42. Use of tools and other objects

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42.1 Introduction

Since Goodall (1963) first discovered termite-fishing behavior among wild chimpanzees at Gombe in Tanzania, it has become well known that not only humans but also wild chimpanzees customarily make and use tools in their natural habitat. Goodall's discovery of tool use among wild chimpanzees had a great impact on the controversy over where and how to draw the boundary between humans and animals, because the making and use of tools had long been considered one of the critical characteristics of human beings (Goodall, 1990). Since the discovery at Gombe, many more examples of tool making and tool use by chimpanzees at Mahale and other long-term study sites have been discovered, and we now know that these behaviors are widespread and diverse among chimpanzee groups and populations, implying that these wild chimpanzee societies have their own cultures (McGrew, 1992; see also Chapter 38).

In this chapter, I review observations of tool making, tool use, and object use among wild chimpanzees at Mahale, and compare them with the behaviors of other groups and populations of wild chimpanzees. Hereafter, I use the word "tool" according to the definition by Shumaker *et al.* (2011):

> The external employment of an unattached or manipulable attached environmental object to alter more efficiently the form, position, or condition of another object, another organism, or the user itself, when the user holds and directly manipulates the tool during or prior to use and is responsible for the proper and effective orientation of the tool.

In their definition, "manipulable attached object" and "unattached object" were included as tools to refer to many examples of possible tool use by various animal species. In addition, they also introduced the concept of "object use" to refer to non-manipulable objects, such as large stones, tree buttresses, and stout branches used as anvils for smashing nuts, which has also been called "substrate use." Thus, this chapter broadly summarizes the use of external objects including both "tools" and "objects or substrates" by Mahale chimpanzees.

42.2 Tool use for feeding

42.2.1 Tool use for feeding on carpenter ants (*Camponotus* spp.)

The first discovery of tool use by Mahale chimpanzees was "ant fishing," which is to feed on arboreal carpenter ants by using probes made of plant matter as "fishing rods" such as peeled bark, vine, branch, or midrib of leaves (Nishida, 1973; Figure 42.1). On November 2, 1971, when Nishida (1981) was observing K-group chimpanzees in the rain, Chausiku, an adult female chimpanzee, climbed 15 m up a *Brachystegia* tree, grasped a stick, inserted it into a hollow of a branch, and then withdrew it and put it in her mouth. Nishida and his assistant picked up and collected the sticks discarded by Chausiku as well as specimens of large ants that had fallen from the tree. Thus, they ascertained that Chausiku used tools as fishing probes to harvest ants (Nishida, 1981).

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Figure 42.1 An adult female chimpanzee of the M group, Miya, using a probe to harvest *Camponotus* ants. ©Michio Nakamura.

Ant-fishing behavior among Mahale chimpanzees has been studied, mainly in the K group by Nishida (1973) and Nishida and Hiraiwa (1982); and in the M group by Nishie (2011) (see also Chapter 41 for information on a lack of laterality of hand preference in ant fishing). Ant-fishing behavior is composed of a sequence of four actions: creating and modifying a fishing probe made of plant matter such as peeled bark, vine, branch, or the midrib of a leaf; inserting the probe into a tree hole where wood- boring carpenter ants are nesting; withdrawing the probe with soldier ants attached; and removing them with the lips and tongue (Nishida *et al.*, 1999). Nishida and Hiraiwa (1982) described four species of *Camponotus* ants as the target species of ant fishing in the K group: *C. vividus, C. brutus, C. maculatus*, and *C.* sp. (*Myromotrema*). Nishie (2011) identified only two in the M group, *C.* sp. (*chrysurus*-complex) and *C. brutus* (Table 42.1; see also Chapter 21). Nishie (2011) implied that this difference in target species between the groups might be at least partly due to different ecological conditions (see also Chapter 21). *Camponotus* predation using tools has been reported in other wild chimpanzee populations. Gombe chimpanzees use tools to prey on at least three species of *Camponotus* ants (*Camponotus vividus, C. chrysurus*, and *C. brutus*) (O'Malley *et al.*, 2012). At Bossou in Guinea, Yamamoto *et al.* (2008) observed two sessions of ant fishing for *C. brutus* by a juvenile male chimpanzee. *Camponotus* ant fishing has also been observed among chimpanzees at Lopé in Gabon (*C. brutus*: Tutin and Fernandez, 1992; Tutin *et al.*, 1995) and Gashaka in Nigeria (*C. chrysurus*: Fowler and Sommer, 2007). At Assirik in Senegal, *Camponotus* ant fishing was inferred from the presence of remaining tools and ants (McGrew, 1983, 1992). We recently launched a comparative study of *Camponotus* ant fishing between Mahale and Gombe chimpanzees (O'Malley and Nishie, 2013). Preliminary analyses revealed some differences; for example, the chimpanzees at Gombe (Kasekela) fish for *Camponotus* ants at a lower frequency, for shorter durations, in fewer tree species, and at fewer locations than at Mahale. We also found that *Camponotus* ant fishing is mostly an arboreal activity at Mahale, whereas this is not the case at Gombe.

