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RESEARCH NOTE

Leaf sponge tool use by Buraiga chimpanzees, *Pan troglodytes schweinfurthii*, in Kibale National Park, Uganda

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Abstract

Chimpanzees (*Pan troglodytes*) are avid tool users, although tool uses and functions vary among communities. Some chimpanzees use stones or wood in extractive foraging to crack open nuts, whereas others use long stems to consume termites or ants. Leaf sponges are versatile and widespread tools used by chimpanzees, created by crumpling leaves in the mouth and then using the hands to immerse the tool to procure liquids from difficult-to-access locations. Here we describe leaf sponge use by two female chimpanzees in Kibale National Park, Uganda, documenting for the first time tool use in the Buraiga chimpanzee community.

KEYWORDS
Buraiga, extractive foraging, leaf sponge, primatology, tool use

Résumé

Les chimpanzés (*Pan troglodytes*) sont de fervents utilisateurs d'outils, bien que l'utilisation et les fonctions des outils varient d'une communauté à l'autre. Certains chimpanzés utilisent des pierres ou du bois pour la recherche extractive de nourriture afin de casser des noix, tandis que d'autres utilisent de longues tiges pour consommer des termites ou des fourmis. Les éponges de feuilles sont des outils polyvalents et très répandus chez les chimpanzés. Elles sont fabriquées en froissant des feuilles dans la bouche, puis en utilisant les mains pour immerger l'outil afin d'obtenir des liquides dansdes endroits difficilement accessibles. Nous décrivons ici l'utilisation des éponges de feuilles par deux chimpanzés femelles dans le parc national de Kibale, en Ouganda, documentant pour la première fois l'utilisation d'outils dans la communauté des chimpanzés de Buraiga.

1 | INTRODUCTION

Chimpanzees (*Pan troglodytes*) are avid tool users, although tools and functions vary among communities (e.g. Carvalho et al., 2009; Whiten et al., 1999, 2001). Some chimpanzees use stones or wood to open nuts (Carvalho et al., 2009; Sugiyama, 1981; Sugiyama & Koman, 1979), whereas others use stems to consume termites or ants (e.g. Goodall, 1964). One versatile tool is the leaf sponge, where crumpled leaves are immersed in liquid, and the 'sponge' is drained of its contents orally (Goodall, 1964; Whiten et al., 1999,

2001). Leaf sponging is widely documented at sites including Gombe (Goodall, 1964), Mahale (Matsusaka et al., 2006), Taï (Boesch & Boesch, 1990), Bossou (Sugiyama, 1995; Tonooka, 2001), Lopé (Tutin et al., 1995), Tongo (Lanjouw, 2002), Goualougo (Sanz & Morgan, 2007), Budongo (Quiatt & Kiwede, 1994; Reynolds et al., 2015), Ngogo (Watts, 2008), Kanyawara (McGrew, 1994) and Semliki (McGrew et al., 2007). Although leaf sponges are generally used to drink water from tree holes or river beds, Bossou chimpanzees use them to ingest fermented sap from *Raphia hookeri* G.Mann & H.Wendl (Hockings et al., 2015), and in Budongo for mineral acquisition (Reynolds et al., 2015). Here we describe leaf sponging by two female chimpanzees in Kibale National Park (KNP), Uganda, documenting for the first time tool use in the Buraiga chimpanzee community and highlighting an area of important future research.

2 | METHODS

2.1 | Study site

KNP is a 795 km^2 protected area in southwestern Uganda (Figure 1). KNP consists of moist evergreen and semideciduous forest, with seasonally flooded swamps (Struhsaker, 1999). KNP has a tropical climate, with bimodal rainy seasons: March–May and September–November (Uganda Wildlife Authority, 2015).

2.2 | Study subjects and observation methodology

Study subjects belong to the >100 member semi-habituated Buraiga chimpanzee community, from the Kisongi subgroup (hereafter Buraiga-Kisongi; other subgroups include Buraiga-Dura). Undergoing habituation for tourism (Uganda Wildlife Authority, 2015), Buraiga-Kisongi group ranges southwest of Fort Portal-Kamwenge road from KNP's eastern boundary to west of the Dura River (Figure 1). Between July 2019 and March 2020, we conducted 229 observations using continuous focal sampling (902 h), as part of an ongoing study. Individuals were chosen ad libitum due to community-level habituation variation.

