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Evidence of Leopard Predation on Bonobos *(Pan paniscus)*

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Abstract
Current models of social organization assume that predation is one of the major forces that promotes group living in diurnal primates. As large body size renders some protection against predators, gregariousness of great apes and other large primate species is usually related to other parameters. The low frequency of observed cases of non-human predation on great apes seems to support this assumption. However, recent efforts to study potential predator species have increasingly accumulated direct and indirect evidence of predation by leopards *(Panthera pardus)* on chimpanzees and gorillas. The following report provides the first evidence of predation by a leopard on bonobos *(Pan paniscus)*.

Introduction

Many studies have investigated the significance of predation by raptors, carnivores and other primates on ranging and grouping patterns of diurnal primates [van Schaik and Höstermann, 1994; Isbell, 1994; Stanford, 1996; Treves, 1999; Bshary and Noe, 1997a, b]. The risk from predation is assumed to decrease with increasing body size relative to the size of predators [van Schaik, 1983; Cheney and Wrangham, 1987]. Indeed, evidence suggests that small species are more vulnerable to predation than species with a larger body size [Miller, 2002]. Accordingly, grouping patterns of small primate species are usually interpreted as a function of predation while

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grouping patterns of species with large body size such as great apes are usually related to variables such as food availability, number of estrous females and intercommunity encounters [Chapman et al., 1994; Furuichi et al., 1998; Anderson et al., 2002; Doran et al., 2002; Hohmann and Fruth, 2002]. Recent publications concerning predation on chimpanzees by lions [Tsukahara, 1993] and by leopards [Zuberbuhler and Jenny, 2002] suggest that the larger size of chimpanzees does not protect them from leopard predation but rather makes them more attractive as a prey species.

Reports of predation on great apes are rare, and the significance of predation on association patterns remains largely unexplored. Reports of chimpanzees *(Pan troglodytes)* at Gombe [Goodall, 1986], Mahale [Hiraiwa-Hasegawa et al., 1986; Tsukahara, 1993], Bossou [Sakura, 1994], Assirik [Tutin et al., 1983] and Tai [Boesch, 1991], and from mountain gorillas *(Gorilla gorilla beringeri)* [Schaller, 1963] and western lowland gorillas *(G. g. gorilla)* [Goldsmith, 1999; Robbins et al., 2004] are the major sources of information. The largest data set comes from the Tai forest (Republic of Ivory Coast) where direct and indirect evidence of predation has been obtained which includes observations of wounded chimpanzees, leopard attacks on chimpanzees and scavenging [Boesch, 1991; Boesch and Boesch-Achermann, 2000]. Data from Tai show temporal fluctuation suggesting that individual leopards may specialize on hunting chimpanzees forcing chimpanzees to develop a number of counterstrategies to avoid predation [Dind, 1995; Boesch and Boesch-Achermann, 2000]. Recently, Henschel [2005] has provided evidence of leopard predation on gorillas in Lope National Park, Gabon. The following report provides first information on predation of leopards on wild bonobos *(Pan paniscus)*.

Materials and Methods

During February and March of 2004, we collected preliminary data on forest leopards in a 65-km^2 study site, Lui Kotal (2°45.610′ S, 20°22.723′ E), in the southern sector of Salonga National Park, Democratic Republic of the Congo [Hohmann and Fruth, 2003]. The goal of the study was to test different field techniques for a more systematic study on predation by leopards in the region.

We walked 450 km of pre-established transects over a 30-day period and recorded all leopard tracks and signs such as scratches, hairballs and feces. The length and general direction of scratch marks were recorded. Also, if there was a sequence of scratching, which we call 'groups', we followed them on the trail until we could not find any more. Length, width and direction of footprints were recorded. Field entries included information on the location where samples were found, along with the approximate age of the sign.

In the camp, feces and hairballs were weighed, washed in a small-mesh sieve, air-dried and separated by hand. Local field assistants tried to identify prey species based on hairs, bones, claws and skin found in the samples. Trained lead scientists later confirmed the samples. After the matrix had been washed out and the samples had been dried, 90% of the remains consistently appeared to be from the same animal.

The golden cat *(Felis aurata)* is another predator in this forest and may overlap in prey preference with leopards. Adult leopard scats are unmistakable due to their size, but juvenile leopard scats may be confused with those of the golden cat. According to information from local hunters and the literature, golden cats tend to prey much more on small rodents [Hart et al., 1996; Ray and Sunquist, 2001].

