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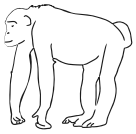
Contents



<NOTE>
An Annular Solar Eclipse at Mahale: Did Chimpanzees Exhibit Any Response?

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INTRODUCTION

Contemporary humans often enjoy observing solar eclipses as astronomical shows. In the mystic atmosphere under an eclipsing sun, one might ask, "How ancestral humans faced such events without understanding their causal mechanism? With fear or with fascination?" Similarly, it may be interesting to know how animals respond to such solar events.

The behavior of animals in captivity has been observed during solar eclipses. For example, antelope ground squirrels (*Ammospermophilus leucurus*) exhibit

increased locomotor activity during a partial solar eclipse (Kavanau & Rischer 1973). In contrast, hamadryas baboons (*Papio hamadryas*) become less active during a solar eclipse (Gil-Burmann & Beltrami 2003). Interestingly, captive chimpanzees (*Pan troglodytes*) have been observed to climb up high structures, orient their bodies toward the sun, and even gesture toward the sun during an annular solar eclipse (Branch & Gust 1986). During an annular eclipse, simultaneous observations of captive chimpanzees were made at eight Japanese institutions (zoos and research institutes). Notable behaviors, such as shouting at the sun, looking up at the sky, or showing general excitement, were reported at four of these institutions (Kato *et al.* 2013). However, the authors caution that these behaviors may be caused by increased human presence (and excitement) rather than the eclipse itself.

There have been fewer reports on the responses of animals in the wild to solar eclipses. In one study, the European ground squirrel (*Spermophilus citellus*) did not show any marked behavioral change during a partial eclipse (Spoelstra *et al.* 2000). An extensive survey on the behaviors of various animals at the Mana Pools National Park in Zimbabwe during a total eclipse revealed that hippopotamuses and many birds behaved as though it was dusk, impalas exhibited increased vigilance, and baboons exhibited feeding cessation (Murdin 2001). However, there appears to be no reports on the responses of wild chimpanzees to solar eclipses.

On September 1, 2016, we unexpectedly observed an annular eclipse at the Kasoje area in the Mahale Mountains National Park, Tanzania, where research on habituated chimpanzees has been conducted for more than 50 years (Nakamura *et al.* 2015). Although there are no records of solar eclipses at Mahale, online eclipse predictions by Fred Espenak (EclipseWise.com online) indicated that till date, several solar eclipses have occurred in the Kasoje area since the commencement of the chimpanzee study (Table 1). However, this was the first annular eclipse in the Mahale research history (and the next will be in 2064). Therefore, here we report the chimpanzee behavior during this rare annular solar eclipse.

PARTICULARS OF THE ANNULAR SOLAR ECLIPSE

On the day of the eclipse, no author was aware that the event was going to occur. HN was at the Kansyana Research Camp, Kasoje area, at Mahale and was notified of the impending solar event by a research assistant who heard the news on the radio. According to EclipseWise.com (online), the annular eclipse was observed in a wide area from the Indian Ocean to Madagascar and Central Africa to the Atlantic Ocean. At Kansyana (6°7′1″S, 29°44′23″E), the event lasted from 09:49 h to 13:29 h, with the annular state occurring for approximately 2.5 min between 11:32 and 11:35 h at a maximum magnitude of 97.3% (Figure 1).

There was no rain during 11 days (August 27 to September 6) including the day of the eclipse owing to September being at the end of the dry season at Mahale. The temperature started falling at 11:00 h, and at 11:50 h, as the eclipse was receding, the temperature was approximately 5°C below the average temperature on the surrounding 10 days (Figure 2); at 12:50 h, toward the end of the eclipse, this difference reduced below 2°C. We did not monitor luminous intensity, but when the eclipse was at maximum magnitude, HN felt that it was as dark as at dusk.

CHIMPANZEE BEHAVIOR DURING THE SOLAR ECLIPSE

On the day of the eclipse, MN met a party of chimpanzees including the alpha male at 07:55 h and started following an adult female, Linda (estimated to be 36 years

Table 1. Solar eclipses observed at Kansyana Camp (6°7′1″S, 29°44′23″E) since the commencement of chimpanzee research in 1965 (based on eclipse predictions by Fred Espenak on EclipseWise.com online).

Date	Season	Kind of eclipse	Eclipse magnitude (%)	Time*
Jun 30, 1973	Dry	Partial	65.9	15:58 h
Apr 18, 1977	Wet	Partial	84.9	13:45 h
Feb 16, 1980	Wet	Partial**	99.8	10:59 h
Dec 4, 1983	Wet	Partial	75.6	17:03 h
Mar 29, 1987	Wet	Partial	58.8	16:59 h
Nov 3, 1994	Wet	Partial	8.8	18:26 h
Jun 21, 2001	Dry	Partial	75.3	16:15 h
Dec 4, 2002	Wet	Partial	62.4	08:56 h
Oct 3, 2005	Dry to Wet	Partial	63.9	14:19 h
Mar 29, 2006	Wet	Partial	8.6	12:33 h
Jan 15, 2010	Wet	Partial	74.1	08:21 h
Nov 3, 2013	Wet	Partial	74.7	17:22 h
Sep 1, 2016	Dry	Annular	97.3	11:34 h

* Local standard time at maximum magnitude (UT + 3).
** Bilenge, which later became the park headquarters, experienced the total eclipse.

