

**SHORT COMMUNICATION****Locomotor Response to Predator Threat in Red Colobus Monkeys**

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**ABSTRACT.** The locomotor patterns of red colobus monkeys (*Colobus badius*) were scored under three different conditions: normal daily activities, in sight of a terrestrial predator, and after the playback of a crowned hawk-eagle call. Relative to the normal movement activities, the terrestrial and avian predator experiments showed fleeing movements to be very rapid with an increase in the frequency of leaping and vertical bounding. Movement distances also increased in response to the avian playback experiments. Although rare, it is possible that rapid movements may better reflect anatomical design than movements during normal daily activities.

**Key Words:** Colobine; Predation; Playbacks; Uganda.

**INTRODUCTION**

Traditionally, studies on primate movement patterns have been based on observations made throughout the day during foraging and travelling activity periods (e.g. FLEAGLE, 1978; MITTERMEIER, 1978; FLEAGLE & MITTERMEIER, 1980; CANT, 1988; DORAN, 1993). During such activities, animals are typically not rushed and can make calculated decisions concerning how they move through the canopy. The objective of this study is to examine how species react and move in crisis situations (i.e. in response to predators). This alternative perspective is important to consider since the anatomical adaptations of a species may be strongly influenced by how animals move during rarely occurring, but rapid locomotor sequences (PROST, 1965; OXNARD, 1974). Rapid flight locomotor sequences increase the risk of a miscalculation and a fall, and are best observed when an animal is fleeing from a predator where the risk of injury and death is elevated (see SCHULTZ, 1969; or LOVELL, 1990, for the frequency of broken bones in arboreal primates). Selection pressure is likely to be elevated during these brief, but critical episodes.

In this study, we followed red colobus monkeys (*Colobus badius*) and recorded locomotor behavior in three different situations. First, we observed red colobus monkeys in the dry and wet seasons in Kibale Forest, Uganda, to score locomotion for all activities, as has been done by traditional studies. Secondly, we approached unhabituated groups of red colobus monkeys and scored their fleeing movements in response to human observers, potential terrestrial predators. Finally, we played back recordings of an adult crowned hawk-eagle, an avian predator (STRUHSAKER & LEAKEY, 1990), and similarly scored red colobus fleeing movements. Comparing each of these three situations showed that some movements are

more essential in escaping predators than are other locomotor abilities, and this in turn may have implications for evaluating anatomical design.

## METHODS

This study was conducted in Kibale Forest Reserve in Western Uganda between June 1990 and October 1991. All observations reported here were made in relatively pristine forest with a canopy height averaging approximately 30 m (maximum 50 m; see STRUHSAKER, 1975; and BUTYNSKI, 1990, for descriptions of the study site). We chose to study red colobus monkeys (*Colobus badius*) since they are relatively common within Kibale Forest and are easily observed (STRUHSAKER, 1975).

Observations were made under three different conditions: (1) during typical travel activities throughout the day; (2) subsequent to unhabituated red colobus monkeys sighting a potential terrestrial predator (i.e. humans); and (3) following the experimental playback of a call of a crowned hawk-eagle (*Spizaetus coronatus*), a known avian predator of red colobus (DANEEL, 1979; SKORUPA, 1989; STRUHSAKER & LEAKEY, 1990; LELAND & STRUHSAKER, 1993).

Focal animal observations were recorded following the technique of FLEAGLE (1976, 1978), SUSMAN (1984), GEBO (1992), and GEBO and CHAPMAN (in prep.) on adult animals. Positional behaviors (e.g. quadrupedalism, leaping, climbing, vertical bounding, and standing) as well as the procedures of observation are described in detail in GEBO and CHAPMAN (in prep.). Observations were made during 200 hours of contact with red colobus groups during the dry and wet seasons of 1990 and 1991 and a total of 15,385 bouts were recorded. Only locomotor bouts during travel ( $N=5738$  bouts) were considered an appropriate comparison for the terrestrial and avian predator responses.

The responses of unhabituated groups of red colobus monkeys to the approach of an observer was used as a measure of their response to a terrestrial predator. In Kibale Forest, potential terrestrial predators include leopards and golden cats, although there is no direct evidence of either species killing red colobus monkeys (STRUHSAKER, 1975). Chimpanzees are predators of *Colobus badius* and their attacks are often initiated from the ground (C. CHAPMAN, pers. obs.). In addition, although there is presently virtually no hunting of primates carried out by the local people surrounding Kibale Forest, there may have been extensive hunting prior to 1964 (STRUHSAKER, 1975).

The observers approached an unhabituated red colobus group and scored the fleeing movements of easily observed adult animals. If the focal animal was lost from view or stopped moving after reaching a position of relative security, the observer selected a new focal subject from those in view, attempting to rotate between the sexes. On average, three animals could be scored by an observer following the approach to a single unhabituated group.