Chimpanzees prepare tools in advance of arriving at the tree where they fish for *Camponotus* ants (Nishida, 1973; Nishida and Hiraiwa, 1982). When a tool becomes dull or bent in the process of repeated fishing, they discard it and make another one from vegetation near the nest hole of the ants. Nishida and Hiraiwa (1982) collected 206 tools used for *Camponotus* ant fishing by the K-group chimpanzees, and classified them into six types as follows (see "Ant" column of K group in the "Tool material" row in Table 42.1): bark tools (B type), modified branches (MBr type), unmodified branches (UBr type), unmodified vines or grasses (UVG type), bark of branches (BBr type), and midribs of leaves (MR type). Tool materials were most frequently derived from vines (71.4%) and secondly from trees (19.9%). The most common plant species used to make tools was *Uvaria angolensis*, which accounted for 48.1% of tools. The top 10 species listed in Table 42.1 accounted for 80.1% of all tools. The mean length of ant-fishing tools was 33.2 cm (N = 37; range: 10.0–80.0 cm) collected and measured by

Table 42.1 Tool use for eating insects by Mahale chimpanzees

	B group		K group		M group	
Prey type	Termite	Ant	Termite	Ant	Termite	Ant
Species fished for	(2)*, (6) *Macrotermes herus*	(3)** *Camponotus* sp.	(2), (3) *Pseudacanthotermes spiniger*	(1), (4) *Camponotus vividus* *C. brutus* *C. maculatus* *C.* sp (*Myromotrema*)	(5) *Pseudacanthotermes* sp.	(7) *Camponotus* sp. (*chrysurus-complex*) *C. brutus*
Type of tool material	(6) Bark: $N = 218$ Sedge: $N = 43$ Vine: $N = 21$ Twig: $N = 6$ Leaf: $N = 1$	–	(3) B: $N = 13$ MBr: $N = 3$ UVG: several	(4) B: $N = 118$ MBr: $N = 32$ UVG: $N = 28$ BBr: $N = 12$ UBr: $N = 8$ MR: $N = 8$	(5) B: $N = 2$	–
Species of tool material	(6) [Woody plants] *Acalypha chirindica* *Artabotrys monteirode* *Bauhinia petersiana* *Carpolobia alba* *Cyphostemma* sp. [Sedge] *Cyperus pseudoleplocladus*	–	(3) [B type] *Uvaria angolensis* *Artabotrys monteiroae* *Grewia platyclada* [MBr type] *Paullinia pinnata* [UVG type] *Olyra latifolia*	(4) *Uvaria angolensis* *Brachystegia bussei* *Tinospora caffra* *Combretum molle* *Grewia forbesii* *Landolphia* sp. *Glycine* sp. *Olyra latifolia* *Setaria candula* *Canthium rubrocostatum*	(5) *Uvaria angolensis* *Artabotrys monteiroae* *Monanthotaxis* sp.	–

Tool length	(3) [*N* = 97] Mean: 54.6 cm Range: 21.7–125.6 cm (6) [*N* = 287] Mean: 37.7 cm Median: 35.9 cm Range: 12–84 cm	–	(3) [Nov. 24, 1977; *N* =16] (Total) Median: 51.5 cm Range: 29.5–97.2 cm (Effective) Median: 30 cm Range: 20–45 cm [20 Nov. 1978; *N* = 9] Median: 45.2 cm Range: 32.0–157.1 cm	(1) [*N* = 37] (Total) Mean: 33.2 cm Range: 10.0–80.0 cm (Effective; *N* = 19) Mean: 14.0 cm Range: 7.3–20.1 cm (3) [*N* = 28] Mean: 21.4 cm Range: 10.5–58.8 cm	(5) [*N* = 2] 18.2 cm ca. 40 cm	–

* Numbers in parentheses represent the references: (1) Nishida, 1973; (2) Nishida and Uehara, 1980; (3) Uehara, 1982; (4) Nishida and Hiraiwa, 1982; (5) Takahata, 1982; (6) McGrew and Collins, 1985; (7) Nishie, 2011.

** *Campnotus* ant-fishing in B group was inferred from circumstantial evidence (Used probes and *Camponotus* ants remained in fecal samples were found in B group) (Uehara, 1982).

Nishida (1973), and was 21.4 cm (N = 28; range: 10.5–58.8 cm) by Uehara (1982). There are no comparable data from other study sites where *Camponotus* ant fishing has been observed, and the characteristics of tools used for *Camponotus* ant fishing among the M-group chimpanzees remain to be studied (Nishie, 2011).

