

DIURNAL ACTIVITY PATTERNS AND TIME BUDGET OF GRANT'S GAZELLE (*NANGER GRANTI*) IN NECHISAR NATIONAL PARK, ETHIOPIA

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ABSTRACT: Information on behavior patterns of animals is important to plan wildlife management programs in conservation areas. The Grant's gazelle (*Nanger granti*) is one of the major larger mammals in the plains of Nechisar National Park. As behavior patterns of this species were not studied earlier, the present investigation was aimed to study the diurnal activity patterns and time budget of its major activities. Observations on activity patterns were carried out on randomly selected herds during day time and recorded for units of five minutes at intervals of 10 minutes. Major activities such as feeding, movement (walking and running), resting and social behaviors of herds consisting of adult male, adult female, juvenile and young were recorded during 2304 unit observations. The percentage of feeding, movement, resting and social behaviors in which they were engaged during the study period was 43.7, 24.2, 23 and 8.2, respectively. There was variation in the percentage of activities of gazelles during morning, noon and in the afternoon. There was a significant difference in the percentage of different activities among individuals ($p < 0.05$). The overall diurnal activities of gazelles showed a bimodal pattern of intensive foraging in the morning and afternoon hours. There was no marked seasonal variation in their activity levels. This might be related to the drought tolerant behavioral adaptation of the Grant's gazelle.

Key words/phrases: Feeding, movement, Nechisar plains, resting, social activities

INTRODUCTION

Grant's gazelle (*Nanger granti* Brooke, 1872) is a common antelope inhabiting the plains of Nechisar National Park, Ethiopia (Duckworth *et al.*, 1992; Yisehak Doku *et al.*, 2007; Workneh Alemu *et al.*, 2016). However, human induced threats are challenging the survival of the species in the area. *Nanger granti* is a social animal, which lives in mixed herds of males and females of different age categories. They are drought tolerant animals, inhabiting dry open areas of grasslands, shrub and bush-lands, savannah woodland, open grassy plains, and montane grasslands (Estes *et al.*, 2006). Gazelles feed on leaves, flowers and shoots of grasses as well as fruits, leaves and pods of shrubs. They rarely drink water directly as they are satisfying their water requirement from the leaves or other parts of vegetation they consume (Grignolio *et al.*, 2003). During the dry season, when many species of artiodactyls migrate in search of water and fodder, gazelles remain in their original habitat. Only when fodder is scarce, they may move to

the surrounding habitats where more fodder resources are available (Estes *et al.*, 2006).

Geffen *et al.* (1999) have stated that gazelles in the northern Israel mainly depend on grasses in their original habitats during winter, on dicotyledons in the surrounding habitats during spring and on leaves as well as fruits of *Ziziphus lotus* during summer, when the green fodder is scarce. Similarly, during the dry season, they forage in the short grassy plains or move to the surrounding shrub and bush-land habitats. However, during the rainy season, they stay in the original habitats of grassland or move to heavily wooded areas (Grignolio *et al.*, 2003; Sakuragi *et al.*, 2003).

Optimum use of resources in the habitat is essential for animals to survive and reproduce (Solanki and Kumar, 2010), and hence various activities of wild animals are oriented to achieve this goal. There are also adaptive modifications in behavioral rhythmicity of animals to achieve optimum benefits of resources available in their habitats. Wild animals might adapt to avoid localities where human interactions are frequent, and they adapt to use resources in such areas by

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shifting the timing of their activity schedule to avoid direct interactions with human beings (Ndhlovu and Balakrishnan, 1991; Balakrishnan and Ndhlovu, 1992). As is the case of most of the African forest habitats, Nechisar plain in Ethiopia is also under the influence of intensive human interactions.

Information presented in this manuscript is part of our wildlife ecology research work with special reference to the activity patterns and time budget of Grant's gazelle in the plains of

Nechisar National Park, which was not studied earlier by other scholars. Even though stable populations are reported from some of the areas of the distribution of the Grant's gazelle, the overall population trend of the species is decreasing due to habitat modification and severe human pressures, including livestock grazing (IUCN, 2016); and hence detailed ecological and behavioral studies on them are warranted.

