

## RESEARCH ARTICLE

## Attacks on Local Persons by Chimpanzees in Bossou, Republic of Guinea: Long-Term Perspectives

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Attacks on humans by nonhuman primates are one of the most serious causes of human–primate conflict, and strongly influence people’s perceptions and tolerance of nonhuman primates. Despite their importance, systematic and extensive records of such attacks are rare. Here, we report the attacks that occurred on local persons by chimpanzees (*Pan troglodytes verus*) at Bossou, Republic of Guinea, from 1995 to 2009. There have been a total of 11 attacks during this period, the majority of which were directed toward children. They varied in their severity, but all were nonfatal. Attacks took place on a road and narrow paths that bordered the forest or in cultivated fields and orchards where opportunities for human–chimpanzee contact are high. Attacks occurred between the months of March and October, coinciding with wild fruit scarcity, increased levels of crop-raiding, and periods of human cultivation with likely increased human usage of paths. Although the families of attack victims felt angry and fearful toward chimpanzees after attacks, some drew on their traditional beliefs to explain why chimpanzees were respected, protected, and could not hurt them, even when attacks occurred. We provide suggestions for reducing future nonhuman primate attacks on humans in an effort to mitigate human–primate conflict situations. *Am. J. Primatol.* 72:887–896, 2010. © 2009 Wiley-Liss, Inc.

**Key words:** attacks; chimpanzees; interspecies aggression; conflict mitigation

## INTRODUCTION

Wild animals attack hundreds of people globally each year, although very little is known about the circumstances associated with these attacks [Thirgood et al., 2005]. In some areas, human fatalities owing to wildlife, in particular large carnivores and large herbivores, are high and cause significant social costs to local communities [for a review, see Thirgood et al., 2005]. Although most nonhuman primates (hereafter “primates”) are actually fearful of humans, certain primate taxa seem to have a higher propensity to attack people than others (e.g. chimpanzees: *Pan troglodytes*; macaques: *Macaca* spp.; baboons: *Papio* spp.). Treves and Naughton-Treves [1999] report that 5.4% of total wildlife attacks ( $n = 636$ , including casualties and fatalities) on people between 1923 and 1994 in Uganda were by primates (baboons and chimpanzees); the most severe attacks by baboons were directed toward children guarding fields.

In some circumstances, appetite resulting from earlier experiences with food provisioning is the underlying cause of primate attacks on people [Fuentes et al., 2008; Hsu et al., 2009]. Otherwise, attacks by primates on humans can occur when an animal is directly provoked and harassed by humans

and the primate then retaliates in response to a perceived threat [McLennan, 2008; Sha et al., 2009], or exhibits protective behavior toward the other party, group or troop members. In the case of some monkey and great ape species, males in particular may act to protect group members, often showing bolder and more aggressive behaviors than females [Fuentes & Gamerl, 2005; Hockings et al., 2006; Muller, 2002]. However, accidental attacks might also result from surprise encounters between humans and primates in areas that are utilized by

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both, such as roads or paths. At some sites, a small number of chimpanzee attacks on humans have been predatory, with children being targeted as prey [Goodall, 1986; McLennan, 2008; Wrangham et al., 2000].

There are obvious difficulties in attempting to characterize wildlife attacks on people. Quigley and Herrero [2005] use two broad categories of “provoked” and “unprovoked.” They emphasize that a provoked attack may take many forms, but can occur when a person enters an animal’s personal space or purposely tries to touch, capture, injure, or kill the animal, and in response the animal attacks. Alternatively, a provoked attack can occur when a person holding food or garbage purposefully draws the animal to within proximity and is then attacked. An unprovoked attack is defined as those cases in which an animal approached, stalked, and attacked a human. In addition to predatory behaviors, unprovoked attacks might involve the primates’ right of way whereby the primate attacks when its travel route is blocked, and thus it is not given priority of travel or access. In the latter situation, there is no food or attractant.