The frequency of *Camponotus* ant fishing was 0.37 sessions per 10 observation hours for K-group chimpanzees (Nishida and Hiraiwa, 1982), and 0.64 sessions per 10 h for M-group chimpanzees (Nishie, 2011). The mean ant-fishing bout length was 33.2 min by the K group (Nishida and Hiraiwa, 1982) and 24.75 min by the M group (Nishie, 2011). However, Nishie (2011) implied that these differences in the frequency and bout length of *Camponotus* ant fishing are likely due to differences in observational conditions or analysis methods between the two studies, rather than actual differences in behavior between the two groups. In both the K and M groups, females fish for *Camponotus* ants more frequently and in longer bouts than males (Nishida and Hiraiwa, 1982; Nishie, 2011). These consistencies in ant fishing between the K and M groups indicate that, except for some differences caused by local ecological conditions, chimpanzees of the K and M groups have similar customs of *Camponotus* ant fishing with regard to the target ant species and the frequency and duration of ant fishing (Nishie, 2011).

42.2.2 Tool use for feeding on termites

When Nishida discovered *Camponotus* ant fishing among the Mahale chimpanzees in 1971, he hypothesized that they were also likely to use tools to feed on termites, as the Gombe chimpanzees did (Nishida, 1973). However, K-group chimpanzees, which were the main study subjects at that time, were sometimes observed feeding on termites using their fingers but never with tools (Nishida, 1973).

In 1975, however, some circumstantial evidence of feeding on termites with tools among B-group chimpanzees, which were distributed north of the K group, was discovered (Nishida and Uehara, 1980). On November 14, 1975, at the beginning of the wet season, a field assistant encountered many chimpanzees gathered together on the ground in the woodland of the B group's home range. After a while, he approached them and found many grass and vine stems protruding from a termite mound after they had fled. On February 6, 1976, when Nishida approached chimpanzees of the B group feeding in the gallery forest, he found a termite mound that was partially destroyed with four fishing probes projecting from the mound. Nishida also collected 133 fishing probes on termite mounds in the B group's home range between November and December 1979. These probes were made of bark (*Uvaria angolensis, Bauhinia petersiana, Grewia platyclada, G. mollis, Acalypha* sp.), vines (*Rhynchosia luteola, Typlophora* sp.), twigs (*Rothmania manganjae, Milletia angustidentata*), and grass, bamboo, or sedge (*Olyra latifolia, Hyparrhenia rufa, Cyperus diffusus*). In 1977, Uehara observed K-group chimpanzees using probes to feed on termites (Figure 42.2). Although this is the only direct observation of termite fishing with tools by K-group chimpanzees, there has been other sporadic indirect evidence such as remnants of probes on termite mounds (Uehara, 1982). Among the M-group chimpanzees, except for the two cases of termite fishing with tools observed in November 1981 by Takahata (1982), no other evidence of tool use for feeding on termites has been observed (Uehara, 1999).

The intergroup differences in termite fishing among the B, K, and M groups at Mahale described above can be explained by differences in the ecological conditions of the home ranges of the different groups (Nishida and Uehara, 1980; Uehara, 1982; McGrew and Collins, 1985; Collins and McGrew, 1987). The home ranges of the B, K, and M groups are distributed adjacently from north to south (see Chapter 4). Rainfall decreases toward the north, resulting in drier environments and more woodlands in the B group's range, while the home ranges of the K and M groups are more forested. Because of these differences in rainfall and vegetation, *Macrotermes* termites, which can be caught with fishing tools, are more abundant in the home range of the B group than in the K and M groups. *Pseudacanthotermes* termites, which can be more easily harvested without tools by destroying their mounds, are more common in the home range of the K group

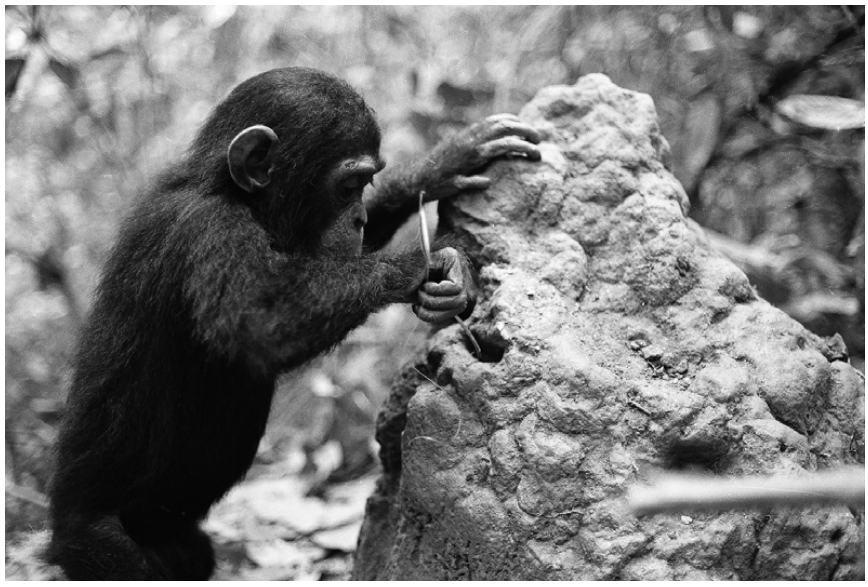

Figure 42.2 An infant male chimpanzee of the K group, Katabi, using a probe to harvest termites (*Pseudacanthotermes spiniger*). ©Shigeo Uehara.