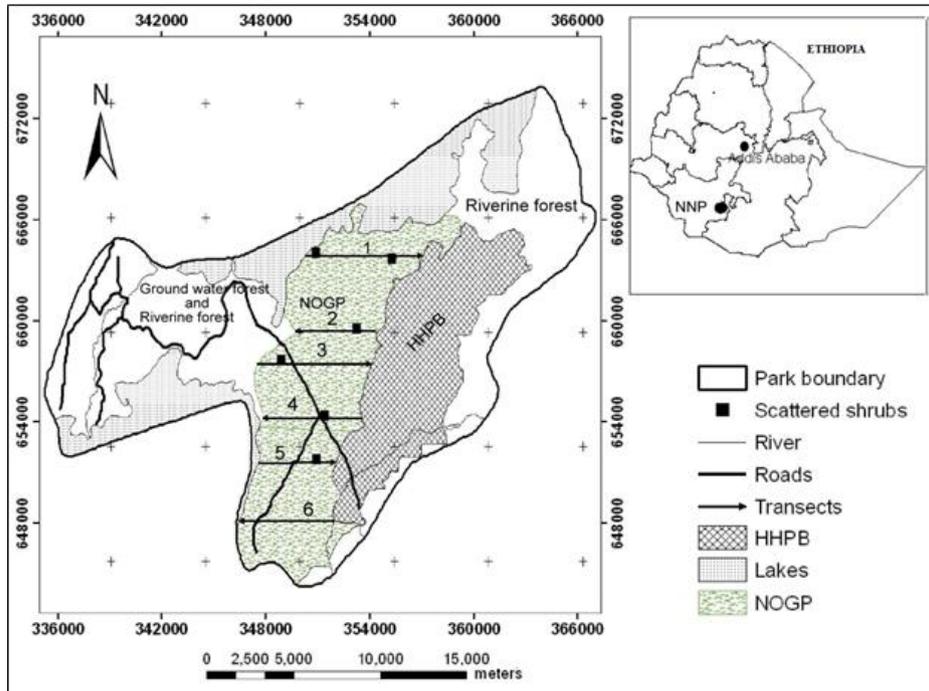


Figure 1. Map of Nechisar National Park (NNP=Nechisar National Park, NOGP=Nechisar open grassy plains, HHPB=Hare hill plateau bush-land) (Adapted from: Wokneh Alemu *et al.*, 2016)

MATERIALS AND METHODS

The study area

Three Nechisar National Park (NNP) is located at about 500 km away from Addis Ababa, in the Amaro Special Woreda and Arba Minch Zuria Woreda of the Southern Nations Nationalities and Peoples Regional State (SNNPRS) of Ethiopia. This Park is located at the eastern edge of Arba Minch town, in the southern part of the country at 5°51'–6°10'N and 37°32'–37°48'E, at altitude ranges of 1108 m a.s.l. at Lake Chamo and 1650 m a.s.l. at the peak of Geda hill. It covers an area of 514 km² of which 436 km² is land area and the remaining 78 km² is lake, and

lies in the floor of the Ethiopian Rift Valley between Lakes Abaya and Chamo (Fig. 1).

Vegetation of NNP area is deliberately burned by the local people to increase growth of fresh fodder during the end of the dry season. Herds of livestock of the local people frequently visit the plains during the wet season and the Sermele valley during the dry season for grazing and to feed on salty soil locally known as 'Bole' near the area called Tebel in the Park. Local people are highly dependent on the resources of the Park for their day to day activities such as farming, honey collection and hunting. As a result of overgrazing in the Nechisar plains, the area is highly degraded especially the northern part (Dache), which is the habitat of a high proportion of gazelles and other wild animals of the Park.

Nechisar savannah grassland is the largest habitat of the Park covering an extent of 270 km² of the plains (Workneh Alemu *et al.*, 2016). In the 1970s there were no trees in the plains, but most of the hills and gentler slopes of the plains were covered with scattered shrubs and bushes. In the early 1990s the vegetation cover of scattered trees and bushes in and around the plains was under expansion (Evans *et al.*, 1992). Currently, a mix of the Somale-Masai edaphic grassland (cover large proportion of the Nechisar plains, highly dominated by common grass species), and the dispersed Somale-Masai *Acacia-Commiphora* deciduous bushland and thickets (cover small proportion of the Nechisar plains, which is composed of low bushy trees and scattered shrubs set in and around the plains) are the characteristic vegetation of the present study area (Yisehak Doku *et al.*, 2007; Workneh Alemu *et al.*, 2016). In this area, there is a serious problem of grassland encroachment prominently by *Dichrostachys cinerea*, *A. mellifera*, *A. niloticus*, *A. oerfota*, and *A. seyal* (Aramde Fetene *et al.*, 2016). Nechisar National Park is also known for its large mammalian fauna that include Burchell's Zebra (*Equus quagga*), greater kudu (*Tragelaphus strepsiceros*), Guenther's dik dik (*Madaqua guentheri*) and warthog (*Phacochoerus africanus*). It is believed that the African buffalo (*Syncerus caffer*) and the Swayne's hartebeest (*Alcelaphus buselaphus swaynei*) are locally extinct in the area (Yisehak Doku *et al.*, 2006; Demeke Datiko and Afework Bekele, 2011; Sintayehu Workeneh *et al.*, 2012; Workneh Alemu *et al.*, 2016).

