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Population Status, Feeding Ecology and Activity Patterns of Grant's Gazelle (*Gazella granti*) in Abijata-Shalla Lakes National Park, Ethiopia

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ABSTRACT

Information on population status, feeding ecology and activities of Grant's gazelle (*Gazella granti*) was collected from January to August, 2010 by means of total count and direct observation. Data were analysed using descriptive statistics, Chi-square test and one way ANOVA. Tukey multiple comparison test was also used to test variation between different activities. The average number of Grant's gazelles in the study area was 78 during the dry season and 59 during the wet season; mean group size was 2.36 ± 0.07 and 2.70 ± 0.1 during the wet and dry seasons, respectively. Grant's gazelles were observed feeding on grasses, herbs, trees and shrubs. The food items consumed by Grant's gazelles between dry ($p < 0.05$) and wet ($p < 0.05$) seasons differed. Grant's gazelles graze more often than browse during both seasons. They frequently fed during early morning and late afternoon. Activity budgets differed seasonally (wet season: $p < 0.05$; dry season: $p < 0.05$). They spent 42.9% of their time on feeding during the wet season. On the other hand, during the dry season, 35.8% of their time spent on resting followed by feeding (29.7%). Different conservation measures should be taken in to consideration to enhance the number of Grant's gazelle and to create suitable habitat for them.

Key words: Diurnal activity pattern, foraging ecology, Grant's gazelle

INTRODUCTION

Grant's gazelles (*Gazella granti*, Brooke, 1872) are larger in size than other gazelles. Adult males weigh 60-81 kg and females weigh 38-67 kg (Kingdon, 1997). Both sexes have horns but males have longer, thicker and highly ringed horns (Kingdon, 1997). Grant's gazelles are distributed in Sudan, Ethiopia, Kenya and Tanzania (Nowak, 1991). They inhabit open grass plains and are frequently found in shrub land. They also occur in semi-arid areas (Arctander *et al.*, 1996). They occupy plains during the dry season and reside in woodlands during the wet season. They are territorial and migratory animals (Estes, 1991).

Grant's gazelles are generally mixed feeders (browse and graze) (Oindo, 2002). They feed on herbs and shrubs during the late wet and dry seasons (Kingdon, 1997). As they derive most of their moisture from the plants they eat, they can stay without water for long period of time (Walther, 1972). They are gregarious. However, size and composition of their social groups are affected by external ecological factors such as habitat, seasonal changes and availability and

quality of food (Estes, 1991; Gerard *et al.*, 2002). The size and composition of groups are the basic elements of their social organization (Raman, 1997). They have several social groups including females and offsprings, bachelor males, mixed herds and dominant males. The average herd size is about 30 (Stuart and Stuart, 1997). Females form groups consisting of nursing mothers and their offspring. Bachelor groups consist of adolescent and older males without territories (Walther, 1972). Territorial males lead all females that enter the boundary and guard these during estrus to prevent other males from mating (Walther, 1991). On average, territorial males are older, larger and have thicker horns than bachelor males (Stelfox *et al.*, 1984). The dominant males mark their territory with urination and defecation (Estes, 1967). Grooming is an essential part of the gazelles behavior because, it prevents parasites from becoming distended in their skin and improves overall health (Hart, 1992).

The most common predators of Grant's gazelles are jackal (*Canis aureus*), cheetah (*Acinonyx jubatus*), leopard (*Panthera pardus*), spotted hyena (*Crocuta crocuta*) and wild dog (*Lycoan pictus*). Grant's and Thomson's gazelles frequently intermix as both species benefit from the enhanced vigilance (Fitzgibbon, 1990). Grant's gazelles are classified as a species of least concern, the majority of species and subspecies within this genus are considered to be threatened, endangered or extinct. Reduction in gazelle numbers is attributed to habitat loss, unregulated sport hunting and the bush meat trade (Nowak, 1991). Limited research has been conducted on Grant's gazelle in Ethiopia and even in Africa. Especially, there is no documented information in ecological and other aspects of Grant's gazelle in Abijata-Shalla Lakes National Park. Therefore, the present study can fill part of the gap. The major objectives of this study include: (1) to identify the feeding behavior of Grant's gazelle, (2) to show their diurnal activity pattern, (3) to reveal the current population status and (4) to show sex and age structure of Grant's gazelle in Abijata-Shalla Lakes National Park, Ethiopia.

