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Sex Structure and Group Size of Oribi (Ourebia ourebi) in Maze National Park, Ethiopia

Wondimagegnehu Tekalign[1]* Afework Bekele[2]
1.Department of Biology, College of Natural and Computational Sciences, Wolaita Sodo University, PO Box 138, Wolaita Sodo, Ethiopia
2.Department of Zoological Sciences, Addis Ababa University, Addis Ababa, Ethiopia

Abstract
Studies on sex structure and group size of oribi (*Ourebia ourebi)* were carried out in the newly established Maze National Park, Southern Nations Nationalities and People's Regional State, Ethiopia, during the wet and dry seasons from October 2009 to February 2012. A total count method was employed to determine the sex and age structure based on silent detection in an area of 220 km^2. The area was divided into eight counting blocks based on natural and artificial boundaries. The ratio of adult males to adult females ranged from 1:1.30 to 1:1.48 and 1:1.25 to 1:1.33 during wet and dry seasons of the study years, respectively. There were more adult females than adult males and young. Group size varied from lone individual to the upper limit of 13 and 19 during the wet and dry seasons, respectively. The largest group was found in the short grasslands and the smallest within woodland and long grasses. Many of the individuals were observed in pairs with a large number of adult male and female couples. Proper and urgent measures should be taken to limit illegal activities to conserve the wildlife of the area.
Keywords: Group size, Maze National Park, Oribi, Sex structure

INTRODUCTION

Oribi (*Ourebia ourebi,* Zimmermann, 1783) is the largest and one of the members of the East African dwarf antelope in the family Bovidae (Stuart and Stuart, 1997; Plowman, 2003). They grow to around 93–111 cm in length; ranges with shoulder height from 50–69 cm and they weigh 12–22 kg (Smithers, 1983; Kingdon, 1997). The hair is fine and silky, and the general body colour is light reddish to reddish brown above, with white on the underparts, chin and the underside of the tail (Estes, 1992). In East Africa and probably other areas close to the equator, the difference in coat between wet and dry seasons is not so marked. However, in other areas, there is a marked coat difference between the summer coat, which is shorter and smoother, and the winter coat which tends to be thicker and shaggier (Skinner and Chimimba, 2007). It possesses a distinctive white line of fur over its eye and beneath the ears there is a bare hairless glandular area, which is usually dark and conspicuous (Nowak, 1991; Frey, 2000).

Males have distinctively large glands beneath the eyes and females are slightly larger and heavier than males (Smithers, 1983; Grey-Ross *et al*., 2009). In East Africa, females are approximately 2 kg heavier than males (Skinner and Chimimba, 2007). The females usually bear a dark crown patch. Both sexes have tufts of long hair on the knees. They have a short, bushy, black tail above and white below (Smithers, 1983; Nowak, 1991; Encyclopedia Britannica, 2010). It has very distinct preorbital glands in males that fill most of the space between the eye and mouth and appear as a vertical fold before the front corner of the eye (Hayman, 1980; Frey, 2000). This is not used and possibly undeveloped in females. Females have four mammae (Nowak, 1991, Estes, 1992). Horns on males rise straight up from the top of the head, sharp, and annulated, grow to 19 cm and angle slightly forward to the anterior or tips (Skinner and Chimimba, 2007).

They live predominantly in pairs, on their own or in small groups of one male with two or more females, to small family groups of up to 12 adults (Everett *et al*., 1991; Coverdale *et al*., 2006; Marchant *et al*., 2007). Flexibility, varying from monogamy in South Africa to polygyny in East Africa has been documented in the mating system of the *Ourebia ourebi* by several authors. Oribi breed throughout the year with peak season in October and November. Young are born most of the time shortly before or during the rainy season in the tropics.

During the breeding season, August to December, the male mates with all the females who share his territory. Usually only one or two females occur in each territory. Following a gestation period of 6 to 7 months, a single offspring is born. For the first 8 to 10 weeks, the female hides her young in thick grass, where it will lie motionless if approached or even within the exposed root system of trees and remain hidden for three or four days without moving except during suckling. The mother returns periodically to suckle her offspring. Thereafter, the offspring begins to follow the mother but still seeks shelter from time to time. Growth is extremely rapid and near adult height is achieved in about three months. Young are weaned at about four to five months. Females may reach sexual maturity and conceive at 10 months, whilst males become sexually active by 14 months. In captivity, they have a lifespan of up to 14 years (Kingdon, 1982; Everett *et al*., 1991; Webkenya Development, 2003; Coverdale *et al*., 2006; Marchant *et al*., 2007; Hill, 2009). The objective of the present study is to identify and determine the sex structure and group size of oribi, which is the flag species of the Maze National Park, Sothern Ethiopia.

