SINET: Ethiop. J. Sci., 34(1): 29-38, 2011
 ISSN: 0379–2897

POPULATION STATUS, FORAGING AND DIURNAL ACTIVITY PATTERNS OF ORIBI (*OUREBIA OUREBI*) IN SENKELE SWAYNE'S HARTEBEEST SANCTUARY, ETHIOPIA

Wondimagegnehu Tekalign [1] and Afework Bekele [2]

[1] Department of Biology, Faculty of Natural Sciences, Wolaita Sodo University, PO Box 138, Wolaita, Ethiopia. E-mail:wondimagegnehubeyene@gmail.com
[2] Zoological Sciences Program Unit, College of Natural Sciences, Addis Ababa University, PO Box 1176, Addis Ababa, Ethiopia

ABSTRACT: The study on the population status, foraging behaviour and diurnal activity pattern of oribi (*Ourebia ourebi)* was carried out in Senkele Swayne's Hartebeest Sanctuary from August 2005 to March 2006 during the wet and dry seasons. Direct observation on selected oribi groups was made to study activity patterns. Total count method was used in an area of 28 km^2. The count of oribi in the study area ranged between 45 and 57 during the wet and dry seasons, respectively. There was no significant difference between the wet and dry season count ($p>0.05$). The sex ratio of adult males to females was 1.00:1.26. Oribi were mostly observed as solitary or in pairs, occasionally forming small groups. Oribi distribution showed preference to grazing on short grass (*Themeda triandra*) in each vegetation community. The distribution of oribi during the wet and dry seasons was similar in all vegetation communities. However, the tendency of population for wider distribution increased in the *Pennisetum* grassland. The annual mean proportion of daylight hours spent feeding by oribi was 54.7%. Morning and evening activity peaks were most obvious during the dry season, with most animals remaining inactive during the midday and hottest hours of the day. Large number of settled human communities in and around the Sanctuary and herds of livestock were frequently observed mainly during the wet season. Overgrazing and settlement encroachment are the major factors that could affect the population status of oribi by lowering the grass quality in the Sanctuary.

Key words/phrases: Ethiopia, Oribi, population dynamics, Senkele Sanctuary

INTRODUCTION

The oribi (*Ourebia ourebi*, Zimmermann, 1783) are small (12–14 kg), highly specialized savannah antelopes (tribe *Neotragini*). They are widely distributed across open grasslands of Africa, south of the Sahara except Gabon (Smithers, 1983; Kingdon, 1997). In Ethiopia, oribi (*Ourebia ourebi*) occur mainly within and to the west of the Rift Valley. They survive widely in open habitats within their historical range, including in some settled areas. They occur in low to moderate numbers in areas such as Senkele Wildlife Sanctuary, Mago, Gambella, Omo and Maze National Parks (Yalden *et al.*, 1984; IUCN, 1998). Recently, a very high number of individuals have been observed in Maze National Park (Girma Timer, 2003). The oribi are widely distributed in Ethiopia. However, due to their shyness, they are not easily observed.

In the single species *Ourebia ourebi*, up to 13 subspecies have been described occurring in different countries of Africa (Nowak, 1991). Oribi are Africa's smallest grazing ungulate (Hofmann, 1989). Two of the subspecies occur in Ethiopia, *Ourebia ourebi montana* along the Sudanese border in the western part of Ethiopia and *Ourebia ourebi gallarum* in central Ethiopia. They are a graceful slender-legged and long-necked small antelope (Smithers, 1983; Webkenya Development, 2003). The hair is fine and silky and the general body colour is light reddish to reddish brown above, with white on the under-parts, chin and the underside of the tail (Walker, 1975; Estes, 1992). They possess a distinctive white line of fur over their eyes and beneath the ears there is a bare hairless glandular area, which is usually dark and conspicuous (Walker, 1975; Nowak, 1991; Frey, 2000). *Ourebia ourebi* breeds throughout the year with peak season in October and November. Oribi show a monogamous to polygamous mating system. The males maintain territory and share one to two or more females (Thirgood *et al.*, 1992). Females are able to conceive as early as ten months old and males are sexually active by

fourteen months; the life span is 8 to 12 years (Estes, 1992).

Oribi prefer an open habitat. They occur in open grassland or flood plain, with or without a sparse scattering of trees and bushes (Hayman, 1980; Smithers, 1983). They prefer short grasses with patchy areas of tall grasses to provide hiding places. They like grasslands that are not extremely tall or dense and with some bushes for protection and avoid steep slopes and habitats dominated by woodland or bush (Estes, 1992; Frey, 2000). The feeding niches of African ruminants have been classified in terms of the quality, quantity and principal composition of the vegetation (Gordon and Illus, 1996). Oribi is the only neotragine that is primarily a grazer although it browses occasionally, especially during the dry season and is water independent (Smithers, 1983; Stuart and Stuart, 1997).