MATERIALS AND METHODS

Study area: Abijata-Shalla Lakes National Park encompasses Lake Abijata and Shalla and surrounding lands (Fig. 1). The Park located about 200 km from Addis Ababa in the Ethiopian Central Rift Valley and covers a total area of 887 km², elevation ranges from 1540 to 2075 m above sea level (EWNHS, 1996). The Park comprises different lakes with varying shoreline and woodland vegetation (Tefera and Almaw, 2002). It was established predominantly as a bird sanctuary in 1971 (EWNHS, 1996). The islands are home to breeding colonies for many birds. The rift floor is fed by perennial rivers originating from adjacent highlands both to the east and west (Ayenew, 2001).

The climate of Abijata-Shalla Lakes National Park is classified as upper kola. Annual rainfall averages about 500 mm and is most prominent during March, April, June and September (CPI, 2000). The average annual temperature is 20.1°C with a maximum of 26.6°C and minimum of 13.5°C (EWNHS, 1996). The type of soil in the area is alluvial and very fine in nature; major vegetation types include *Acacia* savanna covering most hills and shorelines, *Euphorbia* woodland, riverine vegetation, bushland, shrub and grassland. Dominant trees of the *Acacia* woodland include *Acacia tortilis*, *A. Senegal*, *A. seyal* and *A. gerrardii*, *Balanites aegyptica*, *Grewia bicolor*, *Ficus lutea*, *Ficus sycomorus* and *Maytenus senegalensis* (Tefera and Almaw, 2002). According to Hillman (1993), 403 species of birds and 76 species of mammals have been recorded in the Park. The Park is one of the narrowest parts of the Great Rift Valley, a major flyway for both Palearctic and African migratory birds, particularly raptors, flamingos and other water birds (Birdlife International, 2009).

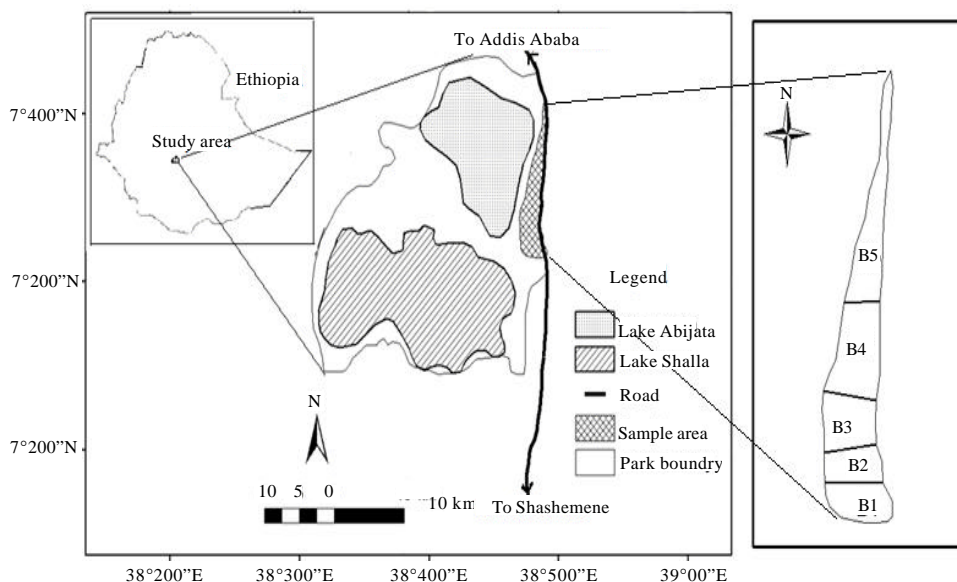


Fig. 1: Map of Abijata-Shalla Lakes National Park, the study area and census blocks