3 | RESULTS

On 30 November 2019, from a 10 m distance, we observed an adult female and her juvenile female offspring making and using leaf sponges to drink water from beneath a *Phoenix reclinata* Jacq. We had followed the two individuals for 8 h when they entered a *P. reclinata* Jacq. swamp (see Figure 1). The swamp was partially flooded because the rainy season was ending. Initially, both individuals disappeared under palm fronds, and behavioural observation was impossible. After 4 min, the juvenile emerged, moved 10 m away from her mother, put *P. reclinata* Jacq. leaves into her mouth and returned to her original position. We then observed mother and offspring

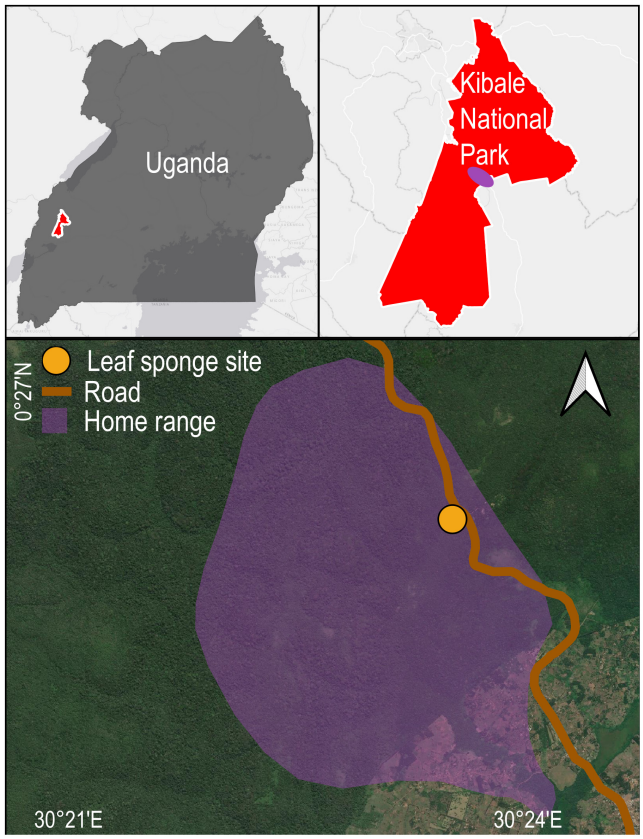

FIGURE 1 Geographic location of study site, with location of leaf sponge manufacture site and use marked by yellow dot, tarmac road indicated by brown line, and approximate Buraiga-Kisongi community home range marked with purple overlay. Map adapted from ESRI basemap imagery.

removing leaf sponges from their mouths, placing them below the *P. reclinata* Jacq. roots, and returning the leaf sponges to their mouths. They continued for 10 min before relocating, retaining the leaf sponges orally. After 30 min, they returned and performed the same activity for 3 min. After each bout, the individuals orally retained their leaf sponges. After they departed the site, we approached the location and found a water-filled hole approximately 20 × 15 cm near the tree's roots where they were dipping the leaf sponges (Figure 2). It is unclear whether the chimpanzees dug the hole, but the hole was not a naturally occurring tree basin, rather a hole in the soil near *P. reclinata* Jacq. roots.

4 | DISCUSSION

This observation is noteworthy in light of variable leaf sponge use among chimpanzee communities. In many sites, chimpanzees use leaf sponges to drink water (Sugiyama, 1995; Whiten et al., 1999), and in Bossou to consume fermented palm sap (Hockings et al., 2015). Chimpanzees in Budongo use sponges made from *Acalphya* L. leaves to ingest clay-rich water containing essential minerals including potassium, phosphorus, calcium, iron, manganese and magnesium,

FIGURE 2 Two female chimpanzees (*Pan troglodytes schweinfurthii*) who were engaged in leaf sponge manufacture and use (a), Location of leaf sponge tool-use (b), Close-up view of hole under date palm tree (*Phoenix reclinata* Jacq.) where leaf sponges were dipped (c). © Wren Edwards.

suggesting that leaf sponges may assist in mineral acquisition/detoxification (Reynolds et al., 2015). Rothman et al. (2006) documented high concentrations of essential sodium in decaying wood and plants from swamps, and Oates (1978) documented that swamps around Kibale contain high levels of sodium, iron, manganese, and zinc. Because our observation occurred in a seasonal swamp with ample decaying wood, chimpanzees possibly used leaf sponges to ingest water containing sodium and other essential minerals. Future work will obtain soil and water samples to test this hypothesis.

If cultural transmission is a primary driver of tool use, one might expect to find a high degree of similarity among chimpanzee communities living in close geographic proximity, with female dispersal potentially facilitating cultural transmission of tool manufacture and use. Hence it is interesting to observe leaf sponge use in the newly habituated Buraiga-Kisongi group, given that extractive foraging is considered rare at nearby Ngogo (Watts, 2008), and undocumented in Kanyantale. Leaf sponge use has been observed among chimpanzees at Kanyawara (McGrew, 1994), offering opportunities to compare fine-grained social and environmental contexts of tool-use across chimpanzee groups at KNP. Fine-scale ecological variation in habitat and resource availability across KNP may result in behavioural variation among neighbouring chimpanzee communities. The Buraiga-Kisongi habitat is heterogeneous with more low-altitude riverine swamps than in nearby Ngogo, Kanyawara, and Kanyantale. Today the Buraiga-Kisongi habitat is largely colonising forest, with primary forest in the west. This reflects land use practices over time, with forest regrowth on land that was formerly home to residents of Mpokya subcounty until the formal designation of KNP in 1991 (Aluma et al., 1989; Van Orsdol, 1986). With an estimated chimpanzee population of >1400 in KNP (Plumptre et al., 2003) and highly variable habitats, our report emphasises that long-term studies in multiple communities of a single population are necessary for documenting chimpanzees' behavioural responses to ecological variation across landscapes and through time.

