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Marking behavior of Andean bears in an Ecuadorian cloud forest: a pilot study

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Abstract: Very little is known about marking behavior of the endangered Andean bear (*Tremarctos ornatus*). Here, we present a first detailed description of Andean bear marking behavior obtained using camera traps. From November 2012 to April 2013, we inspected 16 bear trails in the Napo province of eastern Ecuador, and installed camera traps ($n = 3$) at marking sites to document their marking behavior. We obtained 22 video recordings of Andean bears, all of which were captured during daytime. Almost all recordings ($n = 18$) contained behavior associated with marking. Tree-rubbing was the main behavioral display at marking sites, and consisted of 4 common activities: (1) tree-sniffing, (2) rubbing the neck and/or shoulders, (3) rubbing the flanks, and (4) rubbing the back. Bears also claw-marked and urinated while rubbing trees. We only observed scent-marking from males. Consistent with other bear species, we suggest that Andean bears communicate intra-specifically through their marking behavior.

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Key words: Andean bear, animal behavior, camera trap, claw-marking, ecology, marking behavior, mountain cloud forest, scent-marking, tree-rubbing, *Tremarctos ornatus*

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The Andean bear (*Tremarctos ornatus*) is endemic to South America and is classified as "vulnerable to extinction" according to the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (IUCN 2015), and as "endangered" in Ecuador (Tirira 2011). Despite its IUCN status and the need to protect this species, the Andean bear population is decreasing (García-Rangel 2012). The general ecology of Andean bears is beginning to be well-understood (reviewed in García-Rangel 2012). However, very little is known about their marking behavior.

As with other solitary carnivores, ursids scent-mark on substrates. Chemical communication is relatively well-documented in bears of the northern hemisphere, such as brown bears (*Ursus arctos;* Clapham et al. 2012), American black bears (*U. americanus;* Taylor et al. 2015), and giant pandas (*Ailuropoda melanoleuca;* Swaisgood et al. 2004). Ursid behavior associated with marking includes claw-, bite-, and pede-marking; bark-stripping; urinating; and rubbing shoulders, neck, and head against trees or substrates at marking sites (Clapham et al. 2012, Taylor et al. 2015). Here, we associate scent-marking with activities such as rubbing, claw-marking, biting, and urinating on substrate, as well as bark-stripping (Clapham et al. 2012, Taylor et al. 2015). The functional significance of such marking is not fully understood, and may be part of Andean bear social organization and communication (Peyton 1984, García-Rangel 2012).

A detailed description of Andean bear marking behavior currently is limited. Here, we present the first description of Andean bear marking behavior with its potential functional significance, using camera-trap video recording in an Ecuadorian cloud forest.

Study area

The study area is located on the eastern slopes of the Ecuadorian North-Central Andes, at the border of Sumaco Biospherical Reserve (0°S, 78°W; Fig. 1).

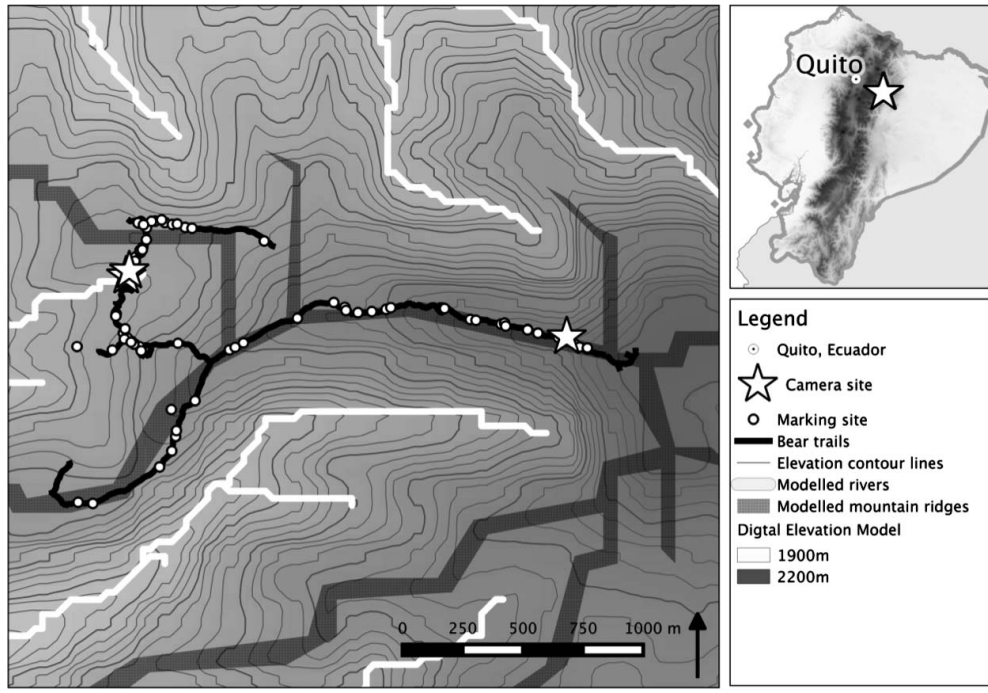

Fig. 1. Study area in the Napo province of northeastern Ecuador, where we used camera traps to record marking behavior of Andean bears from November 2012 to April 2013.