MATERIALS AND METHODS

The study area

The study was carried out in Maze National Park (MNP), which is located in Southern Nations Nationalities and Peoples Regional State, Ethiopia. The name of the Park is derived after the largest river called Maze River, which rises from the southern parts of the surrounding highlands and passes through the Park in the north direction, and finally drains to Omo River. The Park was established by the regional state in 2005. It is about 485 km southwest of the capital Addis Ababa via Wolaita Sodo-Sawla road. It is situated between x=286484.25 and y=671467.31 latitude and x=300963.36 and 696852.69 longitude. The Park is surrounded by chains of mountains and bounded to the north by Quecha Wereda, to the northwest by Omo River and Gofa Wereda, to the west by Zalla Wereda, to the east by Deramalo Wereda and to the south by Kemba Wereda. The altitude ranges from 998 to 1200 m above sea level and covers an area of 220 km^2 (Fig. 1).

Rainfall at Maze (Morka area), although continuous has a moderately bimodal pattern, typical of semi-arid agro-ecological zone of Ethiopia. The annual rainfall varies between 843.8 mm and 1375.3 mm. Maze area experiences a long rainy season that extends from April to October with the highest peak towards the end. The dry season is from November to February (ENMA 1995-2009 Meteorological data). The lowest temperature recorded during the wet season was 17.6°C in June and the highest during the dry season 33.9°C in February.

Methods

During the census period, detailed observation of the entire herd was carried out and categorized as adult male and female, young and unidentified sex following the methods of Lewis and Wilson (1979), Hillman (1986) and Kingdon (1997). Unidentified sexes are the animals that could not be identified due to their far distance observation or swift flee due to their shy and vigilant behaviour during the census period. 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. The age of the male was determined by estimating horn length in relation to ear length and number of annuli on horns based on the method of Brashares and Arcese (2002). During total count, the size of each group of oribi was recorded before further subdividing into the respective sex and age categories. When the distance between individuals was less than 50 m, they were considered as members of the same group, following the method of Lewis and Wilson (1979), and Borkowski and Furubayshi (1998).

The sex and age structure of oribi during different seasons was compared by using descriptive statistics (percentage frequency) and Chi-Square tests. In addition, the variation in sex between groups of individuals at different seasons and blocks was also analyzed using one-way ANOVA test and confirmed through multiple comparisons with Tukey-test. The number and size of group of oribi in various blocks and seasons was analyzed using descriptive statistics and one-way ANOVA test.

