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Tool-Using and -Making Behavior in Wild Chimpanzees at Bossou, Guinea

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ABSTRACT. The bahavior of wild chimpanzees at Bossou, Guinea, was studied from November 1976 to May 1977 recognizing each chimpanzee without artificial feeding. During the study period some tool-using and tool-making behavior was observed, as follows: (1) Although water drinking using a "leaf-sponge" was not seen, that using a "leaf-spoon" was observed for taking water from the hollow of a tree. (2) "Termite fishing" was not seen in this group although there were many termite hills in the moving range of the chimpanzees. They dug termites from the hollow of a tree by pounding with a small stick. Similar use of a stick was made for digging up the resin from a tree. (3) "Aimed throwing" was frequently observed in adult males for attacking an observer, and in adolescents and juveniles as mischief against an observer or for their own play. (4) "Nut cracking" with a pair of stones was seen for removing the ovule from palm-seeds. Particular stones were repeatedly used by many chimpanzees for a long period. (5) "Branch hauling" represented difficult work. Patient and inventive manufacture of proper sticks was necessary for capturing branches which they were unable to reach normally.

Local variations in the tool-using patterns and manufacturing ability of chimpanzees are discussed.

INTRODUCTION

Many observations have been made on the tool-using behavior of wild chimpanzees (LAWICK-GOODALL, 1968; JONES & SABATER PÍ, 1969; STRUHSAKER & HUNKELER, 1971; NISHIDA, 1973; MCGREW, 1974; and others). The present authors studied the behavior of wild chimpanzees at Bossou, Guinea, for six months from November 1976 to May 1977 without artificial feeding but employing the method of individual identification. During the study period, certain tool-using and tool-making activities were observed. The present paper deals mainly with those activities which have so far been little reported.

The Bossou chimpanzee group was composed of 21 chimpanzees (Table 1). Apart from an accident that apparently befell an infant-3 female (*Kubo*) who disappeared in February 1977 and an episode in which two solitary males joined the group for a short period, there was no member change in this group throughout the study period. Of all temporarily formed parties (including solitary movements), 62% were large mixed parties including more than 75% of all the members. This group was highly organized compared to other chimpanzee populations which have been studied. The environment, social structure, and dynamics of the Bossou chimpanzee group are described by us in another report (SUGIYAMA & KOMAN, 1979).

Table 1. Composition of the Bossou chimpanzee group and frequency of confirmed tool users and makers

Name	Sex	Age[1]	Offspring	Use of leaf spoon	Termite digging	Resin digging	Aimed throwing	Nut cracking	Branch hauling
Bafu	♂	Adult					6		2
Tua	♂	Adult			1				2
Aiwa	♂	Adult			1		8(S=2)[3]		9
Kai	♀	Adult	*Kure, Kubo* (♀3±)[2], *Kie* (♀1−)						
Jire	♀	Adult	*Jima, Jie* (♂1±)				3		
Fana	♀	Adult	*Fino, Fon* (♀0.5±)						
Nina	♀	Adult	*Non, Nyu* (♀0.5±)						
Yo	♀	Adult	*Yiri*						
Velu	♀	Adult	*Vu*				1		
Pama	♀	Young adult							1
Non	♂	8±				1	3		1
Kure	♀	8±		1		5	21(O=1)[3]		1
Fino	♀	5±				1	3		
Vu	♂	4±				2	5(O=1)		
Jima	♂	4±				1	15(O=3)		1
Yiri	♂	3±					4(O=1)		
Total			♂8+♀13 = 21	1	2	10	69	7[4]	17

1) Estimated age; 2) *Kubo* disappeared on Feb. 23, 1977; 3) S = Side-arm throwing; O = over-arm throwing; 4) No exponent was identified.

WATER DRINKING WITH A LEAF-SPOON

LAWICK-GOODALL (1968) reported that chimpanzees drank water using leaves like sponges as drinking tools when they were unable to reach water which had collected in the hollows of trees.

In the present study, the authors once observed an adolescent female (*Kure*) who inserted a hard leaf of *Aningueria robusta* into a water hole in a tree which had been left after a dead branch had fallen down from the tree. She pulled it up and licked as well as sucked the water without crumpling the leaf. This occurred on May 17 after there had been some rains but no drinking water could be found in the forest except in such hollows in trees. She repeatedly tried to drink water for 5 min.

