Ethoarchaeology and Elementary Technology of Unhabituated Wild Chimpanzees at Assirik, Senegal, West Africa

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ABSTRACT

Like other wild chimpanzees (*Pan troglodytes*), the savanna-dwelling apes of Assirik, Senegal, West Africa, make and use tools and so have an elementary technology. Unlike their more famous counterparts elsewhere in Africa, these apes are not observable at close range. Instead, they are amenable to etho-archaeological study, in which the indirect data of artifacts, remnants, and fecal contents add to the sparse behavioral data. These open-country hominoids show 15 behavioral patterns that appear to be material culture, in the minimal sense of socially learned behavioral diversity. These can be divided into subsistence (N = 7), social (5) and maintenance (3) activities shown at customary, habitual, or present levels of frequency. Some patterns, such as Termite Fish or Baobab Crack, leave behind assemblages of hundreds of artifacts or remnants in predictable contexts at enduring worksites. Other patterns are rare and ephemeral and are known only from anecdotal data. Almost all artifacts and remnants are non-lithic, and so their perishability limits their discovery and analysis. Maximally productive use of such data depends on close collaboration between archaeology and primatology.

INTRODUCTION

Observers of unhabituated wild chimpanzees and paleoanthropologists face a similar problem: They have artifacts but little or no behavioral data on their use. The aims of this paper are to: Describe comprehensively for the first time the elementary technology of an unhabituated population of wild chimpanzees, analyze these mostly indirect data based mostly on artifacts and other remnants, situtate the Assirik findings in the species-typical context of *Pan troglodytes*, and explore how students of prehistory and primatology might help one another.

Habituation is the process of reducing wild animals' fear of human beings in order to make them accessible to behavioral observation. It can be done in various ways, the best of which is repeated neutral exposure to humans, so that the subjects' wariness declines. Fully habituated subjects can be watched at close-range throughout their active periods. Of the 40–plus sites at which wild chimpanzees have been studied, only a handful (e.g. Gombe, Goodall, 1986) have achieved full habituation. The others yield only indirect, non-observational data or fragmented, intermittent observations to varying extents (e.g. Tutin *et al.*, 1995; Matsuzawa & Yamakoshi, 1996). Therefore, primatologists at most sites must draw inferences about behavior based on circumstantial evidence.

All primates leave behind indirect evidence of their presence, and even of their characteristics and activities, that are comparable to data collected on humans by archaeologists: hair (Bonnichsen *et al.*, 2001), feeding remains (Hardy *et al.*, 1997), DNA (Matheson & Loy, 2001), tracks (Leakey & Hay, 1979), bones (Selvaggio & Wilder, 2001), feces (Hunt *et al.*, 2001), foraging signs (Prince, 2001), shelter (Sommer, 1999), etc. Most of this evidence is non-lithic and is not from artifacts.

In recent years, findings from field studies of chimpanzees have informed directly the interpretation of archaeological discoveries: Sept. (1992, 1998) pioneered analogical analysis of chimpanzee nest-building and hominid home-ranging. Backwell and d'Errico (2001) used knowledge of chimpanzee termite-eating to reanalyse bone digging tools used by australopithecines. Goren-Inbar *et al.* (2002) referred to chimpanzee nut-cracking in order to model the origins of pitted stones as hammers and anvils used by Middle Pleistocene hominids. Finally, Mercader *et al.* (2002) went a step further in excavating the lithic technology of West African chimpanzees, at nut-cracking work-sites.

Among living nonhuman species, only the chimpanzee (*Pan troglodytes*) typically makes and uses a tool-kit in daily life (McGrew, 1992). First described by Goodall (1964), such elementary technology has been recorded across populations in east, central and west Africa. Variation in artifacts across populations ranges from environmentally to culturally determined (McGrew *et al.*, 1997). Most of the well-known findings come from forest or forest-woodland mosaic sites where the apes are fully habituated, e.g. termite fishing at Gombe (Goodall, 1986) or nut cracking at Tai (Boesch & Boesch, 1990).

Recent cross-cultural analyses of these few well-known populations have produced an inclusive framework for systematic comparison (Whiten *et al.*, 1999, 2001). Some of these artifacts cannot now be distinguished as ape or early hominid based on appearance alone, e.g. use-wear patterns on stone anvils (Joulian, 1996, Goren-Inbar *et al.*, 2002).

Here, we report for the first time the comprehensive technology of a savanna-living and unhabituated community of wild chimpanzees at Assirik, Senegal.

METHODS

The chimpanzees of Mont Assirik were studied in 1976–79 by the Stirling African Primate Project, SAPP (McGrew *et al.*, 1981) and in 2000 by the Miami Assirik Pan Project, MAPP (Pruetz *et al.*, 2002). Assirik (12º 50' N, 12º 45' W) is the highest point in the Parc National du Nickolo Koba, a 9130–km^2 protected area in southeastern Republique du Senégal. The 50 km^2 core study area is the hottest, driest and most open site at which chimpanzees have been studied (Hunt & McGrew, 2002). Most of the landscape within a 5-km radius of Assirik's summit is grassland, and less than 3% is evergreen forest found only along the few permanent watercourses. The social organization of the Assirik community is typical of the species (Tutin *et al.*, 1983), but the apes range widely (Baldwin *et al.*, 1982) and eat a limited diet (McGrew *et al.*, 1988) by comparison with other populations.