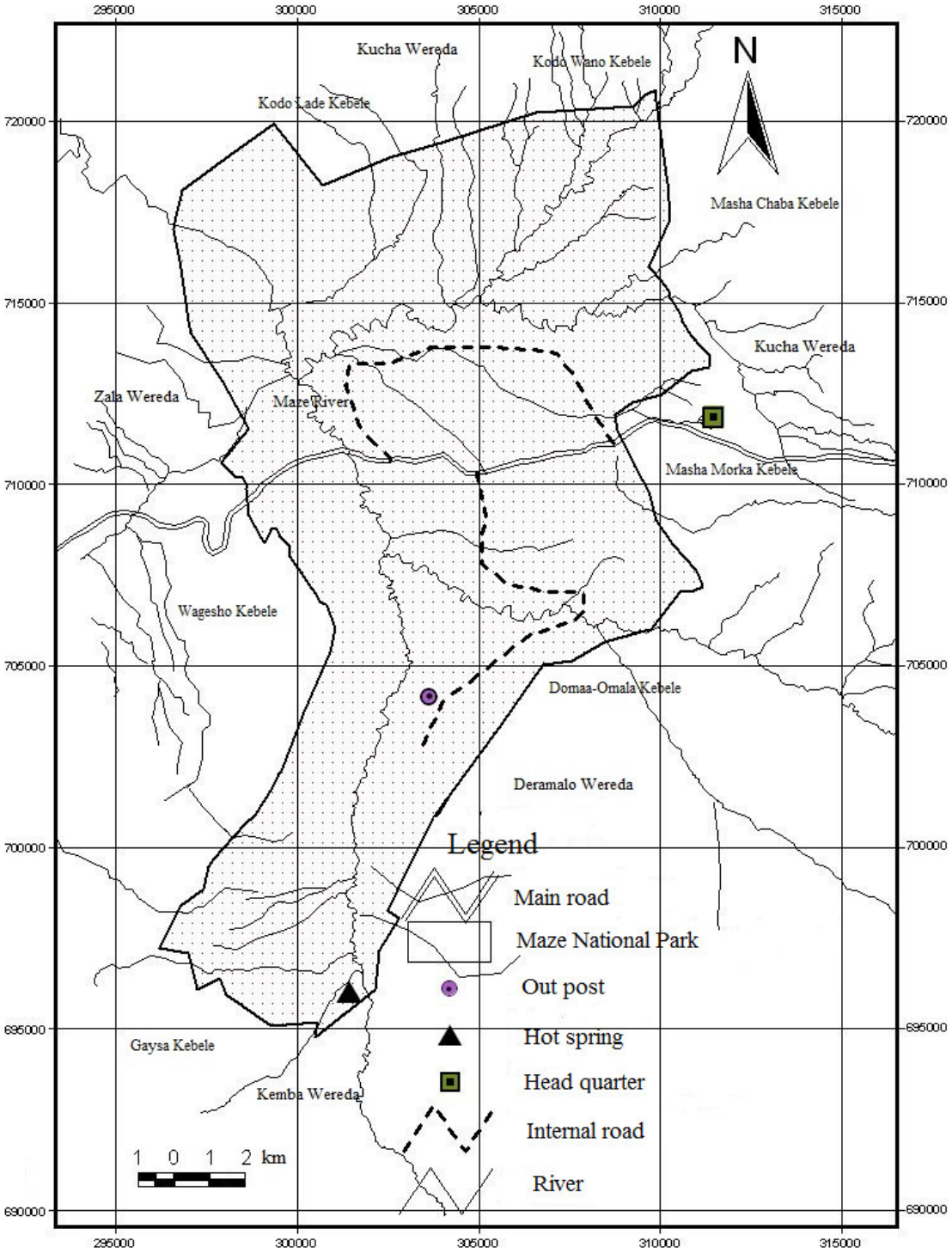

Fig 1 Map of Maze National Park

RESULT AND DISCUSSIONS

The sex and age structure of oribi in MNP showed that adult males comprised 32.49% (wet season) and 35.80% (dry season) ($\chi2=27.059$, df=1, $p<0.05$), adult females 48.13% (wet season) and 44.85% (dry season) ($\chi2=13.603$, df=1, $p<0.05$), young 12.70% (wet season) and 15.59% (dry season) ($\chi2=17.467$, df=1, $p<0.05$), and unidentified sex oribi individuals comprised 6.68% (wet season) and 3.76% (dry season) ($\chi2=1.360$, df=1, $p> 0.05$) during the first year (Fig. 2).

However, during the second year adult males comprised 33.86% (wet season) and 36.12% (dry season) ($\chi2=20.161$, df=1, $p<0.05$), adult females 44.06% (wet season) and 48.07% (dry season) ($\chi2=20.309$, df=1,

p<0.05), young 15.00% (wet season) and 11.16% (dry season) ($\chi 2$=0.88, df=1, p>0.05), and unidentified sex individuals comprised 7.08% (wet season) and 4.65% (dry season) ($\chi 2$=0.794, df=1, p> 0.05) (Fig. 3).

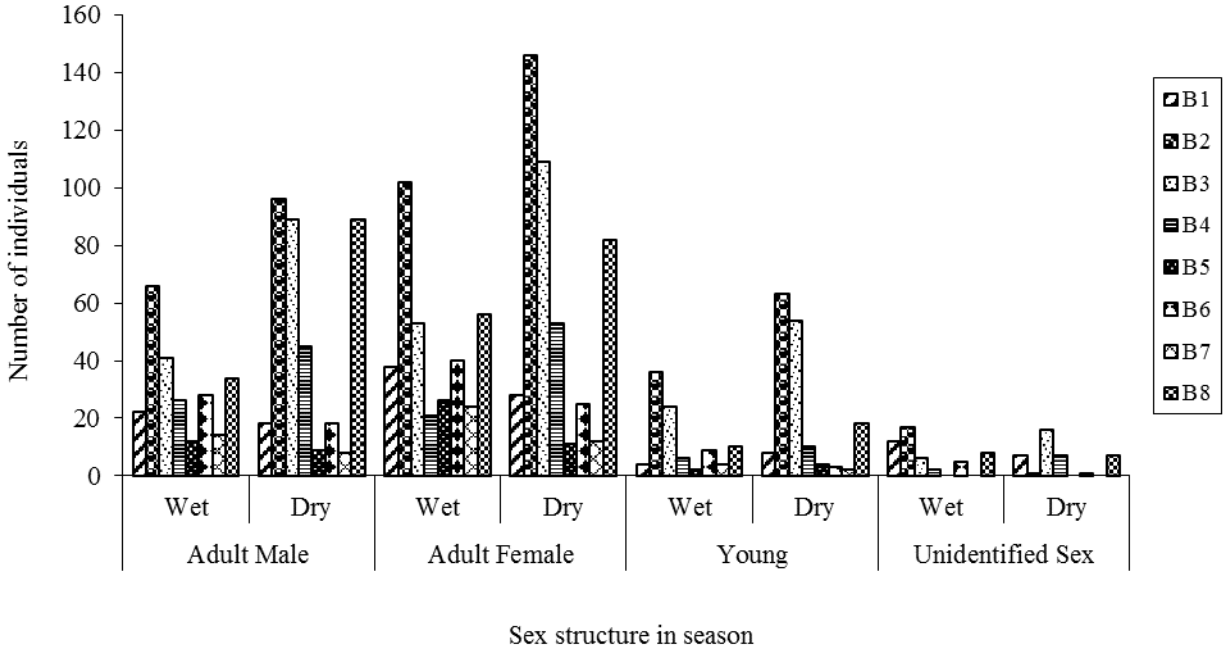

Fig 2 Sex structure of oribi in different blocks during the wet and dry seasons for Year I (B= Block)