Population census: To estimate the population size of Grant's gazelle in the study area, total count method employed during both dry and wet seasons following Caughley and Sinclair (1994) and Sutherland (1996). The identified ranges of Grant's gazelle were classified into five different blocks based on artificial and natural boundaries. Census was conducted during early morning and late afternoon in each block during both wet and dry seasons repeatedly. Counts were carried out within 2-3 h using unaided eyes and/or 12×40 binoculars. During the census period, detailed information on the herd was collected. This enabled to categorize the population according to their responsive ages. The categories included adult male and female, sub-adult male and female, unidentified juvenile sex (Knight, 1970; Bergerud, 1971; Lewis and Wilson, 1979). The total number of individuals in a group was counted to identify the group size. Furthermore, habitat type was also recorded to identify their habitat preference. Animals were treated as the same group if the separation distance is approximately less than 50 m (Hillman and Hillman, 1987). Repeated counting of the same herd or cluster was avoided using recognizable features such as cluster size, harem composition and distinct individuals with body deformities such as cut tail or ear (Wilson *et al.*, 1996).

Feeding ecology: Repeated standard observations were used to collect data on foraging behavior following Hartley (1953). Time spent for foraging was also recorded using focal sampling (Sutherland *et al.*, 2005). Focal sampling consisted of watching an individual for a fixed period (10 min) with unaided eye or binocular according to the size and the distance of the animal from the observer and recording the activities such as the type of food items consumed and amount of time spent for foraging. Parts of the plant species consumed were classified as green leafy twigs, non green leafy twigs, brown leafy twigs, brown twigs, green leafy grass stems, non green leafy grass stems, brown leafy grass stems and tree pods. Furthermore, foraging types including browsing and grazing were also recorded during both wet and dry seasons. Plant samples were

collected from the study area and pressed, then taken to Addis Ababa University herbarium for identification.

Activity patterns: To study the activity patterns of Grant's gazelle, scan sampling method was employed (Altman, 1974). Focal individual was randomly selected by stratifying based on age and sex. When the focal animal was in a group, the dominant activity in the group recorded at the beginning of the observation. Activities included feeding, walking, resting, mating, self-grooming, mutual grooming, nursing, suckling, running, chasing, fighting and social interaction. Observations carried out for five min at an interval of 15 min from 06:00-18:00 h; activities displayed and durations continuously recorded using a stop watch.

Data analysis: Data analyzed using SPSS software version 17 and Microsoft Excel. Descriptive statistics were used to report the Grant's gazelle population size. Food items used were compared using a Chi-square test across seasons. Activity patterns also compared within a day and between seasons using a one-way ANOVA to test differences among hourly time budget over both seasons. Tukey multiple comparison tests applied to test variation between different activities per h within a day.

RESULTS

The maximum number of Grant's gazelle recorded was 78 during the dry season and 59 during the wet season (Table 1). On the other hand, the maximum group size consisted of 17 and 20 individuals during the dry and the wet season, respectively. These include adult males and females, subadult males and females and juveniles. Groups of bachelor males also consisting up to 15 individuals were also recorded. The mean group size was 2.36 ± 0.07 during the wet season and 2.70 ± 0.1 during the dry season.

Of the total individuals sighted in the study area, 21.87% constituted adult males, 43.27% adult females, 15.68% subadult males, 9.08% subadult females and 10.1% unidentified juveniles. The number of animal groups significantly differed during the dry ($\chi^2 = 32.74$, $df = 4$, $p < 0.05$) and wet ($\chi^2 = 93.13$, $df = 4$, $p < 0.05$) seasons. Adult female groups constituted the largest groups during the wet (25.11%) and dry (34.6%) seasons, whereas subadult females were lesser in number among groups during both the wet (4.25%) and dry (8.3%) seasons.

Age and sex ratios differed ($p < 0.05$) between seasons (Table 2). The sex and age ratio of subadult females and adult females were greater during both the dry (1.00:4.17) and the wet (1.00:6.00) seasons.