Some data on the material culture of the Assirik apes have been published piecemeal, especially Termite Fish (Baldwin *et al.*, 1981; McBeath & McGrew, 1982; McGrew *et al.*, 1979; McGrew *et al.*, 1982; McGrew, 1983). Other data were presented only in an unpublished doctoral thesis (Baldwin 1979). Most of the patterns given here have never before been presented in any form, and the complete repertoire of elementary technology was first synthesized in line-by-line analysis of 785 pages of field notes, done by SES. Preliminary data on percussive processing of baobab fruits is given elsewhere (Marchant & McGrew, 2002).

The behavioral repertoire of the chimpanzee is large and varies richly across populations. No two study populations, even neighbors, show identical profiles of behavioral patterns. Nishida *et al.* (1999) catalogued more than 500 behavioral categories at one site, Mahale, in Tanzania. Their three-letter codes are included here for purposes of standardization. Whiten *et al.*, (1999) devised a coding system for precise comparison of the status of 65 behavioral patterns that showed potential for cross-cultural comparison across seven groups. Whiten *et al.* (2001) extended this analysis to two unhabituated populations, Lopé and Assirik. Their numbering system and six-category coding scheme (see Table 1) are also included, with modification from observation to indirect evidence.

In 47 months of field study (44 by SAPP and 3 by MAPP), chimpanzees were seen at Assirik only 370 times, which averages to about two sightings per week. Duration of sightings ranged from seconds to hours, but a typical sighting lasted a few minutes. Progress toward habituation was slight in the SAPP years (Hunt & McGrew, 2002),

TABLE 1. STATUS OF BEHAVIORAL PATTERNS, AS CODED IN SIX CATEGORIES (WHITEN *ET AL.* 1999, 2001) FOR OBSERVATIONAL (OBS.) AND INDIRECT (IND.) DATA

CODE	CATEGORY	DEFINITION	
C	Customary	Obs.:	Shown by all or most able-bodied individuals in at least one-age-sex class (e.g. adult males)
		Ind.:	Evidence found regularly and consistently, e.g. same season and ecotype, year after year.
H	Habitual	Obs.:	Seen repeatedly in several individuals, consistent with some degree of social transmission.
		Ind.:	Evidence found repeatedly, in more than one year.
%	Present	Obs.:	Clearly seen at least once.
		Ind.:	Clear evidence found at least once.
–	Absent	Obs.:	Not seen and no apparent ecological explanation for absence.
		Ind.:	No evidence found, and ditto.
e	Ecological Explanation	Obs.:	Absence explicable because of local environmental constraint.
		Ind.:	No evidence found, and ditto.
(—)	Unknown	Obs.:	Not seen but absence uncertain because of inadequate observational opportunities.
		Ind.:	No evidence found, but status of indirect evidence inadequate.

suggesting that knowledge of these apes will be limited to the etho-archaeological data presented here.

RESULTS

The repertoire of elementary technology of the Assirik chimpanzees numbers 15 items. Depending on how one defines a tool (see Beck, 1980), this could be synonymous with their tool-kit; depending on how one defines culture (see McGrew, 1992, 1998), this could be synonymous with their material culture. Here we inclusively define elementary technology as all known object manipulation except for direct processing of foodstuffs (e.g. pluck and chew a fruit) or other ingestibles (e.g. dip fingers in water and suck). This can be subdivided into *artifacts* (objects modified in being used by chimpanzees) and *remnants* (objects showing evidence of chimpanzees' presence). Table 2 summarizes the repertoire, presented in descending order of frequency.

Nest Build

As in all known populations of wild great apes, chimpanzees past the age of weaning build at least one nest per day, on average (Fruth & Hohmann, 1996). This shelter is actually a bed, constructed of the interwoven, leafy branches of woody vegetation. The resulting sleeping platform is a chimpanzee universal, which is obligatory for overnight rest, and optional for daytime rest. Nests are radially symmetrical and saucer-shaped; a nest may incorporate parts of several trees or lianas, or a single large tree may contain many nests. Most overnight nests are arboreal, presumably for protection against terrestrial carnivores, although the function of nests has never been tested.

