

Seasonal and daily use of natural licks by sambar deer (*Cervus unicolor*) in a Bornean tropical rain forest

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ABSTRACT Seasonal and daily use of natural licks by sambar deer (*Cervus unicolor*) was examined with camera traps in the Deramakot Forest Reserve, Sabah, Malaysian Borneo. The visitation frequency by females was significantly higher in the wet season (October to March) than in the dry season (April to September) (0.277/day and 0.120/day, respectively), while that by males was not significantly different between seasons (0.190/day and 0.138/day, respectively). Our results imply that the increased female visitation frequency in the wet season reflects the peak of their physical demands (e.g., lactation). The visitation frequency in the dark period (1800 h - 0600 h) was significantly higher than that in the light period (0600 h - 1800 h) (85% and 15%, respectively). Sambar deer are generally assumed to forage at night, and the utilisation of natural licks corresponded to their foraging habits. This study suggests that, for sambar deer, natural licks are among the most important habitats not only for daily sustenance but also for reproductive support.

Key words: calcium, minerals, reproduction, sambar deer, wildlife conservation

INTRODUCTION

Natural licks are among the most important mineral sources for herbivores, which have difficulty ingesting a sufficient quantity of some essential minerals through food, especially in inland terrestrial ecosystems, in which plants contain insufficient minerals, particularly sodium (Denton, 1982). Soils in the tropics are generally depleted of major cations (Jordan, 1985), and plants growing in such soils have lower foliar concentrations of essential

minerals than those growing in the temperate zone (Vitousek and Sanford, 1986). Therefore, herbivores in the tropics are expected to depend strongly on natural licks.

Cervids are representative herbivores. The utilisation of natural licks by cervids has been mainly reported for moose (*Alces alces*), white-tailed deer (*Odocoileus virginianus*), and axis deer (*Axis axis*) in frigid, temperate, and subtropical zones, respectively (Tankersley and Gasaway, 1983; Moe, 1993; Atwood and Weeks, 2002). The visitation frequency of natural licks by cervids reflects their physiological demands not only for daily supplement but also for reproductive support, such as pregnancy and/or lactation. For example, the visitation frequency of moose (*Alces alces*) and white-tailed deer (*Odocoileus virginianus*) at natural licks increased during late gestation and/or at the peak of the birth season (Tankersley and Gasaway, 1983; Atwood and Weeks, 2002). However, little is known about the utilisation of natural licks by cervids in the tropics.

The sambar deer (*Cervus unicolor*), a lower risk species (IUCN 2006), is native to Southern and Southeast Asia. The Bornean sambar deer weighs around 100 kg and has a head-and-body length of 154-204 cm, although mature males are larger than females (Payne et al. 1998; Meijaard et al. 2005). The birth season of sambar deer has been reported to be the wet season (Mishra, 1982; Mishra and Wemmer, 1987; Geist, 1998), while no data are available on that of sambar deer in Borneo.

In a previous study using camera traps, we showed that the sambar deer was one of the most frequent visitors to natural licks in the Deramakot Forest Reserve, Sabah, Malaysian Borneo (Matsubayashi et al. 2007). To investigate the importance of natural licks for cervids in the tropics, we examined the visitation frequencies to natural licks by sambar deer between sexes and seasons

using data obtained with camera traps in the Deramakot Forest Reserve.

MATERIALS AND METHODS

The study was conducted in the Deramakot Forest Reserve (55083 ha; 05°22'N, 117°26'E) (Fig. 1), Sabah, Malaysia, which is covered primarily by lowland mixed dipterocarp forests dominated by the family Dipterocarpaceae (*Dipterocarpus* spp., *Shorea* spp., and *Parashorea* spp.). The climate is humid equatorial with a mean annual temperature of about 26 °C and is greatly influenced by the southwest monsoon (May-August) and the northeast monsoon (November-February). The average annual precipitation ranges from 1700 to 5100 mm (Kleine and Heuveldop, 1993; Huth and Ditzer, 2001). To analyse the data of camera traps, we divided the seasons into dry (April-September) and wet (October-March) and the time of day into the light period (0600 h - 1800 h) and the dark period (1800 h - 0600 h).

