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Short Note

Tree rubbing by Asian black bears (*Ursus thibetanus*) in conifer plantations in Okutama Mountain in Japan

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Abstract

Tree rubbing by bears is a well-known behavior, but the behavior has not been investigated systematically in Asian black bears. We installed automatic cameras at trees in planted conifer forests to visually document rubbing behavior and to compare the findings with the results of earlier studies. All trees with bear hair attached had bark damaged from antler sharpening by deer and had secreted resin. Between 2011 and 2015, tree rubbing was observed at five of the 16 trees at which automatic cameras had been installed, with a total of 22 visits by multiple bears. Rubbing was observed from May to October. In the 22 visits, several bears with several attributes (adult male, another male, and mother with cub) visited the same trees to rub them. In our survey, the number of observational confirmations was limited, therefore in order to investigate the factors of Asian black bear's tree-rubbing behavior and determine whether it is the same as in other bears or not, it is desirable to collect further examples of rubbing behavior as well as genetic information of the rubbing individual.

Keywords

Conifer plantation; *Larix kaempferi*; scent marking; scent rubbing; tree rubbing

Introduction

Brown bears (*Ursus arctos*) and American black bears (*Ursus americanus*) rub parts of their bodies against tree trunks (e.g., Green & Mattson, 2003, and Burst & Pelton,

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1983, respectively) and artificial objects, such as creosoted power poles and fence posts (e.g., Karamanlidis et al., 2007). Brown bears and American black bears primarily select conifers for rubbing (e.g., Green & Mattson, 2003 and Burst & Pelton, 1983, respectively). Brown bears tend to more frequently rub trees that secrete large amounts of resin when the bark is damaged (Clapham et al., 2013; Sato et al., 2014).

There are various theories about why bears rub trees, including some that posit physiological drives experienced by the bears and others that relate to the marking of trees with the animal's scent. The former category includes reasons such as response to skin parasites, inflammation, itching, or molting, along with physical stimulation or curiosity (e.g., Green & Mattson, 2003; Taylor et al., 2015). The latter category is based on the observations that several bears may rub the same tree, that males are more likely than females to rub trees, and that tree rubbing peaks during the breeding season (e.g., Green & Mattson, 2003; Clapham et al., 2012; Taylor et al., 2015). Such theories may identify scent marking as a potential method of communication for these solitary animals, which are active across large areas, and particularly as male dominance behavior in mating (Clapham et al., 2012, 2014; Sato et al., 2014).

There are few reports of tree rubbing by Asian black bears (*Ursus thibetanus*). Bromlei (1965) described Asian black bears rubbing their backs on tree trunks from spring to early summer in southern Far East Russia. Latham et al. (2012) collected bear hair from conifers [e.g., Cajander larch (*Larix cajanderi*)] and Maximovich's poplar (*Populus maximowiczii*) for noninvasive genetic sampling from June to August in the Russian Far East and found that the hair of Asian black bears was collected less frequently than that of brown bears. Ngoprasert et al. (2012) obtained still photographs from camera traps showing Asian black bears standing with their back to trunks in front of the bait hanging from branches and it looks like rubbing behavior. However, there have been no systematic studies of tree-rubbing behavior using video recording camera traps and there is no information on the details of tree rubbing by Asian black bears.

We used automatic cameras to observe tree rubbing by the Asian black bear. Revealing the presence or absence and the details of tree rubbing may give us a greater understanding of the bear's mating behavior and communication, about which little is currently known. Previous studies found many hairs remaining on the bark of trees, especially hairs of the Asian black bear on conifers in the Russian Far East from June to August (Latham et al., 2012). In Japan, around that season Asian black bears stay in conifer plantations most of the time (Yasue et al., 2015), and we had experienced before that sometimes, bear hairs could remain adhered to conifers. Therefore, we installed automatic cameras at trees in conifer plantation to visually document tree-rubbing behavior.

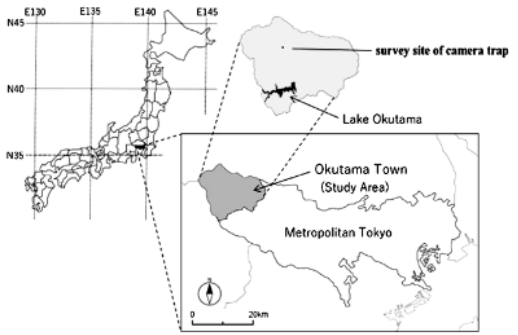

Figure 1. Map of the study area and survey site: Okutama Town, Tokyo, Japan.