Nests may persist for many months after their one day of use, and their deterioration is a predictable sequence, from fresh to recent to old to rotting. Nests made in deciduous trees are especially visible in the next dry season, when the rest of the tree's crown may be leafless, except for the nests that retain the leaves woven into it. The rate of deterioration varies with climate, tree species, and style of construction. For example, when

TABLE 2. ELEMENTARY TECHNOLOGY OF WILD CHIMPANZEES OF ASSIRIK, LISTED IN DESCENDING ORDER OF FREQUENCY

FREQUENCY CODE	PATTERN	WHITEN *ET AL.* (2001) NO.[a]	TYPE OF EVIDENCE[b]			FUNCTION[c]	MAHALE CODE[d]
C	Nest build	25	A	O	-	Mai	MBD
C	Buttress beat	7	A	O	-	Soc	DRM
C	Food pound	27, 28	A	O	F	Sub	
C	Termite fish	36, 37	A		F	Sub	FIT
H	Ant dip	39?	A		F	Sub	
H	Nest line			O	-	Mai	
H	Ant peel		A	O	F	Sub	
H	Ant fish	38	A			Sub	FIA
H	Branch clasp	5	-	O	-	Soc	GNH
H	Fluid dip	41	A		-	Sub	
H	Branch shake	6	-	O	-	Soc	SHB
H	Water dig		A		-	Sub	DGS
%	Object throw	49		O	-	Soc	THO
%	Play start	2		O	-	Soc	PSO
%	Leaf napkin	50		O	-	Mai	WIP

[a]Unnumbered patterns are absent from Whiten et al. (1999, 2001)
[b]A = artifact/remnant; O = observation; F = fecal analysis; - = not applicable; blank = not known
[c]Mai = Maintenance; Soc = Social; Sub = subsistence; (see text for explanation)
[d]See Nishida et al. (1999) for definitions and references

branches are bent but not broken, they deform but do not die; such unnatural deformations signal the presence of a nest years later (Fruth & Hohmann, 1994).

At the least, nests show the onetime presence of an ape. Their abundance, distribution, and patchiness are indicators of home range size and use (Sept, 1992, 1998). Their numbers indicate party size at micro-level ("How many nests in a single group of known age?" Baldwin *et al*., 1981, Assirik) population size at macro-level ("How many total nests in a home-range in an annual cycle?" Baldwin *et al*., 1982, Assirik) and census numbers at supra-level ("How many total nests per region over multiple years?" Tutin & Fernandez, 1984, Gabon). Nests yield shed hairs that are amenable to DNA extraction (Morin *et al*., 1994), and because apes defecate and urinate upon arising, nests are good sources of feces and urine for biological analyses (Knott, 2000).

Whiten *et al*. (1999, 2001) did not include ordinary nest-building in their list of behavioral patterns, but a subset, ground-night-nest (No. 25) was there.

Baldwin *et al*. (1981) compared 252 nests at Assirik with 195 nests at Okorobiko, a rain forest site in Rio Muni (Equatorial Guinea = Mbini) on six variables: height of nest, proportion of nests open to the sky, number of nests per group, number of nests per tree, minimum distance between nests, girth of nest tree. Many cross-populational differences emerged, some readily attributable to environmental constraints (e.g. height, as a function of taller trees in the forest than on the savanna), and some not so (e.g. size of nesting party as indicated by number of nests per group). There were marked seasonal differences: In the wet season, nests were scattered widely throughout woodland; in the dry season they were concentrated in evergreen forest, so that some trees were repeatedly re-used.

Buttress Beat

Chimpanzees throughout Africa drum on the buttress roots of trees with their palms or soles. The rhythmic sound is distinctive, and may function as an identifying "signature" at group or individual level. The pattern is probably universal; in all nine groups tested by Whiten *et al*. (2001, No. 7), it was customary. It is not clear whether such drumming communicates between or within groups; it is likely both, but careful work remains to be done, e.g. the distribution of drumming sites is an obvious constraint that varies with vegetation composition and structure. In a singular study, Boesch (1991) claimed that some drumming at Tai was symbolic communication, giving others notice of group movements in time and space.

At Assirik, to hear drumming was so commonplace that its frequency was not regularly recorded, but it was seen only once, when an adult male used a *Pseudospondias microcarpa* buttress. It occurred day and night, apparently most often from groups on the move. There seem to be no quantitative published data on drumming frequency from any site, bit the rate at Assirik seems high, given the low numbers of buttressed trees in this dry ecotype. Only two species were known to be used, *Ceiba pentandra* and *Pseudospondias microcarpa*, both of which were confined to gallery forest. The former species usually bears thorns, which makes it awkward to drum but its buttresses were the biggest in the study area. Some evidence of wear patterns from drumming on buttresses was seen, e.g. areas worn smooth on the distal edges of buttresses, where resonance is greatest, especially along trails in valley bottoms, but this was not systematically recorded.

Food Pound

Some nonhuman species, including chimpanzees, process their food by holding the food-item in the hand and smashing it against a hard surface (Parker & Gibson, 1977). This type of percussive technology is also called anvil use (McGrew *et al.*, 1999). Typically, the food-item is a relatively large (orange-sized or bigger) hard-shelled fruit (e.g. *Strychnos* spp.) but some have rinds soft enough that they can be bitten open (e.g. *Landolphia* spp.) or are so large (volleyball-sized or bigger) that their diameter exceeds an ape's gape (e.g. *Treculia africana* spp.). Rarely, food-items other than fruit are pounded open, e.g. skulls of prey at Tai (Boesch & Boesch, 1990).