They are active mostly during the day (Frey, 2000) and information on nocturnal activity is sketchy (Estes, 1992). They lie in grass with their heads erect, keeping a watchful eye around them (Smithers, 1983). If suddenly disturbed, they will give the snorting whistle alarm call as they bound off stotting with a rocking-horse motion (Hayman, 1980; Smithers, 1983). Often, they do not attempt to flee until an intruder is within a few meters, remaining motionless in the grass, relying on camouflage (Nowak, 1991). Both sexes contribute to the protection of the group, through increased vigilance (Baldellov and Henzi, 1992; Hannon and Martin, 1992). However, little is known about the effects of predators on oribi (Mduma and Sinclair, 1994). The natural enemies of the oribi include lions, leopard, caracals, hyaenas, hunting dogs, jackals, crocodiles and pythons. The young are also threatened by jackals, eagles, genets, wildcat, ratels and baboons (Frey, 2000; Webkenya Development, 2003). Oribi is classified as "Lower Risk" conservation dependent on the IUCN Red List (Rowe-Rowe *et al.*, 1992; IUCN Red List, 2004). South Africa's latest Red Data Book for mammals (2004) classifies the oribi as "Endangered", due to its rapid decline in recent years caused primarily by habitat destruction and continued persecution by man (EWTOWG, 2001).

There have been few studies on oribi (*Ourebia ourebi*) in Ethiopia. The objective of the present study is to assess the current population status, structure, foraging and diurnal activity patterns of *Ourebia ourebi* in Senkelle Swayne's Hartebeest Sanctuary.

THE STUDY AREA AND METHODOLOGY

The study area

Senkele Swayne's Hartebeest Sanctuary was established in 1976 to conserve the population of the Swayne's Hartebeest, which is an endemic and endangered sub-species. The area is located in south-central Ethiopia, 320 km by road from Addis Ababa to Sodo (Fig. 1).

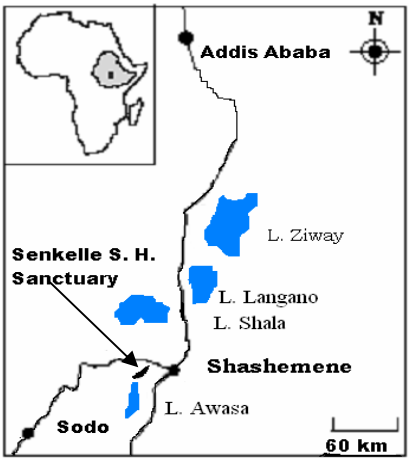

Fig. 1. Location of Senkelle Swayne's Hartebeest Sanctuary along the road to Sodo town.

The 200 km² Sanctuary in 1972 was reduced to about 58 km² in 1973, and to 36 km² thereafter (Messana and Bereket Netsereab, 1994). At present, less than 28 km² of the Sanctuary remains for the animals. Since 1991, the northern and southern parts of the Sanctuary also harbour huts and expanded farmlands. In addition to the hartebeest and oribi (*Ourebia ourebi*), the study area harbours other herbivores such as bohor reedbuck (*Redunca redunca*), warthog (*Phacochoreus aethiopicus*), common duiker (*Cephalophus grimmia*), abyssinian hare (*Lepus habessinicus)* and greater kudu (*Tragelaphus strepsiceros*) and carnivores such as lion (*Panthera leo*), spotted hyaena (*Crocuta crocuta)* and jackals (*Canis aureus)* (Hillman 1993). The name Senkelle in the local language 'Oromigna' refers to the oribi, which was most common in the past (Hillman, 1993).

The altitude at Senkele ranges between 2000 and 2100 masl. The average rainfall is 1,116 mm per annum. It has a moderately bimodal pattern of rainfall, typical of the '*Woinadega*' Agro-ecological Zone of Ethiopia (600–1200 mm annual rainfall). The three-month dry season, from November to January, is followed by the '*Belg*' rains, which peak in April-May, and the '*Kremt*'

rains, from June to August, which peak in September. The mean monthly temperature is relatively constant throughout the year but diurnal variations can be considerable. Monthly maximum temperatures range between 26°C during the dry and early wet seasons and 21°C during the late wet season. Monthly minimum temperatures are lowest during the dry season, falling to 8–9°C on some occasions, and rising to their maximum values of 14–15°C between March and May (SWAO, 1999). Messana and Bereket Netsereab (1994) described the vegetation communities as *Pennisetum* grassland type 1, *Pennisetum* grassland type 2 and mixed grassland.

Methodology

The study area was divided into five blocks based on the vegetation structure, artificial and natural boundaries in addition to the fallowland in the settlement area (Fig. 2). The size of each of the five blocks was: Block 1= 6.6 km^2, Block 2= 4.8 km^2, Block 3= 3.0 km^2, Block 4= 5.8 km^2, Block 5= 7.8 km^2 and the size of the fallowland included in the study was 0.60 km^2. The distance between consecutive transects varied depending on the vegetation cover. Block 1 consisted of tall *Pennisetum* grassland while Block 2 had the shorter type. Block 3 consisted of mixed grassland species that included *Harpachne schimperi, Panicum coloratum, Cyndon dactylon* and *Eragrostis tenuifolia*. Block 4 included shrubs with woodland dominated by *Acacia abyssinica* and Block 5 consisted of bushland interspaced with grassland.

Total count method based on silent detection was applied to estimate the population size as advocated by Norton-Griffiths (1978), Caughley and Sinclair (1994), Sutherland (1996), and Andanje and Ottichilo (1999). Direct observation technique is most appropriate for medium to large sized animals that live in relatively open habitats and on fairly flat terrain. Hence, in the present study, the most direct way to estimate the abundance of a biological population, total count method, was chosen as described by Burnham *et al*. (1980). To mitigate the problem of double counting, the counting blocks were designed based on natural and artificial boundaries, like small gorges and main roads which act as barriers. Four periods of total count were carried out during each wet and dry season and summarized into their mean total. Census was conducted from 07:00 to 10:00 hr in the morning and 16:00–18:00 hr in the late afternoon when the animals were most active and when visibility was good. Each count was completed within three hours a day.