To develop an understanding of the context in which aggressive events involving primates and humans occur in the wild, it is essential that we compile a complete data set with detailed information on the spatial and temporal patterns of such events. Spatial variation in attack location might be affected by vegetation structure, such as density of forest or thicket areas (more open areas have improved visibility and surprise encounters are less likely), or other habitat characteristics, including human paths bordering forested areas. Human-primate contact might increase when crops, such as sugar fruits, are available, thus attracting primates to cultivated areas. The cultural practice of human crop guarding—especially children who frequently assist with crop guarding—may increase the likelihood of human–nonhuman primate conflict on paths and roads [Hockings & Humle, 2009]. Furthermore, temporal changes in wild food availability might modify or expand primate ranging patterns. For example, certain chimpanzee populations have been found to expand their home range during periods of fruit scarcity, despite the energetic demands of travel [Yamagiwa, 1999]. Understanding how specific features of a location or seasonal changes in resource distribution and availability result in higher levels of human–primate interactions and consequent attacks are important elements when establishing locally effective cautionary guidelines [Hockings & Humle, 2009].

Attacks on humans by primates are one of the most serious causes of human–primate conflict, representing a significant disease risk [Wrangham et al., 2000] and having the potential to strongly influence people’s perceptions and tolerance of primates [Quigley & Herrero, 2005]. People often

feel threatened owing to fears for their personal safety and lack of control over such events [Hockings & Humle, 2009]. It is important to consider traditional and spiritual influences on human behavior, attitudes, and perceptions. Such influences are known to be major factors in human–wildlife interaction [Cormier, 2003; Hill, 2000]. Societal taboos regarding the killing and consumption of certain primate species and the existence of local totems—animals that spiritually represent a group of related people—may promote tolerance; however, such attitudes vary markedly among different human cultures and religions. Given that chimpanzees are our closest phylogenetic relatives (bonobo: *Pan paniscus* is equally related to humans as the common chimpanzee) and share many morphological, physiological, and behavioral similarities, in some locations, people attribute human qualities to chimpanzees. This makes human–chimpanzee interactions of particular value to ethno-primatological research in terms of human perceptions and actions toward chimpanzees, and how chimpanzees modify their behavior in anthropogenic environments. Moreover, all chimpanzee subspecies are listed as endangered by the World Conservation Union [Oates et al., 2009], and it has been predicted that by 2030, less than 10% of African great ape habitats will remain undisturbed from infrastructural development, such as road construction, logging, mining, associated bushmeat hunting, and agricultural land conversion [GLOBIO model analysis, Nelleman & Newton, 2002], exacerbating human–chimpanzee conflict issues.

Our objective is to describe the attacks on local persons by chimpanzees at Bossou, Republic of Guinea, and provide suggestions for reducing future primate attacks on people, in an effort to mitigate human–primate conflict situations. Data were specifically collected on (1) the circumstances of chimpanzee attack by researchers present at Bossou at the time of attack, and (2) the perceptions of some families directly affected by chimpanzee attacks.

## METHODS

### Study Site

The Bossou chimpanzees have been studied since 1976 [for a historical perspective, see Matsuzawa, 2006] and are well habituated to being observed by researchers. Bossou village is located in the forest region in south-eastern Republic of Guinea, West Africa (latitude 7°38′71.7″N; and longitude 8°29′38.9″W), approximately 6 km from the Nimba Mountain range.

Humans and chimpanzees coexist at Bossou, where the 15 km<sup>2</sup> home range (7 km<sup>2</sup> core area) of the chimpanzees’ community is fragmented and in a mosaic of cultivated and abandoned fields, farms, roads, and paths (see Fig. 1). There is a clear wet season from March to October and a dry season from