Anvil use should not be confused with hammer-and-anvil use, nor with pestle pound, as both of these employ an instrument that is hit against a resting goal object. In nut cracking, the nut rests on an anvil of wood or stone and is struck by the hand-held hammer; it is restricted to far West Africa (see summary in McGrew, 1992). Pestle pounding is unique to Bossou, Guinea, where a chimpanzee detaches a frond (pestle) from the crown of the oil palm, then uses it to smash to a pulp the heart of the palm (food-item) in the cavity formed in the crown of the palm (mortar) (Yamakoshi & Sugiyama, 1995). None of the nut-bearing species of trees exploited elsewhere by chimpanzees is found in the dry environment of Assirik. For a discussion of the logic of percussive technology, including non-primate examples, see McGrew (1992, pp. 173–176) and Joulian (1996).

Chimpanzees at Assirik regularly pounded open the large fruits of baobab (*Adansonia digitata*) during a season that lasted from Nov. to Jan. (Baldwin, 1979). The apes were repeatedly seen to do this arboreally, as the crowns of the trees were leafless at the time; more often they were heard, as the rhythmic bangs were audible for several hundred meters. Scores of cracked shells were strewn on the ground under each tree. The apes consumed the stringy, tart matrix of the pericarp of the fruit (as do local humans, who sell it in local markets, see McGrew *et al.*, 1982) and swallow the pea-sized seeds. Both fiber and intact seeds are readily found in fecal samples (Baldwin, 1979) that correspond to the season of observations, remnants, and artifacts.

Whiten *et al.*, (1999, 2001) distinguished between "food pound onto wood" (No. 27) and "food pound onto other" (No. 28); the former includes anvils that are roots, branches, or trunks of woody vegetation, while the latter are lithic, from stones to outcrops, or even hard earth. Assirik's chimpanzees are known to use all of these, except hard earth.

Bermejo *et al.* (1989) claimed that Assirik's chimpanzees also used hammer-and-anvil to crack baobabs, and this has been cited accordingly as nut-cracking (Joulian, 1995). However, scrutiny of their criteria, which were circumstantial and not observational, shows them to be inconclusive.

In order to test the competing hypotheses of anvil-only versus hammer-and-anvil, we scrutinized four work-sites at baobab trees (Marchant & McGrew, 2002.) Together, these sites yielded 412 fruits and 845 stones. Fruits were nonrandomly distributed relative to stones, being closer than expected by chance. Fruits were equally often associated with fixed versus portable stones, but stones with fruit associated with them were larger and heavier than stones without associated fruit. Stones weighing 10 kg or more most often had fruit associated with them, which suggests anvil rather than hammer use.

Assirik's chimpanzees also use anvils to pound open the smooth, shiny, spherical fruits of *Strychnos spinosa*, as the apes of Gombe and Tai crack open fruit of sister species (Whiten *et al*., 2001). This was never seen at Assirik, but the distinctively cracked shells were found, as were intact seeds in chimpanzee feces (Baldwin, 1979).

Termite Fish

Some populations of wild chimpanzees use flexible probes made from various parts of vegetation—twig, stem, bark, vine, leaf, etc.—to extract the subterranean castes of Macrotermitinine termites from their earthen mounds (Whiten *et al*., 2001, Nos. 36 and 37). The probe is threaded into one of the insects' passages, where they attack it as an intruding object, affixing themselves to it with their mandibles. The probe is painstakingly withdrawn, so that the prey are 'fished' out to the surface, where they are easily eaten. It is a nondestructive, "tapping" operation that can be repeated daily throughout the rainy season, and on an annual, per capita basis, the intake from such invertebrate faunivory probably exceeds that of vertebrates consumed (McGrew, 1979). Nutritionally and calorifically, termites are a high-quality food, the efficient exploitation of which depends on elementary technology (McGrew, 2001).

At Assirik, termite fishing shows remarkable ecological and technological convergence with fishing at Gombe (McGrew *et al*., 1979) and by Mahale's B group (McGrew & Collins, 1985), although the sites are thousands of kilometers apart (McGrew, 1992, pp. 168–173). However, there are striking inter-populational differences too: Assirik's apes often make fishing tools of leaves but never of bark; for Gombe it is vice-versa, though both populations pluck leaves and peel bark in other contexts (McGrew *et al*., 1979).

McBeath and McGrew (1982) most intensively studied termite fishing at Assirik in the season of 1979. They checked 279 mounds of *Macrotermes subhyalinus* and collected 323 tools in 25 assemblages from 15 mounds. These were concentrated in one particular vegetation zone, the ecotone between plateau-edge woodland and gallery forest. Eighty percent of tools were made from one species of woody plant, *Grewia lasiodiscus*, which was concentrated there, although the termites were widespread.

