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ACTIVITY PATTERNS AND HABITAT USE OF THE WESTERN TREE HYRAX (*DENDROHYRAX DORSALIS*) WITHIN FOREST PATCHES AND IMPLICATIONS FOR CONSERVATION

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Abstract. The Western Tree Hyrax (*Dendrohyrax dorsalis sylvestris*) is one of the least studied small mammals of West Africa. In Benin, it is reported from few remnant forest patches including the Lama Forest Reserve, one of the last undisturbed dense forest patches in the Dahomey Gap. We used station counts based on vocalization to study activity pattern and habitat use. A total of 340 calls were counted at 9 different stations distributed over ca. 5000 ha of undisturbed dense forest. Additionally we located latrines to identify the tree species used by the species. Hyraxes were mainly vocalizing from dusk to midnight followed by a drastic reduction of activity and subsequent resurgence from 3:30 to 6:15. Frequency of vocalizations varied from one station to another (from <2 to >12 calls/15 min). Latrines were mainly associated with the tree species *Dialium guineense*. Tree hyraxes are affected by anthropogenic disturbances and their survival depends on the conservation of the undisturbed dense forest with mature tall trees such as *Dialium guineense*.

Key words: Behavior, Benin, Lama Forest Reserve, small mammal, acoustic monitoring.

INTRODUCTION

Western Tree Hyraxes (*Dendrohyrax dorsalis sylvestris*) belong to the least known small mammals in West Africa. These nocturnal and difficult to observe animals are reported from the Dahomey Gap area (Jones 1978, Wilson & Reeder 1993) that nowadays is totally degraded, particularly in the Republic of Bénin. They inhabit forests, moist savannas and all montane habitats (Jones 1978, Kingdon 1997). Literature on the ecology of the species is scarce (Jones 1978). Habitat, diet and habits have been only briefly described (Richard 1964) and remain poorly known. While the Southern Tree Hyrax from eastern and southern Africa (*Dendrohyrax arboreus*) has been comparatively well studied, *D. dorsalis sylvestris* Temminck, 1855, the Western Tree Hyrax, is found in forest remnants such as the Lama Forest Reserve (Akpona *et al.* 2011) and has received no attention by local wildlife specialists, except from being listed during fauna surveys. The Lama Forest Reserve in southern Bénin is one of the last patches of natural forest in the Dahomey Gap (Sinsin *et al.* 2003). Since 1988, a central core zone covering 4777 ha has been under strict protection, while its former human population has been relocated. This forest is a mosaic of remnants of natural or degraded semi-deciduous forest of variable size and various successional stages (Specht 2002). It is surrounded by teak (*Tectona grandis*) and fuelwood (mainly *Senna siamea* and *Acacia auriculiformis*) plantations, covering 7000 and 2400 ha, respectively.

Management and conservation of a species rely heavily on a good understanding of the variability in population density and habitat use (Sadlier *et al.* 2004, Thompson 2004, Reppucci *et al.* 2011). Knowledge of elusive and crepuscular or nocturnally active species is often limited; therefore such species are of particular conservation and management concern (Smallwood & Schonewald 1998, Gese 2001, Wilson & Delahay 2001). Latrine densities have previously been used as estimators for population densities of tree hyraxes (Kundaeli 1976, Nielsen 2006). For documenting the conservation status of the Western Tree Hyrax, we assessed activity patterns and habitat use, as well as latrine usage in the Lama Forest Reserve, Bénin. We hypothesized that anthropogenic disturbances should have an impact on

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habitat use. Activity periods and latrine use should provide information on roost selection and tree species preferences. This initial study will help in obtaining ecological information that is urgently needed for devising management actions for the conservation of the Western Tree Hyrax.