Field data for the present investigation were collected during August 2008–April, 2009 including both wet and dry seasons in the study area. During a reconnaissance survey, all the relevant information related to the topography of the study area and the distribution patterns of gazelles were gathered. Transect sites, vegetation types and dominant vegetation communities were observed and identified with the help of Park staff and previous records of the Park management archives and work of others.

Prior to the actual data collection, six transects, each of 4 km length were randomly selected and marked on a 1:250,000 topographic map of the Park. Then intensive observations were carried out. Detailed observations on the activity patterns were carried out on randomly selected herds of gazelles consisting of adult male, adult female and young in the open grassland and shrubland habitats during transect walks.

Activities were recorded for five minutes at intervals of 10 minutes following the method of Altman (1974), as adopted by Bezawork Afework *et al.* (2009). Data were collected from an average distance of 100 m and all activities of the herd (if most of them were involved in the same activity) were recorded on a predesigned data sheet. Activities of gazelles were observed during 06:00–18:00 h of the day either by unaided eyes or using a pair of binoculars, while the observer was walking on foot through transects. A total of 2304 unit observations were used to assess the diurnal activity patterns of gazelles during the present investigation. The proportion of time budget was distributed into four major activity types such as feeding, movement (walking and running), resting and socializing (activities such as rutting, mating and fighting). Movements involved walking forward at slow or moderate speed and running (except to escape from predators). Lying down on the ground and standing at a location were considered as resting (part of the time during resting, they ruminate). Social activities included activities such as grooming, mating, fighting, rutting, and playing. The differences in the percentage of time spent in the four major activities of gazelles between morning (06:00–11:00 h), noon (11:00–14:00 h) and evening hours (14:00–18:00 h), and between the wet and dry seasons were analyzed using Wilcoxon test. To see the interdependence of feeding, moving, resting and socializing activities and the levels of significance, Spearman's correlation test was carried out using the SPSS (Version 15).

RESULTS

In the Nechisar plains, Grant's gazelles live in different herd compositions as given in Table 1 below. In most of the herds, females outnumbered males and young scholars.

Activity patterns of gazelles are shown in Fig. 2 below. The percentage of major activities in which gazelles were engaged during the study period were feeding (43.7%), moving (24.2%), resting (23%) and socializing (8.2%). There were variations in the level of activities during morning, noon and evening. The time budget of gazelles with the mean percentage of duration of time engaged in different activities in each of the hours of observation of the day varied significantly ($\chi^2 = 45.27$, $df = 3$, $p < 0.05$).

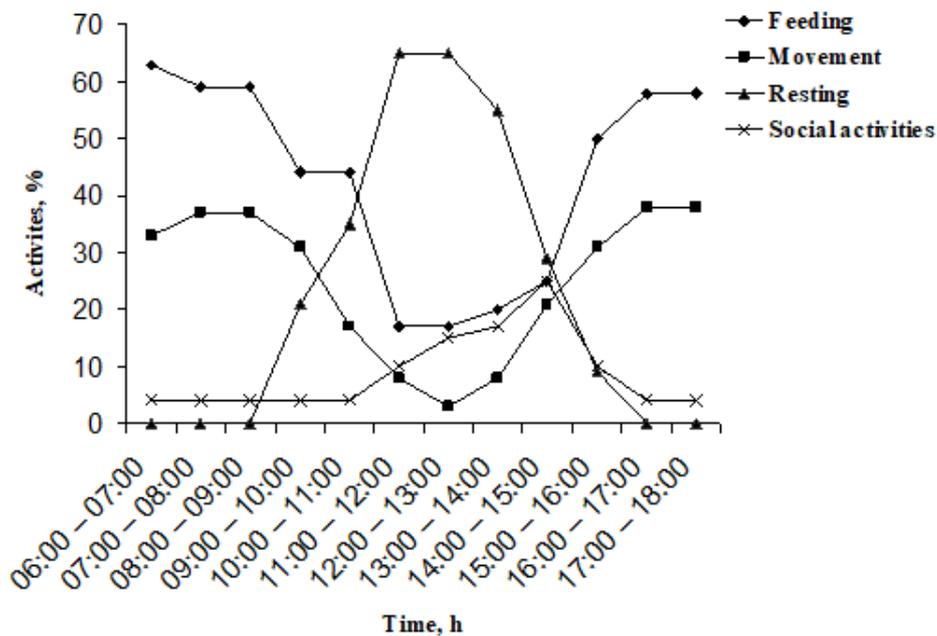
Table 1. Herd composition of Grant's gazelles observed in Nechisar plains.

Sl. No.	Type of herd	Number of individuals in the herd
1	Male	One
2	Pair (one male and one female)	Two
3	All male herd	>one
4	Mixed herd of different sex and age categories	>3 individuals of different sex and age
5	Female herd type i	Two
6	Female herd type ii	3-5
7	Female herd type iii	6-10
8	Female herd type iv	11-14

Feeding

Diurnal feeding activity of gazelles consisted of morning and afternoon peaks, separated by a mid-day minor feeding activity. Active feeding was observed around 06:00–10:00 h (45–65%), and it declined to a minimum level during 11:00–

14:00 h (15–20%). Active foraging activity was also observed in the afternoon during 16:00–18:00 h (50–60%). Thus, feeding has a bimodal pattern with peaks in the morning and evening hours of the day.