There were many sources of indirect

evidence of termite fishing: used artifacts found on mounds, artifacts left inserted in fishing holes, hairs and knuckleprints in mound surfaces, stripped sites of raw materials from vegetation near mounds, chitinous exoskeletons of subterranean termite castes in chimpanzee feces, etc. The resulting tools were virtually identical at Assirik and Gombe; a transported ape from one site would likely have no trouble using the others' implements. Actual fishing was never seen at Assirik, although apes were flushed from mounds at which fresh fishing and uneaten termites were found.

Baldwin (1979) presented data on the proportion of chimpanzees' fecal samples containing remains of the blind, subterrean castes (worker, soldier) of fungus-growing termites. (Unlike other species or populations of chimpanzees, who dig into mounds, these mounds are intact, so the only way to harvest these castes is to fish them out with tools.) Consumption at Assirik peaked in the first full month of the rainy season, just as at Gombe, with > 70% of samples containing the insect prey.

Surprisingly, Bermejo *et al*. (1989) found little evidence of termite fishing at Assirik in a 16–month follow-up study in 1986–87. Their base camp was in a different valley than the SAPP camp, but this seems unlikely to account for their "failure to replicate" the results of four seasons (1976–79) of SAPP data. Perhaps Bermejo *et al*. failed to recognize the tools, as they had never seen them in use elsewhere, unlike members of the SAPP team who had previously studied termite fishing at Gombe. Or, they may have concentrated their attention in areas other than the ecotone habitat, where most of the tools occur.

Ant Dip

Chimpanzees at several sites insert stiff, straight shoots of woody vegetation into nests or columns of driver ants (*Dorylus* spp.) in order to harvest these biting insects. Such exploitation occurs despite the swarming, aggressive defense of these terrestrial army ants. The technology takes two forms (Whiten *et al*., 2001, Nos. 39 and 40): At Gombe, chimpanzees use long (50–100 cm) wands to dip into the shallowly excavated nests of the ants and then the ants are dextrously concentrated into a single, bite-sized mass by a two-handed technique called the pull-through or wipe (McGrew, 1974). At Tai, there is a simpler technique. A shorter (25–50 cm) rod is dipped into the ants and one-handedly put directly to the mouth, where the insects are swiped off with the lips (Boesch & Boesch, 1990). At Bossou, both techniques are used (Sugiyama *et al*., 1988; Humle & Matsuzawa, 2002).

Because the tools seem to have a standard form, these artifacts are readily recognizable, especially if they are left inserted in the ants' nest. (The wands are stripped of leaves, or leaflets, peeled of bark, and dipped at each end.) They are sometimes re-used on different days by different individuals, but since the nests are only bivouacs, they are exploited only for a few days before the ants move on (McGrew, 1974).

At Assirik, ant dipping was never seen, although freshly used tools were collected and the ants were found in 2% of fecal

TABLE 3. TOOLS USED BY ASSIRIK CHIMPANZEES TO GET TWO SPECIES OF ANTS, *CAMPONOTUS* SPP. (ANT FISH) AND *DORYLUS* SP. (ANT DIP).

PATTERN	PREY	RAW MATERIAL	LENGTH (CM)	DIMENSION* DISTAL DIAM. (MM)	PROXIMAL DIAM. (MM)	N
Ant Fish	arboreal wood-boring sedentary	twig	44 (∀16)	4.0 (∀1.3)	2.4 (∀0.7)	7
Ant Dip	terrestrial underground migratory	twig stem stalk	72 (∀20)	5.7 (∀1.9)	3.5 (∀1.0)	8

*mean (standard deviation)

samples of the chimpanzees (Baldwin, 1979; McGrew, 1983). In total, 48 tools were found in seven assemblages at six sites. The tools averaged 72 cm (∀ 20 S.D.) in length, and 5.7 mm (∀ 1.9 S.D.) in distal diameter and 3.5 mm (∀ 1 S.D.) in proximal diameter. (See Table 3) Since the mean lengths were well outside the range for dipping rods and well inside the range for dipping wands, we infer that they were used for the Gombe-style bimanual pull-through technique (No. 39).

Nest Line

Nest building involves creating a shelter in the form of a pallet of bent-over and inter-woven leafy branches or stems. A few large branches form the foundation, and their side-branches are folded back on themselves to provide the bulk of the bed. Depending on their tensility, these branches may bow or split (as in a compound fracture) but they rarely break completely in two. In contrast, when chimpanzees line their nests for additional padding, they always detach the small, leafy twigs from the surrounding vegetation. In Beck's (1980) definition, this makes nest lining a form of tool use, while nest building is not. At least once at Gombe, these twigs were concentrated in one spot to make a headrest or pillow.

At Assirik, nest lining was seen eight times during the construction of six overnight and two daytime sleeping platforms. One adult female plucked 10 leafy twigs in a row to line her nest. However, no nests were deconstructed, so artifactual evidence of nest lining was not collected.