TERMITE AND RESIN DIGGING WITH A SMALL STICK

"Termite fishing" is a well known tool-using behavior in chimpanzees which has been reported from Gombe (LAWICK-GOODALL, 1968; MCGREW, 1977), Mahali (NISHIDA, 1973), Kasakati (SUZUKI, 1966), and Rio Muni (JONES & SABATER PÍ, 1969).

Although there were many termite hills in the major part of the moving range of the Bossou chimpanzee group, no evidence of "fishing" could be found. The termite catching method was different at Bossou. After a dead branch had fallen down, termites sometimes began to make a nest in the hollow of the tree. The chimpanzees would then take a small twig of 5–15 cm in length, remove the side branches and leaves, and so make a small stick. Next, they would beat and pound the bottom of the hole

Fig. 1. A small stick and the hollow in a tree where the chimpanzees dug for termites with it.

several times. On pulling the stick out a few termites would be attached to it, mostly broken and adherent. The chimpanzees would lick them off and again try to pound the bottom of the hollow. Two adult males (*Tua*, *Aiwa*) attempted this for 30 min each on a *Canarium schweinfurthii* tree but succeeded in retrieving only a few termites (Fig. 1).

For obtaining resin the chimpanzees took a somewhat longer twig than that used for termite digging, that is, 10–20 cm in length. Removing the side branches and leaves with their teeth quickly, they repeatedly pounded and mixed by stirring the bottom of the hollow of a tree (always *Carapa procera*). On pulling the stick up, a brown-colored resin was seen to be conglutinated stickily on it. The chimpanzees licked this off and repeated the same procedure for more than a quarter of an hour. This kind of activity was observed only in adolescents (*Non*, *Kure*) and juveniles (*Fino*, *Vu*, *Jima*) (cf. Table 1).

AIMED THROWING

Sixty-nine episodes of throwing of tree-branches or *Platycerium angolense*, an epiphyte, were recorded. During the first stage of our study, most cases of throwing were performed by adults, especially males, in order to attack the authors who were then not familiar to them but persisted in remaining at a short distance. After January when the chimpanzees had become accustomed to the authors sitting under their trees, throwing was performed mainly by adolescents and juveniles for mischief against the authors or for their own play.

Attacking throws by the dominant male (*Bafu*) and the third male (*Aiwa*) were as follows. They broke off the biggest dead branch which was immediately available, carried it in their hand, ran along a branch which stretched above the authors making exaggerated attacking gestures and threatening vocalizations, stopped just above the enemy (one of the authors), swung the dead branch in their hands, and then threw it under-arm. The length and weight of the branches which were thrown by the adult males were 100–190 cm and 1,000–3,500 g, respectively (Fig. 2). However, the branches thrown by adolescents and juveniles were smaller, usually 40–100 cm and less than

Fig. 2. A large dead branch which the dominant male threw at an observer. It was 120 cm in length and weighed 3.2 kg.

1,000 g. The throwing was well controlled, especially that by adult males, and on a few occasions the branches hit one of the authors and his research apparatus which was kept nearby. These actually represented severe attacks for the authors when standing or sitting on a steep hill with no means of quick escape. However, the throwing by females and juveniles was not well controlled since they did not come just above the enemy.

Most throwing was performed by the under-arm method but two cases by the third adult male (*Aiwa*) were side-armed and six by an adolescent female (*Kure*), juvenile males (*Vu*, *Jima*), and an infant-3 male (*Yiri*) were over-armed. After swinging the arm vigorously, the branch was released: Its speed was greater than in under-arm throwing but the throwing was not well controlled except in the case of *Aiwa*.

NUT CRACKING WITH STONES

BEATTY (1951) and STRUHSAKER and HUNKELER (1971) have reported nut cracking with stones and sticks. However, direct observations have remained inadequate.