Camera traps with an infrared trigger system (Sensor

Camera Fieldnote II, Marif Co., Ltd., Yamaguchi, Japan) were set up at a total of 5 camera-trap stations at 5 natural licks in the forest reserve for 13 months between June 2003 and October 2005 (Matsubayashi et al. 2007). The total study effort was 649 camera days.

We counted the number of adult-visitation events. Our study showed that most animals stayed at natural licks for a few minutes and that only Asian elephants stayed more than 30 minutes. Therefore, when two or more photographs of the same species were obtained within 30 minutes, only one was counted as an event visitation. When two or more individuals were photographed in one frame, only one was counted. However, to examine the differences between sexes in both seasons, each individual was counted when an adult male and an adult female were photographed in one frame. Even if the antlers had dropped, males were distinguished by the pedicle.

Differences in the utilisation of natural licks by the same sex in different seasons and by different sexes in the same seasons and those in the activity level in the

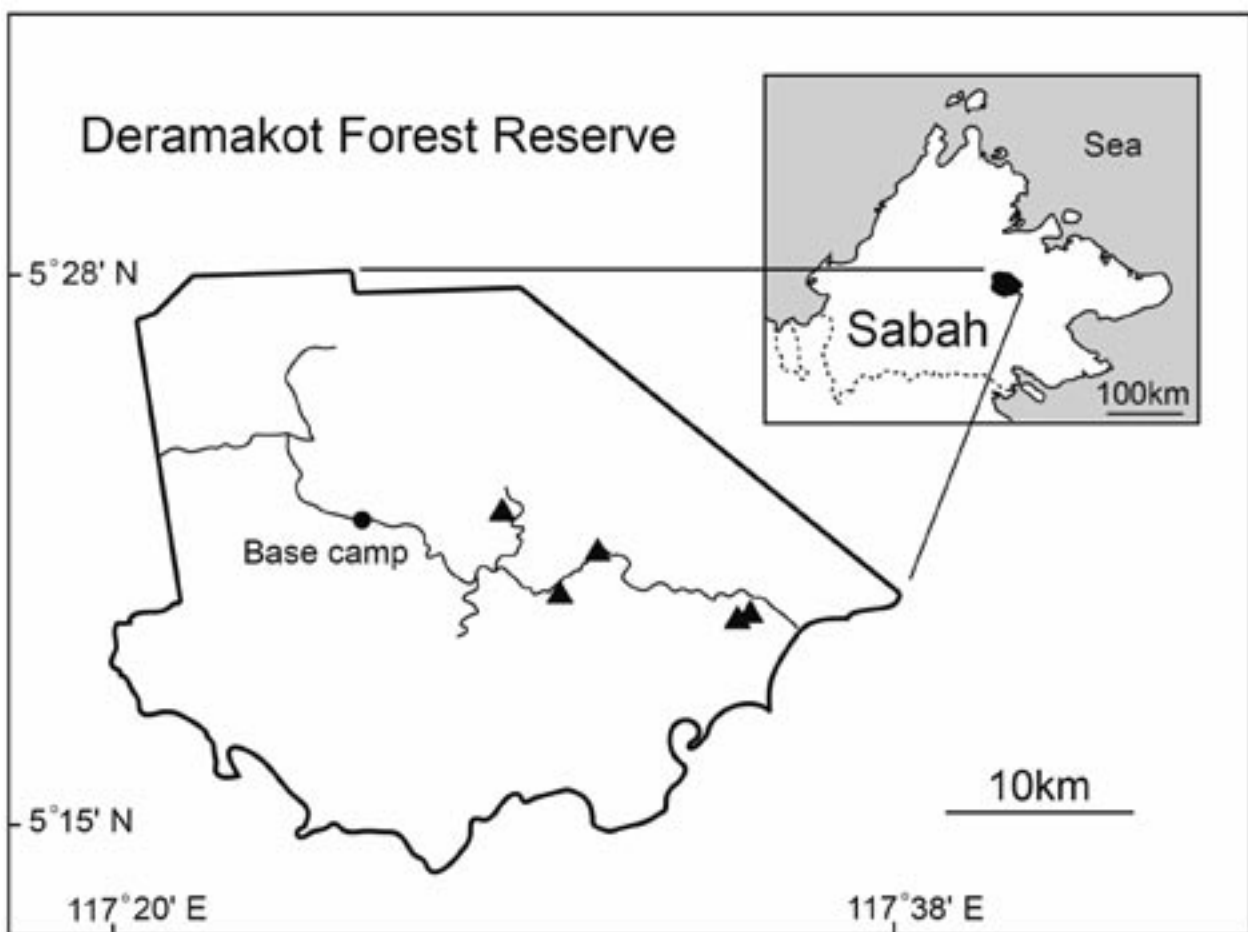


Fig. 1. Location of Deramakot Forest Reserve and the natural licks subject to the camera-trapping study (▲); Base camp of Deramakot, Sabah Forestry Department (●).

light and dark periods were tested by the G test.

RESULTS

Seasonal frequency of visitation to natural licks