Ant Peel

Weaver ants (*Oecophylla longinoda*) construct arboreal shelters of living leaves of woody vegetation by gluing them together with larval silk. These self-made containers house subgroups of a single colony of ants, each numbering scores, usually scattered about the terminal branches of a single plant. These structures are fiercely defended by biting ants, which rush out to attack predators when the plant is agitated (McGrew, 1983).

A chimpanzee carefully plucks this package and quickly retreats, then dispatches the ants by rolling the intact container between the palms (or rarely palm and sole), crushing the ants inside. Then, the ape sits and unpeels at her leisure the leaves, one by one, removing any adhering ants, until all leaves are processed clean. (The procedure resembles the human method of eating an artichoke.) The characteristic assemblage of remnants left on the ground below is a concentration of green but unchewed leaves, some with wisps of silk still attached (Goodall, 1968).

At Assirik, ant peeling was seen once, when an adult female quickly rolled a nest between her hands before descending from a small bush. We found six assemblages of remnants, and 24% of fecal samples (N = 194) contained the distinctive heads of the eaten ants: reddish-brown, triangular, with black eyes (Baldwin, 1979).

Ant Fish

Chimpanzees use limber probes of woody vegetation to fish out wood-boring ants (*Camponotus* spp.) from their nest cavities in living tree trunks. The fisher hangs suspended or sits when possible, using one hand to transfer the ant-laden tool from colony entrance to its mouth. The short probe must be thin enough to insert and withdraw quickly from the ants' entrance-hole (Nishida, 1973; Nishida & Hirawa, 1982). Ant fishing is the only pattern of technological insectivory recorded from the eastern, central, and western subspecies of chimpanzee (Whiten *et al*., 1999, 2001, No. 38).

Ant fishing was not seen at Assirik but artifacts were collected on seven occasions, totalling 67 tools. Concentrations of tools were found on the ground beneath trees with ants active and visible overhead on the trunks. Unfortunately, while the insects could be seen with binoculars, they could not be collected from the canopy. Suggestive evidence of *Camponotus* fragments were found in chimpanzee feces, but these have not yet been identified.

The distribution of lengths of ant fishing probes differs from that of ant dipping wands: 82% of probes are <60 cm. long; 77% of wands are ∃60 cm long. Based on length alone, there is a 70% probability of correctly assigning an unknown tool to ant fish or ant dip. Table 3 gives the mean length, distal diameter, and proximal diameter of 67 ant-fishing tools.

Branch Clasp

Chimpanzees engaged in social grooming sometimes extend an arm vertically overhead, revealing the armpit to be attended to by the grooming partner. The two may clasp hands in perfect symmetry (McGrew & Tutin, 1978; McGrew *et al.*, 2001), or one or both may clasp instead an overhanging branch for support (McGrew, 1992, p. 69). Typically the two sit facing one another in mutual or reciprocal grooming. The clasped branch may be temporarily bent downwards but is not otherwise affected, leaving no sign of use.

At Assirik, branch-clasp grooming was seen four times in bouts of social grooming between adults. The behavioral pattern is a chimpanzee universal (Whiten *et al.*, 2001, No. 5), but the only quantitative, published data are from Mahale's M-group, where it is more common than the grooming handclasp (Nakamura, 2002).

Fluid Dip

Chimpanzees use linear probes to extract liquids from cavities, usually in trees, the openings of which are too narrow to admit the hand. The obvious analogy is the dipstick used to check oil levels in a car's engine; drop-by-drop is not a convenient way to get the liquid but it is better than nothing. In nature, the cavity is usually a tree-hole, and the fluid is usually honey or water (e.g. Brewer & McGrew, 1990).

Fluid dipping to get honey occurs in many populations of chimpanzees across Africa, either for arboreal honey bees (*Apis mellifera*) or for stingless bees (Meloponini) in trees or underground (McGrew, 1992, p. 162–166). At Assirik, Bermejo *et al.* (1989) never saw the behavior, but they did collect four artifacts at three sites. In addition to sticky probes on the ground below the hive, pieces of brood comb and other hive debris are signs of such a bout of honey eating. Honey bees were the third most common type of insect prey found in Assirik chimpanzees' feces by SAPP (Baldwin, 1979; McGrew, 1983).

No other type of fluid dipping (e.g. leaf sponging for water) has been reported for Assirik, but the pattern is habitual or customary at six of eight sites (Whiten *et al.*, 2001, No. 41).

Branch Shake

Shaking an attached, living branch or stem of woody vegetation serves to attract another's attention, especially in courtship at Gombe (Goodall, 1968, p. 217). Typically a male sits with legs spread to display his erect penis, while reaching sideways to shake a branch with one hand. This may be repeated until a female presents herself for copulation or departs. It is also part of agonistic display. As in Branch Clasp, the vegetation is only temporarily deformed and is not detached, so no artifactual record is likely to be left.

Branch shaking was seen three times at Assirik. Once an adult male, Muldoon, repeatedly shook a branch at a sexually swollen female but she moved away. Once an adult female, Rosehip, shook several branches at observers. It was late in the day, and she seemed frustrated at their unwillingness to leave her in peace to build her overnight nest.