Figure 1. The annular eclipse observed at Kansyana Camp on September 1, 2016.

old), at 08:28 h. At around 09:30 h, most party members began moving westward, whereas Linda and her 4-year-old daughter, Lenge, did not follow the others and started moving eastward. At around 11:00 h, MN noticed that the sky began to darken. Being unaware of the occurrence of the eclipse and with limited visibility of the sky from the forest, he thought that the sun was being obscured by thick clouds, as it often happens during the wet season at Mahale, and wrote in the field notes: "it is becoming cloudy"; at 11:30 h, he wrote, "it is very gloomy"; and at 11:59 h, he wrote, "sunlight is back." MN continued to follow Linda until 17:00 h. On return to the research camp, he was informed by HN that the eclipse had occurred.

Ex post facto investigation was conducted on the behaviors of the focal female, Linda, and her daughter, Lenge, during the eclipse. At 11:00 h, when MN first noticed that the sky had begun to dim, Linda was feeding on *Saba comorensis* fruits and Lenge was resting in a nearby

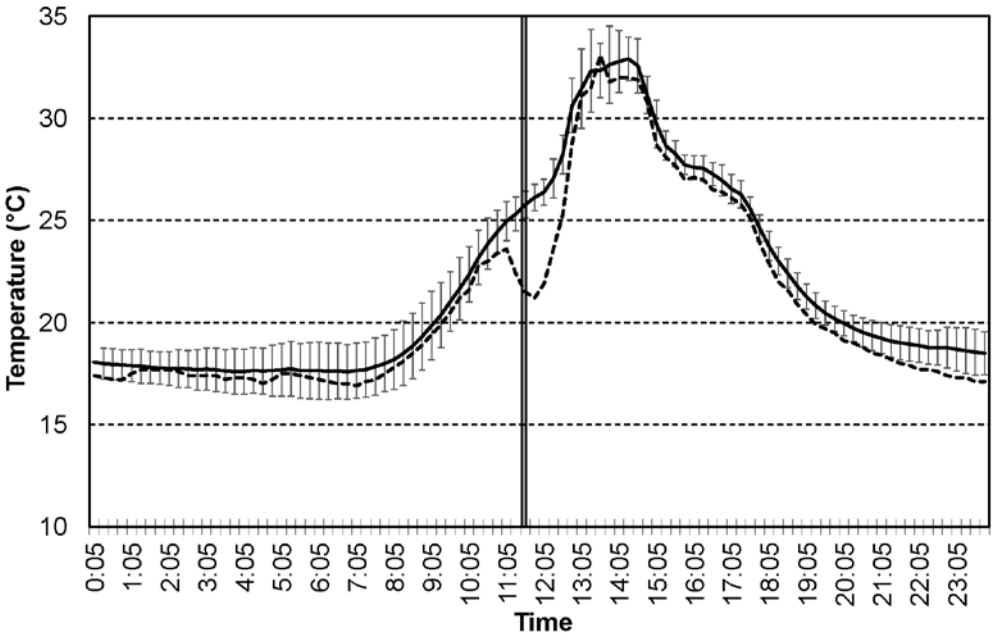

Figure 2. Comparison of temperatures between the day of the eclipse (dashed line) and the average of the surrounding 10-day period (August 27–31 and September 2–6) (solid line). Error bars show standard deviations. A double vertical line shows the time of the annular eclipse.

Figure 3. Linda (above) and Lenge (below) fishing for ants at 12:48 h on the day of the eclipse.

bed. Soon, they began moving eastward. At 11:13 h, Linda made some tools, and both chimpanzees began fishing for arboreal ants. At 11:30 h, when the sky was the darkest, they were still fishing for ants. Linda continued fishing for ants (Figure 3) until 14:56 h, whereas Lenge fished intermittently, begged Linda for tools or a place to fish ants, suckled on Linda's nipple, or foraged nearby for fruits. There was no indication that Linda or Lenge particularly changed their behavior during the eclipse. Although the two were by themselves when the eclipse occurred, MN was aware that other chimpanzees were nearby, so calls by other chimpanzees would have been heard. As no calls were heard during the time of the eclipse, it was assumed that the other chimpanzees did not vocally respond to the eclipse.