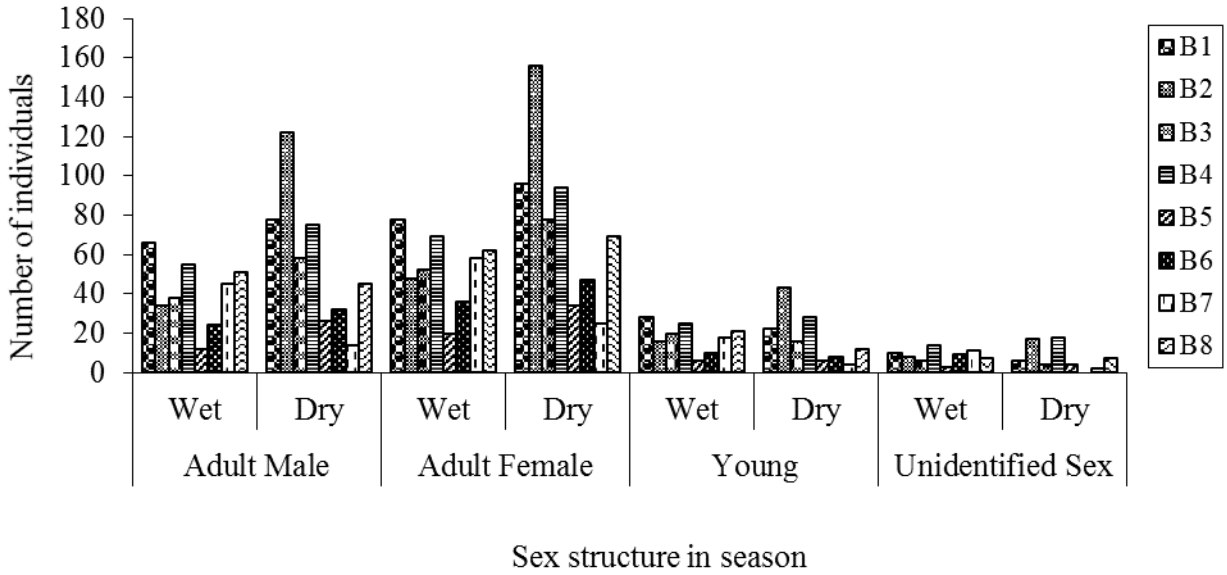

Fig 3 Sex structure of oribi in different blocks during the wet and dry seasons for Year II (B= Block)

The result shows that there was a seasonal significant difference in sex and age structure in adult males, females and young whereas; there was no significant difference in the unidentified sexes during the first year. This means the wet season adult male, adult female and young; sex and age structures of oribi were significantly different compared to that of the dry season. While the age structure of the unidentified sex of the wet season was not significantly different from that of the dry season. During the second year, there was a significant different between seasons in adult males and females but not for young and unidentified sexes. On average, 80.64% (n=1441) of the total individuals were adults, 14.38% (n=257) constituted young and the rest 4.98% (n=89) were unidentified sex during the first year census. However, during the second year census the adult individuals comprised 81.46% (n=1797), 12.83% (n=283) young and 5.71% (n=126) unidentified sex. Based on the one-way ANOVA test, at Year I there was a statistically significant difference in seasonal variation of sexes between groups of individuals ($F_{3\ 1783}$ = 4.163, p=0.006). In addition there was also a significant difference in sex between groups of individuals in blocks ($F_{3\ 1783}$ = 7.283, p=0.000). Multiple comparisons with Tukey-test

confirms that, there was a significant difference in blocks between adult male with young (p=0.000), and adult female with young (p=0.005). But, there was no significant difference in blocks between adult male with adult female (p=0.403) and unidentified sex (p=0.072). However, there was no significant seasonal variation between adult male with adult female (p=0.406) and young (p=0.898), and adult female with young (p=0.236) and unidentified sex (p=0.100).

During the second year, there was a significant difference between sexes at different seasons ($F_{3\ 1783}$ = 4.862, p=0.002), whereas there was no significant sex difference between blocks ($F_{3\ 1783}$ = 0.742, p=0.527). Multiple comparisons with Tukey-test shows that there was no significant difference in blocks between adult male with adult female (p=0.805), young (p=0.995) and unidentified sex (p=0.654). There was no significant difference in season between adult male with adult female (p=0.996) and unidentified sex (p=0.055), and young with unidentified sex (p=0.937).

The ratio of adult male to adult female and young to adult female was 1:1.48 and 1: 3.79 during the wet season and 1:1.25 and 1:2.88 during the dry season, respectively for Year I, while for Year II, the ratio of adult male to adult female and young to adult female was 1:1.30 and 1:2.94, and 1:1.33 and 1:4.31 during both wet and dry seasons, respectively (Table 1). During the first year, the sex ratio was significantly different in adult males compared to adult females in both wet ($\chi2$=22.701, df=1, p<0.05) and dry ($\chi2$=10.544, df=1, p<0.05) seasons. Besides the ratio between young and adult females was significantly different during both wet ($\chi2$=154.341, df=1, p<0.05) and dry ($\chi2$=147.159, df=1, p<0.05) seasons. The ratio between young and adult was also significantly different during both wet ($\chi2$=369.719, df=1, p<0.05) and dry ($\chi2$=456.976, df=1, p<0.05) seasons. The result shows that the ratio was inclined significantly to adult females compared to adult males and young in the study area.