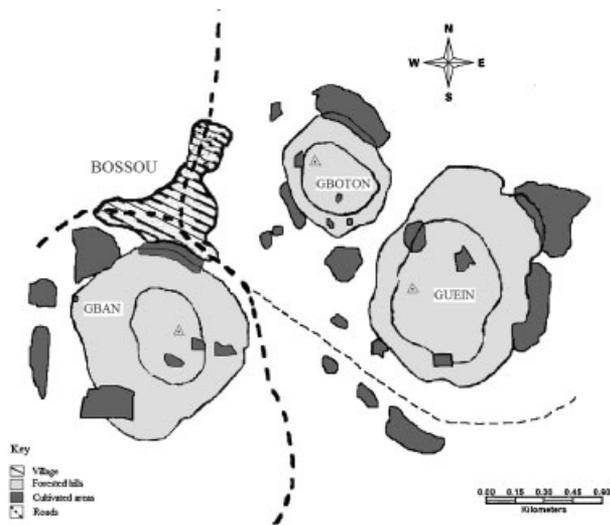


Fig. 1. A map of the field study site, in Bossou, showing the village, the large roads (thick dashes), path (thin dashes), and the three main forested hills of Gban, Guein, and Gboton. The presence of cultivated areas within and surrounding the Bossou chimpanzees' core area in 2005 are highlighted in dark gray.

November to February. The study area also is characterized by marked seasonal variation in the availability of ripe fruit; months of high wild fruit availability are December through April, whereas low fruit availability months are May through November [Hockings et al., 2009].

The village of Bossou contains 2,500 people and is mainly inhabited by the Manon people. The Manon family that founded Bossou (year unknown, but the village of Bossou was described in the 16th century Portuguese documents [Carvalho, personal communication]) still remains one of its most influential families and holds the local chimpanzees as a sacred totem, believing that their ancestors' souls rest on the sacred hill of Gban, the core area of the Bossou chimpanzee community [Kortlandt, 1986]. Yamakoshi [2005] proposed that Gban was an important location for village protection, having served as a refuge for women and children during periods of tribal conflict. The forests currently sustain few small- and medium-sized mammals, no large mammals except chimpanzees, and no large predators [Sugiyama, 2004]. The absence of large mammals is likely the result of past hunting activities.

### Chimpanzee Behavior and Ecology

Chimpanzees at Bossou, especially adult males, regularly visit cultivated areas (14% of feeding time (monthly range: 3.6–26.3%,  $SD \pm 6.9$ )) particularly during periods of wild fruit scarcity [see Hockings et al., 2009]. In these cultivated areas, they forage for and consume 17 different types of cultivated foods. Additionally, the chimpanzees' home range is intersected by dirt tracks and roads that the chimpanzees

regularly cross to access different parts of their home range, to move from one forested area to the another [Hockings et al., 2006].

### Reports of Attacks

Despite on-going research at Bossou, attacks by chimpanzees on local people were not systematically recorded until 1995. Written reports were made at the time of the attack by in situ researchers between 1995 and 2009. Accounts of incidents that did not result in an attack were not consistently reported by researchers. Differences in the detail of the reports provided by different researchers exist, as there was no standard method for recording attack information. Ten out of 11 attacks were recorded indirectly by second-hand reports from the victim or the victim's family to a Kyoto University Primate Research Institute (KUPRI) researcher or Institut de Recherche Environnementale de Bossou (IREB) representative. Exact GPS locations were not recorded, so specific habitat characteristics of the attack sites are not known. All chimpanzee attacks on people reported here involve either contact aggression, including hits, kicks, or slaps, or more extended episodes of dragging and biting, possibly leading to serious injury [Goodall, 1986].

### Perceptions of People Attacked

Four interviews in total were carried out on the attack victims and their families by AK, between June 15, 2005 and July 21, 2005. AK also interviewed the family of the baby that was temporarily taken by a young female chimpanzee on August 22, 2001—this event does not fit our definition of an attack, but is included in the results section. There was variation in the intervals between the attack incident and interview (see Table I for attack dates). Informal interviews lasted an average of 65 min (range: 35–90 min,  $SD \pm 19.7$  min), and were conducted in the local Manon language by AK and a local translator. The interviews were semi-structured, meaning that they were flexible and allowed new questions to be brought up as a result of what the interviewee said. All interviews began with questions on the totemic beliefs of family members and then progressed toward details of the attack and feelings toward chimpanzees. The respondents were not prompted and the interviewer sought to maintain a neutral demeanour. No money or gifts were offered to the interviewee. AK was managing the Bossou research site while conducting interviews of attack victims and this might have affected the responses of people. Although the actual attack event was probably reported as accurately as can be expected, people may have felt an obligation to overpromote the importance of chimpanzee conservation to AK.

