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NEWS AND PERSPECTIVES

Pestle-pounding and nut-cracking by wild chimpanzees at Kpala, Liberia

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Abstract Bossou in Guinea is one of the longitudinal study sites of wild chimpanzees, and is located only a few kilometers away from the national border between Guinea and Liberia. The forests in the area spread over the national border of Guinea, and the Bossou chimpanzees have been found to use the neighboring Liberian forest. Local assistants and I started surveying these forests in Liberia, and found that additional groups of chimpanzees lived in Nimba County, Liberia. The present study reports tool use behaviors by chimpanzees living in forests of the Kpala area in Nimba County. We directly observed pestle-pounding behavior, which had been confirmed only in the Bossou group of wild chimpanzees. Moreover, we heard sounds of nut-cracking, and successfully filmed chimpanzees cracking open oil palm nuts with stones. The uniqueness of stone-tool use behaviors has been emphasized with the group of chimpanzees that have been longitudinally studied at Bossou, but the behaviors probably have a wide distribution in this area. Emigrant chimpanzees are thought to contribute to the propagation of the cultural tool-use behaviors. It is also thought that, if the distantly located groups share similar cultural behaviors, there might be genetic exchange between them. Conservation efforts should be needed not only at Bossou, but also in a wider area including nonprotected forests beyond the national border.

Keywords Chimpanzee · Culture · Tool use · Oil palm · Nonprotected areas · Liberia · Bossou

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Introduction

Tool using behavior is one of the major topics in wild chimpanzee research. Various kinds of such behavior have been reported from many research sites across Africa (Yamakoshi 2001). Gombe chimpanzees, for example, fish for termites with a grass stalk, thin twig, or piece of vine (Goodall 1965), but this behavioral pattern has not been seen at Mahale, another study site in the same country. The accumulation of reports suggests that there are cultural differences among chimpanzee groups in their repertoires of tool use (McGrew 1992; Whiten et al. 1999).

Bossou is located in the southeastern corner of Guinea (Fig. 1). Study of wild chimpanzees at Bossou was first conducted in the 1960s (Kortlandt 1986; Yamakoshi 2011a). Since 1976, the chimpanzees have been studied intensively (Matsuzawa et al. 2011a). The local Manon people respect chimpanzees as their totem, and think of them as the reincarnation of their ancestors. For this reason, the chimpanzees have been allowed to survive near the Village of Bossou (Yamakoshi 2011a). Bossou chimpanzees are known to utilize various kinds of tools (Ohashi 2006a). Nut-cracking behavior has been especially well investigated using field experiments. Bossou chimpanzees crack open dried oil palm nuts (*Elaeis guineensis*) with a pair of stones. The chimpanzees learn to crack open nuts at around 3–4 years old. Chimpanzee mothers do not actively teach the behavior to their offspring; they do not prepare a

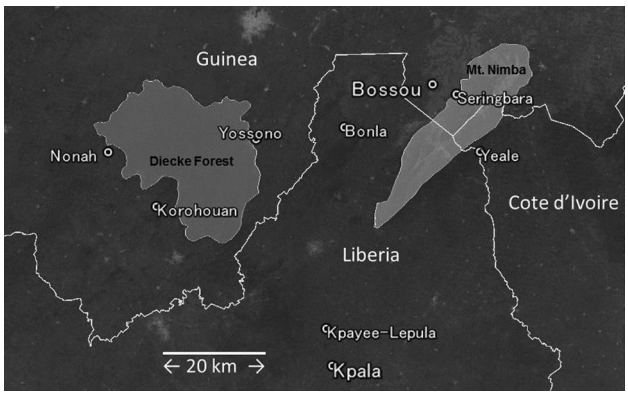

Fig. 1 Map indicating the location of study sites around Bossou, longitudinal study site of wild chimpanzees. Kpala is a small village in Yarpea-Mah Administrative District, Nimba County, Liberia. The distance between Bossou and Kpala is about 57 km

proper stone tool for their offspring, nor mold their hands to teach how to use a stone as a hammer (Matsuzawa et al. 2001). There seems to be a critical learning period for acquiring the nut-cracking technique, as two chimpanzees in the group that could not utilize stones to crack open oil palm nuts have been observed. Longitudinal studies have also revealed the acquisition process of the tool use behavior (Biro et al. 2003).

Bossou chimpanzees consume various parts of oil palm (Yamakoshi 1998). Pestle-pounding is a unique tool using behavior performed on oil palm trees, having only been reported in Bossou chimpanzees (Sugiyama 1994). Chimpanzees pull out young fronds from the crown of an oil palm tree first, and eat the base of the petioles. Then they use the frond to pound the top of the tree several times, lick the frond, and eat broken fibrous matter (Yamakoshi and Sugiyama 1995). Many chimpanzees that have used the pestle-pounding technique have disappeared from the Bossou group. These chimpanzees that are thought to have emigrated might contribute to propagate this behavior into new groups.

