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SHORT COMMUNICATION

Do chimpanzees (*Pan troglodytes*) use cleavers and anvils to fracture *Treculia africana* fruits? Preliminary data on a new form of percussive technology

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Abstract Wild chimpanzees (*Pan troglodytes*) are renowned for their use of tools in activities ranging from foraging to social interactions. Different populations across Africa vary in their tool use repertoires, giving rise to cultural variation. We report a new type of percussive technology in food processing by chimpanzees in the Nimba Mountains, Guinea: *Treculia* fracturing. Chimpanzees appear to use stone and wooden "cleavers" as tools, as well as stone outcrop "anvils" as substrate to fracture the large and fibrous fruits of *Treculia africana*, a rare but prized food source. This newly described form of percussive technology is distinctive, as the apparent aim is not to extract an embedded food item, as is the case in nut cracking, baobab smashing, or pestle pounding, but rather to reduce a large food item to manageably sized pieces. Furthermore, these preliminary data provide the first evidence of chimpanzees using two types of percussive technology for the same purpose.

Keywords Tool use · Percussive technology · Chimpanzee · Material culture

Introduction

Chimpanzees (*P. troglodytes*) across Africa use tools in various foraging activities, ranging from sticks to dip for army ants to stones to crack open nuts. Tool kits differ remarkably among chimpanzee populations, showing the existence of cultural variation (Whiten et al. 2001). Nut cracking is the best-studied example of percussive technology in chimpanzees and is restricted to West African rainforests (Matsuzawa 1994). Percussive technology can be defined as the application of forceful strikes of one solid body against another as a means to achieve an end (McGrew 2004; Marchant and McGrew 2005). In the case of nut cracking, hammer and anvil are used to crack a hard-shelled nut in order to access the edible kernel within. Nut cracking is an example of extractive tool use, which refers to the tool-assisted removal of a food item from a matrix in which it is embedded or encased (Parker and Gibson 1977). This type of food processing allows the harvesting of otherwise inaccessible resources that can yield substantial nutritional benefits (Guenther and Boesch 1993). Other examples of extractive percussive technology used by chimpanzees are baobab smashing (Marchant and McGrew 2005), *Strychnos* smashing (McGrew et al. 1999) and pestle pounding (Yamakoshi and Sugiyama 1995). However, not all percussive technology used by chimpanzees entails extractive foraging. Here we report evidence which suggests that unhabituated chimpanzees (*P. t. verus*) in the Nimba Mountains (Guinea) use stone and wooden "cleavers," as well as stone "anvils," to fracture the large fruits of *Treculia africana*. At Nimba, these fruits reach volleyball size and weigh up to 8.5 kg. They are densely fibrous and firm, but lack a hard shell or matrix. The large size and dense structure of these fruit spheres may make it difficult to bite into as it exceeds a chimpanzee's maximum gape width. Our findings suggest that the chimpanzees use tools to reduce these food items to manageable bite-sized pieces and thus employ a nonextractive type of percussive technology. This newly discovered food-processing technique may be the first

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evidence of chimpanzees using a pounding tool technology to break down large food items. In addition, our findings provide the first account of wild chimpanzees using two distinct types of percussive technology (movable cleaver vs. nonmovable anvil) to achieve what appears to be the same goal, thereby emphasizing the capacity for behavioral flexibility in chimpanzees.

Methods

Study site

The Nimba Mountains in the southeastern part of the Republic of Guinea, West Africa, are covered by primary evergreen forest and high-altitude grasslands. The Seringbara study site (07.37°N; 08.28°W), on the western side of the Nimba Mountains, comprises about 25 km^2 of steep, forested hills and valleys, with altitudes ranging between approximately 600 and 1,752 m. The climate is characterized by one long rainy season from February to November and a three-month dry season. A permanent research presence at the Seringbara study site was established in 2003. The study community remains largely unhabituated to human observers, although a number of individuals can be regularly observed.

Data collection

During a 12-month study period (January–December 2008), we systematically monitored all known *Treculia africana* (Moraceae) trees ($n = 7$) in the study area on a monthly basis for fruit availability and chimpanzee feeding traces. The *Treculia* trees were located between 870 and 1090 m altitude and had a mean diameter at breast height (DBH) of 84.3 ± 24.7 cm (range 51.5–123.5; $n = 7$). All seven trees bore fruit between January and April, and under two of these trees we found chimpanzee feeding traces on *Treculia* fruits.