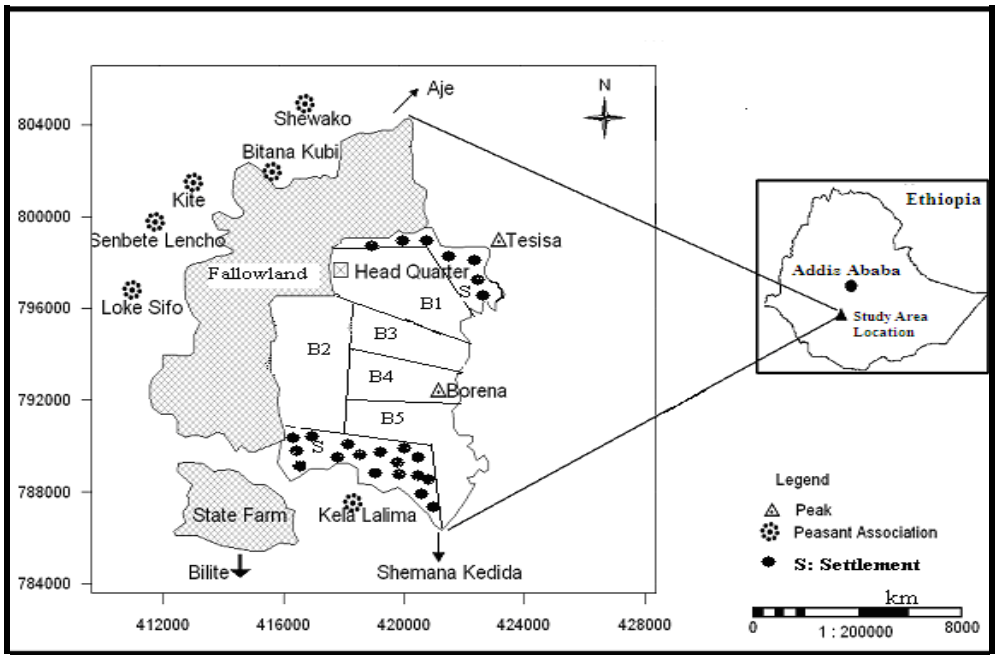

Fig. 2. Map showing division of the study area into five counting blocks.

During the census period, detailed observation of the entire herd was carried out and categorized as adult male, adult female and young, based on the methods of Bergerud (1971), Kitchen (1974), Lewis and Wilson (1979), Bowyer (1984) and Fischer and Linsenmair (1999). The respective sex and age categories were determined based on body size, presence or absence of horns, size of horns, and development of the preorbital gland. Male age was determined by estimating horn length in relation to ear length and number of annuli on horns (Brashares and Arcese, 2002).

During each census, the type of vegetation where the animals were observed and the food taken was recorded for each season (Martinka, 1969; Campton *et al*., 1988). The location of each herd and the vegetation type at each location was recorded. The method of Larson *et al*. (1978) and Norton-Griffiths (1978) was used to describe the dry and wet season distribution and utilization of the vegetation type. An animal was followed during active feeding time to observe the plant species that were consumed. For this, a focal animal was chosen and observed with the help of binoculars and/or naked eye depending on the distance of observation. The place where the animal was feeding was spotted, immediately after the animal moved away from the site, freshly cut plants were carefully examined; samples were collected, and brought to the Ethiopian National Herbarium, Addis Ababa University, for identification.

To record the activity pattern of oribi, the methods described by Leuthold (1971), Jarman and Jarman (1973), Mitchell (1977), Irby (1982), Brashares and Arcese (2002) were used. The activity of each oribi individual in each group under observation was recorded and ticked on the sheet at five-minute intervals. Alternate focal periods were used between morning (6:00–10:00 hrs), mid-day (10:00 to 2:00 hrs) and late afternoon (2:00–6:00 hrs) sessions. Animals were classified as 'inactive' (pooled sitting and standing without motion) or 'active' (walking, running, feeding and grooming). The major activities were recorded as feeding (whether the animal is grazing or browsing), walking (if the animals were walking at a steady pace), sitting/lying (head up or down in the open or in the shade), standing (if not engaged in any other activities) and other activities (watching, grooming, courting/mating, urinating, defecating, sniffing of genitalia, running, antagonism towards other oribi).

Data were analyzed using SPSS version 12. One way ANOVA was used to compare population sizes from different blocks and independent sample t-test was used to see significant differences in population between the wet and dry seasons.

RESULTS

The highest number of oribi counted was 57 during the dry season and the lowest number was 45 during the wet season. However, the difference was not statistically significant ($P>0.05$). There were no significant differences in the mean number of oribi observed during the wet and dry seasons in different study blocks (Fig. 3). The mean density of oribi in the study area was estimated to be 1.62 and 2.05 oribi per km^2 during wet and dry seasons, respectively. The highest density was obtained in Block 3 during the dry season (4.33/km^2) and the lowest in Block 4 during the wet season (0.78/ km^2). During the wet season, higher numbers of oribi were observed in Blocks 1 and 2 and in the fallowland than during the dry season count. More oribi was observed during the dry season in Blocks 3, 4 and 5 than the wet season. However, a significant difference was observed only in the case of Block 3 and Block 4 ($P<0.05$).

