoli, Sergio, Mbi, Tanyi, Julius, Mihindou, Vianet, Moebius, Yasmin, Morgan, David, Morgan, Bethan, Mulindahabi, Felix, Murai, Mizuki, Niyigaba, Protais, Normand, Emma, Ntare, Nicolas, Ormsby, Lucy, Jayne, Piel, Alex, Pruetz, Jill, Rundus, Aaron, Sanz, Crickette, Sommer, Volker, Stewart, Fiona, Tagg, Nikki, Vanleeuwe, Hilde, Vergnes, Virginie, Willie, Jacob, Wittig, Roman M., Zuberbuehler, Klaus & Boesch, Christophe 2016. Chimpanzee accumulative stone throwing. *Science Reports* 6, 22219. https://doi.org/10.1038/srep22219

Juan Lapuente, Mimi Arandjelovic, Hjalmar Kühl, Paula Dieguez, Christophe Boesch & K. Eduard Linsenmair. 2020. *International Journal of Primatology*, 1–27. https://doi.org/10.1007/s10764-020-00152-9

Luncz, Lydia, Gill, Mike, Proffitt, Tomos, Svensson, Magdalena, Kulik, Lars, Malaivijitnond, Suchinda. 2019. Group-specific archaeological signatures of stone tool use in wild macaques. eLife. 8. e46961. 10.7554/elife.46961.

Matsuzawa, Tetsuro., 2011. Field experiments of tool-use. In: Matsuzawa, T., Humle, T., Sugiyama, Y. (Eds.), *The Chimpanzees of Bossou and Nimba*, first ed. Springer Japan, Tokyo, pp. 145–155.

Julio Mercader, Huw Barton, Jason Gillespie, Jack Harris, Steven Kuhn, Robert Tyler, and Christophe Boesch. 2007. 4300-year-old chimpanzee sites and the origins of percussive stone technology. *Proceedings of the National Academy of Sciences of the United States of America* 104, 3043–3048.

Michael Pante, Ignacio de la Torre, Francesco d'Errico, Jackson Njau, Robert Blumenschine. 2020. Bone tools from Beds II–IV, Olduvai Gorge, Tanzania, and implications for the origins and evolution of bone technology, *Journal of Human Evolution* 148. https://doi.org/10.1016/j.jhevol.2020.102885

Proffitt, Tomos, Luncz, Lydia, Falótico, Tiago, Ottoni, Eduardo, Torre, Ignacio and Haslam, Michael. 2016. Wild monkeys flake stone tools. *Nature*. 539. 85-88. 10.1038/nature20112.

Pika, Simone., Klein, Harmonie., Bunel, Sarah, Baas Pauline, Théleste, Erwan and Deschner, Tobias. 2019. Wild chimpanzees *(Pan troglodytes troglodytes*) exploit tortoises *(Kinixys erosa)* via percussive technology. *Science Reports* 9, 7661. https://doi.org/10.1038/s41598-019-43301-8

Wadley, Lynn, Esteban, Irene, De La Peña, Paloma, Wojcieszak, Marine, Stratford, Dominic, Sandra Lennox, D'errico, Francesco, Eugenia Rosso, Daniela, Orange, François, Backwell, Lucinda, Sievers, Christine. 2020. Fire and grass-bedding construction 200 thousand years ago at Border Cave, South Africa. *Science* 369: 863-866.