A total of 649 photographs of wildlife were obtained. There were 242 photographs in the wet season and 407 in the dry season. A total of 257 photographs were of sambar deer (0.396/day), and 218 of them were identified by sex (male, 102; female, 116) (Fig. 2).

The frequency of visitation by sambar deer was significantly higher in the wet than in the dry season (wet season, 0.467/day; dry season, 0.258/day; $p < 0.001$). The visitation frequency of the females was significantly higher in the wet than in the dry season (wet season, 0.277/day; dry season, 0.120/day; $p < 0.001$). That of the males also increased in the wet season, but not significantly (wet season, 0.190/day; dry season, 0.138/day; $p = 0.103$). The visitation frequency of the females was significantly higher than that of the males in the wet season (male, 0.190/day; female, 0.277/day; $p = 0.048$), although that of both sexes in the dry season was not significantly different (male, 0.138/day; female, 0.120/day; $p = 0.495$) (Fig. 3). These results showed that

the visitation frequency of both sexes of sambar deer, but particularly that of the female, was higher in the wet season than in the dry season.

Daily frequency of visitation to natural licks

The frequency of visitation was significantly higher in the dark period than in the light period (dark, 85%; light, 15%; $p < 0.001$) (Fig. 4). The visitation patterns of both sexes



Fig. 2. A female sambar deer at the natural lick.

