

# Stone tool production and utilization by bonobo-chimpanzees (*Pan paniscus*)

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**Using direct percussion, language-competent bonobo-chimpanzees Kanzi and Pan-Banisha produced a significantly wider variety of flint tool types than hitherto reported, and used them task-specifically to break wooden logs or to dig underground for food retrieval. For log breaking, small flakes were rotated drill-like or used as scrapers, whereas thick cortical flakes were used as axes or wedges, leaving consistent wear patterns along the glued slits, the weakest areas of the log. For digging underground, a variety of modified stone tools, as well as unmodified flint nodules, were used as shovels. Such tool production and utilization competencies reported here in *Pan* indicate that present-day *Pan* exhibits *Homo*-like technological competencies.**

hominin | bonobo targeted tool use | stone tool wear pattern | food acquisition | bonobo survival strategy

The ability to produce stone tools and use them successfully across habitats and climates was a major innovation and driving force in early *Homo* adaptability, advancement, and species dispersal (1). *Pan* [bonobo-chimpanzees (*Pan paniscus*) and chimpanzees (*Pan troglodytes*)], which are sister species to the *Homo* genus (2), also use tools (3), for example, hunting with spears (4), digging tubers with sticks (5, 6), and breaking nuts with a stone hammer and anvil (7–9). Here we describe the ability of two language-competent bonobos (10), Kanzi (KZ; male, age 30 y) and Pan-Banisha (PB; female, age 28 y), to produce novel stone tools and effectively use them, supporting the hypothesis that present-day *Pan* exhibit technological competencies formerly assigned only to the *Homo* genus.

In the 1990s, KZ and PB were taught by Toth et al. (11, 12) to knap flint flakes and use their sharp edges to cut rope or leather. Our current work with KZ and PB more than a decade later expands and complements those studies with respect to tool forms manufactured and their specific uses.

## Results

All of the stone tools made by KZ and PB were created solely by direct percussion, with the core held in the left hand and the hammer stone in the right hand (Fig. 1*J*). In previous experiments, the bonobos used various knapping methods (11). Both KZ and PB preferred to work with flint products (Fig. 2); some of their tools are shown in 3D in Figs. 3–5. KZ produced two types of artifacts: thick cortical flakes removed from the core's edge (Figs. 1*A*, *G*, and *K* and 3) and small flakes with sharp edges (Figs. 1*D* and 4). PB made flakes of various sizes, but not core-edge thick flakes (Fig. 5). Our present findings indicate that the stone tools manufactured by the bonobos were subsequently targeted to achieve the experimental missions. Each time KZ or PB picked up a tool for use, it was recorded as one observation.

**Log-Breaking Experiments and Quantification.** In 24 log-breaking sessions, KZ used the following stepwise strategy: (i) hammering the log with large cobble stones; (ii) throwing the log on the cement floor, or aiming rocks at it; (iii) inserting sticks into the glued slits; (iv) making stone tools and using them in drilling, wedging, chopping, scraping, and cutting actions; and (v) using

body weight and limbs to force the log open. Fig. 1*I* shows an open log after food extraction.

KZ processed a total of 24 logs. The 156 tool uses observed during this processing included 13 stick tool insertions, 3 antler strikes, 4 log-on-log strikes, 76 unmodified-stone log hammering (50 hammering log with rocks, 22 stone throwing on log, and 4 throwing log on rock, with precision), and 60 observations of modified stone tool uses (18 uses of chopper-like tools, 22 uses of drill-like tools, 2 uses of scraper-like tools, 10 uses of small flake insertions, and 8 observations of cutting logs). KZ made a total of 23 stone tools, including 5 thick cortical flakes struck from a core's edge (Fig. 3) and 18 smaller flakes with sharp edges (Fig. 4).

In contrast, PB managed to break only two logs, by throwing them on the floor. The 10 observations of PB's tool use in log processing included 1 stick insertion, 8 rock hammering, and 1 use of KZ's drill tool, along with 2 small flint tools that she made but did not use after the first try.

In the aforementioned step iv, KZ used the thick cortical flakes as an axe and wedge (Figs. 1*A*, *B*, *G*, and *H* and 3) and used the small flakes as drills or scrapers (Fig. 4, tools 1–5). Fig. 1*E* and *F* shows the drilling motion and its resulting wear patterns. Of note, KZ's accuracy in specific tool use in log processing is clearly demonstrated by the wear patterns left repeatedly along the glued slit, the weakest area of the log (Fig. 1*C* and *F* and [Movie S1](#)). The various wear patterns left on the logs processed by KZ are shown in Fig. 2 and discussed below.

**Digging Experiments and Quantification.** The digging experiments further exemplify task-specific tool use. We repeatedly observed that both KZ and PB dug according to soil conditions. Digging in soft sand was done with the hands, digging in muddy soil was done with branches, and digging in hard soil was done with stone tools and antlers. Of note, both KZ and PB used unmodified flint nodules for digging; however, KZ also dug with a thick oval flake that he made (Figs. 1*K* and *L* and 3, tool 4), whereas PB used most of the stone tools that she made for this task (Fig. 5 and [Movie S1](#)).

KZ was observed using the following tool types for digging (a total of 13 occasions): one antler, seven branch tools, and five stone tools (two modified and three unmodified). PB used the following tool types for digging (a total of 89 occasions): 6 antler tools, 73 branch tools, and 10 stone tools (1 unmodified) (Fig. 5).

## Discussion

Stone tool uses have evolved separately across taxa; for example, *Neophron* vultures use pebbles to break eggs, *Cariama* seriema birds kill prey by striking them on rocks, and *Cebus* capuchin monkeys use stones as hammers to break nuts on flat rock anvils

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