METHODS

Study area. The Lama Forest Reserve (Lama FR) is located in southern Benin, and stretches from 6°55' to 7°00'N and from 2°04' to 2°12'E. It was declared a protected area in 1946 under French colonial administration (decree 05574/SE of December 24, 1946). The protected area covers 16 250 ha, of which approximately 4777 ha form an undisturbed natural forest core zone. The remainder includes plantations and agricultural lands (Fig. 1). The forest is surrounded by about 20 villages with an estimated population of 41 500 inhabitants (ONAB 1998). The ethnic groups living there belong to the Holli, Fon, and Aïzo. Typical houses are wooden huts covered with cane stalks.

The Lama FR is located in a lowland area with an average altitude of 60 m above sea level. The soil of this forest is a black cotton soil and the hydrographical network consists of seasonal marshes. The climate is sub-equatorial, with an average annual rainfall of 1112 mm, annual temperatures ranging from 25°C to 29°C, and high relative humidity even in the dry season. The core zone harbors more than 170 plant species belonging to 67 families (Sinsin *et al.* 2003). The vegetation consists of a mosaic of dense forest islands, surrounded by fallow fields at different stages of development, showing former human use of the forest. In certain places, assisted regeneration leads to the zoning that is typical for this forest. In spite of intense poaching activities around the Lama FR, the core zone is home to many animals.

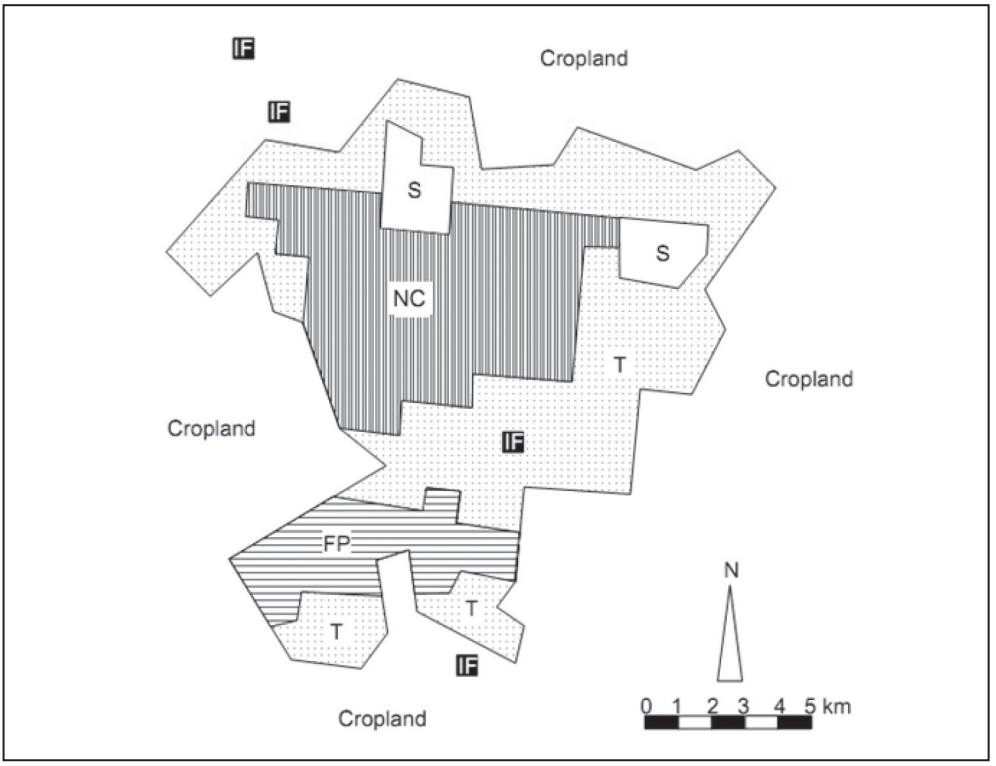

FIG. 1. Study area and land use (NC = core zone; FP = fuelwood plantations; IF = isolated forest fragments; T = teak plantations; S = settlements, small-scale agriculture)