Elevations range from 2,077 m to 2,674 m. The climate is warm and wet with an average annual temperature of 18°C, and with an average precipitation of 2,500 mm/year. The landscape is heterogeneous and is primarily covered by mountain cloud forests. Other land-cover types include bamboo (*Chusquea* spp.) forests, pastures, and clear-cuts. The rainy season lasts from March to August. The dry season lasts approximately from September to February. The closest settlement, Las Palmas de Cosanga, is located approximately 1 km from the study area. Extensive cattle management is present in the study area.

Methods

First, we conducted a field survey with an experienced local guide to identify suitable places for mounting the camera traps. We identified bear trails based on signs of bear presence (e.g., tracks, scats, beds, rub trees). We recorded rub trees with a handheld Global Positioning System (Garmin Ltd., Kansas City, Missouri, USA) and refer to these hereafter as "marking sites." On each marking site, we counted and registered the number of claw and bite marks and presence of rubbing.

According to the number of bear marks and the presence of rubbing, we determined the 3 most actively used marking sites for mounting cameras. We placed one digital camera trap with infrared function (Bushnell Trophy Cam; B Bushnell, Kansas City, Missouri, USA) at each of these marking sites (hereafter, "camera sites"; Fig. 1). Two most actively used marking sites belonged to the same bear trail. Therefore, we installed 2 camera traps at these marking sites. We installed the third camera trap on a separate bear trail. The camera traps were operative from November 2012 to April 2013, thus encompassing both the dry and the rainy seasons, including the fruiting season (Mar 2013–Apr 2013). We installed the camera traps on trees approximately 2 m from, and facing, the rub tree, and between 110 and 180 cm above the ground depending on tree and terrain characteristics. We did not use baits to attract bears. The camera traps recorded 30-second videos after being triggered by movement. If the animal movement continued on-site, a new recording was initiated. We changed memory cards once every 17–36 days. We used BS.Player (AB Team Ltd., Version 2.65, http://bsplayer.com) software to analyze camera-trap videos and for individual bear identification. We identified sex for each individual based on

Table 1. The list of all identified ($n = 49$) standing live tree species forming Andean bear marking sites, tree species numbers and frequency, and whether tree species are aromatic (A) or an Andean bear food source (F) in the study area in the Napo province of eastern Ecuador. Data collected by camera traps from November 2012 to April 2013.

Identified live tree species				
Spanish common name	**Scientific name**	**No. of marking sites**	**Frequency (%)**	**Species category**
Tilo de monte	*Palicourea* sp.	8	16.3	-
Lengua de potro	*Hieronyma* sp.	6	12.2	-
Aguacatillo	*Lauraceae*	6	12.2	A, F
Panta silvestre	*Graffenrieda cf. emarginata*	5	10.2	-
Arrayan	*Myrcianthes hallii*	3	6.1	A
Chisinco	*Nectandra* sp.	3	6.1	A, F
Motilon	*Hieronyma asperifolia*	3	6.1	F
Pinchimuyo	*Ocotea* sp.	3	6.1	A, F
Higo	*Ficus* sp.	2	4.1	F
Poroton	*Erythrina edulis*	2	4.1	F
Canelo	*Lauraceae*	1	2.0	A
Cedrillo	*Trichillia* sp.	1	2.0	A
Flor de mayo silvestre	*Tibouchina lepidota*	1	2.0	-
Guarumbo	*Cecropia* sp.	1	2.0	F
Ishpingo	*Ocotea quixos*	1	2.0	A, F
Mokuillo	*Saurauia herthae*	1	2.0	F
Mus mus	*Nectandra membranacea*	1	2.0	A, F
Pera silvestris	*cf. Bellucia pentamera*	1	2.0	-

our camera-trap video recordings. We only identified an individual's sex when we saw its genitals on the camera-trap recording while it stood up on its hind legs during marking.

Results

We investigated 16 bear trails and registered 78 marking sites. Out of the 78 marking sites, bears marked on 71 standing live trees (91.0%), 2 dead standing trees (2.6%), 4 fallen trees (5.1%), and 1 wooden pole (1.3%). We could identify 49 out of 71 (69.0%) live trees to genera. The most common genus among the identified live-marked trees was *Palicourea* (8 trees, 16.3%). Nineteen (38.8%) identified live trees had aromatic properties and 23 (46.9%) identified live trees were part of the Andean bear diet (Table 1).