Within the major part of the moving range of the Bossou chimpanzee group, 29 cracking sites were found. Direct observations of nut cracking were made three times, although all the sites were on the dark forest floor and the tool-user could not be recognized. All cracking-sites were under oil-palm (*Elaeis guinensis*) trees. In all sites except three, there were some stones other than "tools" and many dried as well as wet palm-seeds were always scattered around the cracking site. A pair of stones, a pebble tool, and a platform stone, were always prepared. The platform stone sometimes weighed less than 1,000 g but usually more. The pebble tool weighed 500–850 g which must be quite comfortable to grip and strike a palm-seed of dimensions about 1.5×2.5 cm (Fig. 3). It was a little too heavy for the authors' use. The striking surface of both stones was almost flat and in the center of the face was a cavity about 0.5 cm in depth and 3–4 cm in diameter. This provided evidence of the numerous trials regularly made with the same stones in the same way (Fig. 4).

The pebble tool was always kept within 30 cm of the platform stone and more than

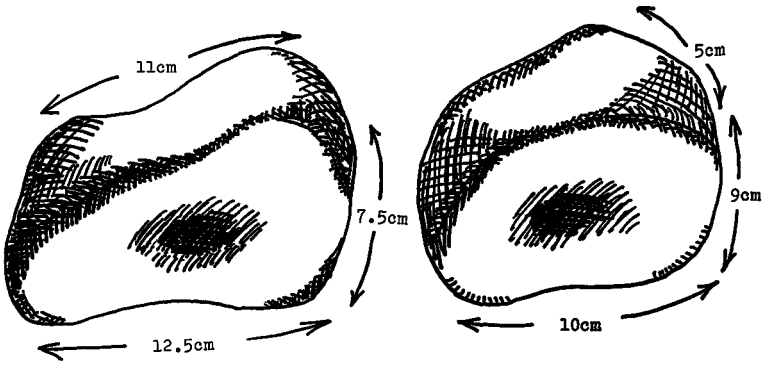

Fig. 3. Two examples of pebble tools. The lower part (near-side) is the striking surface and the upper part (far-side) is the grip. The left stone weighed 750 g and the right stone, 745 g.

Fig. 4. A platform stone (left) and a pebble-tool (right) for the cracking of palm-seed. The surfaces are flat and there are shallow cavities in the centers which provide evidence of their repeated and extended use.

20% of them were kept properly just on the platform stone. At three cracking sites there was no stone appropriate for nut-cracking within 15 m, except the pair of tool stones. They must therefore have been transported from some other place for their intended purpose. Around the tool stones there were always more than a hundred broken shells.

A chimpanzee who crouched in front of the platform stone chose a dry palm-seed, placed it in the cavity of the platform stone, gripped the handle side of the pebble tool, lifted it up to a height of 5–20 cm, and then struck the palm-seed. It took the chimpanzees 2.84 strikes on average ($n = 18$ crackings) to crack a palm-seed, although it took the unexperienced author 2.5 strikings on average. When a palm-seed was broken, the chimpanzee removed the white ovule with his fingers and ate it in about 1 min. Then, he attempted to crack another palm-seed. After the chimpanzees had left the authors examined the broken shells and found little remaining ovule in them. However, in the author's broken shells there was sometimes much remaining ovule which could not be separated from the shell.

Fig. 5. Nut-cracking stones used by men. The selection of stones and cracking method are in general the same as of the chimpanzees, although the human pebble tool is smaller than that used by the chimpanzees.

The villagers of Bossou also remove the ovule from palm-seeds in the same manner (Fig. 5), boil it and obtain the palm-oil. However, they usually collect the palm-seeds first and crack them at the boiling site. Sometimes they crack and eat palm-seeds like the chimpanzees but do their cracking on the path. The chimpanzees' cracking sites were always in the forest where people rarely ventured.

At one cracking site there were 1–4 pairs of tool stones and the site could accommodate only 1–4 chimpanzees at a time. When a party of chimpanzees came to the cracking site, chimpanzees other than the cracker would feed on other fruits or nuts and the cracking site would be used by a few individuals in succession during the time they stayed there (20–60 min). The cracking site and the tool stones were not in the exclusive possession of any particular chimpanzee and must have been used for more than several years by successive generations.