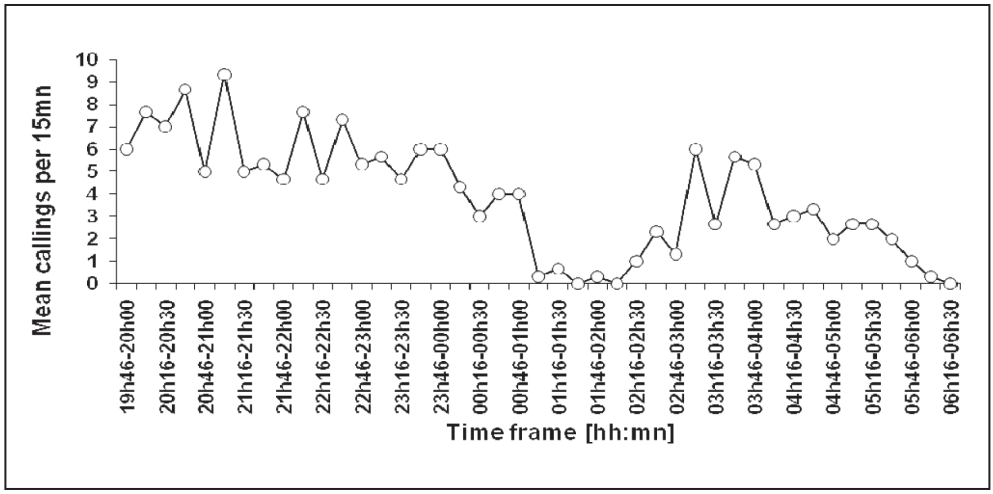

FIG. 2. Activity pattern of tree hyrax in the Lama FR. Values are mean number of calls per 15 min, calculated from all calls counted over an entire night at stations 1, 2, & 3.

Activity patterns. Tree hyraxes vocalize most frequently when they ascend or descend trees at night. Hyrax vocalizations include twitters, growls, whistles and shrieks. The tree hyrax emits a raucous shriek that starts as a squeak or whistle, and then rises to a pig-like squeal and finally to a child-like scream. Individuals from one group will answer to contact calls of another group. In order to assess activity throughout the night we recorded a number of hyrax calls at intervals of fifteen minutes, starting at nightfall. Three stations, located at different sides of the forest, were surveyed for one night each.

Habitat use. A total of nine observation stations were established for studying habitat use. We surveyed these 9 stations for a total of 22 nights between June 14 and July 27, 2010.

We counted individual calls during subsequent 90-minute intervals, starting at nightfall. This time frame was chosen based on preliminary observations in the study area. Based on frequency of the vocalizations, we could assess habitat preference. Utilizing a compass we determined for each call its directional origin, relative to the count station (north, northeast, east, southeast, south, southwest, west, and northwest). In order to detect significant changes in numbers of individual calls from one day to another, we counted calls at stations 1, 2 and 3 during 3 consecutive nights in June and 2 consecutive nights in July 2010.

Latrine search. We searched in the forest for latrines with the help of an experienced forest guard. We considered a latrine the foot of a tree with old and fresh hyrax droppings. For each latrine we identified the adjacent tree species.

Data analysis. We performed a Kruskal-Wallis One-Way Analysis of Variance on Ranks with a Tukey post-hoc test to identify significant differences between stations. A One-Way Analysis of Variance (ANOVA) was utilized to detect statistically significant differences between numbers of individual calls throughout the five days in the three stations. Statistical analyses were done using SigmaStat 3.1 software and graphs were drawn with Excel 2003.

RESULTS

Activity pattern. Darkness started around 19:30 h and tree hyraxes began to call shortly after, with a high calling rate (Fig. 2). It remained high for about three hours and decreased subsequently towards midnight. A second period of vocalization started around 03:00 h and dropped more or less quickly towards 06:00 h. This basic activity pattern was observed at station 1 (328 calls over one night), station 2 (111 calls), and station 3 (61 calls).