Table 1 Sex and age structure ratio of oribi during Year I and Year II in MNP

Year	Seasons	Sex and age structure ratio		
		AM: AF	Young: AF	Young: Adult
Year I	Wet-I	1:1.48	1:3.79	1:6.35
	Dry-I	1:1.25	1:2.88	1:5.17
Year II	Wet-II	1:1.30	1:2.94	1:5.19
	Dry-II	1:1.33	1:4.31	1:7.55

During the second year, the sex ratio was also significantly different in adult males compared to adult females in both wet ($\chi2$=12.840, df=1, p<0.05) and dry ($\chi2$=21.164, df=1, p<0.001) seasons and the ratio between young and adult females was also significantly different in both wet ($\chi2$=137.286, df=1, p<0.05) and dry ($\chi2$=286.721, df=1, p<0.05) seasons. During both wet ($\chi2$=408.987, df=1, p<0.05) and dry ($\chi2$=697.054, df=1, p<0.05) seasons, the young and adult ratio was also significantly different. This also shows that the existence of more adult females compared to adult males and young in the study area. When the sexes and age of the two years were compared at 95% confidence interval by 2-tailed significance test, adult males (p=0.001), adult females (p=0.024) and young (p=0.002) of wet II season were greater and significantly different compared to that of the wet I season (Table 2).

Table 2 The mean total number of oribi based on sex and age structure during seasons for the two years

Season	Adult male	Adult female	Young	Unidentified sex	Total
Wet-I	243	360	95	50	748
Wet-II	325	423	144	68	960
Dry-I	372	466	162	39	1039
Dry-II	450	599	139	58	1246

In addition, adult males (p=0.007) and adult females (p=0.000) of the dry II season was greater and significantly different compared to the dry I season. While, the young (p=0.185) during the dry II season was slightly smaller and not significantly different compared to the dry I. Adult males (p=0.000) and adult females (p=0.000) of Year II were greater and significantly different than that of the Year I. However, the young (0.263) during Year II although slightly high it was not significantly different compared to the Year I.

During the two years census, a total of 1599 groups of oribi was observed in the study area, of which 734 was during wet and 865 during the dry seasons. The variation in group size was from solitary individuals to maximum group size of 13 and 19 during the wet and dry seasons, respectively. The result shows that the highest range of group size (1-19) was recorded during the dry season with the mean group of 45.53 ± 9.90 and the difference among the number of oribi groups within the group sizes was also significant (t=4.599, df=18, p<0.05) (Fig. 4). The wet season range of group size (1-13) was lower than the dry with the mean group of 56.46 ± 18.13. There was a statistical significant difference among the number of groups within the group sizes (t=3.115, df=12, p<0.05) (Fig. 5).

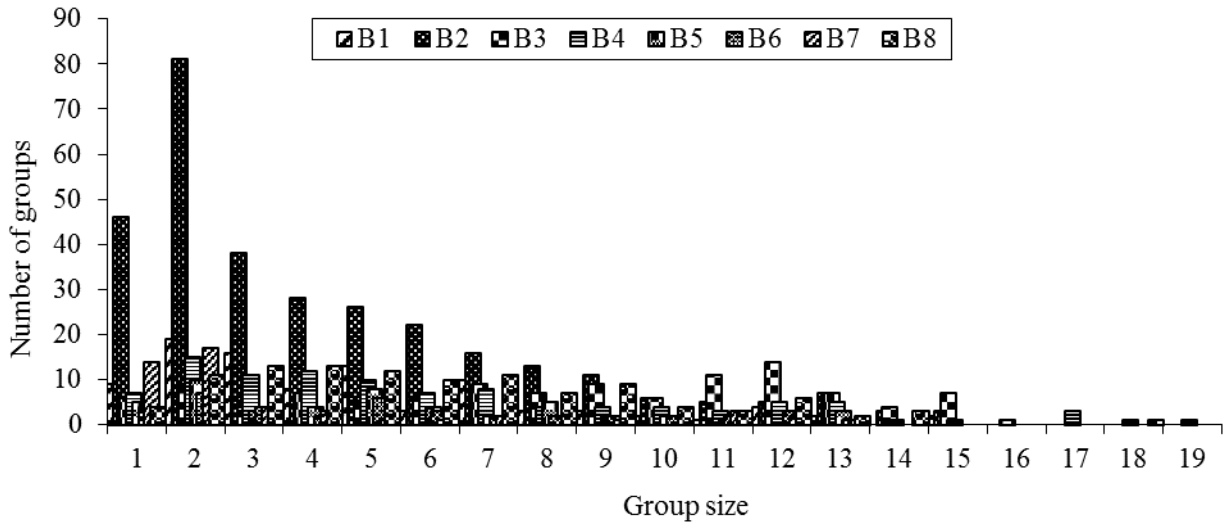

Fig 4 Group size of oribi during the dry season (B= Block)