(Collins and McGrew, 1987). Thus, termite fishing is seldom observed in the K and M groups at Mahale, because few if any *Macrotermes* termites are present in their home ranges (McGrew and Collins, 1985; Collins and McGrew, 1987; Uehara, 1999).

Tools used for termite fishing by Mahale chimpanzees in the B and K groups were collected and analysed in detail (summarized in Table 42.1). In the B group, most tools for termite fishing were made of bark, sedge, or vines, with a mean length of 54.6 cm (range: 21.7–125.6 cm) measured by Uehara (1982) and 37.7 cm (range: 12–84 cm) by McGrew and Collins (1985). The length of termite-fishing tools measured by McGrew and Collins (1985) was as long as that of *Camponotus* ant-fishing tools measured by Nishida (1973). However, Uehara (1982) pointed out that their effective length, defined as the portion of the probe actually inserted into a hole, was about twice as long as that of *Camponotus* ant-fishing tools, and that greater effective length and higher elasticity of materials are necessary to fish for termites than for ants. Therefore, fishing tools made of the midribs of leaves (MR type), bark of branches (BBr type), or unmodified branches (UBr type) would be of less use for termite fishing because they tend to be short (MR type) and/or non-elastic (BBr and UBr types) (Uehara, 1982).

Although termite fishing is a relatively minor tool- use behavior in Mahale chimpanzees, it has been observed in many other populations of wild chimpanzees across Africa: at Gombe (McGrew *et al.*, 1979; Goodall, 1986; Lonsdorf, 2005), Kasakati (Tanzania: Suzuki, 1966), Ndakan and Bai Hokou (Central Africa: Fay and Carroll 1994), Ndoki (Congo: Suzuki *et al.*, 1995), Lossi (Congo: Bermejo and Illera, 1999), Goualougo (Congo: Sanz *et al.*, 2004), Campo (Cameroon: Sugiyama, 1985; Muroyama, 1991), Dja (Cameroon: Deblauwe *et al.*, 2006), Belinga (Gabon: McGrew and Rogers, 1983), Okorobikó (Equatorial Guinea: Jones and Sabater Pi, 1969; Sabater Pi, 1974), Bossou (Sugiyama and Koman, 1979; Humle, 1999), Mt. Assirik (McBeath and McGrew, 1982; Bermejo *et al.*, 1989), and Fongoli (Senegal: McGrew *et al.*, 2005; Bogart and Pruetz, 2008).

42.2.3 Hunting with tools

Huffman and Kalunde (1993) reported the first case of tool-assisted hunting of mammalian prey by a

chimpanzee at Mahale. On December 16, 1991, they observed a 12-year-old female, Tula, use a modified branch to probe a tree hole, rouse and grab a squirrel from the hole, and then eat it, sharing a small piece with a 4.5-year-old female, Maggie. The tool used for rousing the squirrel was 73 cm long, 9 cm in circumference, and weighed 155 g.

Nakamura and Itoh (2008) observed additional cases of hunting with tools in 1995 and 2004. On October 4, 1995, Maggie, the chimpanzee who was previously observed begging Tula for squirrel meat and now 8 years old, was found poking a stick (about 50 cm long and 3 cm in diameter) into a tree hollow. After a while, she took out an immobilized (either dying or already dead) squirrel from the tree hollow, and ate it.

On October 5, 2004, Darwin (16-year-old male) and Cadmus (13-year-old male) inserted and poked tools (vine and stem: about 60 cm long and 1–3 cm in diameter) into a cave at the bottom of a large rock, and wielded a tool (vine: 80 cm long and 0.5 cm in diameter) like a whip at the entrance of the cave. After a while, Orion (a 13-year-old male) came and also wielded the whip-like tool that had been used by Darwin and Cadmus. The cave was thought to be the nest of yellow-spotted hyraxes, although the existence of the hyraxes could not be confirmed.

The tools used to hunt mammalian prey in these (two successful and one attempted) cases were longer and thicker than those used for ants and termites, because they were used to poke into and rummage within tree hollows or a cave. Hunting with tools by wild chimpanzees is habitually observed at Fongoli, where chimpanzees hunt lesser bushbabies by using sticks as "spears" (Pruetz and Bertolani, 2007). Nakamura and Itoh (2008) implied that Mahale chimpanzees use tools to hunt mammalian prey more frequently than observed.