There was an unexplained lack of vocalizations during one night at station 4, but when we returned to the same station six days later calling activity had resumed.

Tree hyrax habitat use. A total of 340 calls was recorded at all stations over the 90-minute stretches during the study period. Calling activity varied greatly between stations (Fig. 3).

Call frequency showed significant differences between recording stations (KW-ANOVA, H = 40.405, df = 8, $p < 0.001$ with Tukey post-hoc test $p < 0.05$). Lowest call frequencies were recorded at stations situated in the forest area adjacent to cropland (4,2,6,5), highest calling activity was found in the forest interior. Stations situated deep inside the forest (7, 8) showed significantly higher individual call frequencies than those situated near the border (2, 5 and 6) (Fig. 3).

Geographical orientation of recorded individual calls shows a concentration of the vocalizations towards the center of the forest (Fig. 4). We registered 83.2% of the total number of calls at the five stations located in the core zone of the forest versus only 16.8% at the four remaining stations, which were situated mostly on the western side at the border of the forest (Fig. 4).

Temporal variability in calling frequency. Five days of recording at three different stations showed that rates of individual calls at a given station varied distinctly from one day to another (Fig. 5). There was a significant difference between numbers of calls per hour between the days at the stations 1 (ANOVA: $p = 0.009$) and 2 ($p = 0.032$), but there was no difference at station 3 ($p = 0.225$).

Trees utilized as latrines. Three of the four latrines found in the Lama FR were situated at the foot of *Dialium guineense* (Caesalpiniaceae) trees, and one at the foot of *Mimusops kummel* (Sapotaceae).

DISCUSSION

The loud vocalizations of the Western Tree Hyrax, which are similar to those of the Southern Tree Hyrax (*Dendrohyrax arboreus*) occurring in eastern and southern Africa (Wilson and Reeder 2005), allowed us to record its activity pattern in the Lama FR. Calling rate can additionally be used for estimating relative abundance, as both male and females call while