Importantly, this study documents a juvenile observing her mother engaged in tool use and performing her mother's actions. Tool use transmission has been attributed to the extended period of offspring dependency in chimpanzees, whereby offspring learn many behaviours including tool use from their mothers (Biro et al., 2003; Lonsdorf, 2006; VanLawick-Goodall, 1968). Long term projects have carefully crafted methodologies for describing, documenting, and analysing tool use, defining insightful criteria for inferring knowledge transmission over time by measuring tool use and proficiency across multiple opportunities for offspring learning

(Almeida-Warren et al., 2022; Biro et al., 2003; Lonsdorf, 2006; Whiten et al., 2022). Although our observation is insufficient for this degree of analysis, documenting co-occurring tool use by mother and offspring highlights potential for further research in this area. Although we have observed Buraiga-Kisongi chimpanzees drinking from standing water or rivers on many occasions, this is the first documented case of tool use in Buraiga chimpanzees, and we speculate that perhaps this adult female individual transferred in from a community where leaf sponging occurs more frequently.

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DATA AVAILABILITY STATEMENT

Data are available from the authors upon request.

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REFERENCES

Almeida-Warren, K., Camara, H. D., Matsuzawa, T., & Carvalho, S. (2022). Landscaping the Behavioural ecology of primate stone tool use. *International Journal of Primatology*, *43*(2), 885–912. https://doi.org/10.1007/s10764-022-00305-y

Aluma, J., Drennon, C., Kigula, J., Lawry, S. W., Muwanga-Zake, E. S., & Were, J. (1989). *Settlement in forest reserves, game reserves and national parks in Uganda: A study of social, economic, and tenure factors affecting land use and deforestation in Mabira Forest reserve, Kibale Forest reserve, and Kibale game reserve/corridor*. Madison. https://doi.org/10.4324/9781003232506-9

Biro, D., Inoue-Nakamura, N., Tonooka, R., Yamakoshi, G., Sousa, C., & Matsuzawa, T. (2003). Cultural innovation and transmission of tool use in wild chimpanzees: Evidence from field experiments. *Animal Cognition*, *6*, 213–223.

Boesch, C., & Boesch, H. (1990). Tool use and tool making in wild chimpanzees. *Folia Primatologica*, *54*, 86–99. https://doi.org/10.1159/000156428

Carvalho, S., Biro, D., McGrew, W. C., & Matsuzawa, T. (2009). Tool-composite reuse in wild chimpanzees (pan troglodytes): Archaeologically invisible steps in the technological evolution of early hominins? *Animal Cognition*, *12*(Suppl 1), S103–S114. https://doi.org/10.1007/s10071-009-0271-7

Goodall, J. (1964). Tool-using and aimed throwing in a community of free-living chimpanzees. *Nature*, *201*, 1264–1266.

Hockings, K. J., Bryson-Morrison, N., Carvalho, S., Fujisawa, M., Humle, T., McGrew, W., & Matsuzawa, T. (2015). Tools to tipple: Ethanol ingestion by wild chimpanzees using leaf-sponges. *Royal Society Open Science*, *2*, 150150.

Lanjouw, A. (2002). Behavioural adaptations to water scarcity in Tongo chimpanzees. In C. Boesch, G. Hohmann, & L. F. Marchant (Eds.), *Behavioural diversity in chimpanzees and bonobos* (pp. 52–60). Cambridge University Press.

Lonsdorf, E. V. (2006). What is the role of mothers in the acquisition of termite-fishing behaviors in wild chimpanzees (pan troglodytes schweinfurthii)? *Animal Cognition*, *9*, 36–46. https://doi.org/10.1007/s10071-005-0002-7

Matsusaka, T., Nishie, H., Shimada, M., Kutsukake, N., Zamma, K., Nakamura, M., & Nishida, T. (2006). Tool-use for drinking water by immature chimpanzees of Mahale: Prevalence of an unessential behavior. *Primates*, *47*, 113–122. https://doi.org/10.1007/s10329-005-0158-4