42.3 Courtship behaviors with tools

42.3.1 Leaf clipping

Mahale chimpanzees use a leaf as a kind of communicatory tool in social interactions. This is termed leaf-clipping behavior (Figure 42.3). The

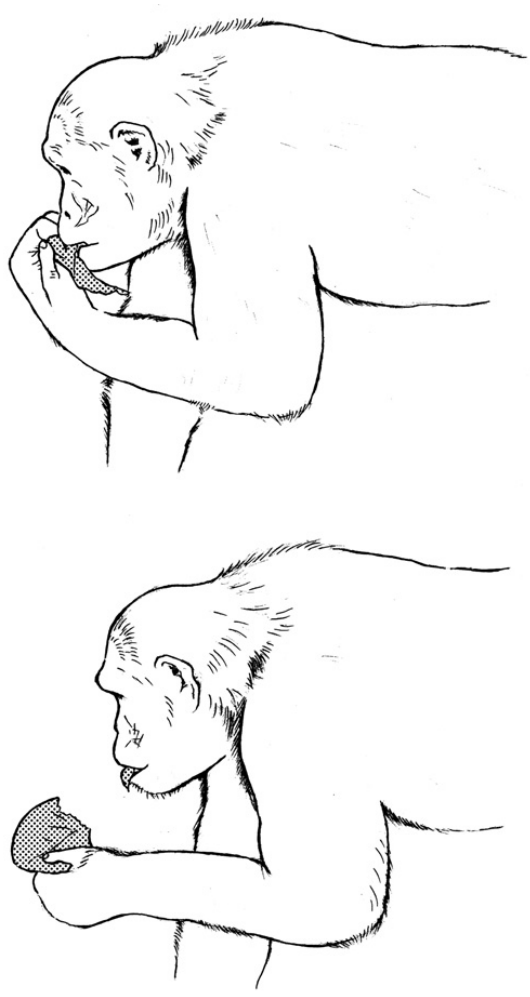

Figure 42.3 Leaf clipping by an adult female, Cynthia. Based on image ©Michio Nakamura.

sequence of this behavior is that a chimpanzee picks off a leaf, grasps the petiole between the thumb and the index finger, and repeatedly pulls it between its lips or teeth while removing the leaf blade, producing a conspicuous sound that attracts attention from a prospective sex partner (Nishida, 1980b; Nishida *et al.*, 1999; Chapter 35). Nishida (1980b) analysed 41 cases of leaf clipping among K-group chimpanzees, and classified them as follows: 23 cases (56.1%) in sexual contexts such as soliciting copulation or "herding" behavior, 13 cases (31.7%) in frustration or play, and 5

cases (12.2%) in demanding food from the human observer. Nishida (1997) studied the sexual behaviors of adult male chimpanzees of the M group, and indicated that leaf clipping was observed in 26.4% (19 cases) of the 72 total cases of courtship displays observed. Thus, Nishida *et al.* (1999) concluded that leaf clipping was one of the most common courtship displays in Mahale, although he also noted that it sometimes occurred in other contexts, such as frustration or play (Nishida, 1980b, 1987).

Recently, we re-examined the social context of leaf clipping among M-group chimpanzees (Nishie *et al.*, 2014). We analysed 536 cases of leaf clipping observed between 1994 and 2012, and reconfirmed that leaf clipping frequently occurred in sexual contexts, but there were also several cases of leaf clipping in nonsexual contexts, such as a male leaf clipping toward another male or a non-estrous female leaf clipping toward her offspring. Thus, we presumed that these multiple uses of leaf clipping imply that the behavior itself is not a fixed signal of courtship as indicated by Nishida (1980b), but that it is widely used as a gesture to get the attention of a recipient(s) for subsequent interactions.

42.3.2 Shrub bend

In the late 1980s, another style of courtship display was discovered among M-group chimpanzees: shrub bend. Typically, a male sitting on the ground or in a tree faces an estrous female and makes a crude day bed or cushion by bending 2–4 shrubs to the ground, which he then sits on and repeatedly stamps with one foot (Nishida, 1987, 1997; Nishida *et al.*, 1999). Nishida (1997) showed that shrub bend accounted for only 4.2% (three cases) of the 72 courtship displays observed. Shrub bend has not been observed in the K group. This behavior has been reported as habitual in Bossou and customary in Budongo, Uganda (Whiten *et al.*, 2001).

42.3.3 Stem pull-through

Nishida (1997) described stem pull-through as a courtship display performed by only two adult males of the M group, Musa and Ntologi. Typically, they pulled the leafy branch of a shrub or a clump of grass stems through their hand by a rapid movement of the forearm, and then released the stem, producing a conspicuous sound while seated and watching an estrous female. This behavior has been reported as customary in Bossou, habitual in Kibale (Uganda), and present in Gombe (Whiten *et al.*, 2001).