Extensive surveys have been carried out around Bossou to assess similarities and differences in cultural tradition among neighboring chimpanzee groups. Specifically two protected reserve forest areas have been studied: Mt. Nimba Strict Nature Reserve and Diecke Forest Reserve (Matsuzawa et al. 2011a; Fig. 1). However, the chimpanzees in nonprotected areas have not been studied around Bossou, including secondary forests and abandoned fields that spread outside the forest reserve.

Bossou is close to the national border with Liberia (Fig. 1). The Village of Bossou is located about 5.4 km from the border. The border in the forest has no physical barrier. In fact, Bossou chimpanzees were found to go across the national border (Ohashi 2006b). There are several reports regarding study of wild chimpanzees in Liberia in the past. Savage and Wyman (1843–1844) reported nut-cracking of unknown species with stones at Cape Palmas in the 19th century. Beatty (1951) reported the observation of oil palm nut-cracking in matted vegetation somewhere in Liberia. Anderson et al. (1983) found evidence that chimpanzees crack open nuts from four species (*Coula edulis*, *Panda oleosa*, *Parinari excelsa*, and *Sacoglottis gabonensis*) with stones in Sapo National Park. Chimpanzee research in Liberia was stopped because of two major civil wars (1989–1996, 1999–2003). Since 2006, I have started chimpanzee surveys in Liberia, including nonprotected forests, to determine the distribution of cultural behaviors in chimpanzees of groups neighboring Bossou (Ohashi 2011). This paper reports new findings of tool using behavior by wild chimpanzees at Kpala, Liberia.

Methods

Kpala is a small village in Yarpea-Mah Administrative District, Nimba County, Liberia (7°09.535′N, 8°40.869′W, Fig. 1). The distance between Bossou and Kpala is about 57 km. The Village of Kpala is surrounded by secondary forests, cultivated fields, and abandoned fields. Oil palm trees are superabundant in both active and abandoned fields, because farmers do not cut down the useful trees. Kpala consists of Manon people, and the villagers think of chimpanzees as the reincarnation of their ancestors, as is the case in Bossou. The hunters in the village do not shoot chimpanzees. The chimpanzees do not have too much fear of humans, but were also not fully habituated by the local assistants and me. We tried to find chimpanzees by following their footprints, feeding remains, feces, and vocalizations. Once we found chimpanzees, we could observe them from about 50 meters distance. This report is based on the observation on 21 August 2012. Moreover, we monitored a nut-cracking site using a motion-sensing camera (Bushnell Trophy Cam XLT). The camera was installed on tree after the chimpanzees had moved away from a particular location. The distance between the camera and the nut-cracking site was about 2 m. Each time some animals subsequently passed in front of the camera, it filmed them for a minute.

Results

At 14:20 on 21 August 2012, local assistants and I heard chimpanzees pant-hooting once from a distance, and then five more times in a short period of time. We approached them, and found a young chimpanzee in an oil palm tree at 14:37 (7°10.278′N, 8°40.126′W). The chimpanzee descended from the tree 2 min later. At 14:42, we heard a pant-grunt followed by screams coming from ground level.

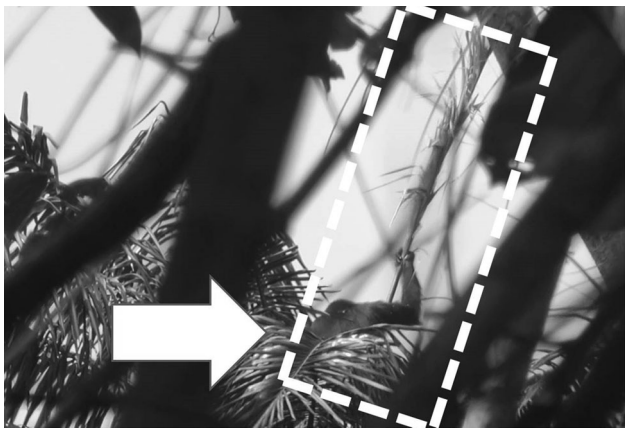

Fig. 2 A young female chimpanzee (indicated by a *white arrow*, and enclosed by a *dashed line*) was observed performing pestle-pounding behavior at Kpala forest, Liberia on 21 August 2012