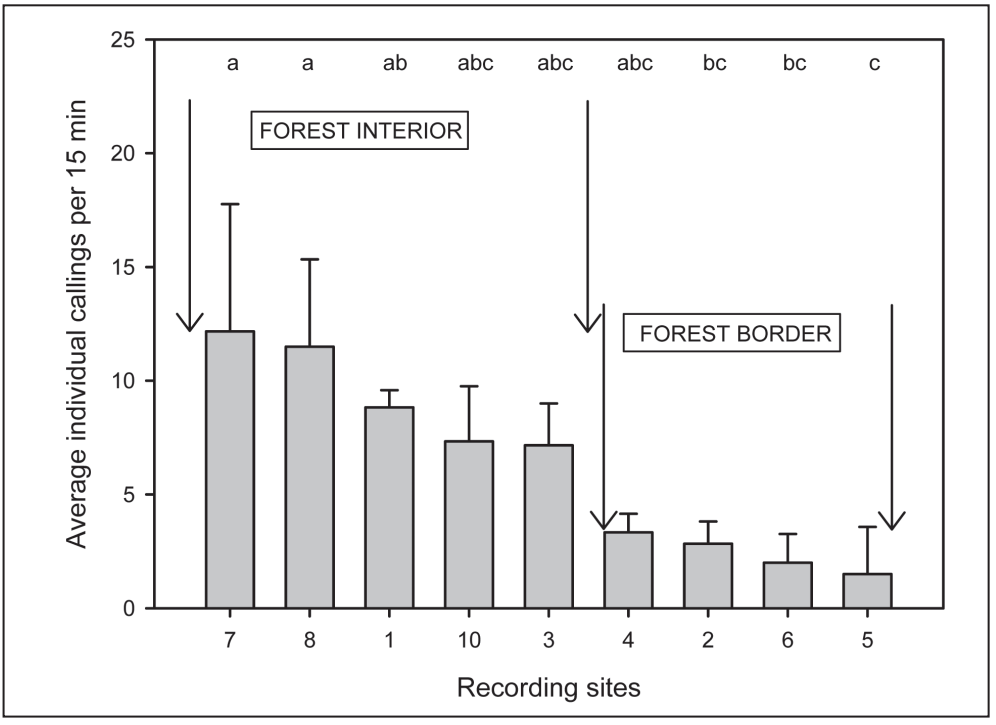

FIG. 3. Western Tree Hyrax callings counts per station in the Lama FR. Different letters indicate significant differences between sites (KW-ANOVA, Tukey post hoc test).

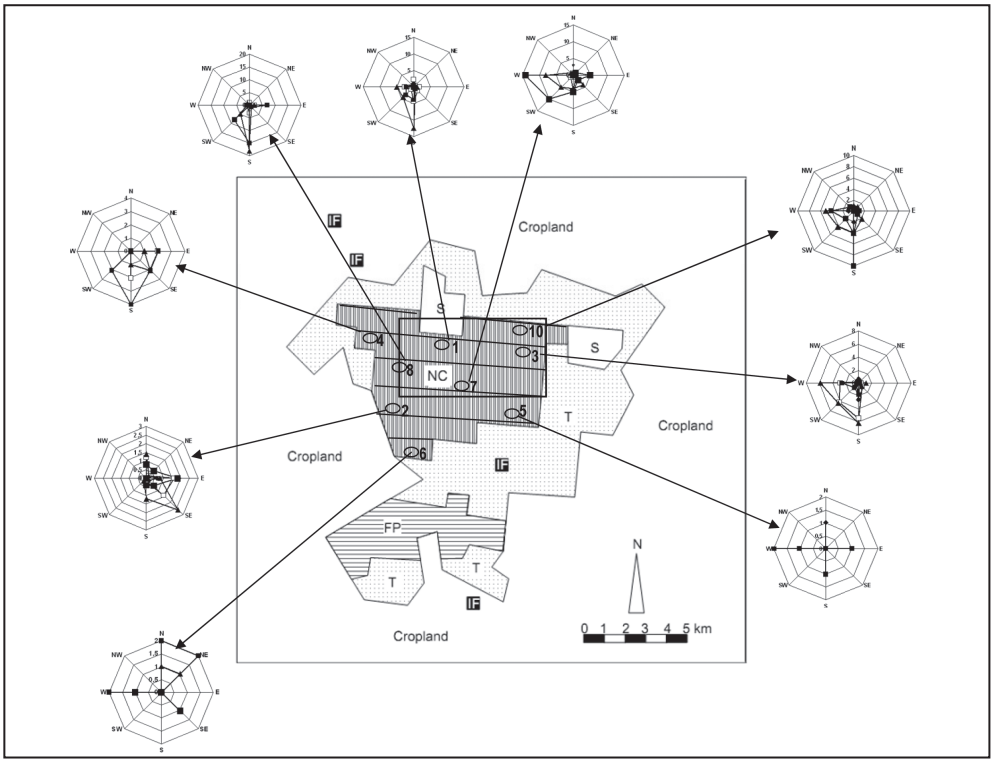

FIG. 4. Map of the Lama FR, different compartments, count stations and mean calling frequencies presented with radar graphs (---- : paths in Lama Forest, NC = core zone, FP = fuelwood plantations, IF = isolated forest fragments, T = teak plantations, S = settlements, small-scale agriculture, black rectangle = concentration zone)