BRANCH HAULING WITH A BIG STICK

From mid-February a huge fig tree (*Ficus mucuso*) which was located on the western side of the peak of Gban, a small hill behind the village (see SUGIYAMA & KOMAN, 1979), became covered with ripened fruits. The chimpanzees showed a great liking for figs, like the chimpanzees of the Budongo Forest, Uganda (SUGIYAMA, 1968), but this tree was too thick for them to climb. They usually reached out to a branch of the tree from the upper branches of an adjacent tree but there were few suitable trees from which they could easily reach this fig tree. It was therefore necessary for the chimpanzees to catch a branch of the fig tree by pulling it towards them using tools or some other technique. The typical activity of the chimpanzees on March 3, 1977 is described next.

At 16:45 the chimpanzees arrived from the elephant grass (*Pennisetum purpurium*) plateau on the southern side of Gban and climbed up the kapok tree (*Ceiba pentandra*) which had large branches extending beneath those of the fig tree. The first individual, *Bafu* (the dominant male), sat on the base of the branch while the second individual, *Aiwa* (the third ranking male), proceeded to its mid-point from where he could look up at the fig branch just above him about 170 cm from his branch.

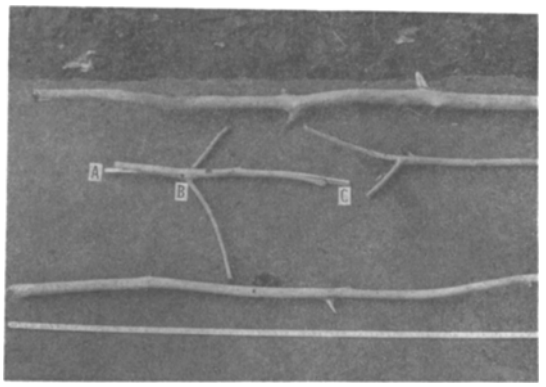

Fig. 6. Hook-type stick-tools made from *Ceiba pentandra*. The thorn bark was always removed quickly and skillfully with the teeth.

(1) Standing bipedally he stretched his right arm up to the fig branch above but it was too high for him to reach. (2) Then he broke a small branch off the kapok tree and removed the thorn bark and side branches with his teeth. Taking the 50 cm straight stick in his left hand, he beat the fig branch but it would not fall nearer.

(3) At 16:52 he dropped the first stick and broke a new branch. After repeating the same process of manufacture he prepared a hook-type stick (Fig. 6). He then gripped the point A which was nearer to the base, stood bipedally and tried to pull the fig branch which was caught in the side branch of the hook-type stick, but the fig branch slipped away as it approached his hand. (4) After discarding the second stick he took another branch of about 120 cm in length, prepared a hook-type stick again and gripped the point C but the distance B–C was too short. The side branch of the hook-type stick for capturing the fig branch was unable to reach its destination and he again failed.

(5) To make a fourth stick of about 120 cm in length, *Aiwa* bit away the thorn bark but sufficiently only so that it remained hanging to the stick. When he stretched and pulled the stick, the hanging bark became entangled around the fig branch which came half way towards him. All the chimpanzees who were waiting on the kapok tree gave an exciting high pitched call but unfortunately the branch slipped away again. (6) He broke this stick in two, dropped one piece and took the other. The stick was not long enough to reach the fig branch.

(7) He then stopped making tools. Gripping his standing branch with both arms and legs, he swung with all his power and when the swinging branch reached its highest point he suddenly stood bipedally and stretched out his left hand. The top of his fingers touched a fig leaf but he failed to grip it. The waiting chimpanzees again called and barked synchronously.

(8) He next broke off a big curved branch of 250 cm in length and using a similar process of manufacture to the above, prepared a long curved stick but it was too heavy for him to control its use. (The stick weighed more than 1,000 g.) (9) Dividing the long stick into two he prepared a shorter hook-type stick of length 120 cm and weight 800 g but discarded the curved part. He gripped the point C, stretched and caught the fig branch, but on its way to his hand the branch again slipped away. If he had remained sufficiently patient to try three or four times he probably could have succeeded in capturing the fig branch but he dropped the stick. (10) Incorrigibly persistent he prepared another stick of the hook type, gripped the point A and stretched, but again failed to catch the fig branch.

At 17:22, *Bafu* was unable to wait any longer and came to the same vantage point with a stick of about 80 cm in length in his mouth. *Aiwa* retreated and *Bafu* looked up at the fig branch. However, without trying to stretch the stick upwards, he dejectedly returned to his own position.