Some chimpanzees had seemed to come and join the party. At 14:45, we heard the sound of a palm frond being pulled and pounded on the top of an oil palm tree. We confirmed that an adult female and an infant were situated on the top of the tree, and a young female was sitting nearby on the palm leaves. At 14:46, a chimpanzee uttered a pant-hoot from a distance. At 14:48, the female and infant descended the tree, and the young female chimpanzee climbed up on the top. She pushed down the leaves to expose the top of tree, and grasped a frond which the adult female had pulled out. The young female started to pound it into the hole on the top of tree (Fig. 2). She continued with the pestle-pounding behavior until 14:56, at which point she climbed down the tree. After that, we heard nut-cracking sound on the ground. We approached the sound, but chimpanzees noticed our presence and started to utter alarm call at 15:08. All of the chimpanzees moved away at 15:15. At 15:27, we arrived at a nut-cracking site where some chimpanzees had been, and found a tool (7°10.299′N, 8°40.102′W). Oil palm nuts seemed to be cracked open with a stone as a hammer on an embedded stone that had apparently served as an anvil. The weight of the hammer stone was 512 g. We installed a motion-sensing camera (Bushnell Trophy Cam XLT) near the anvil stone to film future nut-cracking.

We retrieved the camera on 12 February 2013, and the battery was not empty. The camera successfully filmed that a young adult male visited there at 07:39 on 17 January 2013, and cracked open oil palm nuts with stones (Fig. 3). He put nuts on the embedded stone, and used a mobile stone as a hammer with his right hand. We could not find the hammer stone in the area. We set the camera again on the same day, and retrieved it on 25 January 2014. The battery seemed to be down after filming a video image on 7 January 2014. The camera filmed three other nut-cracking scenes; an adolescent did it with his left hand on 9 September 2013 (Fig. 4), an adult male did it with his right hand on 29 October 2013, and an adolescent male did it with his left hand on 2 November 2013. The hammer stones could not be found. We could not discriminate between the two adolescent males because of the poor quality of the video images. In total, at least three individuals were engaged in nut-cracking at this filming site.

Fig. 3 A motion-sensing camera successfully filmed that a young adult male visited there at 07:39 on 17 January 2013. He cracked open oil palm nuts with stones

Fig. 4 An adolescent male was filmed cracking open oil palm nuts with stones on 9 September 2013

Discussion

This is the first report of confirmed pestle-pounding behavior other than in the Bossou group. Feeding behavior on oil palm petiole has been reported from many chimpanzee groups, including at two longitudinal study sites, Tai and Gombe (Humle and Matsuzawa 2004). However, pestle-pounding behavior had been observed only in Bossou group. Because of the uniqueness of the behavior, Yamakoshi (2011b) suggested that pestle-pounding behavior might have been established at Bossou after a single innovation. If so, emigrant chimpanzees must have

contributed to the propagation of this cultural behavior between the groups. This finding suggests that social and genetic interchanges also occur among the groups.

Kpala chimpanzees crack open oil palm nuts with stones. This behavior had been observed only in Bossou and at Beatty's site. In this study, the behavior was successfully filmed for the first time in chimpanzees other than those in the Bossou group. The paucity of observations of this behavior might be due to the lack of chimpanzee studies in nonprotected forests in West Africa.

The Bossou group currently consists of only nine chimpanzees. We have made great conservation efforts, such as the "Green Corridor Project" (Matsuzawa et al. 2011b; Ohashi et al. 2008) and environmental education (Humle 2011) around Bossou. Given the findings of this paper that Kpala chimpanzees have the same cultural behavior as Bossou chimpanzees, it is necessary to conduct a broader range of research and conservation activities beyond national borders in order to care for chimpanzees at population level.

Quite a lot of wild chimpanzees are thought to live in nonprotected areas (Butynski 2003; Yamakoshi 2011b). Some people do not regard chimpanzees as game animals, and the chimpanzees can live in close proximity to villages. Although the chimpanzees have been able to survive up to the present time, it is a cause for concern that the chimpanzees could easily be negatively affected by the influence of human development. The habitats in nonprotected areas are very fragile. It is possible that the groups could disappear without anyone noticing. When considering conservation of chimpanzees, we first have to know the actual status of wild chimpanzees in these nonprotected areas. Local residents make their living by slash-and-burn agriculture, but they tend to leave oil palm trees in the field. If we assume that the chimpanzees share the same tool-use culture in areas surrounding where we researched, they must be using the abundant oil palm. Pursuing research that tracks oil palm nut-cracking may be an effective means to determine the distribution of chimpanzees near human dwellings. Cooperation from local people is indispensable to maintain the population of chimpanzees. The present study area serves as a good model for future conservation efforts along these lines because it is nonprotected, and the chimpanzees coexist with local ethnic Manon. Deepening understanding of traditional Manon culture would surely contribute to catalyzing sustainable coexistence between humans and wildlife in the region.