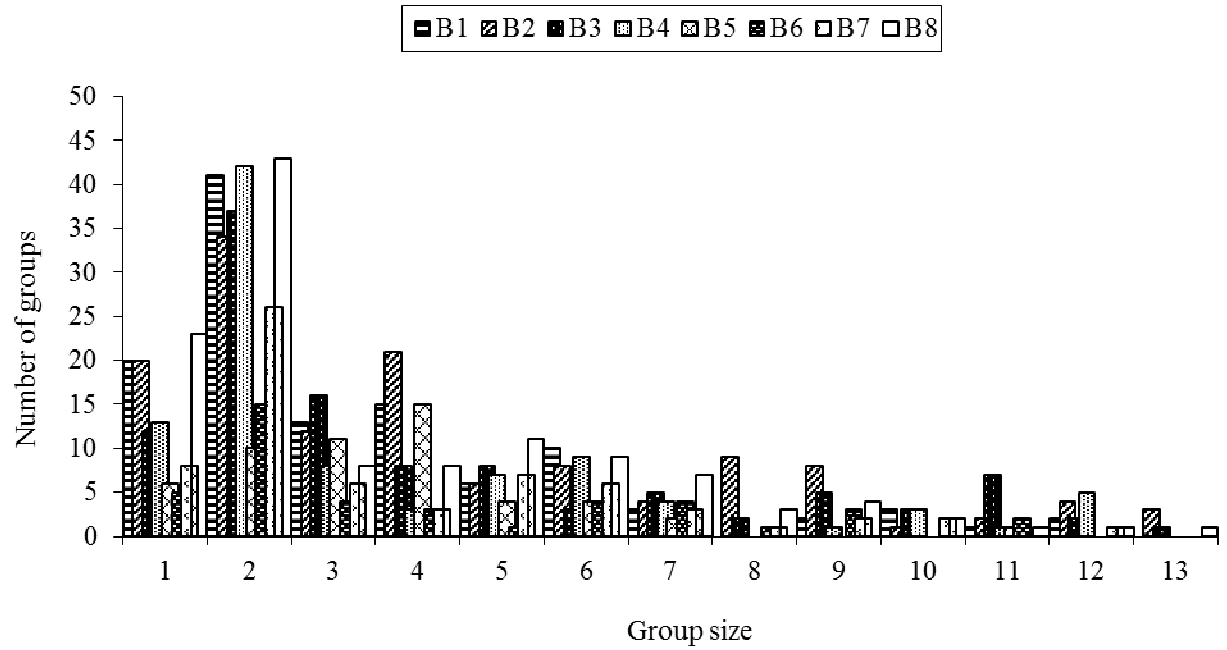

Fig 5 Group size of oribi during the wet season (B= Block)

Groups of oribi were territorial in the study area and were separated from each other. The largest groups were found on the short grasslands and the smallest within woodland and long grasses. More percentage of the grouped individuals was observed in groups of pair with a large number of adult male and adult female couples (33.79%, n=248) during the wet season compared to other group assembly observed during the study period. The least percentage of oribi group observed during the dry season in group sizes of 16 and 19 with similar values (0.12%, n=1) and during the wet season in group size 13 (0.68%, n=5). Among blocks, the largest number of groups was recorded at Block 2 both during the dry (35.84%, n=310) and wet (17.98%, n=132) seasons while the least number of oribi groups was recorded at Block 6 both during the dry (4.62%, n=40) and wet (5.72%, n=42) seasons (Table 3). ANOVA test indicated that there was a significant difference among group size in blocks during wet and dry seasons ($F_{7\ 1591} = 9.956$, p=0.000). There was also a significant difference between group size in different blocks ($F_{7\ 1591} = 9.956$, p=0.000).

Table 3 Percentage of oribi groups along blocks and group size during wet and dry seasons

	Percentage of groups in seasons	
Blocks	Wet (n=381)	Dry (n=413)
Block 1	15.80%, n=116	10.98%, n=95
Block 2	17.98%, n=132	35.84%, n=310
Block 3	14.85%, n=109	12.95%, n=112
Block 4	13.08%, n=96	11.79%, n=102
Block 5	7.22%, n=53	5.67%, n=49
Block 6	5.72%, n=42	4.62%, n=40
Block 7	8.86%, n=65	5.55%, n=48
Block 8	16.49%, n=121	12.60, n=109
Group size		
1	14.58%, n=107	10.98%, n=95
2	33.79%, n=248	19.54%, n=169
3	10.63%, n=78	10.75%, n=93
4	10.35%, n=76	8.90%, n=77
5	6.81%, n=50	9.36%, n=81
6	7.22%, n=53	6.47%, n=56
7	4.36%, n=32	6.94%, n=60
8	2.18%, n=16	4.74%, n=41
9	3.41%, n=25	4.74%, n=41
10	1.91%, n=14	3.01%, n=26
11	2.04%, n=15	3.35%, n=29
12	2.04%, n=15	4.51%, n=39
13	0.68%, n=5	3.12%, n=27
14	_	1.27%, n=11
15	_	1.50%, n=13
16	_	0.12%, n=1
17	_	0.35%, n=3
18	_	0.23%, n=2
19	_	0.12%, n=1