Methods

Study area

The study was conducted in Okutama Town (35°48′N, 139°5′E), the westernmost suburb of Tokyo (fig. 1). The climate of the study area is of the Pacific Ocean type, with heavy rainfall in summer and little snow in winter. The mean annual precipitation is 1510 mm and the mean annual temperature is 12.4°C, ranging from 0.6°C in January to 24.2°C in August 2006-2017 (Japan Meteorological Agency, 2018).

The study area is mostly covered with forest vegetation. Natural forests cover 40% of the area, and conifer plantation (Japanese cedar *Cryptomeria japonica*, Japanese cypress *Chamaecyparis obtusa*, and Japanese larch *Larix kaempferi*) covers 50% (Koike et al., 2008). The natural forest is dominated by broadleaf trees (*Castanea crenata* and *Quercus serrata*) in the lower mountain zone (400-500 m above sea level [a.s.l.]), by broadleaf trees (*Q. crispula*, *C. crenata*, and *Fagus crenata*) in the middle zone (500-1500 m a.s.l.), and by conifer trees (*Abies homolepis* and *Tsuga diversifolia*) in the upper zone (1500 to 1800 m a.s.l.). In the conifer plantation, Japanese cedar covers 65% of the area and Japanese cypress covers 25% of the area. Japanese larch occurs mainly above 1000 m elevation and covers 10% of the area. The conifer plantation and the natural broadleaf forest are mosaicked and mixed (Okutama Town Environment Basic Plan: Okutama Town, 2014, p. 23). In our study area, the major bear habitat was broadleaf forest below 1500 m a.s.l. (Okutama Town, 2014, p. 19). Our survey was conducted in a mixed plantation of Japanese larch and Japanese cedar (elevation range: 950-1.000 m).

Recording tree rubbing

To record images of tree rubbing by bears, we installed cameras at tree species (Japanese larch and Japanese cedar) where we had previously found bear hairs on the bark and that had a damaged bark.

The camera survey was conducted between 2010 and 2015 (excluding 2012 and 2014) on a total of 16 trees: six Japanese larch and ten Japanese cedar (five cedar in 2010, four cedar and two larch in 2011, two larch in 2013, and two larch and one cedar in 2015; all trees were uniquely identifiable). These trees were located in planted conifer forests (Japanese larch and cedar). The cameras were generally installed between early May and early November. The automatic cameras (HCO ScoutGuard SG550, Reconyx RC55, and Bushnell HD Max) were set to take a 60-s video each time they were activated, with 5-s intervals between videos. Some of the devices did not have the functionality to take videos and therefore were set to take a series of 10 still pictures at 1-s intervals, with 5-s intervals between series. The cameras were installed 2 to 5 m away from the target trees at a height of 1-2 m above the ground and were placed with the damaged bark side of the tree facing them. If the bear was photographed at the same location within 30 min, we excluded the individuals. During the camera survey period, memory cards were replaced and battery maintenance was conducted once a month. When maintenance was conducted, if resin had been secreted, its state was recorded.

In the captured footage, any behavior that involved a bear's body part coming into contact with one of the target trees was treated as tree rubbing. Each camera activation recording a given bear's tree rubbing was treated as one visit. If two bears performed tree rubbing during the same camera activation, this was treated as two visits. If tree rubbing by the same bear was captured within 1 min of the end of the previous camera activation, this was treated as one visit. Where possible, individual bears and their sex were identified based on genitalia, chest markings (Higashide et al., 2012), and natural markings (e.g., traces of injury). Finally, the month in which tree rubbing took place was recorded.

Results and discussion

The total number of camera trap nights was 2107 (131 ± 35 per tree). Tree rubbing was observed at five of the 16 trees where automatic cameras were installed (Japanese cedar two, Japanese larch three), for a total of 22 visits (fig. 2; supplementary fig. S1).

The visits were observed between May and October (table 1). Specifically, in 2011, tree rubbing was observed on two Japanese cedar trees (one visit each in late June and late August) and one on Japanese larch (14 visits by at least four identified individuals in a little over two months); it was also observed on one Japanese larch (three visits) in 2013 and one Japanese larch (three visits) in 2015 (table 1). Of the 22 visits, the two that took place at the same tree (larch) in September were by a mother and cub (estimated to be half a year old on the basis of its size), whereas

Figure 2. Camera trap photographs of an Asian black bear rubbing a *Larix kaempferi* tree in a conifer plantation. The left photograph (adult male) was taken in late August 2011, and the right photograph (adult female with one cub) was taken in late September 2011, both at the same tree.

the remaining visits were all by solitary bears. At 13 of these visits, the bears were identified as adult males (one in June, three in July, four in August, three in September, and two in October), and at the remaining seven visits, the bears were adults of undetermined sex (two in May, one in June, two in July, one in August, and one in September) (table 1). In the 22 visits, three bears were identified as having visited multiple times (13 visits) (table 2). During the total of three years, at least six identified different individuals rubbed, including the female with a young cub.