The research adheres to the American Primatological Society Ethical Principles for the treatment of

TABLE I. Details of Attacks by Chimpanzees on Local People at Bossou

	Time, month, year	Area	Age/sex of person(s)	Activity of person	Chimpanzee behavior	Injury	Evidence direct/indirect	Compensation
1	NR, March 7, 1998	Path	(i) M-8 years, (ii) F-6 years	Walking on the path with rice, palm oil, and other cooking materials. Children ran from chimpanzees	Chimpanzee bit one child and then dragged the other into the forest. Chimpanzee left child when adult human arrived	One child lost a toe	Indirect—report from victims and adults. AK interview	Medical expenses covered by KUPRI
2	NR, October 3, 2002	Field, forest	(i) M-10 years	Child left field and went into forest	Chimpanzees left child when parents arrived	Cuts and bruises	Indirect—report from victim and parents. AK interview	No serious injury obtained
3	NR, August 31, 2003	NR	(i) Child	Child was carrying bananas	YL (Yolo, 12-year-old male) obtained banana, researcher chased YL back to forest	No injury due to intervention	Direct—report from researcher Sugiyama	No serious injury obtained
4	10:00 am, May 2004	Orchard	(i) M-12 years	Child was up a mango tree bordering the forest	Children threw wood at chimpanzees, chimpanzees climbed down	Severe bite to arm	Indirect—report from victim, injuries	Child of IREB received medical care from KUPRI
5	09:00 am, October 7, 2004	Path	(i) M-1.5 years	Children throwing stones at chimpanzees. Toddler fell from mothers back	Adult male dragged toddler into forest, adults chased, and chimpanzees dropped the toddler	Severe wound to stomach, probably from chimpanzee fingernail, child went to hospital	Indirect—direct observation of toddler 2 min after attack. AK interview	Medical expenses covered by KUPRI
6	NR, May 30, 2005	Orchard, path	(i) F-6 years, (ii) M-2 years	Child walking along a path near an orchard with toddler on back	Chimpanzee took toddler and dragged him into forest	Girl had cut lip	Indirect—report from victim. AK interview	No serious injury obtained

7	NR, May 4, 2006	Field* <sup>1</sup>	(i) F-30 years	Woman in field alone, ran when saw chimpanzee	YL, alpha-male, traveling back alone from consortship Chimpanzee traveling back from consortship. Chimpanzee displayed and wounded toddler on head and stomach	Woman had cuts on her leg, probably from fingernail Severe wound to head and cut to stomach, probably from fingernail	Indirect—report from victim	Medical expenses covered by KUPRI
8	NR, March 30, 2007	Field* <sup>2</sup>	(i) M-2 years	Mother alone with toddler working in field	YL, alpha-male, traveling back alone from consortship	Injured but no details	Indirect—report from mother	Medical expenses covered by KUPRI IREB handled situation. KURRI researcher not present when father visited
9	NR, 2007	NR* <sup>2</sup>	(i) Child	Six children walking along road. All children ran from the chimpanzees except the 12-year-old that froze	One of two chimpanzees took the leg of the girl and dragged her. Girl screamed and two men ran to help and the chimpanzee left		Indirect—report from father to IREB	Medical expenses covered by KUPRI and IREB
10	NR, October 3, 2009	Large road	(i) F-12 years	Three people walking along a path (2 m between individuals), including a slightly disabled adult man, a 12-year-old boy and a 6-year-old boy	Two chimpanzees were moving along a path when people were encountered. One of them bit the child's foot and dragged the child, then both moved back along the path	Grazes on both knees	Indirect—report from family	Medical expenses covered by KUPRI and IREB
11	NR, October 22, 2009	Path	(i) M-6 years		Bitten on top and back of foot. Only the surface of the skin was broken		Indirect—report from man that was present	Medical expenses covered by KUPRI