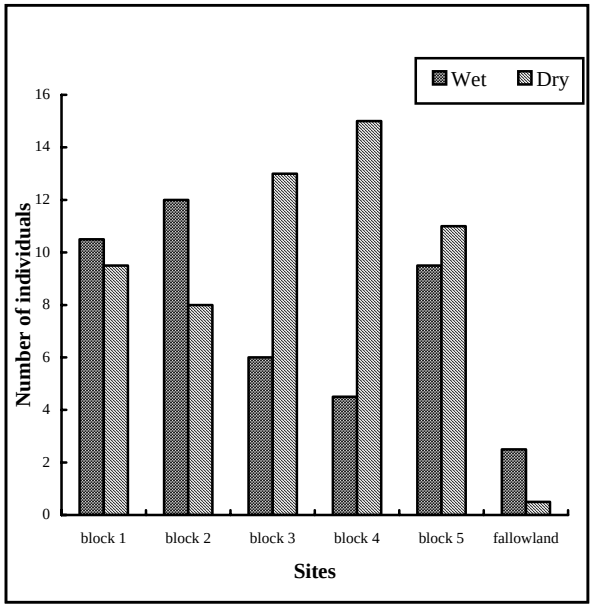

Fig. 3. Number of oribi recorded from different habitats during the wet and dry seasons.

Out of the 51 mean total individuals counted during both seasons, adult males comprised 41.2%; adult females were 51.7% and 7.1% were young. The sex ratio of adult males to adult females was 1.00:1.23 and 1.00:1.28 during the wet and dry seasons, respectively. In addition, the sex ratio of adult female to young was 1.00:0.16 and 1.00:0.12 during wet and dry seasons, respectively. There was no significant difference in the sex ratio observed during both seasons (P>0.05). On average, 92.9% of the total population was adults and only 7.1% constituted young (Fig. 4).

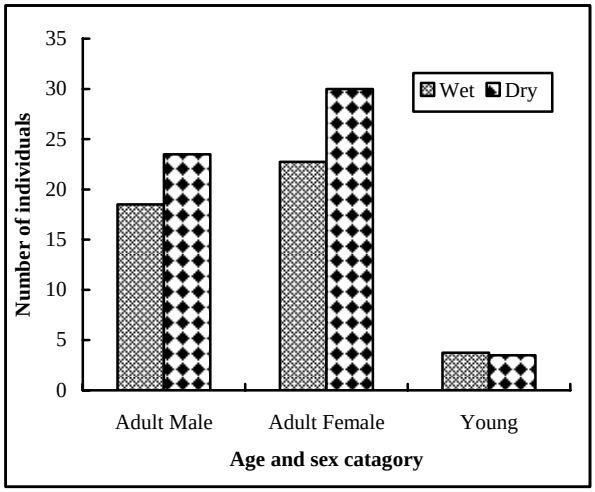

Fig. 4. Age and sex structure of oribi.

The group size ranged from 1–7 individuals. Oribi were commonly observed in groups of up to five individuals. They were often associated with Swayne's hartebeest and sometimes fed among domestic livestock for protection. Groups are territorial and are separated from each other. The highest range of group size was recorded during the wet season (1–7) with the mean group size of 3.2. However, the mean number of oribi groups observed during the wet season was 13. While the mean number of oribi groups observed was highest (21) during the dry season the range of group size was smallest (1–5), with the mean group size of 2.6. Individual groups varied in size from one to seven across the area, with a modal group size of two. There were no significant differences in the group size across blocks (P>0.05). The largest groups were found on the 'short' grasslands and the smallest within woodland and long grasses.

The percentage distribution of oribi for wet and dry seasons was almost similar all over the study area in all vegetation communities. Larger number of oribi was observed in all vegetation types during the dry season than the wet season, except the fallowland (P>0.05) (Fig. 5). The tendency of population distribution towards *Pennisetum* grassland type 1 increased during both wet and dry seasons *i.e.* 44.4% and 42.1%, respectively. While in *Pennisetum* grassland type 2 and mixed grassland, the mean distribution was 29.4% and 24.5% respectively. Such vegetation communities were utilized more during the dry season than the wet season. Comparably, very small number of oribi population (2.9%) was observed moving out of the study area into the fallowland during the late wet and early dry seasons.