Branch shaking is a chimpanzee universal (Whiten *et al.*, 2001, No. 6), but there seem to be no quantitative data on its performance at any site.

Water Dig

Several species of mammals (e.g. elephant, warthog) dig wells on watercourses when surface water is no longer available, but only chimpanzees are said to use tools to do so (Galat-Luong & Galat, 2000). Also, only these apes are known to dig holes in streambeds that have surface water available nearby. It seems that sand-filtered water from freshly dug holes may be preferable to stagnant pools (Hunt & McGrew, 2002).

Apart from Hunt's more extensive data from Semliki, Uganda, Assirik is the only other study site from which water digging is reported as habitual or customary. Galat-Luong and Galat (2000) found wells dug by sympatric chimpanzees and baboons, but reported that only the apes used tools to do so. MAPP and SAPP found only wells but no tools.

Object Throw

Chimpanzees propel a variety of objects by hand; the ballistic motion may be underarm from a tripedal posture or overarm from a bipedal posture. Goodall (1964) distinguished between aimed throwing (targeted missile) and unaimed throwing (untargeted display), but with poor aiming, especially in a sidearm motion, it is not always possible to say which is which. Thrown objects vary from sand or leaves to boulders or logs. The pattern is probably universal, but is hard to discern from artifacts strewn about. Aimed throwing can be effective: An observer's scalp was split open by a tennis-ball-sized stone thrown underarm from within 10m distance (Marchant, pers. comm.)

At Assirik, an adult male threw at least three rocks as he did a charging display down a dry streambed. An adult female hurled a dead branch at observers.

Play Start

Chimpanzees, especially youngsters, may initiate or prolong play by using an object to provoke a potential or flagging partner. This may be held in mouth or hand or foot and dangled, waved, flailed, brandished or otherwise displayed to another individual. The toy is usually vegetation, but can be any object, e.g. scrap of monkey skin. Such teasing can be distinguished from agonism by the accompanying play face expression (Goodall, 1986, p. 560; McGrew, 1992, Figure 8.5). Such objects are unlikely to be recognized as artifacts unless seen to be used.

Play start is a chimpanzee universal (Whiten *et al.*, 1999, 2001, No. 2).

We saw one case of play start at Assirik, in which one immature chimpanzee initiated chasing play with another, holding in her teeth the stem of a dangling baobab fruit.

Leaf Napkin

Chimpanzees use green leaves as napkins to wipe away substances from their body surface. This hygienic technology is directed to their bodily fluids (blood, semen, feces, urine, snot) or to fluids from other sources (sap, juice). Their use ranges from delicate dabbing to vigorous wiping (Goodall, 1964). Both sexes use napkins after copulation, but males are more fastidious (Goodall, 1986, p. 545). Leafy napkins may be recognized by the substances adhering to them, and their discovery is sometimes aided by the flies that the residues attract.

We saw one case of leaf napkin use at Assirik, when a female infant used a leafy branch (*Cola cordifolia*) to wipe sticky sap from her lips and chin.

DISCUSSION

The elementary technology of Assirik's chimpanzees comprises 15 behavioral patterns. This is a small repertoire, in terms of the 65 patterns from the eight study sites compared systematically by Whiten *et al*. (2001). These eight sites split readily into three subsets: Four are longterm studies of fully habituated populations: Gombe (N = 36 patterns), Tai (35), Bossou (31) and Mahale (29). Two are shorter term, less well-studied populations from Uganda: Budongo (19) and Kibale (Kanyawara) (19). Two are unhabituated populations: Assirik (13) and Lopé (11). It seems that size of the elementary technological repertoire is positively correlated with observability, and that repertoire size reaches a ceiling at about 30 patterns. This figure must be taken with caution, however, as many published behavioral patterns remain to be added to Whiten *et al.*'s list, e.g. Social Scratch (Nakamura *et al.*, 2000). The largest published inventory of behavioral patterns is the ethogram for Mahale's chimpanzees (Nishida *et al.*, 1999). It totals 515 behavioral terms (plus 116 synonyms). There is nothing to suggest that Mahale is exceptional in this regard, so the overall repertoire of *Pan troglodytes* appears to be largely undescribed.

Functionally, one can put patterns into three classes: *Subsistence*, which is finding, accessing, and processing food and drink; *Social*, which is interaction with conspecifics, and *Maintenance*, which is all else, typically being activities that enable or facilitate individual survival. At Assirik, the 15 patterns break down as Subsistence = 7, Social = 5, and Maintenance = 3, as given in Table 2. This distribution closely mirrors that of Whiten *et al.*'s (1999, 20001) overall compenduum of 65 patterns that were considered as candidates for cultural variants: Subsistence = 34, Social = 17, and Maintenance = 14. Thus, Assirik's apes may be impoverished or incompletely known, but what is known is typical. This is reassuring.