Some data were not recorded by a researcher at the time of the incident and could not be obtained (NR). The attacks that did not take place in Bossou are highlighted (\*<sup>1</sup> took place near Seringbara; \*<sup>2</sup> took place near to Liberia). Chimpanzees consort to both areas—where an adult female and an adult male move together to the periphery of their community range, so that the male gains exclusive mating access. Kyoto University Primate Research Institute (KUPRI) and Institut de Recherche Environnementale de Bossou (IREB).

nonhuman primates, complies with protocols approved by the Stirling University institutional animal care committee, and adheres to the legal requirements of the Republic of Guinea. Anthropological protocols followed the ethical guidelines proposed by the Association of Social Anthropologists in the United Kingdom and Commonwealth (ASA). Permission to interview members of the local community was obtained by IREB, Direction Nationale de la Recherche Scientifique et Technologique (DNRST), the villagers themselves, and the chiefs of Bossou, Seringbara, and Nyon villages.

## RESULTS

### Attack Incidences

Only one attack was directly observed by a researcher who intervened and prevented injury to the child (see incident 3, Table I). According to the head research assistant at Bossou, there were three attacks by chimpanzees on local people before long-term research began in 1976 [Matsuzawa, unpublished data]; however, this figure cannot be confirmed. Since regular habituation efforts commenced in 1995, there have been 11 attacks on local people (see Table I for a summary of incidences). In 10 out of 11 cases, attacks were directed toward children between 18 months and 12 years old; 7 out of 10 attacks happened when children were unaccompanied by adults and only one attack occurred when a man was present, and this man had a physical disability. In five out of five cases, the chimpanzee stopped attacks when pursued by a human adult. In addition to the attack incidences presented in Table I, on August 22, 2001, a mother left her two year old toddler in a hut located within a cultivated field to fetch water. An 8-year-old female chimpanzee then took the toddler and put it on her stomach, but when chased by the mother the chimpanzee dropped the toddler—there was no harm done to the toddler (AK performed the interview). Attacks varied in their severity, and although four out of ten victims received very serious injuries (see incidents 1, 4, 5, and 8, Table I), including one victim that sustained life-threatening injuries (incident 5, Table I; see Fig. 2), all attacks were nonfatal.

The contexts of attacks varied considerably. One attack involved children provoking the chimpanzees by throwing stones, although this human behavior might have gone unreported in other cases. One other attack involved a child carrying bananas (*Musa* sp.) along a path and another when a child had climbed a mango (*Mangifera indica*) tree during fruiting season. Four attacks at Bossou occurred when people were travelling along small paths that followed the edges of forests. These paths are narrow and often lie between forest and crop lands. One of the most recent attacks (incident 10) occurred whilst chimpanzees were crossing the 12 m-wide road that



Fig. 2. An 18 month old boy sustained severe injuries to the abdominal skin during a chimpanzee attack on October 7, 2004 (see Table I for more details). The coloration around the wound is caused by an antiseptic solution.

borders the forest of Mont Gban (see large road, Fig. 1). Five attacks took place within or on the border of cultivated fields and orchards, within proximity to the forest boundary. All attacks occurred between the months of March and October, coinciding with periods of wild fruit scarcity, increased levels of crop-raiding [see Hockings et al., 2009, for further details], and periods of human cultivation of rice (*Oryza* sp.) and cassava (*Manihot esculenta*). During these periods, path usage by humans likely increased. In 2006 and 2007, three attacks (once near Seringbara and twice in Liberia) occurred outside the Bossou core area during periods when a male and a female chimpanzee were engaged in a consortship.