Table 1: Number of Grant's gazelles recorded during wet and dry seasons

Seasons	Block 1	Block 2	Block 3	Block 4	Block 5	Total
Dry	16.0	15.0	12.0	25.0	10.0	78.0
Wet	15.0	10.0	17.0	4.0	13.0	59.0
Mean	15.5	12.5	14.5	14.5	11.5	68.5

Table 2: Sex and age ratio of Grant's gazelles during wet and dry seasons

Season	Sex and age ratio				
	AM:AF	SAM:SAF	M:F	SAM: AM	SAF:AF
Wet	1.00:2.15	3.00:1.00	1.00:1.20	1.08:1.00	1.00:6.00
Dry	1.00:1.87	1.08:1.00	1.00:1.56	1.00:2.00	1.00:4.17

Table 3: Relative percentage of plant species consumed by Grant's gazelles during wet and dry seasons

Species	Common name	Family	Relative percentage	
			Dry season	Wet season
<i>Acacia tortilis</i>	Umbrella thorn	Fabaceae	8.1	3.0
<i>Acacia senegal</i>	Gum acacia	Fabaceae	5.9	18.8
<i>Acacia seyal</i>	Shittim wood	Fabaceae	4.4	4.0
<i>Heteropogon contortus</i>	Black spear grass	Poaceae	16.3	10.9
<i>Cenchrus ciliaris</i>	Buffel grass	Poaceae	26.7	24.8
<i>Eragrostis papposa</i>	Love grass	Poaceae	2.2	5.9
<i>Hackelochloa</i> spp.	-	Poaceae	2.2	-
<i>Erucastrum abyssinicum</i>	Abyssinian mustard	Brassicaceae	17.8	-
<i>Commelina</i> spp.	Dayflower	Commelinaceae	2.2	-
<i>Ritchiea albersii</i>	Ritchiea	Capparidaceae	0.7	-
<i>Rhus natalensis</i>	Natal rhus	Anacardiaceae	7.4	3.0
<i>Balanites aegyptiaca</i>	Simple thorned torch tree	Zygophyllaceae	5.9	3.0
<i>Croton dichogamus</i>	Orange leaved croton	Euphorbiaceae	-	2.0
<i>Bidens biternata</i>	Black jack	Asteraceae	-	1.0
<i>Rhoicissus tridentata</i>	Wild grape	Vitaceae	-	1.0
	Other shrubs and herbs	-	-	22.8
Total			100	100

Grant's gazelles were observed feeding on 16 different plant species in 10 families during the study period. Plant species consumed were grasses, herbs, trees and shrubs. *Cenchrus ciliaris* (26.7%) was the most frequently consumed food item by Grant's gazelle followed by *Erucastrum abyssinicum* (17.8%), whereas *Ritchiea albersii* (0.7%) was the least consumed during the dry season. On the other hand, *Cenchrus ciliaris* (24.8%) was the most frequently consumed food item and *Bidens biternata* (1%) and *Rhoicissus tridentata* (1%) were the least consumed food item during the wet season (Table 3). There was a significant difference in food items consumed between dry ($\chi^2 = 74.79$, $df = 13$, $p < 0.05$) and wet seasons ($\chi^2 = 103.47$, $df = 11$, $p < 0.05$).

Of the diet during the wet season, 54.8% constituted green leafy twigs followed by green leafy grass stems (37.5%). Grant's gazelles were not observed feeding on brown leafy twigs, brown twigs and tree pods during this season. During the dry season, they consumed green leafy twigs (34.6%) and brown leafy grass stem (19.9%) but were not observed feeding on brown twigs (Fig. 2).

Grant's gazelles browsed 28.9% of their time during the dry season and 31.7% during the wet seasons and grazed 68.3% of their time during the wet season and 71.1% during the dry season. Browsing decreased over the dry season as grazing increased. There was a significant variation in the proportions of grazing and browsing between dry ($\chi^2 = 24.06$, $df = 1$, $p < 0.05$) and wet ($\chi^2 = 13.55$, $df = 1$, $p < 0.05$) seasons.

Diurnal feeding behavior of Grant's gazelle was greatest between 6:00-7:00 h and 17:00-18:00 h during both wet and dry seasons. Feeding frequency was least between 9:00-10:00 h during the wet season (Fig. 3).