42.4 Intimidation displays with tools

42.4.1 Throwing objects

Throwing objects such as stones, rocks, branches, sticks, handfuls of grass or sand, and so on, has been documented in many populations of wild chimpanzees as intimidation displays (Nishida *et al.*, 1999). In particular, a pattern of rock throwing displayed by Mahale chimpanzees is unique. When M-group chimpanzees cross a streambed, adult males, and more rarely adolescent males, typically throw rocks into the stream, producing a loud splash that intimidates others (Nishida, 1994, 2003b; Nishida *et al.*, 1999; see also Chapter 31 for descriptions of "streambed display"). This pattern of rock throwing into water ("throw splash": Nishida *et al.*, 1999) has been observed only at Mahale, although it is not known when this type of display began (Nishida, 2003b). Older skillful males often stand bipedally, choose a large rock weighing 10 kg or more, lift it with both hands, and make an aimed throw into the water.

42.4.2 Drumming objects

Mahale chimpanzees drum objects such as buttress roots, metal walls or wooden doors of the researchers' and tourists' camp, and metal barrels as intimidation displays (Nishida, 1994, 2003b; Nishida *et al.*, 1999). Drumming natural objects such as buttress roots or trunks is common among many populations (Whiten *et al.*, 2001), whereas drumming artificial objects such as metal walls or barrels is an idiosyncratic pattern of Mahale chimpanzees, although a Gombe male, Mike,

learned to incorporate empty kerosene cans into his intimidation displays (Goodall, 1971). At Mahale, chimpanzees initially ignored and simply passed by the metal houses for some years after they were built in 1976; however, by August 1979, many adult males began to use the metal walls of the houses as drumming objects (Nishida, 1994, 2003a). Drumming natural objects is performed not only by adult males but also by adolescent, juvenile, and even 4-year-old males as well as by adult, adolescent, and juvenile females. However, drumming metal walls is performed exclusively by adult males. Adult males vary in their patterns of drumming on metal walls. Some regularly stand on their feet and slap quickly with both hands, while others stand bipedally and slap slowly with one hand, and others stand on their feet and slap and kick simultaneously. This variation in drumming behavior among males partly derives from individual preferences in the loudness and rhythm of drumming; this in turn could represent individualistic "signature patterns" that are potentially recognizable to the others in the same unit-group (Nishida, 2003a; see also Chapter 31).

42.4.3 Other intimidation displays with tools/objects

Nishida (2003b) reported that immature male chimpanzees sometimes threaten older individuals, adult females in particular, by clubbing, flailing, or throwing branches. In all, 25 behaviors were confirmed to be "harassment" mostly by adolescent and juvenile males toward adult females, 14 of which included tool or object use such as shaking, throwing, dragging, or flailing branches; clubbing or stamping the ground; or throwing dead leaves. Shaking branches was the most frequently observed harassment behavior; however, interestingly, shaking branches has also been observed in other broad contexts, including courtship (solicitation for copulation), continuation of consortship (herding technique), enticement to travel together, and solicitation for play (Nishida *et al.*, 1999).

42.5 Hygienic behaviors with tools

42.5.1 Muzzle rubbing and hand rubbing with objects

Leaf napkins, which are tools used for wiping off feces, semen, blood, and other excreted matter, have been customarily observed in Gombe, Kibale, and Budongo, but only rarely at Mahale (Goodall, 1986; Nishida, 1994, 2003a; Nishida *et al.*, 1999; Whiten *et al.*, 2001). However, in 1998, four chimpanzees began to regularly wipe lemon juice from their mouths with leaves and branches without detaching them from the lemon trees (Nishida, 2003a; Corp *et al.*, 2009). In 1999, 18 and 12 chimpanzees were observed wiping their faces or hands, respectively. This behavior, termed "muzzle rubbing" (Nishida *et al.*, 1999; Corp *et al.*, 2009), differed from leaf napkin behavior because Mahale chimpanzees rub their bodies (muzzles and hands) with undetached plant materials, not with detached leaves or twigs. Muzzle rubbing at Mahale increased from 1998, reached a peak around 2000, and declined after 2002. Corp *et al.* (2009) implied that the muzzle and hand rubbing at Mahale became prevalent via the influence of the alpha male, Fanana, who was one of the first individuals to exhibit muzzle rubbing while eating lemons, but was never observed after 2002, despite more than 300 h of focal observations in 2002–5.

42.5.2 Leaf grooming

The chimpanzees of Gombe (van Lawick-Goodall, 1968; Boesch, 1995), Mahale (Nishida, 1980b), Kibale, and Budongo (Whiten *et al.*, 2001; Assersohn *et al.*, 2004) have been observed to seize a leaf and manipulate it in a grooming context as if they were grooming the leaf (see also Chapter 34). However, the function of this behavior was a puzzle for decades (Nishida *et al.*, 1999; Zamma, 2002).