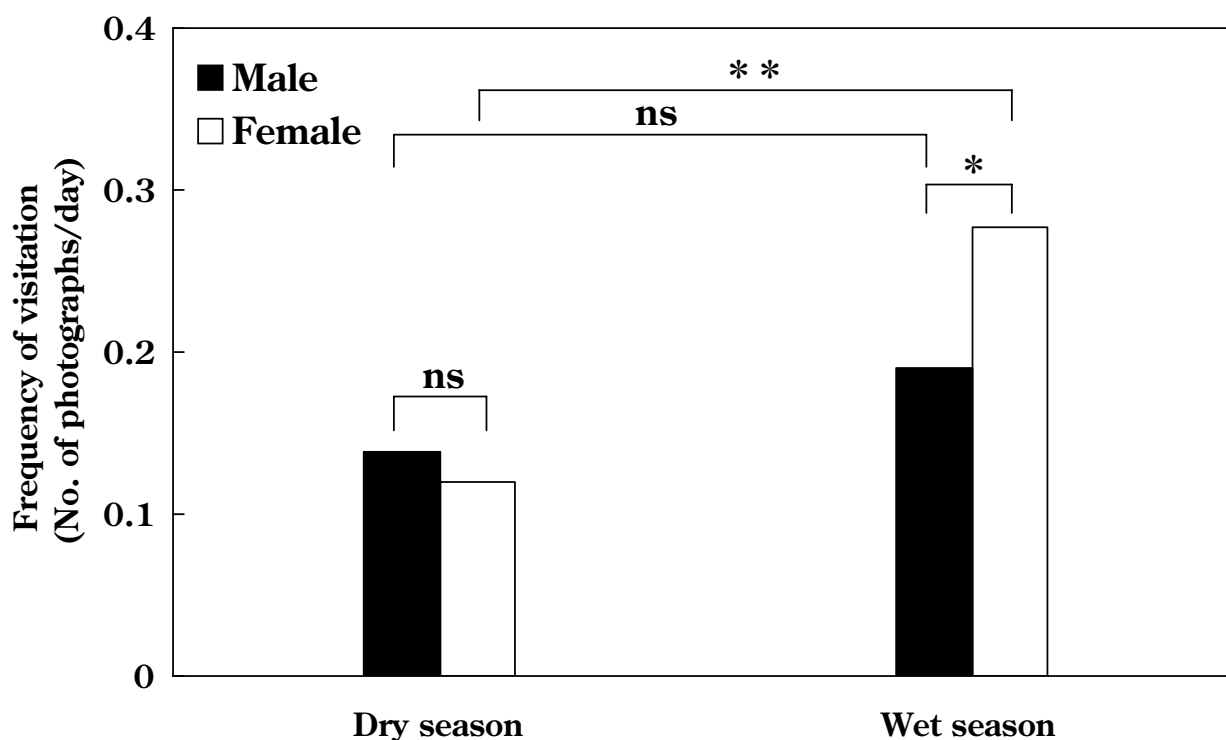


Fig. 3. Seasonal frequency of visitation to natural licks by sambar deer*, $P < 0.05$; **, $p < 0.001$; ns, not significant.

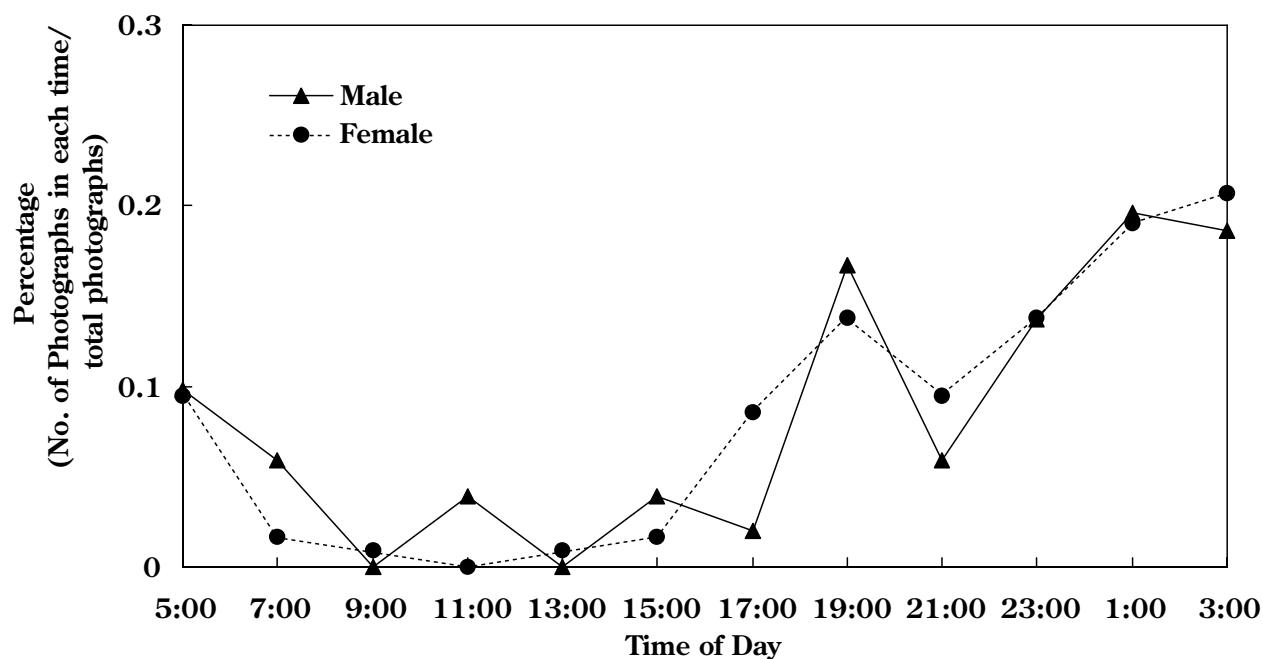


Fig. 4. Daily frequency of visitation to natural licks by sambar deer.