(11) *Aiwa* moved back to the vantage point and broke off most of the nearby branches. He did not prepare any sticks but dropped the branches without hesitation. The main branch on

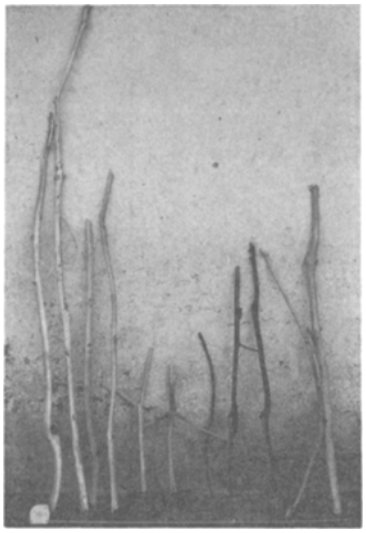

Fig. 7. Stick-tools made and used by the chimpanzees. The rule indicates 100 cm.

which he was sitting became lighter and rose slightly. He swung on it with all his power as before, stood up and stretched out his left hand. He slightly touched a fig leaf, but it slipped away. (12) *Aiwa* repeated the same process and at last, at 17:36, he succeeded in catching a fig twig. It was then 51 min since he had begun his endeavors. All the waiting chimpanzees made a hooting and booming noise with tree shaking. *Aiwa* climbed onto the fig tree and uttering high pitched calls ran throughout the tree for 2 min without eating the fig fruit which he had sought to reach for so long.

At 17:37, *Bafu* came to the vantage point, prepared a stick and stretched it upwards. The stick beat the fig branch but he was unable to pull it towards him.

At 17:50 *Bafu* returned to his place and *Tua* (the second ranking male) approached the vantage point. (1′) *Tua* swung the main branch, stretched his hand up like *Aiwa* and touched a fig leaf but failed to catch it.

(2′) He broke off a long slender branch and prepared a stick of length 174 cm and weight 1,000 g (Fig. 7). He then beat the fig branch. The stick caught in the fig branch but the latter slipped away. (3′) He raised the long stick as high as possible and placed its upper part on the fig branch keeping the other end in his left hand. The fig branch hung down under the weight of the stick which he gripped standing bipedally and stretched up his right hand. The waiting chimpanzees made a hooting and booming noise. *Tua*, with the long stick in his hand, climbed up the fig branch.

Immediately *Tua* was on the branch, *Bafu* ran to the vantage point and captured the fig branch which was hanging down under the weight of *Tua*. *Bafu* was then able to climb up too. *Nina* (a mother) with a baby (*Nyu*), *Pama* (a young adult female), *Non* (an adolescent male), and all the waiting chimpanzees captured the fig branch before he had left the hanging fig branch. All the chimpanzees became strongly excited and made a booming noise. *Non* tightly embraced his mother, *Nina*, face to face giving an exaggerated excited gesture with grins and uttering a high pitched vocalization.

It had taken *Tua* 5 min to capture the fig branch.

The endeavors to reach this fig tree continued until March 5 but the leaves and twigs became broken and fell off. Climbing up the fig tree subsequently became even more difficult. There were few branches left at the vantage point on the kapok tree but the chimpanzees never retrieved the used sticks from the ground (Figs. 7 & 8a–e).

Fig. 8 a. An adolescent male, *Non*, broke a branch from *Ceiba pentandra* and removed the thorn bark with his teeth. (Most of the branches had already been destroyed). (March 4, 1977) **b.** Having the stick in his left hand he stretched it towards a hanging branch of *Ficus mucuso*. However, because he remained seated on the main branch and gripped it with his right hand for support, the stick failed to touch the fig branch. **c.** He stood up bipedally but still supported himself with his right hand. The stick only slightly touched the fig branch. **d.** Standing as straight as possible he stretched the stick up with his left hand. **e.** The stick beat the fig branch but he lost balance on the rocking main branch. **f.** After attaining success, all the chimpanzees climbed up into the fig tree.