Zamma (2002, 2006) identified a function of leaf grooming at Mahale by collecting and analysing leaves discarded by chimpanzees after leaf grooming. Zamma (2002) observed a case of leaf grooming in which an adult male, Masudi, groomed with a leaf and a louse

was found on the discarded leaf. In this case, Masudi picked a leaf and transferred a louse from his lower lip to it, folded it and crushed the edge where the louse was placed inside, opened it and touched the crushed point with his lips. Zamma (2002) indicated that at least one function of leaf grooming is "squashing ectoparasites." In addition, Zamma (2006) found a hatched egg of a louse on a leaf discarded after leaf grooming, and suggested that chimpanzees have the skill to remove louse eggs as well as adult lice and ticks by grooming, and squash them by leaf grooming.

42.5.3 Probe use for removing sand fleas from a toe

On September 25, 2001, Nishida (2002) observed an 8-year-old female of the M group, Ivana, broke a small twig from a shrub, held its leafy part, and pushed the sharp edge under the nail of a toe on her left foot with her right hand. After trying to insert the probe several times over 5 min, she threw the probe away and put her toe into her mouth, apparently trying to suck something out. This use of a probe inserted under the nail with visual and manual inspection strongly suggested that Ivana was trying to remove a sand flea (or fleas), because such behavior is performed by humans in the same circumstances (Nishida, 2002).

42.5.4 Nasal probe

Nishida and Nakamura (1993) reported a case in which an adult male, Kalunde, used a "toothpick-like tool" to induce sneezing that cleared the nasal passage during a flu-like illness in 1992. Kalunde showed this behavior for more than 10 years (which was also observed by Kenji Kawanaka in 1996, by Toshisada Nishida in 1997, and by Koichiro Zamma in 2000; Nishida *et al.*, 2009). Marchant and McGrew (1999) observed a similar case in which a 9-year-old female, Maggie, held a small twig in her left hand to probe her left nostril on October 8, 1996. She removed mucus by probing her nostril and ate it, putting the twig crosswise in her mouth. Soon after, she repeated the procedure and succeeded in inducing a sneeze that yielded more mucus, which she ate with some leaves.

42.6 Play with objects

42.6.1 Tool use for drinking water

Tool use for drinking water is customary among the chimpanzees of Bossou, Taï, Gombe, Kibale, and Budongo (Whiten *et al.*, 2001). In contrast, it was observed only rarely at Mahale (Whiten *et al.*, 2001; Matsusaka *et al.*, 2006) until the 1990s. Subsequently, 42 cases of drinking water with tools were observed between 1999 and 2004 among M-group chimpanzees, all of which were performed by immature individuals (2.3–10.8 years old: Matsusaka *et al.*, 2006). In these cases, water was obtained from tree holes in 20 cases and from streams in 22 cases. Chimpanzees successively used several objects such as leaves (leaf sponge, leaf spoon, uncrumpled leaf) and sticks (twig, vine, grass stem, peeled vine, midrib of leaf) during one episode of tool use for drinking water. In two cases, the use of a "tool set" was observed: the chimpanzees used a stick to pick a leaf sponge out of a tree hole. In contrast to other study sites, Mahale chimpanzees rarely modified leaf sponges before soaking them in water, but usually soaked an uncrumpled leaf in water and chewed the drenched leaf, consequently making the leaf like a sponge. The increase in this behavior in the 2000s among only immature chimpanzees at Mahale was likely the result of social learning because it occurred within a very short period and adults paid little attention to the behavior while immature individuals often observed the tool use of others with great interest. This suggests that tool use for drinking water at Mahale seems to be a playful activity, i.e. not done out of necessity (see also Chapter 40).

42.6.2 Leaf-pile pulling

Leaf-pile pulling is a playful behavior customarily performed by Mahale chimpanzees (Nishida and Wallauer, 2003). Typically, when a party of chimpanzees moves in a procession down a slope, a chimpanzee turns around and walks backward while raking many dry leaves on the ground with both hands. This activity accumulates many dry leaves while

producing a lot of sound. A performer usually faces another individual that is immediately following him or her in the procession.

Since leaf-pile pulling is performed by one individual as a locomotory movement, includes manipulation of objects (dead leaves), and is often displayed to an individual following the performer, it comprises all three components of primate play (locomotory, object, and social play; Nishida and Wallauer, 2003), although few detailed studies of play have been conducted among primates (see also Chapter 40).

According to Nishida and Wallauer (2003), leaf-pile pulling was first recorded in 1989 at Mahale, and 73 cases were observed during 339 observation hours between 1999 and 2002. The performers were 11 infant males, 11 infant females, 22 juvenile males, 19 juvenile females, 6 adolescent males, 1 adolescent male, and 3 adult males. Thus, leaf-pile pulling was performed mostly by infants and juveniles (63/73 = 86.3%). The contexts in which leaf-pile pulling was displayed were travel (39/73 = 53.4%), play (13/73 = 17.8%), and rest (8/73 = 11.0%).