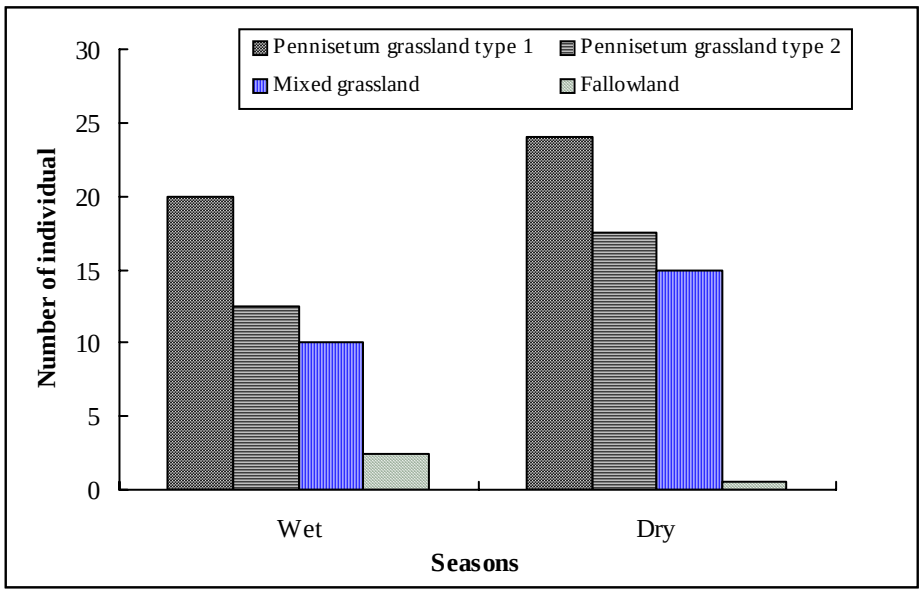

Fig. 5. Number of oribi population in different habitat types during the wet and dry season

Oribi favoured moist grassland on flat to gently sloping area with actively growing short grass for food adjacent to long grass which is required to provide cover from predators and shelter for the young. Oribi were observed selecting certain species and parts of grass. They leave when the grass becomes too long. They were often associated with Swayne's hartebeest and sometimes fed among domestic livestock. Oribi showed a high preference for foraging grasses in burnt areas during the dry season. They were observed to utilize post-burn green grasses.

From identification at the National Herbarium, AAU, twenty two plant species were identified as being eaten by oribi in Senkelle, among which 9 were the most preferred throughout the year. These were: *Themeda triandra* (Oat grass), *Hyparrhenia hirta* (thatch grass), *Pennisetum schimperi*, *Melinis repens*, *Cyndon dactylon* and *Acacia* species, including *Acacia abyssinica*, *A. clavigera*, *A. lahai* and *A. albida*. Oribi preferred mostly grass species throughout the year. Out of a total of 288 feeding behavioural observations, 256 were spent foraging on grass species. There was no seasonal difference in the percentage frequency of grass species consumption between the wet and dry seasons. *Themeda triandra* was the most preferred grass accounting for 59.8% while *Cyndon dactylon* comprised only 7% of the total grass intake (Fig. 6). These data were obtained by following 24 oribi individuals for about 1440 minutes (24 hours) during the wet and dry seasons.

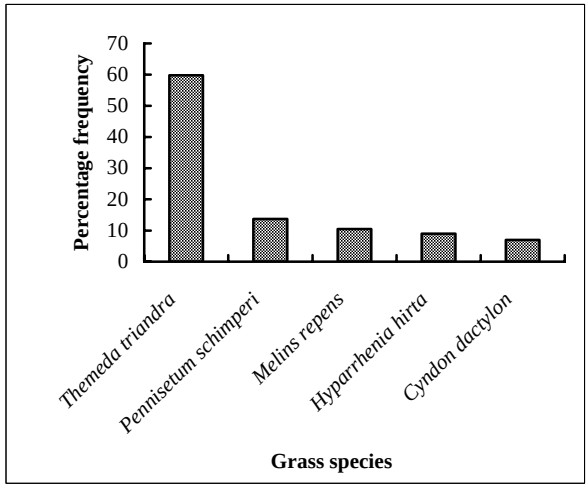

Fig. 6. Percentage of feeding observations on grass species.

The average proportion of animals engaged in each of the five activities for the whole day was: 1) feeding, 54.7%, 2) standing, 8.6%, 3) sitting/-lying, 19.9%, 4) walking, 8.6%, and 5) other activities, 8.3%. The annual mean proportion of daylight hours spent feeding was 54.7%. An equivalent amount of time was spent on standing or walking (8.6%), while the remaining time was spent on sitting or lying and other activities (Fig. 7).

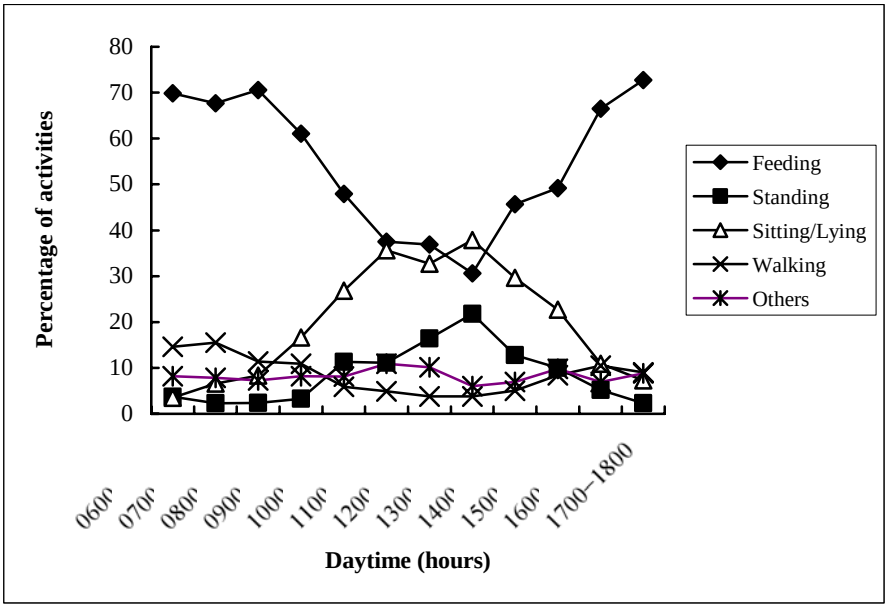

Fig. 7. Diurnal activity patterns of oribi.