were similar. There were two distinct peaks of activity in the dark period. The primary peak was sharp from 1900 h to 2000 h, while the second peak was broad from 0100 h to 0500 h.

DISCUSSION

The findings in this study suggest that the visitation frequency by sambar deer, especially females, to natural licks increased in the wet season, implying that females have a strong requirement for minerals. The following are two possible explanations for the phenomenon: (1) in the wet season, food has a high water content; therefore, animals imbibe water from food and lose minerals through urination (Suttle and Field, 1967), and (2) the peak of the birthing season might be in the wet season in Borneo. Although (1) can demonstrate the increase of visitation by both sexes in the wet season, it is insufficient to explain the great increase in female visitation. The significant difference regarding females could be explained by (2).

In mammals, it has been reported that mothers in late pregnancy and during lactation demand large quantities of calcium for their infants and newborn (Hays and Swenson, 1984; Kovacs, 2005). The natural licks in Deramakot contain a high concentration of calcium (Matsubayashi et al. 2007). We observed that sambar deer foraged for tree bark (*Pterospermum* spp.)

in the wet season. The bark contains a higher calcium concentration than other foods examined (Matsubayashi et al. 2007). Although we could not identify which sex showed such bark eating behaviour, this observation suggests that there is an increase in the calcium demand in the wet season. In our camera-trapping study, fawns were recorded at natural licks four times, and only in the wet season (31 January 2004; 5–7 November 2004).

This study also suggests that sambar deer visited the natural licks primarily in the dark and the visitation patterns of both sexes were similar. In Borneo, sambar deer are known as nocturnal animals (Payne et al. 1998). A camera-trap study in Peninsular Malaysia also revealed that the activity level of sambar deer increased at night (Kawanishi and Sunquist, 2004). Therefore, the utilisation of natural licks by sambar deer corresponded to their foraging habits. Such behaviour patterns have been reported in other ungulates, such as babirusa (*Babirusa babirusa*) in Sulawesi (Clayton and MacDonald, 1999), and differences were observed in North American moose (*Alces alces*) with regard to nighttime visitation of natural licks and daytime foraging (Tankersley and Gasaway, 1983). Two distinct peaks were recorded with regard to visitation to natural licks, although the activity pattern of sambar deer in Peninsular Malaysia showed only one peak (Kawanishi and Sunquist, 2004). We could not explain whether or not the decreasing visitation at around 2100 h reflected an original activity pattern.

This study clarified the seasonal and daily use of natural licks of sambar deer in north Borneo, and the results suggested that, for sambar deer, natural licks are among the most important habitats not only for daily supplement but also for reproductive support. This seasonal use of natural licks might be applied to other animals. For example, our previous study showed that orangutan frequently visited natural licks as well (Matsubayashi et al. 2007), and pregnant individuals and mothers with their infants were photographed there. Therefore, natural licks should be considered a high priority in wildlife conservation in the forest.

ACKNOWLEDGEMENTS We are grateful to Datuk Sam Mannan and Mr. Azny Ahmad, Sabah Forestry Department, Mr. Patrick Andau, Sabah Wildlife Department, Professor Tohru Nakashizuka, Research Institute for Humanity and Nature (RIHN) for their encouraging our work. Our gratitude goes to Ms. Yuko Matsubayashi and anonymous referees for useful suggestions on this manuscript. This study was supported by RIHN Project 2-2.

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Received 23rd Apr. 2007

Accepted 29th Aug. 2007