Leaf-pile pulling has not been reported at Taï, Bossou, Kibale, Budongo, or Kalinzu (Uganda). At Gombe, this behavior was observed in five different chimpanzees on 10–15 occasions between 1996 and 2002. At Mahale, leaf-pile pulling is a standardized play pattern that is displayed by most immature chimpanzees of the M group and can be called customary (Whiten *et al.*, 2001). Because this behavior has been performed for more than two decades, it might be socially learned and thus be a tradition of the M-group chimpanzees.

42.7 Carrying objects

42.7.1 Knotted skin "necklace"

McGrew and Marchant (1998) reported a case of a knot tied in a piece of the skin of a red colobus monkey worn by a chimpanzee at Mahale. On November 7, 1996, chimpanzees of the M group killed and ate a red colobus monkey, and the next morning they still carried "leftovers." On the morning of November 8, a juvenile female, Ai, was playing with and grooming a strip of skin. It was stolen by a juvenile male, Primus, while playing. After a while, an adolescent female, Ako, was seen wearing what appeared to be the skin draped around her neck. The knot created a "necklace" of 68 cm circumference, with a "tail" of 31 cm length. McGrew and Marchant (1998) noted that this was the first case in which a draped adornment was made by nonhuman animals.

42.7.2 Carrying guineafowl feathers

Nakamura (2009) reported a case in which an old female, Wakusi, collected some guineafowl feathers and carried them for more than 30 min without displaying any emotional expressions. It is unlikely that Wakusi assumed the feathers represented bird meat because she never sniffed or licked them. The feathers did not seem to be "toys" for Wakusi either, because she did not show any attempt to manipulate them in a playful manner, but just held them in her hand, lips, or groin pocket. Nakamura (2009) noted that Wakusi did not seem to collect and carry the feathers for a particular functional reason, and that it is possible she did it with a kind of aesthetic sensibility that might be shared with humans.

42.8 Conclusion

Mahale chimpanzees have a smaller repertoire of tool and object use than chimpanzees at other long-term study sites. In particular, the repertoire of tool use for feeding is not rich at Mahale. For example, nut-cracking behavior using stone or wood hammers and anvils to obtain kernels inside hard shells of nuts, which has been widely observed among wild chimpanzee populations in West Africa (Sugiyama and Koman, 1979; Boesch and Boesch, 1990), and *Dorylus* ant-dipping behavior, which is popular among many populations across Africa (McGrew, 1974; Sugiyama *et al.*, 1988; Boesch and Boesch, 1990), have never been observed at Mahale. Furthermore, as noted above (42.2), although termite-

fishing behavior has been reported from many populations of wild chimpanzees across Africa, at Mahale it has been observed customarily only in the B group, and seldom in the K and M groups, indicating it is a relatively minor tool-using behavior at Mahale. In sum, Mahale chimpanzees do not seem to be eager to forage for potential food resources that are hard to obtain without tools.

On the other hand, the repertoire of tool and object use in social, hygienic, and play behaviors of Mahale chimpanzees is rather rich. This may imply that Mahale chimpanzees spend more time on non-subsistence activities such as social grooming and play compared with chimpanzees at other sites.

Although a detailed comparison of food availability across chimpanzee study sites has not yet been conducted, there might be relatively more food resources at Mahale, making Mahale chimpanzees less eager to forage for potential food resources that require tools to be accessed. The relationship between tool use for food extraction and ecological factors, such as food availability or time allocated to foraging, remains to be studied in detail.

It is also notable that many "rare cases" of tool and object use, which have not become customary in a group, have been reported from Mahale. This chapter reviewed only some of them: termite fishing with tools by M-group chimpanzees, hunting with tools, probe use for removing sand fleas from toes, nasal probing, wearing of a skin "necklace," and carrying guineafowl feathers. There are many other reported cases of idiosyncratic behavioral patterns of tool and object use that this chapter does not describe in detail. For instance, Nishida (1994) reported a case of "washing" a colobus coat in a riverbed by dunking and shaking it underwater and by stamping on the skin with one foot on a rock by an adult male. Nishida *et al.* (2009) reported a case of digging with a stick in a streambed by a juvenile female to obtain water. Only long-term, painstaking observation enables researchers to encounter and detect such rare behaviors; therefore, the many rare or idiosyncratic cases of tool or object use reported from Mahale are the fruit of 50 years of long-term study (Nakamura and Nishida, 2012).

Although this chapter failed to include them all, some other tool- or object-use behaviors have been reported in Mahale chimpanzees as well, such as bed making (see Chapter 43), ground grooming (see Chapter 34), and back rubbing against a tree trunk after rain (Nishida, 1980a). Further studies on tool- or object-use behaviors of Mahale chimpanzees are necessary to elucidate changes in these behaviors over time, the relationship between tool or object use and ecological factors, and the mode of tool or object use in social interactions.

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