DISCUSSION

In the total count of oribi population in the Senkelle Swayne's Hartebeest Sanctuary, no significant difference was observed between counts during the wet and dry seasons. However there was a slight increase during the late dry season. The reason for the difference may be due to the maximum growth of grass in relation to their small size that made detection more difficult. Mduma and Sinclair (1994) described oribi as occurring close to rocks during the dry season and in areas with long grass during the wet season. These are used for cover against predators. The significant association of oribi with larger resident ungulates such as Swayne's hartebeest and also livestock suggested that oribi were avoiding predators (Mduma and Sinclair, 1994).

The male to female sex ratio was female biased. In the Gorangoza National Park, Mozambique, an adult sex ratio of 1.00:1.40 male:female was registered (Estes, 1992). Possible reasons for an unequal sex ratio may be increased predation pressure on males, due to greater boldness or the emigration of subordinate males to less favourable habitats (Estes, 1974). Fire sweeps through long grasslands every dry season, leave little and sometimes no cover in oribi territories for concealment against predators (Estes, 1992). In addition, most of the time, the adult males are solitary and are exposed to danger (Smithers, 1983). Estes (1974) suggested that in most gregarious antelopes, adult sex ratios generally vary from 1.00:1.50 to 1.00:2.00 in favour of females. Polygyny and territoriality may co-occur when the sex ratio becomes skewed towards females because of the dispersion of females which allows males to defend more than one female while excluding other males (Brashares and Arcese, 2002). The average adult female to young ratio was 1.00:0.14. The low proportion of young may be due to concealment of oribi calves which are more susceptible to predators, particularly to common jackal. In addition, the grassland habitat may not be suitable for calves due to the ongoing encroachment of bush and the burning practices by the local community during the dry season.

A group of oribi usually monitors in all directions and is alarmed by any one of the group members when disturbed. Hannon and Martin (1992) described how both sexes of oribi could contribute indirectly to the protection of the group through increased vigilance. The oribi group was also alarmed by association with other herbivores such as hartebeest, domestic livestock and also some bird species like francolins when there is danger. Based on the result, the aggregation of large group of oribi population during the wet season in a limited area and splitting into smaller groups and dispersal to a wider area may be due to their selective feeding behaviour to get more preferable forage. Frey (2000) described this as typical of small-bodied antelopes which are selective feeders and must disperse widely to get better food. In the dwarf antelopes, the length of time food stays in the rumen is so low that they have to choose plants of high nutritive quality (Macdonald, 1984). Oribi were not observed drinking water during the study period. Lewis and Wilson (1979) confirmed that these animals live without drinking free water, getting their entire water requirement from the vegetation they eat.

The distribution of oribi over wider area of all vegetation communities might be in search of short palatable grasses due to limited foraging grass access in the dominant unpalatable tall *Pennisetum* grass species in the area. Oribi were distributed more during the dry season in *Pennisetum* grassland type 2 and mixed grassland communities than during the wet season because they could get more protection or hiding places from the disturbance of domestic livestock. They may also get more palatable soft grass. Owen-Smith (1982) reported that during the dry season, there is an increase in feeding time with decreasing food availability for several African grazing animals. Feeding in woody cover helps them to avoid the heat and minimize water loss. Generally, larger numbers of oribi were observed during the dry season than the wet season in all vegetation communities. However, in the fallow-land, highest number was observed during the wet season compared to the dry season. Oribi move out of the Sanctuary to the fallowland following the movement of Swayne's hartebeest. This is because local people and their livestock migrate from the area (Berhanu Gebre and Solomon Yirga, 2004), and also due to the appearance of bruchid larvae on the large grasses of *Pennisetum* which may bite and suck blood (Lamprey *et al*., 1974).

Time devoted by oribi to feeding was at a maximum during the dry season. It then gradually decreased during the late wet season. An increase in feeding time with decreasing food availability during the dry season has been

reported for several African grazers (Owen-Smith, 1982). During the present study, the mean proportion of diurnal time spent feeding by oribi at Senkelle ranged from a minimum during the wet season to a maximum in the dry season. Lying/sitting showed a similar pattern, although variation was less. Walking and standing activities showed maximum values recorded during the dry season and minimum values during the late wet season. The reason is probably due to better forage availability, requiring less movement in search of suitable pastures. The levels of other activities were at their maximum during the early wet season. The morning and evening activity peaks were most obvious during the dry season, with most animals remaining inactive during the hottest hours of the day. As the wet season progressed, feeding and other activities continued for longer period and, by the end of the wet season, even at mid-day, more than 30% of oribi were still active. Sheltering behaviour in response to high temperature was most conspicuous during the late dry and early wet seasons. At Senkelle, oribi make significant use of shades only in the hottest months/periods and only during the warmest hours of the day. Food availability, weather condition, nutritive demand and protection from predation may be the determining factors for a slight variation in the wet and dry season's activity patterns (Delany and Happold, 1979; Roberts and Dunbar, 1991).