The present investigation revealed that the adult male to female ratio was varied. The sex ratio was biased towards females in the area. This result may point out that if proper attention is given to the area, there will be a tendency of the population number to increase in the future. Study of oribi in Northern KwaZulu-Natal, South Africa indicates that the adult sex ratio was one male to 1.38 females (Adamczak and Dunbar, 2008). Goldspink *et al*. (2002) pointed out on the oribi population at the two study areas in Zambia that the male: female sex ratio (1:1.72 and 1:3.55) were biased towards females. According to Adamczak and Dunbar (2008), comparison of the sex ratio differences of oribi among the three geographical areas in Africa i.e. West Africa, East Africa and South Africa, was higher in East Africa. However, the sex ratio difference is low in the present study, compared to the study in Northern KwaZulu-Natal, South Africa. Seasonal variation between sexes has also been observed in other oribi populations (Brashares and Arcese, 2002) as well as other ungulates (e.g. kudu, *Tragelaphus strepsiceros*, and big horn sheep, *Ovis canadensis*). Mooring *et al.* (2003) explained that, this might be due to sex differences in nutritional requirements and predation risk. Kruger *et al*. (2005) stated that environmental conditions that affect nutritional stress in mothers can also have a profound influence on offspring sex ratios.

According to Smithers (1983), most of the time, adult males are solitary and are exposed to danger. Goldspink *et al*. (2002) also stated that as a sedentary species, oribi would be particularly vulnerable to predation and males may be more committed to the defense of the territorial boundaries. Fighting and competition for food and mating may possibly force bachelor male oribi to marginal habitat that are poor in food quality and also exposed them to predator attacks. Further study is important to describe the real causes of mortality in males and to identify the reasons for sex ratio variation in the MNP area. The actual rationale for the low proportion of new born oribi in the study area also is not well understood. However, one possible reason might be the presence of predators, such as jackals, hyaena, leopards and wild dogs, and uncontrolled wildfire activities by the locals exposing the young. A proper count of the young ones is difficult because of their concealing behavior. In some of the animals, it was difficult to distinguish their sexes due to their invisibility from distant, shyness to approach and the swift flee of the animals from the long grass cover when they were approached instantly during the census survey.

Oribi groups varied in size from one to 13 and 19 across both wet and dry seasons, respectively. The largest groups were found during the dry seasons at the shortest grasslands which hold palatable grasses,

especially across the recently burned areas with fresh grown grasses. However, the smallest was group mainly recorded at the longest grass during the wet season and bushland and riverine forests. These outcomes show that grouping might help animals to make them vigilant against the intruders. Jarman (1974) stated that ungulate species living in open habitats generally form larger groups than those in bushland or forests and the majority of the ungulate species are too large to be able to forage in the open habitats. At the same time, this will hide them from potential predators by active vigilance behaviour. In thick vegetation cover, a lone animal can easily hide itself from the intruders. Berihun Gebremedhin (2001) discussed that group size differences among ungulates shows differences in vegetation cover-loving species like bushbucks and reedbuck, and cover-avoiding herbivores such as gazelles. Durant *et al*. (1986) explained that the largest groups of Thomson's gazelles formed during the wet season and the number of individuals in a group declined during the dry season in the Serengeti Plains. However, the present study on oribi group in Maze National Park showed opposite to other studies. Food was ample during the wet seasons and fresh green grasses appeared due to the burning activities during dry seasons increasing the group size. Small groups merge into larger ones, apparently as protection against predation and other disturbances. However, as food became scarce due to livestock grazing and lack of rain, groups tended to break up.

During the present study, multi-male groups were occasionally recorded. Large number of adult male and female pair was recorded compared to other group congregation during the study period. Adamczak and Dunbar (2008) explained that the mean adult group size varied across Africa and was significantly larger in Eastern Africa than in Southern Africa. The predation pressure hypothesis predicts that female home range and group size are a function of predation pressure, and that oribi being an open-country species, should form large groups with small home ranges, where predation pressure is high (Brashares and Arcese, 2002). Brashares and Arcese (2002) in their study found no relationship between oribi group size and predation risk in a set of Ghanaian habitats, and concluded that resource density was the only factor influencing grouping patterns. According to their conclusion, variation in social organization among oribi subpopulations in Ghana reflected female responses to the availability and quality of food resources and male responses to the variable distribution and ranging behaviour of females. However, the typical anti-predator behaviour of oribi i.e. sinking to the ground and lying face down (Estes, 1992) would not seem to be especially suitable for a group-living species (Adamczak and Dunbar, 2008). Geffen *et al.* (1999) discussed that the principal advantages of gazelles living in groups are defense against predation and reduced vigilance, which in turn increases feeding efficiency. However, the disadvantages are higher visibility of individuals to predators and greater competition for resources. Effective conservation measures should be taken for sustainable survival of oribi in the future, mainly by controlling the serious impacts that had been observed during the study period, from adverse human activities and livestock abundance.