Overall, Grant's gazelles spent 42.9% of their time on feeding, 25% on resting and least time on mating (0.2%) and social interactions (0.2%) during the wet season. Fighting (1.9%) was only

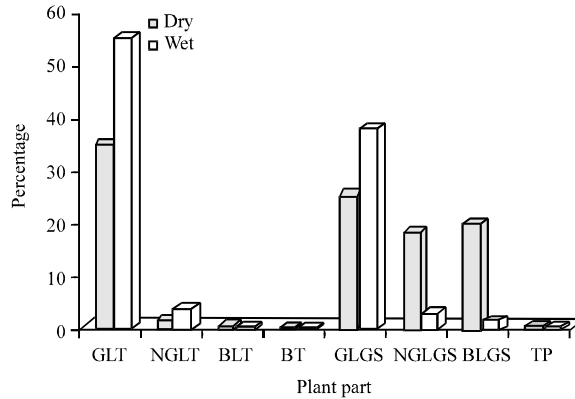


Fig. 2: Plant parts preferred by Grant's gazelles and their percentage in the study area during the dry and wet seasons (GLT: Green leafy twigs, NGLT: Non green leafy twigs, BLT: Brown leafy twigs, BT: Brown twigs, GLGS: Green leafy grass stem, NGLGS: Non green leafy grass stem, BLGS: Brown leafy grass stem and TP: Tree pod)

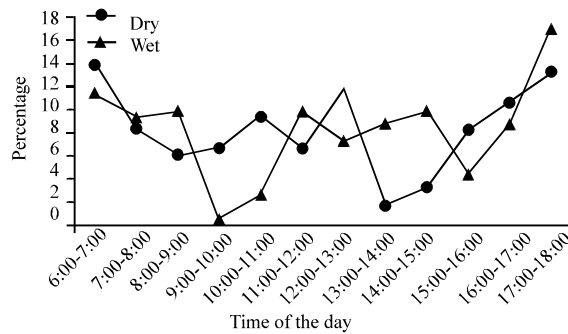


Fig. 3: Seasonal feeding pattern in the study area within different time range

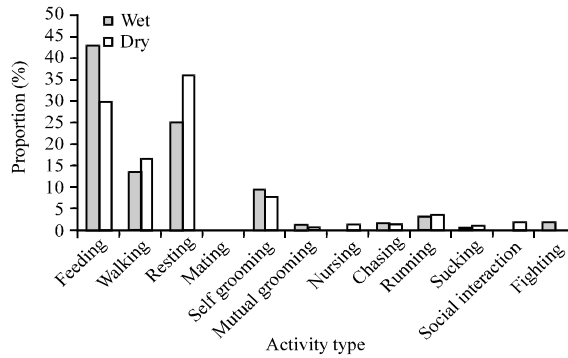


Fig. 4: Percentage of different activities conducted by Grant's gazelles during the wet and dry seasons

observed during the wet season whereas nursing (1.5%) was only observed during the dry season. On the other hand, 35.8% of their time was spent resting followed by feeding (29.7%). The least amount of time spent on mutual grooming (0.7%) during the dry season (Fig. 4). Hourly time

budget differed significantly over both seasons (wet season: $F_{11\ 412} = 1.82$, $p < 0.05$; dry season: $F_{11\ 595} = 4.28$, $p < 0.05$). Multiple comparison tests showed significant differences among h of the day. During the dry season, a significant difference ($p < 0.05$) was observed between 2:00-3:00 h and 6:00-7:00 h and 11:00-12:00 h.

During the dry season feeding showed two peaks for both adults and juveniles in the early morning (6:00-7:00 h) and late afternoon (17:00-18:00 h). It was least at 13:00-14:00 h for all the three age groups and greatest for juveniles in the late afternoon (17:00-18:00 h) during the wet season. Feeding was less frequent during 9:00-10:00 h for adults and subadults. On the other hand, resting activity peaked for adults at 9:00-10:00 h while juveniles rested more frequently at 16:00-17:00 h during the dry season. Juveniles showed almost no resting pattern in the morning (6:00-7:00 h and 7:00-8:00 h), mid day (11:00-12:00 h) and late afternoon (17:00-18:00 h). During the wet season, resting pattern was identified by highest peak at 12:00-13:00 h for subadults, juveniles and adults, respectively. However, very low resting pattern was recorded between 15:00-16:00 h and 17:00-18:00 h for all the three animal groups.