According to the local people, oribi were much more common in the past in the Senkele Plains. However, the present study indicated that the population is very low in number. It is very important to establish effective protection and management of oribi population within its range. The need to protect the oribi population and the associated hartebeest demands great effort. The local community and concerned bodies in the Sanctuary should take immediate conservation measures to save the population. The Sanctuary area should be protected from overgrazing by domestic livestock. It is important to improve both the quality and quantity of forage available within the Sanctuary. This could be achieved by adopting a more effective vegetation management programme based on controlled burning and selective ploughing of the natural grasslands within the Sanctuary. Both the burning and ploughing programmes should be controlled and monitored by the Sanctuary authorities. The experience and vested interests of pastoral communities is crucial for the implementation of such vegetation management programme. Protecting the Sanctuary from any illegal activity by regular patrolling is crucial. Such tourist potential Sanctuary can be expanded back towards its original size/shape if all concerned governmental bodies and stake holders pay more attention to community based programmes. Unless immediate and effective conservation measures are taken, the Senkele Oribi might not survive long.

ACKNOWLEDGEMENTS

We would like to thank Addis Ababa University for the financial support and the Ethiopian Wildlife Conservation and Protection Authority for the permit. We are also grateful to the local people and the staff of the Senkelle Swayne's Hartebeest Sanctuary. We also appreciate the help provided by Melaku Wondafrash, The National Herbarium, Addis Ababa University.

REFERENCES

1. Andanje, S.A. and Ottichilo, W.K. (1999). Population status and feeding habits of the translocated subpopulation of Hunter's antelope or hirola (*Beatragus hunteri*, Scalter 1889) in Tsavo East National Park, Kenya. *Afr. J. Ecol.* **37**:38–48.
2. Baldellov, M. and Henzi, S.P. (1992). Vigilance, predator detection and the presence of supernumerary males in vervet monkey troops. *Anim. Behav.* **43**:451–461.
3. Berhanu Gebre and Solomon Yirga (2004). Seasonal home range of Swayne's Hartebeest (*Alcelaphus buselaphus swaynei*) in Senkele Swayne's Hartebeest Sanctuary. *SINET: Ethiop. J. Sci.* **27**:121–126.
4. Bergerud, A.T. (1971). The population dynamics of Newfoundland caribou. *Wildl. Monogr.* **25**:1–55.
5. Bowyer, R.T. (1984). Sexual segregation in southern Mule Deer. *J. Mammal.* **65**(3):410–417.
6. Brashares, J.S. and Arcese, P. (2002). Role of forage, habitat and predation in the behavioural plasticity of a small African antelope. *J. Anim. Ecol.* **71**(4):626– 638.
7. Burnham, K.P., Anderson, D.R. and Lake, J.L. (1980). Estimation of density from line transects sampling of biological population. *Wildl. Monogr.* **72**:1–202.
8. Campton, B.B., Mackie, R.J. and Dusek, G.L. (1988). Factors influencing distribution of white-tailed deer. *J. Wildl. Manage.* **52**(3):544–548.
9. Caughley, G. and Sinclair, A.R.E. (1994). *Wildlife Ecology and Management*. Blackwell Science, London, 68 pp.

10. Delany, M.J. and Happold, D.C.D. (1979). *Ecology of African mammals*. Longman Inc., New York, 434 pp.

11. EWTOWG (2001). *Ourebia ourebi*. The status of Oribi antelope in Kwazulu-Natal-the oribi-working group. Endangered Wildlife Trust Oribi Working Group (EWTOWG). Accessed on December 10, 2005 at http://www.Kzn-wildlife.com/oribi-update 05.htm.

12. Estes, R.D. (1974). Social organization of the African Bovidae. **In**: *The Behaviour of Ungulates and its Relation to Management*, pp. 166–205, (Geiest, V. and Walter, F., eds). IUCN Publ. Number 24, Morgse, Switzerland.

13. Estes, R.D. (1992). *The Behaviour Guide to African Mammals*. University of California Press, Los Angeles, pp. 47–52.

14. Fischer, F. and Linsenmair, K.E. (1999). The territorial system of the kob antelope. (*Kobus kob kob*) in Comoe' National Park, Cote d'Ivoire. *Afr. J. Ecol*. **37**:386–399.

15. Frey, D. (2000). "*Ourebia ourebi*" (on line), Animal Diversity Web. Accessed on December 17, 2005 at http://www.animaldiversity. ummz.-umich.edu/site/accounts/information/*Ourebia-ourebi*.htm.

16. Girma Timer (2003). Technical report on the biodiversity of Mazie National Park, Arba Minch, Unpublished document.

17. Gordon, I.J. and Illus, A.W. (1996). The nutritional ecology of African ruminants: a reinterpretation. *J. Anim. Ecol*. **65**:18–28.

18. Hayman, R.W. (1980). *A Field Guide to the Mammals of Africa Including Madagascar*. William Collins Sons and Co Ltd, London, 54 pp.

19. Hannon, S.J. and Martin, K. (1992). Monogamy in willow ptarmigan: is male vigilance important for reproductive success and survival of females? *Anim. Behav*. **43**:747–757.

20. Hillman, J.C. (1993). *Ethiopia: Compendium of Wildlife Conservation Information*. Vol. l. The Wildlife Conservation Society, New York and Ethiopian Wildlife Conservation Department, Addis Ababa, 454 pp.