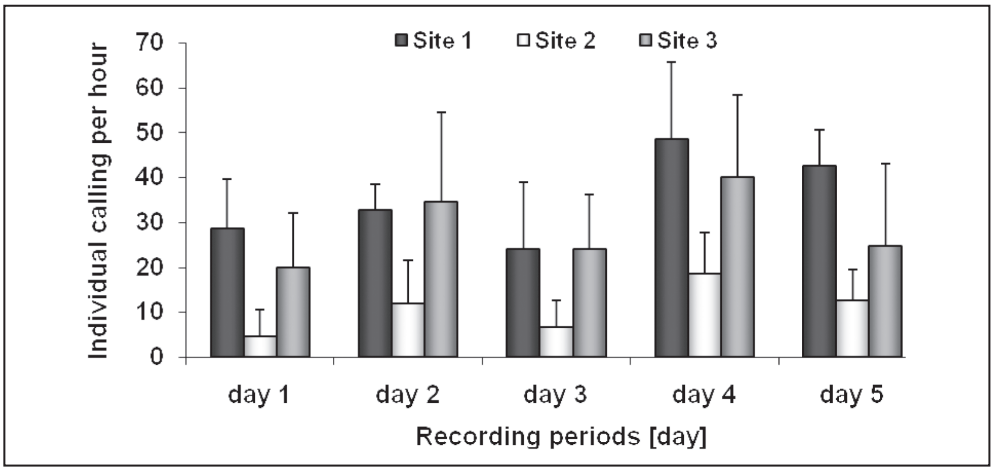

FIG. 5. Hourly call rates over 5 days at three stations (1, 2, & 3) in the core zone of the Lama Forest Reserve.

climbing up or down a tree (Kingdon 1971). While the animals were calling for most of the night they showed a period of reduced activity from shortly after midnight to just before 03:00 h. A similar activity pattern was reported from Rwanda for the Southern Tree Hyrax (*Dendrohyrax arboreus*) (Milner & Harris 1999). This bimodal pattern is also known from other small nocturnal mammals such as some bats (Arnett *et al.* 2007, Djossa 2007). A previous study showed a higher number of vocalizations during the dry season (Milner & Harris 1999), which might indicate that our records from the wet season do not reflect maximum vocalization activity. For understanding changes in activity patterns of the Western Tree Hyrax in this region it will be necessary to repeat this study during the dry season.

Habitat use and behavior of forest-dependent animals must be known in order to assess their habitat requirements and their conservation status. For the management of rare species, determining the impact of disturbance is also of great importance (Topp-Jørgensen *et al.* 2008). According to a study on Eastern Tree Hyrax (*Dendrohyrax validus*) in Tanzania, population densities decrease rapidly in reaction to disturbance and hunting pressure (Topp-Jørgensen *et al.* 2008). This raises the question of whether our findings, which only referred to individual calls rates, indicate either a reduced population status in the Lama FR or differences between *D. validus* and perhaps also *D. arboreus occurring* in eastern and southern Africa and *D. dorsalis* inhabiting West and Central Africa in term of home range size, population dynamics and/or calling behavior. A more detailed analysis of our data revealed a preference for areas situated deep inside the undisturbed natural forest, while the old teak plantations acted as a buffer zone between croplands and the Lama FR. An absence of the tree holes and dense lianas that are used by hyraxes for shelter could be the major reason of their avoidance of the old teak plantations. Human settlements and their associated agricultural activities seemed to affect tree hyrax habitat use: highest activity was recorded at stations far from settlements, while stations near settlements showed lower activity. The conservation of habitats with dense canopy cover is therefore necessary for the long-term conservation of tree hyraxes. Tree hyrax habitat preferences are tightly linked to tree species providing food and also to cavities in decaying trunks, preferably with several entrances (Milner & Harris 1999, Gaylard & Kerley 2001). These preferences likely explain the patterns in distribution and habitat use found during this study. While tree hyraxes may spend some time on the ground (Funmilayo 1979) for foraging, they need canopy pathways between trees (Milner & Harris 1999) and avoid open forest, where they are exposed to predators and hunting.

Latrines were found almost exclusively at the foot of *Dialium guineense*, which raises two questions: are these trees preferred for their fruits or because mature tall individuals decay and have holes that shelter tree hyraxes? Additional studies could help to clarify latrine selection as well as habitat use in the Lama FR.

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