Examination of the state of the bark of trees where rubbing was observed revealed that the Japanese larch trees, which were rubbed multiple times, had secreted new resin in multiple locations. The two Japanese cedar trees, both with only one visit, had only old resin secretions. In every instance of rubbing behavior, the part of the tree trunk rubbed by the bear's body corresponded to the damaged side where the wood exuded resin. Old resin was also present on the camera-monitored trees where no visits were observed.

As found in studies of brown and American black bears (e.g., Green & Mattson, 2003 and Burst & Pelton, 1983, respectively), we could also demonstrate that Asian black bears rub conifers. Previous studies indicated that these bear species often rub on objects such as signs, fence posts, creosoted power poles, and some species of trees, especially conifers that secrete large amounts of resin (brown bears: Karamanlidis et al., 2007; Stetz et al., 2010; Clapham et al., 2013, American black bears: Burst & Pelton, 1983), and the strong smell exuded by the resin of conifer trees may function as an effective communication tool in marking behavior and may thus be one of the factors determining tree selection (Clapham et al., 2013, 2014; Sato et al., 2014). Scent rubbing, in which the body is rubbed against objects with a strong smell, is performed by many mammals and is believed to be done as part of scent marking (Gosling & McKay, 1990; Gosling & Roberts, 2001). In our survey, there was a tendency to rub on conifers with high resin secretion, but the number of surveys is extremely limited. Future research would need to collect many examples of factors that cause the rubbing behavior of Asian black bears, including the odor

Table 1.
Seasonal frequency of number of visits by individuals to target trees for rubbing and seasonal frequency of number of visits for each plant species.

	May	June	July	August	September	October	November
Bear attributes							
2011							
Adult male		1	3	4	3	2	
Adult female and one cub					1 + 1		
Adult unknown					1		
2013							
Adult unknown	2	1					
2015							
Adult unknown			2	1			
Plant species							
2011							
Cryptomeria japonica		1		1			
Larix kaempferi			3	3	6	2	
2013							
Larix kaempferi	2	1					
2015							
Larix kaempferi			2	1			
Total	2	2	5	5	6	2	0

of the resins. In contrast, the behavior of removing the bark of conifers to eat the underlying layer is known (Yamada & Fujioka, 2010), but such behavior was not recorded this time. Both behaviors target the bark of conifers and may be related to each other, so further research is also needed in the future.

Table 2.
History of visits with rubbing by individuals identified on the basis of genitalia, chest markings, and degree of molting.

	May	June	July	August	September	October	November
2011							
Adult male							
Cryptomeria japonica				1			
Larix kaempferi			3	3	2		
Adult male							
Larix kaempferi						2	
2013							
Adult unknown							
Larix kaempferi	2						

Some studies have shown that brown bears and American black bears rub trees throughout the year (except during hibernation periods) and that for males, in particular, there is a peak in the mating season; other studies found no indication of a peak in the mating season (e.g., Sato et al., 2014; Taylor et al., 2015). In any case, tree rubbing during the mating season is suspected to be a form of communication related to mating, whereas in other seasons it may be related to the search for food resources (Clapham et al., 2012). In our survey, the number of observational confirmations was limited; therefore we cannot discuss the peak of this behavior, but it is desirable to collect further examples of rubbing behavior with some ingenuity.

Some studies have shown that, although tree rubbing is performed by both male and female brown bears and American black bears, it is performed more frequently by males during the mating season (Clapham et al., 2014; Sato et al., 2014; Taylor et al., 2015). In contrast, in American black bears others have found no differences in this behavior between males and females (Stetz et al., 2014). We could not accurately determine the rate of tree rubbing by males and females, as no genetic information was collected.

Future research should therefore focus on collecting genetic information to clearly establish the sex ratio among bears performing tree rubbing and to distinguish between individual bears; moreover, capture and follow-up surveys should be conducted to add age information. There should also be examination of the areas in which bears are active and the locations where they perform tree rubbing. These data could help to reveal the purpose of tree rubbing by Asian black bears in different seasons.

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Supplementary material

Supplementary material is available online at:
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