As 10 out of 11 attacks were not directly observed by someone who can identify individual chimpanzees, we have no information on the identity of the chimpanzee(s) responsible for each attack. In one of the reported cases (incident 3, Table I), an adult male chimpanzee (Yolo) was directly observed trying to take bananas from a child. This same individual was also involved in consort relationships with an adult female in Seringbara and Liberia when the attacks occurred in these locations (incidents 7, 8, 9, Table I). Because of his generally bold behavior during crop-raids and road-crossings [Hockings et al., 2007], researchers at Bossou strongly suspect that the same individual was responsible for the other attacks that occurred between 2003 and 2007; this period coincided with Yolo asserting more dominance and increasing his status within the Bossou community [Nakamura & Ohashi, 2003].

### Perceptions of Attack Victims and Their Families

All families reported that they were angry following the attack on their child, and women also reported being scared of chimpanzees. One woman said that she moved her family to a nearby village to get away from the chimpanzees. All families

interviewed had at least one family member with chimpanzee as their totem, and this influenced their general attitudes toward chimpanzees and their conservation. People drew on their traditional totemic beliefs to explain why chimpanzees were respected, protected, and could not be hurt. Two out of five families explained that they did not commit revenge killings on chimpanzees for this reason. Four out of five families also said that the preservation of chimpanzees was important for scientific research, and indicated that the benefits of such research included a primary school and health center. People also noted the many physical and behavioral similarities between humans and chimpanzees. Two families remarked that there are now less cultivated foods for the chimpanzees to eat than before, which makes them angry so they attack people. There also is a belief that it cannot be the chimpanzees of Bossou that commit these attacks. Certain local people attribute these incidences to chimpanzees living elsewhere or say that people from Liberia (Bossou is 4 km from the Liberian border) and Bossou village itself [Humle, personal communication] can transform into chimpanzees to commit attacks.

All families expected compensation from KUPRI, IREB, or the local community to help cover medical expenses for injuries inflicted by chimpanzee attacks on their children. The reasons given include: (a) Villagers have stopped cultivating the forests to protect the chimpanzees and should be helped when the chimpanzees cause damage, (b) KUPRI researchers should pay as they are responsible for the chimpanzees, and (c) assistance should be given as a sign of goodwill. See Table I for details of assistance following attack.

## DISCUSSION

Attacks on people by wild chimpanzees in Africa are rare, especially considering that at some sites, such as Bossou, local people and chimpanzees encounter each other on a daily basis. Wrangham et al. [2000] reported eight cases between August 1994 and September 1998 in which a wild chimpanzee, or possibly more than one individual, in Kibale caused severe injury or death to children between the ages of 6 months and 5 years. In all cases, the victim was either alone or only accompanied by other children or women, but never with a man. The chimpanzee(s) consumed parts of the victims that could be carried off to an undisturbed site. The attacks occurred in an area composed of scattered villages, cultivated fields, and secondary forest. The chimpanzee(s) often exhibited bold behavior by travelling far from the forest edge (up to 182 m) to capture victims, and on two occasions a baby was removed from the doorway of a house. Before 1960 and before habituation efforts at Gombe, there were

two reports of chimpanzee attacks on human infants. The first occurred outside the National Park where a woman was collecting firewood. A chimpanzee appeared and took the baby from the woman's back, injuring the woman, and killing and partially eating the baby [Goodall, 1986; Thomas, 1961]. The second case occurred within the National Park (previously a game reserve) when a 6-year-old boy was looking after his baby brother and a chimpanzee approached and took the baby. The boy ran after the chimpanzee that dropped the baby and consequently started attacking the young boy, causing severe injuries to his face [see Goodall, 1986, p 282, for a photo of the victim]. The chimpanzee fled when pursued by local women. Within Gombe National Park on May 15, 2002, a well-habituated and particularly bold alpha male chimpanzee, Frodo, kidnapped and killed a 14-month-old baby that was being carried on the back of a woman. As the baby was partially eaten, it was proposed that Frodo displayed predatory behavior toward the baby [Kamenya, 2002].