DISCUSSION

Five different types of tool-using and -making activities which were observed in the wild chimpanzees at Bossou, Guinea, are described in this report.

a) Although the chimpanzees of Tanzania drink water from hollows in trees into

which they cannot reach, using a crumpled leaf like a sponge, they do not drink water using a leaf like a spoon (LAWICK-GOODALL, 1968; and others). Termite fishing by chimpanzees is observed not only in Tanzania (SUZUKI, 1966; LAWICK-GOODALL, 1968; NISHIDA, 1974) but also at Rio Muni, West Africa (JONES & SABATER PÍ, 1969). On the other hand it is not seen in the Budongo Forest, Uganda (REYNOLDS & REYNOLDS, 1965; SUGIYAMA, 1969). KORTLANDT (1972), who extensively studied wild chimpanzees throughout West Africa, failed to observe any case of termite fishing. Although at Bossou there were many termite hills within the chimpanzees' territory, they never attempted termite fishing but did occasionally try "termite digging or pounding" from the hollows in trees.

Employing the same or similar object as a tool to achieve the same or similar purpose, clearly gives rise to local differences in the precise manner of tool using. This is a form of cultural variation, however primitive.

b) Aimed throwing of branches and other objects does not require a complicated technique of tool making, but its frequent usage for attacking an enemy proves the power of the stick-tool as a weapon. Actually, it had sufficient effect to repel all men, apart from the senior author of this article. Recent studies on the behavior of free ranging chimpanzees who had extensive leisure time and lost their enemies through artificial feeding, have indicated that the important tool-using and -making activities could be seen mainly during the resting time of the day when animals were neither busy for collecting the minimal requirement of food nor engaged in fighting against an enemy for survival (NISHIDA, 1974). Nevertheless, the frequent usage of aimed throwing for attacking an enemy from a safer place suggests that weapon carrying and throwing techniques as well as fine manipulations for obtaining favorable food such as termite fishing, have had an important place in the evolution of bipedalism and culture during hominization.

c) The nut cracking behavior using stone tools is highly suggestive of early man's stone-tool culture, although the stones were not actually manufactured purposefully. The best type and best-sized stones were selected for the specific task and were used by many individuals in the same way at the same working site over successive generations. The cavity in the center of the striking surface which was formed by repeated use, became the best place to hold the nut which should not be allowed to fall. This kind of tool must be almost identical to those used by earliest man. Indeed, if they had been found at excavation sites, archaeologists almost certainly would have judged them as human stone tools from the unnatural cavities on the pebble tool and platform stone surfaces.

d) Stick-tool-using behavior for banana hauling by caged chimpanzees has been known since KÖHLER's experiments (1917). However, the manner of use of this potential ability and the manner of making the tools from natural resources among wild chimpanzees, remained undetermined. Branch hauling behavior using a stick-tool to reach a tree which was too thick to be accessible by climbing, was performed in the present group of chimpanzees after patient trials at making many kinds of stick-tools differing in size, weight, length, and manner of use. The chimpanzees exercised an extensive range of inventiveness and ability according to the situation.

The third exponent, *Tua*, tried not only the first animal's methods but also a new method of his own invention. This indicates that the chimpanzees were not only able to imitate a previous method but also to devise and improvise in their daily life. On the other hand the second animal observed, *Bafu*, failed to reach the fig tree by his own efforts. This indicates a range of ability, talent, and patience among different individuals. However, after *Tua* had succeeded, *Bafu* immediately occupied the vantage point and captured the fig branch before *Tua* had left the hanging branch. This suggests that even *Bafu* himself must have introspectively accepted that he had failed to capture the branch when *Aiwa* succeeded.

Although the chimpanzees devised and invented many techniques, they failed to make an effective hook-type stick-tool. However, if they had succeeded in the manner easily possible to man, they would readily have pulled and captured the hanging fig branch. This must show the limit of the chimpanzees' tool-making ability in this direction.

e) All the chimpanzees who attempted to prepare a stick-tool quickly removed the thorn bark and side branches without hesitation in most cases and made a stick-tool from a rough broken branch. The manufacturing process was almost the same as that for preparing termite and resin digging tools. This may represent a traditional technique for manufacturing stick-tools which, although not known from fossil remains, could have been used in similar form by earliest man.

f) The success attained after the long-sustained efforts and waiting sent the chimpanzees into a deeply excited condition. This type of excitement had rarely been observed among wild chimpanzees even by the senior author. It is apparently based on human-like emotions within a thinking mind.

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