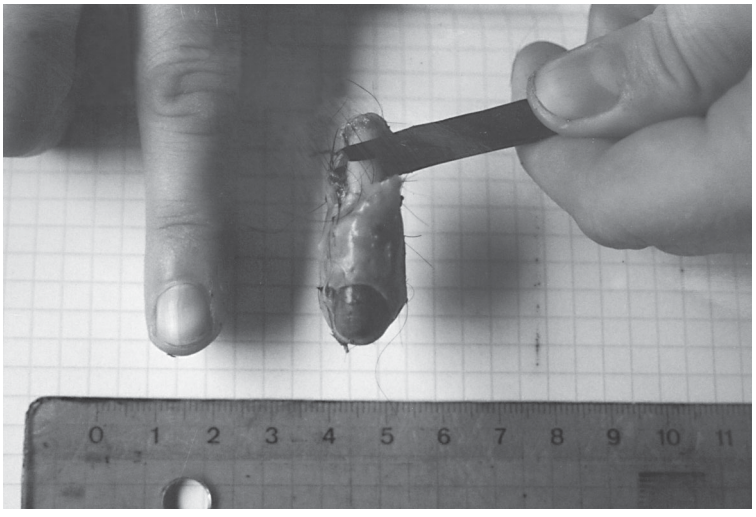

Fig. 1. Bonobo digit found in a leopard scat sample.

Results

We found 15 groups of 40 ground scratchings, 2 fully visible footprints and 1 partial footprint, an average of 0.11 tracks or scratchings/km of trail searched. In addition, we found 5 scats and 3 hairballs. The two prints were very similar in measurements, both 8.5 cm in length and 5.8 and 6.0 cm in width. We also found and identified 3 leopard hairballs, with dry weights of 8–9 g each. The identified prey in these hairballs were cusimanse *(Crossarchus)*, red river hog *(Potamochoerus porcus)* and Peter's duiker *(Cephalophus callipygus)*. The 5 fecal samples also contained remains of red river hog, blue duiker *(C. monticola)* and Peter's duiker. One scat contained portions of 2 digits of a bonobo (fig. 1). Visual inspection suggests that the digits were of a juvenile bonobo. Samples were undigested with nails, skin, tissue and bones to the first and second knuckles, measuring 2.7 and 3.9 cm in length, respectively.

Discussion

Over the last decades, considerable efforts have been made to explain the forces that promote group living in nonhuman primates, and evidence suggests that such forces are predation, avoidance of aggression from conspecifics and infanticide [van Schaik and Höstermann, 1994; Isbell, 1994; Stanford, 1996; Treves, 1999; Bshary and Noe, 1997a, b; Wrangham, 2002]. Predation by carnivores, snakes and raptors is most obvious in species with small or medium body size [Vasquez and Heymann, 2001; Cui, 2003; Perry et al., 2003]. The large body size of great apes is thought to render protection against nonhuman predators [Cheney and Wrangham, 1987]. On

the contrary, Tsukahara [1993] suggests that the large body size of chimpanzees makes them more preferable to lions than other smaller available prey. Zuberbuhler and Jenny [2002] found evidence to support this theory as they found remains of larger-bodied species in leopard feces more often than those of smaller-bodied individuals. Ultimately they suggest that chimpanzees have successfully avoided leopard predation due to 'evolutionary timing', that is, in chimpanzee and leopard evolution, body sizes were smaller in cats and, therefore, they did not see chimpanzees as prey. The few reports on direct and indirect evidence on predation on great apes seem to support this assumption.

Bonobos have been studied at a number of sites, and some populations have been monitored for periods that appear long enough to furnish representative information [Boesch, 2002]. While leopards have always been suspected to be potential predators, evidence supporting this view was not available. In this context, it is important to note that there is a general paucity of information on causes of mortality in bonobos [McGrew et al., 1996]. Even with the published records from Wamba, representing the most complete set of life history data available, the number of documented cases of mortality is very low [Furuichi et al., 1998]. Close proximity between human observers and habituated apes may repel predators and predation rates observed in habituated groups may not be representative. Leopards are known to be very adaptive and opportunistic predators [Bailey, 1993] and predation on bonobos and other great apes may be characterized by individual preferences, spatial variation and temporal fluctuation. Hence, for a better understanding of causes of mortality in bonobos, studies of the potential predators may be essential.

Compared to other field sites like Lomako where bonobos have been studied, evidence for the presence of leopards in Lui Kotal appears to be high. In addition to occasional sightings and vocal cues, indirect evidence such as footprints, scratch marks, feces and kills is more frequent than at other sites. Information from kills found within the study site suggests that leopards target animals of considerable body size such as mature red forest hogs and yellow-backed duikers. It must be considered that leopards do occasionally scavenge and may not have actively hunted each prey species found in the fecal analysis; however, Furuichi [2000] suggests that leopards do not normally eat dead animals and therefore concluded that a leopard did prey on a chimpanzee in the Petit Loango Reserve, Gabon. Future studies on leopard ecology and bonobo socioecology in the region of Lui Kotal will provide more detailed information on predatory behavior of leopards and how the activity of leopards affects grouping and ranging of bonobos.

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