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References

Anderson JR, Williamson EA, Carter J (1983) Chimpanzees of Sapo Forest, Liberia: density, nests, tools and meat-eating. Primates 24:594–601

Beatty H (1951) A note on the behavior of the chimpanzee. J Mamm 32:118

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. Anim Cogn 6:213–223

Butynski TM (2003) The robust chimpanzee *Pan troglodytes*: taxonomy, distribution, abundance, and conservation status. In: Kormos R, Boesch C, Bakarr MI, Butynski TM (eds) West African chimpanzees: status survey and conservation action plan. IUCN/SSC Primate Specialist Group, IUCN, Gland, Switzerland, pp 5–12

Goodall J (1965) Chimpanzees of the Gombe Stream Reserve. In: Devore I (ed) Primate behavior: field studies of monkeys and apes. Holt, Rinehart and Winston, New York, pp 425–473

Humle T (2011) Environmental education and community development in and around Bossou. In: Matsuzawa T, Humle T, Sugiyama Y (eds) The chimpanzees of Bossou and Nimba. Springer, Tokyo, pp 361–370

Humle T, Matsuzawa T (2004) Oil palm use by adjacent communities of chimpanzees at Bossou and Nimba Mountains, West Africa. Int J Primatol 25:551–581

Kortlandt A (1986) The use of stone tools by wild-living chimpanzees and earliest hominids. J Hum Evol 15:77–132

Matsuzawa T, Biro D, Humle T, Inoue-Nakamura N, Tonooka R, Yamakoshi G (2001) Emergence of culture in wild chimpanzees: education by master-apprenticeship. In: Matsuzawa T (ed) Primate origins of human cognition and behavior. Springer, Tokyo, pp 557–574

Matsuzawa T, Humle T, Sugiyama Y (eds) (2011a) The chimpanzees of Bossou and Nimba. Springer, Tokyo

Matsuzawa T, Ohashi G, Humle T, Granier N, Kourouma M, Soumah AG (2011b) Green corridor project: planting trees in the savanna between Bossou and Nimba. In: Matsuzawa T, Humle T, Sugiyama Y (eds) The chimpanzees of Bossou and Nimba. Springer, Tokyo, pp 361–370

McGrew WC (1992) Chimpanzee material culture: implications for human evolution. Cambridge University Press, Cambridge

Ohashi G (2006a) Behavioral repertoire of tool use in the wild chimpanzees at Bossou. In: Matsuzawa T, Tomonaga M, Tanaka M (eds) Cognitive development in chimpanzees. Springer, Tokyo, pp 439–451

Ohashi G (2006b) Bossou chimpanzees crossed the national border of Guinea into Liberia. Pan Africa News 13:10–12

Ohashi G (2011) From Bossou to the forests of Liberia. In: Matsuzawa T, Humle T, Sugiyama Y (eds) The chimpanzees of Bossou and Nimba. Springer, Tokyo, pp 313–321

Ohashi G, Hasegawa R, Kourouma M, Matsuzawa T (2008) Arbors and cuttings: new trials for green corridor project at Bossou-Nimba. Pan Africa News 15:20–23

Savage TS, Wyman J (1843–1844) Observations on the external characters and habits of the *Troglodytes niger*, Geoff. and on its organization. Boston J Nat Hist 4:362–386

Sugiyama Y (1994) Tool use by wild chimpanzees. Nature 367:327

Whiten A, Goodall J, McGrew WC, Nishida T, Reynolds V, Sugiyama Y, Tutin CEG, Wrangham RW, Boesch C (1999) Cultures in chimpanzees. Nature 399:682–685

Yamakoshi G (1998) Dietary responses to fruit scarcity of wild chimpanzees at Bossou, Guinea: possible implications for ecological importance of tool use. Am J Phys Anthropol 106:283–295

Yamakoshi G (2001) Ecology of tool use in wild chimpanzees: toward reconstruction of early hominid evolution. In: Matsuzawa T (ed) Primate origins of human cognition and behavior. Springer, Tokyo, pp 537–556

Yamakoshi G (2011a) The "prehistory" before 1976: Looking back on three decades of research on Bossou chimpanzees. In: Matsuzawa T, Humle T, Sugiyama Y (eds) The chimpanzees of Bossou and Nimba. Springer, Tokyo, pp 35–44

Yamakoshi G (2011b) Pestle-pounding behavior: the key to the coexistence of humans and chimpanzees. In: Matsuzawa T, Humle T, Sugiyama Y (eds) The chimpanzees of Bossou and Nimba. Springer, Tokyo, pp 107–115

Yamakoshi G, Sugiyama Y (1995) Pestle-pounding behavior of wild chimpanzees at Bossou, Guinea: a newly observed tool-using behavior. Primates 36:489–500