Not all chimpanzee communities that live in human-influenced areas are reported to attack people. For example, an unhabituated community of chimpanzees at Caiquene-Cadique in Guinea-Bissau, where ethological research began in February 2009, frequently cross roads and enter orchards to raid crops, but there have been no reports by local villagers of chimpanzee attacks [KH, unpublished data]. Women and children living in this area show very little fear when they encounter chimpanzees [KH, unpublished data]. This one limited case study highlights that we should not automatically assume that wild chimpanzees will be violent toward humans, especially when not provoked by people. However, data from other sites, such as several unhabituated communities living in heavily fragmented habitats in the Hoima District in Uganda, illustrate that when chimpanzees are threatened or persecuted by people, they can become very aggressive and attack humans, resulting in very high levels of conflict [McLennan, 2008]. At River Hoima (this area probably contains one chimpanzee community), the two recorded attacks "seem to have involved a chimpanzee first being speared or attacked with pangas [machetes], or set upon by dogs. In these cases an attempt may have been made to take an infant chimpanzee from its mother or otherwise confront a crop raiding ape" [McLennan, 2008, p 50]. Furthermore, in Bulindi, a 4-year-old boy was attacked by a chimpanzee while collecting water at a well with other children. Although local reports vary, it appears that the chimpanzees were moving through a narrow forest strip and the children may have harassed the chimpanzees. The children ran away and the youngest child fell down, and was bitten on the head, foot, and below the armpits. Villagers then arrived with dogs and spears and the chimpanzees moved away [McLennan, personal

communication]. McLennan [2008] also reports a fatal attack on a child in a sugarcane (*Saccharum officinarum*) field on the edge of the sparsely forested Kasongore Forest Reserve, Uganda, in what was probably a predatory incident.

Data from Bossou show that an attack has occurred every 1–2 years since written records began in 1995. However, in October 2009, there were two separate attacks. Like reports from other sites including Kibale, Hoima, and Gombe, the majority of attacks at Bossou were directed toward children. However, they are not consistent with predatory behavior by chimpanzees on children which is typically characterized by eating the victim [Goodall, 1986; McLennan, 2008; Wrangham et al., 2000]. Attacks occurred in areas of high anthropogenic disturbance, in particular on paths and within crop fields and orchards. In some cases, the chimpanzees were directly provoked before attacking (e.g. children throwing stones at the chimpanzees or were carrying food). However, in at least 8 out of 11 cases, it is difficult to ascertain exactly why the chimpanzees at Bossou attacked people. Reasons might include unreported provocation by people, hunger motivating the chimpanzees to feed on crops in fields or orchards, aggressive behavior by chimpanzee(s) in less familiar areas outside the core area, and adult male chimpanzees asserting their dominance. Although it is unknown what caused the two attacks in October 2009, in both cases two adult males were travelling along a path or road when people were encountered and one of the males attacked. Certain human behaviors, such as running and screaming, seem to excite and provoke the chimpanzees [Hockings & Humle, 2009], and therefore, it is unclear as to whether the chimpanzees attacked in response to particular behaviors exhibited by the children. Although definitions of provoked and unprovoked attacks were presented in the Introduction, it is difficult to employ these terms to accurately describe all attacks at Bossou, especially in light of the fact that the habitats of humans and chimpanzees at Bossou overlap so extensively.

The urgent need to protect species on the brink of extinction demands the coexistence of people and endangered wildlife. As evident at Bossou and other chimpanzee research sites, a single attack by an animal can elicit much more hostility and panic than less immediately severe but persistent problems, such as crop-raiding [Hockings et al., 2009; McLennan, 2008]. The attack victims and their families at Bossou were very angry but, unlike reports from Kibale [Wrangham, 2001; Wrangham et al., 2000], did not engage in retaliatory killings owing to local traditional beliefs that protect chimpanzees. At the moment, there are approximately 2,500 people living in Bossou, although numbers have increased owing to the establishment of temporary refugee camps in response to civil wars

in Liberia and Côte d'Ivoire. Moreover, some of these people who have recently settled in Bossou have different cultural beliefs and tolerance levels concerning relationships with chimpanzees.