Recordings for use in the playback experiment were made of an adult crowned hawk-eagle (*S. coronatus*) using a Sony (WM-D6C) cassette recorder and a Sennheiser directional microphone (ME 80). The crowned hawk-eagle is a large (3.4–4.1 kg) bird of prey (BROWN et al., 1982) known to kill red colobus monkeys (SKORUPA, 1989; LELAND & STRUHSAKER, 1993), particularly young juveniles and infants (STRUHSAKER & LEAKEY, 1990). A 40-second recording of the call was played to habituated calm red colobus groups. A speaker (Toshiba model SS-A1W; possessing a flat frequency response to 11 KHz) was elevated

into the canopy using a 11 m pole. The recording was standardized at an amplitude of 60 dB using a calibrated Realistic sound level meter (weighting, slow response, 60 m from the source). The speaker was placed approximately 20 m from the observer.

Prior to playing the stimulus, a focal individual was selected on the basis of sex and ease of observation. The movement of the focal animal was scored during and immediately after the stimulus was played. Two observers watched different animals during each trial. If the animal fled out of sight, a new focal animal was selected. All observations stopped approximately 60 seconds after the end of the crowned hawk-eagle call. Only one trial was conducted on a particular group in a given day. To prevent the animals becoming habituated to the call or to the experimental procedure, no group was exposed to the stimulus within 2 days of the previous trial, and intertrial duration averaged 6.9 days (S.D.=4.9, range=2–18).

RESULTS AND DISCUSSION

Table 1 lists locomotor frequencies for each of the three situations. Comparing the fleeing movement frequencies in both predation situations shows quadrupedalism and climbing to decrease in frequency, while leaping increases rather substantially (as does vertical bounding during the avian response). The rarer types of locomotor behavior are equivocal in their frequency changes relative to normal travel. For the avian response, quadrupedalism and climbing have the lowest frequencies, and leaping the highest across all three comparisons. It is the change in leaping frequencies which appears to modify the frequency alterations for quadrupedalism and climbing. Leaping frequency increases from only 33.7% during travel to 47.5% when in sight of a terrestrial predator, to 52.9% in response to an avian predator. Small increases or decreases in frequency are also recorded for bimanualism, bridging, and other. Of the rarer locomotor behaviors, only vertical bounding during the avian playback experiment increases substantially.

As with the increased emphasis of leaping in red colobus fleeing responses, longer maximum leaping distances also occur in the predator experiments (Table 2). The avian predator response, shows the most substantial changes with longer mean distances, higher maximum leaping distances, and more frequent use of long distance movements (Table 2). Mean distances as well as the number of long distance movements are similar in both the terrestrial predator and normal travel observations. Thus, only the avian response shows any substantial increase in distances relative to normal travel activities.

**Table 1.** Red colobus locomotion during travel (1990 and 1991) and their response to terrestrial and avian predators.

	Locomotion during travel (%)	Terrestrial predator (%)	Avian predator (%)
Quadrupedalism	31.0	23.3	14.8
Leaping	33.4	47.5	52.9
Climbing	27.9	21.9	16.4
Bimanualism	3.0	2.1	4.5
Bridging	0.4	0.6	0.0
Vertical bounding	4.0	4.6	11.1
Other	0.3	0.0	0.3
Sample size (bouts)	5738	804	512

**Table 2.** Horizontal or linear distances moved during a leap under three conditions.

	<i>N</i>	Mean distance (BL)	Maximum (BL)	% > 4BL (%)
All activities – Travel	1593	1.82	8	4.0
Terrestrial predator	314	1.88	11	5.1
Avian predator	186	2.50	16	10.2

Distances are measured in body lengths (BL). The average head and body length for adult *Colobus badius* is 533 cm (NAPIER & NAPIER, 1967), thus two body lengths are approximately equal to 1 m in linear distance.

In summary, leaping appears to increase in frequency in times of crisis, and obviously represents a rapid method of crossing distances quickly. Of the two predator situations, the avian playback experiment clearly displayed more substantial changes in red colobus locomotor frequencies as well as increased movement distances (Tables 1 and 2), perhaps indicating a greater potential threat (see LELAND & STRUHSAKER, 1993).

Traditional studies have concentrated on normal daily activities during feeding, foraging, and traveling. Responses to predators are rarely noted but may well represent critical situations that influence limb design. For red colobus monkeys, this response is leaping away from danger. It is tempting to speculate that although red colobus monkeys often utilize quadrupedalism, climbing, and leaping in their daily activities, anatomical features associated with leaping may be better developed relative to other species, which move in similar ways but use alternative methods of escape. Thus, information gained under situations of crisis may offer alternative premises for understanding anatomical design in primate limbs. Unfortunately, this suggestion will require far greater behavioral documentation of “crisis” situations in the field and a thorough comparative examination of limb biomechanics in primates before general acceptance of this idea is forthcoming.

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