If lack of observational data *is* important, then one might expect fewer patterns at Assirik to have reached Customary status, since this requires that a pattern be shown by all or most able-bodied members of at least one age-sex class (Whiten *et al.*, 2001). Without the complete individual identification of subjects that comes with full habituation, this cannot be achieved with indirect evidence, but a proxy measure for an unhabituated population is ubiquity (Table 1). At Assirik, four of 15 (27%) patterns, Nest Build, Buttress Beat, Food Pound, and Termite Fish, had customary status. This is a smaller proportion than all of the other sites (range: Bossou, 12 of 31, 40%, to Tai, 21 of 35, 60%), except for the other unhabituated population at Lopé, which showed a similar 36% (4 of 11). This suggests that Assirik and Lopé are not technologically or culturally impoverished but instead are incompletely known.

Of the 15 patterns, all but two (Branch Clasp, Branch Shake) leave artifacts or remnants of their use, ranging from the obvious (Nest Build) to the obscure (Buttress Beat). In some cases, not only the tools, but also their targets, are left behind in association, e.g. probes and insects in Termite Fish. Sometimes the context constrains the activity, e.g. Water Dig occurs only in watercourses, not on hilltops. Sometimes the artifacts are distinctive as to their function, e.g. honey on a flexible probe indicates that specific form of Fluid Dip, but sometimes the context is "invisible," e.g. a detached stick alone could have been used as Object Throw in aggression or as Play Start in non-aggression, or in some other way. Sometimes, accompanying evidence suggests a function, e.g. "fear" diarrhea may indicate agonism, but this remains only a probabilistic interpretation. Sometimes the artifact requires processing, e.g. to seek Nest Line, one must access and deconstruct an arboreal sleeping platform on terminal branches high overhead. Sometimes the artifacts or remnants are so slight that they are unlikely to be noticed unless one has seen their use. The remains of Ant Peel may look like nothing more than a few leaves on the ground unless one has the right "search image."

Of the 15 patterns, 10 were seen at least once, providing observational validation. For the other five, three (Termite Fish, Ant Dip, Ant Fish) are behaviorally well known to at least some of the authors from prior field study at Gombe or Mahale. The other two (Fluid Dip, Water Dig) rely on reports from other investigators (Bermejo *et al.*, 1989; Galat-Luong & Galat, 2000). Sometimes the observations are crucial: In Food Pound, we would not have known from baobab shards on the ground that in addition to root and stone anvils, the apes also cracked the fruits on boughs overhead in the canopy.

Fecal evidence collected as nearly simultaneously as possible provides limited corroboration, but only for subsistence categories. (Actually, fecal analysis of ingested items applies only to food, not drink, so Fluid Dip and Water Dig do not show up in fecal sieving.) For Termite Fish, Ant Dip, Ant Peel, and Ant Fish, it is the chitinous exoskeletons of the insect prey that reveal their having been eaten (McGrew, 2001). For Food Pound, it is the seeds of the fruit in the feces that give the evidence. For *Adansonia digitata*, the seeds get a double fecal treatment: The mature seeds are so hard that they are initially passed intact and so are easily recogizable. However, we also found feces smeared on rocks, apparently to facilitate removal of such seeds, now softened by digestion, for secondary re-ingestion. Since some chimpanzees' feces contained chewed-up seed shells with the kernals removed, we attributed this "recycling" to the apes, although we never saw it (McGrew *et al.*, 1988). Such extraction of baobab seeds from feces is known for *Homo sapiens*: Hadza foragers do so from baboon scats (Schoeninger *et al.*, 2001, p. 182).

The main problem in doing the ethoarchaeology of Assirik's ape technology is its perishable materials. Some, such as leaves used in Ant Peel or Leaf Napkin may be recogizable only for a day or two before they dry up and blow away. Others, such as non-woody vines used as probes in Termite Fish last a few days longer. Woody tools, such as the wands used in Ant Dip, may last for weeks. Finally, the constricted shelters of Nest Build last for months and change predictably as they deteriorate. A year or more later, only the occasional deformed branches of vanished nests (Fruth & Hohmann, 1994) and possibly some macroscopic wear on stones used as anvils will remain to be found (cf. Joulian, 1995). Microscopic analysis of organic residues on the stones might yield more.

Etho-archaeology can be done on living hominoids by field primatologists. As Joulian (1995, 1996) and Mercader *et al.* (2002) have shown for lithic materials used by rain forest chimpanzees, trained archaeologists are likely to derive much more information from artifacts and remnants, even from unhabituated subjects in harsh environments. If perishability of materials is a limitation, it is also a reminder (McGrew, 1992, 1998, 2001; Sept. 1993, 1998) that much of the technology of our hominid ancestors was likely to have been similarly ephemeral, and so archaeologically "invisible." Finally, fully productive archaeology of apes will occur only if primatologists and archaeologists work side-by-side, day in and day out, at the same field sites (Tutin & Oslisly, 1995). This should be done sooner rather than later, while the subjects still survive to provide the behavioral data to go with the artifacts.

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