**Figure 2. Diurnal activity patterns of Grant's gazelles in Nechisar plains.**

Moving

Gazelles were moving for short distances when searching for food, place for rest or when involving in social activities. Females often initiate and lead the movement of the herd. The territorial male prohibits other males entering its territory and interacting with the herd members. Their movements were more during 06:00–08:00 and 16:00–18:00 h (36%), during the morning and evening hours, respectively. Movements were less during 11:00–14:00 h (4–8%). Movement and feeding have shown a high level of positive

correlation, with a bimodal rhythm ($r=0.79$; $p<0.05$).

Resting

Gazelles rest under bushes or in open grasslands during the mid-day, i.e. between 11:00–14:00 h (35–65%). No resting was observed during 06:00–09:00 h and 16:00–18:00 h. Only a small proportion of the animals were observed resting during other times of the day.

Social activities

Social behavior of gazelles such as grooming, courting, fighting and other related activities were observed during 14:00–15:00 h (20%), 06:00–11:00 h (5%) and 16:00–18:00 h (5–10%). Social activities were observed more during the noon hours. Resting activity was positively correlated with social activities ($r=0.426$; $p<0.05$).

The overall diurnal activity pattern of gazelles showed rhythmicity during the different hours of the day. However, there was no significant seasonal variations in their activity patterns between wet and dry seasons ($P>0.05$).

DISCUSSION

Diurnal and nocturnal patterns of activities, food preferences and habitat association of animals are part of their adaptive strategies. Changes in the rhythmicity of activity patterns in relation to time and season make them to be successful to gather essential resources at an optimum level (Pyke *et al.*, 1977). Diurnal activity patterns of animals are influenced by factors such as food availability, intensity of sunlight, temperature and breeding season (Wronski *et al.*, 2006).

The levels of prominent activities of gazelles differed significantly during morning, noon and afternoon hours of the day, but did not vary between the wet and dry seasons. Foraging is one of the main activities of most of the artiodactyls during the day time (Wronski *et al.*, 2006). Results of the present study showed that feeding related activities of Grant's gazelles were longer (43.7%) than other activities. Usually, artiodactyls spend more time in feeding during the dry season when there is shortage of food resources than during the wet season when food is available in plenty (Bezawork Afework *et al.*, 2009). However, the duration of feeding in Grant's gazelles decreases with increasing atmospheric temperature. When there is shortage of food and increased atmospheric temperature in the open dry grassland habitat, they restrict their energy expenditure through restricted movements, and satisfy themselves with the reduced resources available in the grassland and bushland habitats.

Activities of animals vary in response to environmental factors (Taylor *et al.*, 2006). Movement and resting activities of animals fluctuate diurnally. Grant's gazelles move while searching for food during morning and afternoon hours of the day, indicating positive correlation

of these two activities with respect to the time of the day. Herds of Grant's gazelles rest during the noon time between morning and afternoon grazing peaks. During the resting period, they remain inactive in open tall grassy areas or under shades of trees to escape the intense heat and sunlight. Gazelles are also involved in other behavioral activities after their noon time rest. Territorial males follow movements of neighboring territorial or bachelor males at a distance. Fighting displays are common during such movements.

Irregularly distributed rainfall in the NNP during the wet season creates patches of green vegetation in the plains. During this time, activities of ungulates increase in general due to the availability of food, moderate temperature, and intensity of sunlight, which are more suitable for grazing. During the dry season, forage value of the grassland drops, sunlight intensifies and temperature increases leading to reduced activities of animals. However, adapted to dry weather conditions, Grant's gazelles do not show any major difference in the activity levels during wet and dry seasons. They sustain with the limited available food and water resources during the dry season, rather than spending more energy by moving through larger areas through extended periods of foraging, which is common among most of the other ungulates (Bezawork Afework *et al.*, 2009; Aberham Megaze *et al.*, 2012). This is a general deviation from the expected seasonal difference in the activity patterns of gazelles compared to most of the other ungulates in the tropics.

In conclusion, gazelles have a bimodal diurnal activity pattern, one in the morning hours and the other in the evening lasting until dusk, and with a period of rest during noon. Feeding and walking were more intensive in the morning and afternoon hours as it is the case in most ungulates (Bezawork Afework *et al.*, 2009). However, activity patterns of gazelles do not differ with respect to wet and dry seasons in the plains of the Nechisar National Park. This might be related to the drought tolerant behavioral adaptation of the Grant's gazelle.

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