DISCUSSION

Monitoring populations of wild animals is essential for sustainable management (De Paul and De Clercq, 2009). According to our survey, the average number of Grant's gazelle decreased from 78 (dry season) to 59 (wet season) in the study area. This could be related to increasing the existence of cattle in the study area during the wet season. The displacement of herdsmen from the Afar region and other areas may be displacing Grant's gazelles from their original habitat. Similarly, according to Dunham (2001), mountain gazelle populations are affected due to domestic livestock in central Arabia. Generally, mammalian herbivores are important components of many terrestrial ecosystems (Olf *et al.*, 2002) and human interventions are causing major changes in composition of herbivore assemblages across the world. With the intensification of pastoralism, herbivores have become severely depleted both in diversity and abundance in many parts of the world (Prins, 1992). Therefore, for future research in our study area, use of telemetry may be a better method to locate missing individuals.

One of the advantages of living in groups is that individuals may need to be less vigilant, allowing them more time for other important activities such as foraging (Shorrocks and Cokayne, 2005). In this study, the maximum group size of Grant's gazelle was recorded during the wet season, probably due to increased availability of food. Similarly, a research conducted in China indicated that gazelles gathered together and formed larger herds in areas where they found enough suitable food (Qiao *et al.*, 2011). The number of animal groups differed during seasons. Groups of adult female Grant's gazelles were more abundant than other age groups followed by adult males. This could provide an opportunity to increase populations of the Grant's gazelle at Abijata-Shalla Lakes National Park provided the area of protected habitat is enlarged. Furthermore, bachelor male groups were common during the wet season, reflecting social and breeding behavior.

According to our result, Grant's gazelle foraged on over 16 different species of grasses, herbs, trees and shrubs. However, there were seasonal differences in food items consumed. Similarly, a study conducted in Kapiti ranch (Kenya) indicated that Grant's gazelles tended to have a wide variety of plant species in their diets (Kilonzo *et al.*, 2005). Food availability and preference may be the major reasons for the seasonal variation in food items consumed. The grass *Cenchrus ciliaris* was the most commonly consumed food item by Grant's gazelle during both seasons. During the

wet season, it was difficult to identify the type of shrubs and herbs consumed by Grant's gazelle due to their diverse nature so that they were grouped as shrubs and herbs. Shrubs and herbs constituted 22.8% of the diet of Grant's gazelle during the wet season. This might be due to easy digestibility of shrubs and herbs. They were observed feeding the different parts of plants during both dry and wet seasons. However, they avoided tree pods and brown leafy twigs during both seasons. Because, according to Woie (1984), green parts are more nutritious with high moisture content and easily be digested due to low fiber content as opposed to the dry parts. The present study identified Grant's gazelles as more grazers than browsers. However, Spinage *et al.* (1980) reported as opposed to this pattern which means more browsers than grazers. These differences probably related to the availability of food in our study area. Diurnal feeding behavior indicated that Grant's gazelles were mostly active during early morning and late afternoon. They devoted more time for feeding during the wet season. Similarly, Grier and Burk (1992) concluded that feeding is the most important activity for all organisms in which they devoted most of their time. However, Grant's gazelles spent most of their time with resting followed by feeding relative to other activities conducted during the dry season. This is likely related to the high diurnal temperatures during the dry season and consequently, the need for shelter to overcome heat stress and water loss (Belovsky and Slade, 1986; Stark, 1986). The biodiversity of Abijata-Shalla National Park has been declining from time to time (Gobena, 2008). Although the Park is 887 km², it is highly disturbed from extensive agriculture, human settlement, firewood collection and charcoal production and overutilization of water from Lake Abijata for caustic soda factory. A 1 km² fenced area used to be utilized for ostrich farming harbors the majority of the Grant's gazelles due to the existing threats. In East Africa, many conservation areas do not encompass whole ecosystems (Okello, 2005). Consequently, variations in wildlife numbers, especially herbivores observed within confined protected areas are common, because their natural ranges do not extend well beyond the boundaries of the protected areas particularly for the fenced protected areas (Owino *et al.*, 2011). Therefore, special attention should be given to conserve not only the Grant's gazelles but also other wildlife in the area. Frequent patrols of the Park should be conducted to curtail human disturbances and funds must be allocated to relocate people that live in the Park. The Park should focus on prevention/banning of cutting trees rather than collecting charcoal from farmers.

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