Each of the 3 camera traps was active for 102 camera days. No cameras failed during the study. We obtained 22 videos of Andean bears. Bears displayed scent-marking on 18 recordings (81.8%). In 4 recordings (18.2%), bears did not mark the tree and passed without changing their walking direction. Out of the 18 recordings, tree-rubbing ($n = 18$ [100%]) was the main behavioral display related to scent-marking at the marking sites (Table 2).

We distinguished 4 common tree-rubbing activities that are associated with scent-marking (Fig. 2; https://youtu.be/Zc9NtJACcZE). First, bears usually sniffed the marked tree (rubbing activity 1). Second, they rubbed their heads, necks, and/or shoulders against the tree (rubbing activity 2). Third, they rubbed their flanks while remaining on all 4 legs (rubbing activity 3). Fourth, bears turned around and rubbed their napes and backs (rubbing activity 4). Bears usually performed these activities in order; however, only in 2 recordings (11.1%) were all 4 activities performed. In only one instance, a bear sniffed the marking site and then left. The majority of recordings ($n = 7$ [38.9%]) showed bears that carried out 3 of 4 activities (Table 2). In 6 recordings (33.3%), 2 activities were performed; and 3 recordings (16.7%) contained only 1 activity (Table 2). One male urinated while rubbing the tree and 2 males claw-marked (Table 2). Also, 2 males sniffed the surroundings of the marked trees with their heads facing the marked tree. One male cleaned and licked his abdomen while sitting next to the marked tree (Table 2). Two smaller individuals tried to climb the rub tree trunk with their hind legs while marking.

Two camera sites belonged to the same bear trail and were located only approximately 25 m from each other, so the same individual bears visited them. Therefore, we used only 1 of those 2 camera traps to describe visiting frequencies, individual characteristics, and additional information about the bears. Altogether, we recorded 11

Table 2. Summary of Andean bear activities at camera sites in the Napo province of eastern Ecuador from November 2012 to April 2013. Label "x" means that the activity was present. Label "-" means the activity was not present. Frequencies are calculated as number of the video-recordings with the activity divided by the total number of videos where marking behavior was present ($n = 18$).

					Scent-marking						Other activities	
					Tree-rubbing[b]							
Video no.	Bear ID	Sex[a]	Time of day	Time spent at the camera site (sec)	Activity 1	Activity 2	Activity 3	Activity 4	Claw-marking	Urinating	Cleaning[c]	Sniffing surroundings[d]
1	1	M	18:29:00 hr	29	-	x	x	x	-	-	-	-
2	2	M	10:30:00 hr	29	x	x	x	x	-	-	-	-
3	3	M	06:44:00 hr	13	x	x	-	x	-	-	-	-
4	3	M	11:29:00 hr	19	x	x	x	-	x	-	-	-
5	3	M	06:37:00 hr	30	x	x	-	x	-	-	-	x
6	3	M	11:26:00 hr	0	-	-	-	-	-	-	-	-
7	4	M	08:11:00 hr	13	x	x	x	x	-	-	-	-
8	4	M	09:42:00 hr	30	x	x	-	x	-	x	-	-
9	4	M	08:10:00 hr	12	-	-	-	x	-	-	-	-
10	4	M	09:44:00 hr	0	-	-	-	-	-	-	-	-
11	5	M	14:08:00 hr	4	-	-	-	x	-	-	x	-
12	5	M	14:10:00 hr	17	-	x	-	x	-	-	-	-
13	6	M	14:34:00 hr	4	x	x	-	-	-	-	-	-
14	6	M	09:26:00 hr	30	x	x	-	x	x	-	-	-
15	6	M	14:29:00 hr	28	x	x	-	x	-	-	-	-
16	6	M	09:28:00 hr	17	-	x	-	x	-	-	-	-
17	7	M	16:40:00 hr	13	x	x	-	-	-	-	-	-
18	7	M	16:41:00 hr	6	x	-	-	x	-	-	-	-
19	8	U	09:09:00 hr	16	x	x	-	-	-	-	-	-
20	8	U	09:09:00 hr	1	-	-	x	-	-	-	-	x
21	NA	U	13:16:00 hr	0	-	-	-	-	-	-	-	-
22	NA	U	13:20:00 hr	0	-	-	-	-	-	-	-	-
Counts					12	14	5	13	2	1	1	2
Frequencies					66.7	77.8	27.8	72.2	11.1	5.6	5.6	11.1

[a]"M" = male, "U" = unknown.
[b]Activity 1 is bear sniffing tree. Activity 2 is bear rubbing head, neck, and/or shoulders against the tree. Activity 3 is bear rubbing flanks on the tree while remaining on all 4 legs. Activity 4 is bear turning around and rubbing nape and back against the tree.
[c]Bear is cleaning itself.
[d]Bear is sniffing the surroundings of the marked tree.