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REFERENCES

Adamczak, V. G. and Dunbar, R. I. M. (2008). Variation in the mating system of oribi and its ecological determinants. *Afr. J. Ecol*. 46: 197 – 206.

Berihun Gebremedhin (2001). Population status and some ecological aspects of Soemmerring's gazelle (*Gazella soemmeringi*) in Awash National Park and Alledeghi Wildlife Reserve, Ethiopia. M.Sc. Thesis, Addis Ababa University, 83pp.

Borkowski, J. and Furubayashi, K. (1998). Seasonal and diet variation in group size among Japanese Sika deer in different habitats. *J. Zool., Lond*. 245: 29-34.

Brashares, J. S. and Arcese, P. (2002). Role of forage, habitat and predation in the behavioral plasticity of a small African antelope. *J. Anim. Ecol*. 71(4):626- 638.

Coverdale, B., Daly, B., Friedmann Y., Lemmer, F., Marchant, A., McCann, K., Rushworth, I. and Wakelin, J. (2006). Oribi antelope (*Ourebia ourebi*) Population and Habitat Viability Assessment Workshop Report. Conservation Breeding Specialist Group (SSC /IUCN) / CBSG Southern Africa. Endangered Wildlife Trust, Johannesburg, 109pp.

Durant, S. M., Caro, T. M., Collins, D. A. and Fitzgibbon, C. D. (1986). Migration Patterns of Thomson's gazelle and Cheetahs on the Serengeti Plains. *Afr. J. Ecol.* 26: 17-33.

Encyclopaedia Britannica (2010). Oribi. Retrieved November 08, 2010, from Encyclopedia Britannica Online: http://www.britannica.com/EBchecked/ topic/432296/oribi

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

Everett, P. S., Perrin, M. R. and Rowe-Rowe, D. T. (1991). Responses by oribi to different range management practices in Natal. *S. Afr. J. Wild. Res*. 21: 114-118.

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

Geffen, H., Perevolotsky, A., Geffen, E. and Yom-Tov, Y. (1999). Use of space and social organization of female mountain gazelles (*Gazella gazella gazella*) in Ramat HaNadiv, Israel. *J. Zool., Lond*. 247: 113-119.

Goldspink, C. R., Holland, R. K., Sweet, G. and Stewart, L. (2002). A note on group sizes of oribi (*Ourebia ourebi*, Zimmermann, 1783) from two contrasting sites in Zambia, with and without predation. *Afr. J. Ecol*. 40: 372-378.

Grey-Ross, R., Downs, C. T. and Kirkman, K. (2009). Is use of translocation for the conservation of subpopulations of oribi *Ourebia ourebi* (Zimmermann) effective? A case study. *Afr. J. Ecol*. 47: 409–415.

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

Hill, A. (2009). A GIS based habitat suitability analysis of the oribi antelope in KwaZulu-Natal. Thesis submitted in fulfillment of the requirements for the degree of Master of Science at the University of KwaZulu-Natal, KwaZulu-Natal, 88pp.

Hillman, J. C. (1986). Bale Mountains National Park Management Plan. Report to Ethiopian Wildlife Conservation Organization (EWCO), Addis Ababa.

Jarman, P. J. (1974). The social organization of antelope in relation to their ecology. *Behaviour* 48: 215-268.

Kingdon, J. (1982). *East African Mammals*. *An Atlas of Evolution in Africa.* Volume III. Part C and D (Bovid). Academic Press, London, 395pp.

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

Kruger, O., Radford, A. N., Anderson, C. and Liversidge, R. (2005). Successful sons or superior daughters: sex-ratio variation in springbok. *Proc. R. Soc. Lond., B* 272: 375-381.

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

Marchant, A., Rushworth, I. and McCann, K. (2007). *KwaZulu-Natal (KZN) Oribi (Ourebia ourebi) Conservation Plan.* Oribi Working Group–Endangered Wildlife Trust, Johannesburg, 31pp.

Mooring, M. S., Fitzpatrick, T. A., Benjamin, J. E., Fraser, I. C., Nishihira, T. T., Reisig, D. D. and Rominger, E. M. (2003). Sexual segregation in desert bighorn sheep (*Ovis canadensis mexicana*). *Behaviour* 140: 183–207.

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

Plowman, A. (2003). Ecology and Conservation of Mini-antelope: Proceedings of an International Symposium on Duiker and Dwarf Antelope in Africa. Filander Verlag. pp. 59-118. Available at http://www.Antelopediversityandspecies conceptsJan2004.pdf. Accessed on August 31, 2010.

Skinner, J. D. and Chimimba, C. T. (2007). *The Mammals of Southern Africa Sub-region*. Cambridge University Press, Cambridge, 698pp.

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

Stuart, C. T. and Stuart, M. D. (1997). *Field Guide to the Large Mammals of Africa.* Struik Publishers, Cape Town, pp. 68-76.

Webkenya Development (2003). Wildlife in all Kenya Parks "Oribi" (*Ourebia ourebi*) (on- line), webkenya. Accessed on December 12, 2010 at http://www.webkenya.com /eng /safari/wildlife.htm/.