McGrew, W. C. (1994). Tools compared: The materials of culture. In R. W. Wrangham, W. C. Mcgrew, & F. B. de Waal (Eds.), *Chimpanzee Cultures* (Vol. *4*, pp. 25–39). Harvard University Press. https://doi.org/10.2307/3032644

McGrew, W. C., Marchant, L. F., & Hunt, K. D. (2007). Etho-archaeology of manual laterality: Well digging by wild chimpanzees. *Folia Primatologica*, *78*, 240–244. https://doi.org/10.1159/000102319

Oates, J. F. (1978). Water-plant and soil consumption by Guereza monkeys (*Colobus guereza*): A relationship with minerals and toxins in the diet? *Biotropica*, *10*(4), 241–253. https://doi.org/10.2307/2387676

Plumptre, A. J., Cox, D., & Mugume, S. (2003). The status of chimpanzees in Uganda. *Albertine Rift Technical Report Series*, *2*, 9–80.

Quiatt, D., & Kiwede, Z. (1994). Leaf sponge drinking by the Budongo forest chimpanzees. *American Journal of Primatology*, *33*, 236.

Reynolds, V., Lloyd, A. W., English, C. J., Lyons, P., Dodd, H., Hobaiter, C., Newton-Fisher, N., Mullins, C., Lamon, N., Schel, A. M., & Fallon, B. (2015). Mineral acquisition from clay by budongo forest chimpanzees. *PLoS One*, *10*(7), 1–14. https://doi.org/10.1371/journal.pone.0134075

Rothman, J. M., Van Soest, P. J., & Pell, A. N. (2006). Decaying wood is a sodium source for mountain gorillas. *Biology Letters*, *2*, 321–324. https://doi.org/10.1098/rsbl.2006.0480

Sanz, C. M., & Morgan, D. B. (2007). Chimpanzee tool technology in the Goulougo triangle, republic of Congo. *Journal of Human Evolution*, *52*, 420–433.

Struhsaker, T. T. (1999). *Ecology of an African rain Forest: Logging in Kibale and the conflict between conservation and exploitation*. University Press of Florida.

Sugiyama, Y. (1981). Observations on the population dynamics and behavior of wild chimpanzees at Bossou, Guinea, in 1979-1980. *Primates*, *22*(4), 435–444. https://doi.org/10.1007/BF02381236

Sugiyama, Y. (1995). Drinking tools of wild chimpanzees at Bossou. *American Journal of Primatology*, *37*(3), 263–269. https://doi.org/10.1002/ajp.1350370308

Sugiyama, Y., & Koman, J. (1979). Tool-using and -making behavior in wild chimpanzees at Bossou, Guinea. *Primates*, *20*(4), 513–524.

Tonooka, R. (2001). Leaf-folding behavior for drinking water by wild chimpanzees (pan troglodytes verus) at Bossou, Guinea. *Animal Cognition*, *4*(3–4), 325–334. https://doi.org/10.1007/s100710100110

Tutin, C. E. G., Ham, R., & Wrogemann, D. (1995). Tool use by chimpanzees (pan t. troglodytes) in the Lopé reserve, Gabon. *Primates*, *36*, 181–192.

Uganda Wildlife Authority. (2015). *Kibale National Park – General Management Plan (2015–2025)*. https://www.ugandawildlife.org/wildlife-a-conservation-2/researchers-corner/general-management-plans?download=15:kibale_national_park_gmp

Van Orsdol, K. G. (1986). Agricultural encroachment in Uganda's Kibale Forest. *Oryx*, *20*(2), 115–117. https://doi.org/10.1017/S0030605300026363

VanLawick-Goodall, J. (1968). The behaviour of free-living chimpanzees in the Gombe stream reserve. *Animal Behaviour Monographs*, *1*(3), 161–311. https://doi.org/10.1016/S0066-1856(68)80003-2

Watts, D. P. (2008). Tool use by chimpanzees at Ngogo, Kibale National Park, Uganda. *International Journal of Primatology*, *29*, 83–94. https://doi.org/10.1007/s10764-007-9227-4

Whiten, A., Goodall, J., Mcgrew, W. C., Nishida, T., Reynolds, V., Sugiyama, Y., & Boesch, C. (1999). Culture in chimpanzees. *Letters to Nature*, *399*, 682–685.

Whiten, A., Goodall, J., McGrew, W. C., Nishida, T., Reynolds, V., Sugiyama, Y., & Boesch, C. (2001). Charting cultural variation in chimpanzees. *Behaviour*, *138*, 1481–1516. https://doi.org/10.1163/156853901317367717

Whiten, A., Harrison, R. A., McGuigan, N., Vale, G. L., & Watson, S. K. (2022). Collective knowledge and the dynamics of culture in chimpanzees. *Philosophical Transactions of the Royal Society, B: Biological Sciences*, *377*, 20200321. https://doi.org/10.1098/rstb.2020.0321

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