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Short communication

Scent-post preference of free-ranging Namibian cheetahs

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ABSTRACT

Namibian cheetahs (*Acinonyx jubatus*) are known to use specific trees when choosing sites for scent-marking and these are normally large and visually conspicuous trees, often referred to by Namibian farmers as "playtrees". The aim of this study was to identify the physical and ecological attributes of known scent-marking trees within a fixed area and in turn identify the key characteristics preferred by cheetahs when selecting these trees for use. We used mulitple linear regression to determine the physical characteristics most influential on cheetah scent-marking tree preference. Results show that cheetahs prefer scent-marking trees that are easy to detect and provide good visibility to the cheetah while at the tree as it maximises each mark's detectability by conspecifics. This study provides new insight into the spatial structuring and organisation of Namibian cheetahs.

Olfactory communication via scent-marking serves a vital role in the conspecific interactions of numerous mammalian species. Scent-marking possesses considerable advantages over other forms of communication as olfactory signals persist in the absence of the sender and can contain detailed information about the sender (Eisenberg and Kleiman, 1972; Roberts and Gosling, 2001). Many species demonstrate a specific preference for distinct scent-marking sites (Clapham et al., 2013; Smith et al., 1989). One reason, and likely the leading reason, of this behaviour is to maximise the detectability of individual marks, as an animal benefits from scent-marking when conspecifics find and react to the marks (Roberts and Gosling, 2001).

Namibian cheetah (*Acinonyx jubatus*) home ranges do overlap considerably as reported by Marker et al. (2008). Eaton (1970) identified that cheetahs potentially use scent-marking to establish a time-share approach to territorial spacing. In such a system, cheetahs space themselves apart from each other within the same geographical region through a comprehensive network of scent-marks, which allows for an individual to know the general location of other individuals and whether or not a particular area is occupied at a specific time. Such a system reduces the chances of aggressive or unexpected encounters with conspecifics while allowing multiple individuals to use the same general area. This system is beneficial for all individuals but relies on effective and predictable scent-marking.

Cheetahs prefer large, conspicuous landmarks as scent-posts, and large trees are predominant amongst these (Broomhall et al., 2003; Eaton, 1970; Marker, 2002; Marnewick et al., 2006). These trees, commonly referred to by Namibian farmers as "playtrees" or "newspaper trees", are found throughout cheetah ranges (Marker-Kraus and Kraus, 1994) and are potentially crucial to the spatial organisation of cheetahs on Namibian landscapes. Of known cheetah scent-marking trees, certain ones are utilised more frequently than others, which may suggest that certain characteristics, either morphological or ecological, of the trees themselves define the quality of that tree as a scent-marking tree rendering it more or less attractive for use by cheetahs.

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Table 1
The two top models (all $\Delta_i < 2$) and the regression output for both.

Model	Covariate	Slope parameter	Lower 95%	Upper 95%
CIRC	CIRC	−2.6991	−4.2413	−1.1570
CIRC+VISI	CIRC	−2.3201	−3.8570	−0.7832
	VISI	0.0089	−0.0007	0.0184

In this study, we measured morphological and ecological characteristics of 31 known cheetah scent-marking trees and then assigned a monthly visitation rate based on camera trap visitation data collected between 2005 and 2012 in north central Namibia. We built, tested, and selected candidate models using multiple linear regression analysis in RStudio® Version 3.2.2 (R Core Team, 2015) and the Akaike Information Criterion corrected for small sample size (AIC_c) to determine the explanatory characteristics used by cheetahs when selecting scent-marking trees within their homerange for use. Visitation rates could not be determined for all 31 trees and therefore we only used 20 trees in the final regression analysis.

We used a total of 337 visitations from 38 individual cheetahs in determining visitation rates for each scent-marking tree sampled. Visitation rates varied from 0.08 visitations per month to 6.50 visitations per month. After running non-parametric correlation analyses between measured variables, we removed height and canopy area from the set of potential explanatory variables. Canopy area correlated significantly with height ($rs = 0.8062$, $n = 29$, $P < 0.001$) and visibility ($rs = 0.6364$, $n = 29$, $P = 0.0015$), and height correlated significantly with visibility ($rs = 0.5278$, $n = 29$, $P = 0.0116$). The final variables used in the logistic regression analysis included: species (SPEC), stem circumference (CIRC), angle of lean (AOLE), lean direction (LDIR), visibility (VISI), road/fence-line proximity (RFRP), and species richness (SRIC).

Based on AIC_c stem circumference alone was the top model (Table 1). However, the next best model had a delta AIC_c value of just 0.30, suggesting that there was not a clear best model amongst the two. Results indicate that stem circumference is clearly a driving factor in cheetah scent-marking tree preference as it appeared in both the top models and the confidence intervals for its slope parameters did not include zero (Table 1). Results indicate an inverse linear relationship between stem circumference and visitation meaning that as stem circumference decreased visitation increased. Visibility occurred in the second top model (Table 1) suggesting it influences scent-marking tree preference, however the confidence intervals for its slope parameter include zero.

The results of our study show that stem circumference and visibility from the tree are driving factors in scent-marking tree preference by cheetahs and that the stem's angle of lean and the area's faunal species richness do not influence cheetah scent-marking tree preference. These results support the findings of Muntifering et al. (2006) in that visibility is a key factor in habitat utilisation by cheetah. Though results show an inverse relationship between visitation and stem circumference, all sampled scent-marking trees have a stem circumference large enough ($\geq$1.00 m) to allow the cheetahs to climb into them. Our results indicate that cheetah preference of scent-marking relies not upon size alone but upon the level of visibility and visual conspicuousness within its surroundings. These findings are similar to the findings of studies conducted on other carnivore species in relation to scent-post selection (Barja, 2009; Piñeiro and Barja, 2012; Roberts and Lowen, 1997; Smith et al., 1989). This selective behaviour supports the ideas proposed by Roberts and Gosling (2001) that animals approach scent-marking economically by maximising the mark's detectability by any conspecifics, thus maximising the cost to benefit ratio of scent-marking. A cheetah benefits from scent-marking when other cheetahs detect and react to marks, and therefore is best served by maximising the detectability and predictability (in terms of location) of each mark (Bowyer et al., 1994; Roberts and Gosling, 2001; Roberts and Lowen, 1997; Soler et al., 2009). By choosing scent-posts with high visibility that are visually conspicuous, cheetahs may ensure that conspecifics have the highest chance of detecting their marks.

These preliminary findings contribute to our knowledge and understanding of cheetah scent-marking behaviour and its affects on cheetah spatial ecology, which to date has been largely unexplored. Futures studies investigating scent-marking trees in order to identify the explanatory characteristics of cheetah scent-marking tree selection, rather than just preference would be beneficial. Future studies through the use of camera trapping, scat detection dogs, and genetic analysis will provide better understanding of behaviour and scent-marking patterns and their relationship to home range size and habitat use by Namibian cheetahs, as well as to corroborate our understanding of intraspecific cheetah interaction in regards to scent-marking.

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