Following guidelines by Hockings and Humle [2009], it is important to determine the seriousness of the threat of primate attack. Chimpanzees at Bossou are very well habituated to human observers, and it is unknown whether over the years this has lessened the chimpanzees' fear of people and contributed to increased contact between chimpanzee and local people. At Bossou, the rule of 7 m between researchers or tourists and chimpanzees is enforced in an effort to minimize very close contact, including the spread of infectious diseases [for more information, see special issue on "Disease transmission, ecosystems health and great apes research. 2008." *Am J Primatol* 70: pp 715–1777, including articles by Boesch, 2008; Kaur et al., 2008; Lukasik-Braum & Spelman, 2008; Williams et al., 2008].

When attacks do occur, it is likely that people will expect compensation, especially for medical expenses. At Bossou, compensation for immediate medical treatment is offered as a sign of goodwill, although it is made clear that KUPRI are not responsible for the chimpanzees or their actions. Such situations can be particularly complicated when the species involved is protected by law. However, issues of compensation must not overshadow discussions of other measures that might be used to prevent primate attacks on people, such as the removal of certain crops or educating people how to behave when chimpanzees are encountered [for cost-benefit analysis of compensation schemes, see Hockings & Humle, 2009].

### Preventative Measures

The conservation of remaining forest and wild food species in human-influenced areas is imperative when attempting to reduce human-chimpanzee contact. In addition, where possible, the amount of forested zones available to the chimpanzees should be increased, especially in areas distant from human habitation. One objective of the green corridor project at Bossou is to increase the availability of wild foods to the chimpanzees in areas that are not frequented by local people [Matsuzawa & Kourouma, 2008]. Regular small-scale cutting back of vegetation, including crops, along the village edge, fields, paths, and trails frequented by humans and primates is one method which can help reduce surprise encounters and instances of great ape attacks on humans. For example, some local people at Bossou have cut down papaya (*Carica papaya*) trees located near the forest edge, successfully reducing chimpanzee visits to the area [Hockings et al., 2009]. Although this approach is not appropriate for all cultivated areas (e.g. fields of cassava, or when there is high economic loss

through removal of a crop), it demonstrates that in some situations simple measures can be taken by local people to reduce human–primate contact and potential conflict. Given that carrying food that is attractive to the chimpanzees probably increases the chance of attack, especially against children, transported food should always be hidden from sight.

Like at Bossou, education and long-term awareness-raising programs can be developed for villages and schools with the participation of locally trained educators to increase tolerance and promote behavior that lessens the chance of conflict arising in the first place [Hirata et al., 1998]. Programs designed to inform villagers of the best way to behave when encountering primates in different situations should be useful in reducing the incidence of attacks on humans; however, species-specific differences in response to humans are likely. In general, “people should keep calm, try not to scream, and avoid running off and scattering, especially when within groups, as human infants are often left behind increasing the likelihood of serious injury” [Hockings & Humle, 2009, p 20]. To this point, education programs at Bossou recommend that when near the forest boundary, children should not be left alone and women and children should be accompanied by a man whenever possible. It is also important to assess the effectiveness of educational programs by measuring if people follow this advice and adapt their behavior accordingly when primates are encountered, in addition to monitoring changes in attack rates [see Hockings & Humle, 2009, p 25, for how to monitor and evaluate the performance of a conflict management plan].

When assessing human attacks by primates, it is imperative that we understand both the behavioral ecology of the primate species involved and the many ways in which human beliefs and behaviors influence the potential for coexistence. Attacks, however rare, need to be recorded thoroughly and objectively. Integration of attack information into an overall plan that deals with other aspects of human–primate conflict and management will help establish more effective and sustainable primate conservation strategies.

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