Results

On 4 March 2008, we found approximately 1 week old chimpanzee feeding traces, knuckle prints and feces below a *Treculia africana* tree (DBH: 77.6 cm) on one of the main trails in the core of the chimpanzees' home range. It is highly likely that the traces were left behind by chimpanzees and not by humans: chimpanzees at Nimba have been seen to eat *Treculia* fruits (unpublished data), while humans do not. Thus, the apes' feeding remains are reliably recognizable. Furthermore, local people rarely enter deep into the forest and have not been seen at this feeding site. Under the *Treculia* tree we found two tools that appeared to have been used to fracture *Treculia* fruits: a stone cleaver (Fig. 1) and a dead branch ("club"). The stone tool was laterite rock and weighed 1.5 kg (length 17.5 cm, width 13 cm, height 7.5 cm). The dead branch weighed 200 g (length 50 cm, diameter 3.5 cm). Both tools had clear traces of fruit fibers and seeds on the bottom surface (i.e., facing the ground), and the upper surfaces of the associated fruits showed corresponding tool-shaped indentations. These orientations are consistent with the interpretation that the stone and club were used to pound the fruits (i.e., tool use; Beck 1980), rather than the other way around. In addition, two outcropping rocks showed evidence of use as anvils to smash *Treculia* fruits (i.e., substrate use; Boinski et al. 2000), with clear fruit remains and seeds embedded in the exposed tops of the outcrops (anvil 1: length 45 cm, width 25 cm, height 18 cm; anvil 2: length 60 cm, width 50 cm, height 25 cm). Anvil 2 (Fig. 2) was on a chimpanzee trail, 55 m from the *Treculia* tree, and no tools were found within 50 m of the anvil. The other cases of *Treculia* processing took place within a 10 m radius of the tree. The distances between anvil 1 and the two tools were about 5 and 10 m. Anvil 1 lacked a level surface; instead, it had an angular ridge on which a fruit appeared to have been smashed. Thus, the two supposed tools were not close to the anvils, and no evidence was found for the combined use of tools and anvils, as seen in nut cracking. The processed fruits ranged from 12 to 23 cm in diameter, which is typical for *Treculia* fruits at this site (mean = 16.7 ± 2.8; range 10–23; $n = 94$).

Discussion

Treculia fruits are an important food source at several chimpanzee study sites, but evidence has not been found

Fig. 1 Cleaver (*left*) and *Treculia africana* fruit (*right*) about 1 week after fracturing. *Arrow* indicates the tool-shaped indentation on the fruit

Fig. 2 Anvil (*right*) and *Treculia africana* fruit (*left*) about 1 week after fracturing. *Arrow* indicates the location of fruit traces on the anvil

anywhere else of apes using tools to process this plant food (Whiten et al. 2001). This widespread consumption is surprising considering the amount of effort needed to open the fruits when using only the teeth and upper body muscles (Watts 2008). The fact that *Treculia* fruits can be processed both with and without the use of percussive technology makes the use of cleavers and anvils a nonessential but useful form of feeding technology. At Seringbara, not all *Treculia* feeding involves percussive technology, raising the possibility that only the toughest ''hard-to-get'' fruits require tools (Yamakoshi 2001). Alternatively, only young individuals may need to use tools, whereas adults may be able to use their canine teeth. At Yealé (Ivory Coast), on the eastern side of the Nimba range, chimpanzees crack hard-shelled *Strychnos* fruits on stone anvils (Matsuzawa and Yamakoshi 1996), but *Treculia* fracturing has not been found. At Bossou, only 6 km from the Seringbara study site, *Treculia* trees are rare and the chimpanzees have not been seen to eat the fruits of the one *Treculia* tree in their home range (unpublished data). The only other study site where chimpanzees are known to smash *Treculia* fruits is the Taï Forest (Ivory Coast), where they pound fruits on branches or roots (Whiten et al. 2001). However, Taï chimpanzees have not been seen to use tools to fracture *Treculia* fruits, although they commonly use hammers to crack nuts (Boesch and Boesch-Achermann 2000).

The density of *Treculia* trees is low in the Seringbara region, with only one tree per 2 km^2, on average. This amounts to an estimated total of 12 trees in the circa 25 km^2 home range of the chimpanzees. The number of trees bearing fruit during the three-month *Treculia* fruiting season is even lower, since not all *Treculia* trees fruit every year. For example, only four of seven *Treculia* trees monitored in 2008 fruited in early 2009 (unpublished data). In addition, productivity varies greatly between *Treculia* trees, with fruit counts ranging from only 2 to more than 70 fruits per tree (unpublished data). The low density and varying productivity of *Treculia* trees may explain the low number of *Treculia* processing cases observed. Moreover, *Treculia* fruits decompose rapidly and feeding traces are only reliably detectable during a time window of a few weeks.

Surprisingly, chimpanzees at the Seringbara study site do not crack nuts (Humle and Matsuzawa 2004), although the nearby chimpanzees at Bossou are highly dependent on cracking oil palm nuts *(Elaeis guineensis*) for subsistence (Yamakoshi 1998). The absence of nut cracking at Seringbara cannot be explained by a lack of nut-bearing trees, suggesting a lack of nut-cracking knowledge. Thus, it does not appear that one type of percussive technology can be necessarily generalized to another. To investigate further why tool-assisted *Treculia* fracturing occurs at Seringbara, we have to compare the availabilities and properties of *Treculia* fruits, potential fracturing tools and alternative food sources across chimpanzee study sites.

In conclusion, these findings raise interesting questions about the emergence of diverse material cultures in neighboring chimpanzee communities with regard to percussive technology. *Treculia* fracturing with cleaving tools presents a new type of percussive plant food processing, which supports the suggestion that the evolutionary origins of lithic percussive technology may have occurred before the first flaked-stone Oldowan industries at 2.6 Myr, and may be an ancestral trait present in the last common ancestor of living apes and humans (Mercader et al. 2007; Haslam et al. 2009). This is also the first report of two distinct types of percussive technology—i.e., movable stone or wooden "cleavers" and nonmovable stone "anvils"—being used to perform the same task with seemingly the same function. This behavioral flexibility in the use of different percussive food-processing *techniques*, rather than simply different raw materials, may be helpful in alerting us to a variety of alternative interpretations for artifacts when analyzing the earliest records of material culture in hominins (Haslam et al. 2009).

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