21. Hofmann, R.R. (1989). Evolution steps of ecophysiological adaptation and diversification of ruminants: a comparative view of their digestive systems. *Oecologia* **78**:443–457.

22. Irby, L.R. (1982). Diurnal activity and habitat use patterns in a population of Chanler's Mountain reedbuck in the Rift Valley of Kenya. *E. Afr. J. Eclo.* **20**:169–178.

23. IUCN (1998). *African Antelope Database 1998*. IUCN/SSC Antelope Specialist Group Report, International Union for Conservation of Nature and Natural resource (IUCN), Cambridge, pp. 290–295.

24. IUCN Red List (2004). Accessed on December 19, 2005 at http://www.redlist.org/.

25. Jarman, M.V. and Jarman, P.J. (1973). Daily activity of impala. *E. Afr. Wildl. J*. **11**:75–92.

26. Kingdon, J. (1997). *The Kingdon Field Guide to African Mammals*. Academic Press, London, pp. 1–464.

27. Kitchen, D.W. (1974). Social behaviour and ecology of the Pronghorn. *Wildl. Monogr*. **38**:1–96.

28. Larson, T.J., Rongstad, O.J. and Terbilocx, F.W. (1978). Movement and habitat use by white tailed deer in south-central Wisconsin. *J. Wildl. Manage*. **42**(1):113–117.

29. Lamprey, H.F., Halevy, G. and Makacha, S. (1974). Interactions between *Acacia*, bruchid seed beetles and large herbivores. *E. Afr. Wildl. J*. **12**:81–85.

30. Leuthold, W. (1971). Studies on the food habits of lesser kudu in Tsavo National Park, Kenya. *E. Afr. Wildl. J*. **9**:35–45.

31. Lewis, J.G. and Wilson, R.T. (1979). The ecology of Swayne's Hartebeest. *Biol. Conserv*. **15**:1–12.

32. Macdonald, D. (1984). *The Encyclopedia of Mammals:* 2. Allen George and Unwin. London and Sydney, pp. 89–106.

33. Martinka, C.J. (1969). Population ecology of summer resident elk in Jackson Hole, Wyoming. *J. Wildl. Manage*. **33**(3):465–481.

34. Mduma, S.A.R. and Sinclair, A.R.E. (1994). The function of habitat selection by oribi in Serengeti, Tanzania. *Afr. J. Ecol*. **32**:16–29.

35. Messana, G.M. and Bereket Netsereab (1994). The Senkele Swayne's Hartebeest Sanctuary management plan. Ethiopian Wildlife Conservation Department, Addis Ababa, Ethiopia, pp. 13–17.

36. Mitchell, A.W. (1977). Preliminary observation on the daytime activity pattern of lesser Kudu in Tsavo National Park, Kenya. *E. Afr. Wildl. J*. **15**:199–206.

37. Norton-Griffith, M. (1978). *Counting Animals*, 2nd ed., Africa Wildlife Leadership, Nairobi, pp. 89–91.

38. Nowak, R.M. (1991). *Walker's Mammals of the World*. The Johns Hopkins Press Ltd., London, 1455 pp.

39. Owen-Smith, N. (1982). Factors influencing the consumption of plant products by large herbivores. **In**: *Ecology of Tropical Savannas*, pp. 359–404, (Huntley, B.J. and Walker, B.H., eds). Springer-Verlag, Berlin.

40. Roberts, S.C. and Dunbar, R.I.M. (1991). Climate influences on the behavioural ecology of Chanler's mountain reedbuck in Kenya. *Afr. J. Ecol*. **29**:316–329.

41. Rowe-Rowe, D.T., Everett. P.S. and Perrin, M.R. (1992). Group size of Oribi in different habitats. *S. Afr. J. Zool*. **27**(3):140–143.

42. Smithers, R.H.N. (1983). *The Mammals of the Southern Africa Sub-region*. University of Pretoria, Pretoria, pp. 186–189.

43. Stuart, C.T. and Stuart, M.D. (1997). *Field guide to the Larger Mammals of Africa.* Struik Publishers, Cape Town, pp. 68–76.

44. Sutherland, W.J. (1996). *Ecological Census Technique.* A handbook Cambridge University Press, Cambridge, 336 pp.

45. SWAO (1999). Climate data for Siraro Woreda, Seraro Woreda Agricultural Office (SWAO), Unpublished document.

46. Thirgood, S.J., Robertsons, A., Jarvios, A.M., Belbin, S.V., Robertson, D. and Nefdt, R.J. (1992). Mating system and ecology of black lechwe (*Kobus: Bovidae*) in Zambia. *J. Zool. Lond.* **228**:155–172.

47. Walker, E.P. (1975). *Mammals of the World,* 3rd ed., Vol. II. The Johns Hopkins University Press Ltd., London, pp. 178–184.

48. Webkenya Development (2003). Wildlife in all Kenya Parks "Oribi" [*Ourebia ourebi*) (on-line), webkenya. Accessed December 12, 2005 at http://www.webkenya.com/eng/ safari/-wildlife.htm/.

49. Yalden, D.W., Largen, M.J. and Kock, D. (1984). Catalogue of the mammals of Ethiopia. 5. Artiodactyla. *Moni. Zool. Ital. (NS). Suppl*. **4**:67–221.