Fig. 2. Four Andean bear rubbing activities related to scent-marking: tree-sniffing (upper left); rubbing the head, neck, and/or shoulders against the tree (upper right); rubbing the flanks while remaining on all 4 legs (lower left); and rubbing the nape and back (lower right). Behaviors were recorded by camera traps in the Napo province of eastern Ecuador, from November 2012 to April 2013.

visits of 6 males and 2 individuals of unknown sex. Three of the 6 males (Bear IDs = 3, 4, and 6) visited the camera sites twice within the study period (Table 2). There were on average 16.4 days between these visits at the 2 camera sites (min. = 2 days, max. = 71 days, median = 13 days). All observations were recorded during daytime, between 06:44 hours and 18:29 hours. We were not able to distinguish the sexes of 2 additional video-recorded bears that passed the camera sites without showing any marking activity or changing their walking direction. We did not record any female bears marking a tree at the camera sites.

Discussion

Our pilot study produced 3 main results. First, Andean bears do indeed display behavior that is commonly associated with scent-marking, suggesting that chemical communication is an integral part of Andean bear ecology. Second, only male bears conducted scent-marking, which suggests that females may scent-mark very rarely or do so on different trails than males, or outside of our study area or period. Third, all video recordings of bear activity were obtained during daytime, showing that Andean bears in our study area exhibit a diurnal lifestyle.

It is now generally accepted that scent-marking is an important aspect of the general ecology of a wide range of mammals (Ralls 1971), including most ursids. As with most other ursids, Andean bears exhibit a wide range of behaviors at marking sites, including inspecting the tree, rubbing, clawing and biting the tree, urinating, bark-stripping, and pede-marking (e.g., Peyton 1984; Castellanos et al. 2010; R. Van Horn, Institute for Conservation Research, San Diego Zoo Global, personal communication). We associate these behaviors with scent-marking and chemical communication.

Bears in our study inspected the smell of scent marks of other bears on the rubbed trees and their surroundings before they scent-marked the trees themselves, assuming that our definition of scent-marking is valid. The functional significance of scent-marking in Andean bears remains unclear, however, and may be related to intraspecific communication (e.g., territory marking, sex attractant, self-advertisement; Johnson 1973). Because bears in our study areas marked aromatic and food trees, we do not exclude the relationship of scent-marking to grooming or foraging. We suggest that scent-marking in Andean bears may have several, non–mutually exclusive functions.

Only males marked in our study area. This finding is comparable to the results found in other bear species (Clapham et al. 2012, Taylor et al. 2015). We only observed males scent-marking; therefore, we suggest that scent-marking in Andean bears can function to self-advertise male quality. We propose 3 main reasons to explain why we did not observe female marking behavior. First, scent-marking and communicating dominance is more important for males than for females in the struggle for reproduction (Gosling 1990), especially for sexually dimorphic species such as the Andean bear. Second, as in other ursids, infanticide by males also may cause sexual segregation in the use of marking sites (Clapham et al. 2012), and our marking sites may have been located in areas that were predominantly used by males. Third, our study area was adjacent to pastures. Male bears are responsible for most cases of cattle depredation (Castellanos et al. 2010); therefore, we assume that more males occupy forest edges compared with females, which may avoid such edges.

Andean bears in our study area were diurnal. This finding corresponds with findings of Paisley and Garshelis (2006). However, activity patterns may vary seasonally and geographically (Paisley and Garshelis 2006). Human activity and persecution may have altered the diurnal activity patterns in several ursids and other wildlife species (Ordiz et al. 2014). We suggest that the level of human disturbance in our study area was relatively low and did not affect diurnal behavior of Andean bears, or that Andean bears have not yet adapted to human presence and persecution, as suggested in other ursids (e.g., Zedrosser et al. 2011). Replicating our study in areas of varying levels of human disturbance could reveal effects of human disturbance on diurnal activity patterns of Andean bears.

Twenty-five years ago, there were approximately 20,000 Andean bears left in the wild (IUCN 2015). Since then, the Andean bear population has been steadily declining. Habitat fragmentation is one of the major threats to the Andean bears (Kattan et al. 2004). If scent-marking is indeed important in terms of bear chemical communication, then destroying or removing marking trees and trails can represent a disturbance of the communication and travel network of Andean bears. Conserving Andean bear trails and their marking sites may be an important way to keep the Andean bear populations socially healthy, and to reduce their decline.

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