DISCUSSION

Unlike that in previous studies on captive chimpanzees (e.g., Branch & Gust 1986), Linda and her daughter, Lenge, did not exhibit any specific behavioral change during the eclipse, and continued fishing for ants in the tree. This lack of response to the eclipse may have been due to them not being able to see the eclipsing sun as the location where they were fishing for ants was covered by a thick canopy of leaves. This may be consistent with the results in the report on captive chimpanzees, in which cloud cover prevented the observation of the eclipse because of which chimpanzees exhibited no any specific response (Kato *et al.* 2013). Apparent excitement or curiosity observed in some captive chimpanzees may be more likely when there is no overhead coverage, as in zoos, and when the eclipsing sun is directly visible.

Owing to overhead tree coverage, wild chimpanzees may not be able to directly observe eclipse events. Thus the question is whether or not wild chimpanzees can detect something unusual in the unexpected onset of darkness alone. As we experienced an annular rather than a total solar eclipse in the present study, although it became quite dark, it still was sufficiently bright for chimpanzees to continue ant-fishing and for MN to write field notes. During partial eclipses with smaller eclipse magnitudes, it may be increasingly difficult for chimpanzees to detect a difference between darkness caused by cloudiness and that by eclipse. Onset of darkness to some extent may not affect them much as they are accustomed to such darkening events by sudden occurrences of heavy clouds in the wet season. Furthermore, it is likely that solar eclipses during the wet season go unnoticed because the sky is often covered with thick clouds. This may also explain the lack of previous reports on eclipses at Mahale, as most eclipses occurred in the wet season (Table 1). Although wild chimpanzees are known to perform "rain dances" when it starts raining heavily (Goodall 1986), no obvious behavioral changes have been noted when the sun is simply obscured by thick clouds. Thus, the lack of obvious behavioral changes by Linda and Lenge was unsurprising.

The question still remains on how chimpanzees respond during a total solar eclipse when the forest is suddenly covered in complete darkness during the day. There will be long wait before a total eclipse occurs at Mahale or at other chimpanzee research sites in the wild.

ACKNOWLEDGEMENTS

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<NOTE>
Do Not Disturb! A Factor in Bed Site Relocation among Mahale Chimpanzees

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INTRODUCTION

Chimpanzees (*Pan troglodytes*) sleep in self-made beds in trees; the sleeping sites are associated with daily activity and selected to ensure safe, comfortable sleeping. In the daytime, chimpanzees forage within their home range. Therefore, sleeping site selection can be affected by the distribution of food resources. For example, chimpanzees in Kalinzu Forest, Uganda, prefer to make beds in fruit-rich areas (Furuichi & Hashimoto 2004), while chimpanzees in the savanna woodland of Ugalla, Tanzania, frequently select slopes close to water as bed sites (Ogawa *et al.* 2014). A slope is also a safe place that allows avoidance of predators, such as lions (*Panthera leo*) and leopards (*P. pardus*), because the slope underbrush is insufficiently dense to conceal these predators (Hernandez-Aguilar 2009; Ogawa *et al.* 2014).

The beds are made of branches, twigs and leaves, such that the comfort of beds may differ among bed tree species. In Semliki, Uganda, chimpanzees prefer a tree species with stiff branches because this affords firm, stable beds (Samson & Hunt 2014). Chimpanzees in Mahale, Tanzania, prefer tree species with greater total leaf area on the branch, because these yield leafier beds (Zamma & Ihobe 2015).

However, chimpanzees do not always make their beds in the most suitable tree, or in the optimum location. For example, fruiting trees may be good locations for beds to monopolize the available fruit (Fruth & Hohmann 1996; Basabose & Yamagiwa 2002), but sleep in fruiting trees might be disturbed by nocturnal frugivores (Fruth & Hohmann 1996). There are many animals in forests, and bed tree selection by chimpanzees is presumably limited by the activity of these animals.

The eastern red colobus (*Procolobus rufomitratus*) is the predominant prey species of Mahale chimpanzees (Hosaka 2015), but colobus monkeys sometimes counterattack chimpanzees that are attempting to hunt them (Hosaka 2002; Boesch *et al.* 2002); chimpanzees also occasionally detour to avoid a colobus (Boesch *et al.* 2002). Furthermore, it was reported in the early 2000s that colobus males in Mahale even began to attack chimpanzees that were not attempting to hunt them (Hosaka & Ihobe 2015).

In this paper, I report a case in which chimpanzees abandoned an attempt to make beds in a tree because of the threat posed by two red colobus monkeys.

METHODS

I conducted this research in Mahale Mountains National Park, Tanzania, in October and November 2016. In Mahale, 70 mammal species (11 orders) have been recorded (Ihobe 2015). I observed the M-group chimpanzees in the Park. During the study period, the mean time at which chimpanzees started making beds was 18:34 h (range: 18:19–19:11 h; $n = 15$).

OBSERVATION

On October 19, 2016, I observed a party consisting of two adult females (Zola and Puffy), their offspring (Zolfa, Zamma, and PF14), and an adult male (Primus).

Figure 1. Chimpanzees and a red colobus monkey. The chimpanzees attempted to hunt the red colobus monkey, but they hesitated to approach it. The photo was taken on October 23, 2006.