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## The Ecological and Behavioural Studies of Bohor Reedbuck in Jimma Airport Compound, Southwestern Ethiopia

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### ABSTRACT

The semi-ranched Bohor reedbuck *Redunca redunca* (Pallas 1767) population was studied in Jimma Airport Compound (JAC), southwestern Ethiopia, to assess the ecology, activity patterns, threats and the potential hazards they pose on the aviation services of the area. Total count method was employed to determine the population size. Scan sampling, from 2-10 min interval was used to record the diurnal and nocturnal activities. The swampy grassland habitat of JAC harboured over 220 individual Bohor reedbucks of all age categories. The sex ratio of the reedbuck population was 1:1, however, biased towards adult individuals (63%). Bohor reedbucks of the JAC are exclusively diurnal. They usually form unstable groups of four different herds comprising 3-11 individuals. Over 85% of the reedbuck population passes the night within 200 m radius of the main terminal. They cross the runway at any hour of the day but most with three peaks (early morning, mid-day and early evening). Pregnant, lambing and estrous female reedbucks were commonly observed during both seasons. They employ cryptic behaviour, lying position, alarming whistles and night time refugia selection as an anti-predatory behavior. Predation pressure, habitat confinement, poaching, habitat fragmentation and excessive human activities were considered threats to these animals. By connecting these populations with the ones found nearby in the Kitto-Furdisa University campus, establishing Bohor reedbuck sanctuary is recommended to safeguard the survival of this conservation dependent endemic sub-species.

**Key words:** Activity pattern, Bohor reedbuck, Jimma airport, semi-ranched, endemic sub-species

### INTRODUCTION

Bohor reedbuck comprises about five sub-species. Bohor reedbuck, *R. r. bohor*, is the common name of the Ethiopian sub-species. The physical description and behavioural attributes of this sub-species is well stated by Estes (1991) and Kingdom (1997). The IUCN red list for threatened species described Bohor reedbuck as low-risk conservation dependent endemic Ethiopian species (IUCN SSC Antelope Specialist Group, 2008).

Bohor reedbucks prefer grassland savanna and particularly favour wide shallow plains with extensive annual flooding (Yalden *et al.*, 1984; Estes, 1991; Kingdom, 1997). They avoid thick vegetation, closed woodland and thick forest but favour open grassy habitat, for grazing and cover and pockets of bushy thickets for breeding and hiding their lambs (Estes, 1991; Kingdom, 1997). They have distribution ranging from Senegal to Ethiopia, south to Lake Tanganyika and the Rovuma Valley, excluding the southern Africa (Estes, 1991).

According to Nowak (1999), Bohor reedbucks normally graze early in the morning and late in the evening, though they were observed grazing frequently throughout the night. However, several other workers reported that Bohor reedbucks are exclusively nocturnal, feeding mainly after dusk (Estes, 1991; Kingdom, 1997; Afework *et al.*, 2010). Factors such as hunting, habitat destruction, predation, cattle grazing and cultivation are reported to be major reasons for restricting the original range of the animal (Hillman, 1986; Afework *et al.*, 2010).

Yalden *et al.* (1984) summarized the former distribution records of Bohor reed buck in Ethiopia. This record and other recent studies, excepting for the Baro, Akobo and Diddessa River plains, most areas covered were the central, northern, eastern and southeastern highlands of Ethiopia. In the stated areas, Bohor reedbucks are common in lowland savanna at altitude as low as 400 m and range up to 3250 m in the eastern and southeastern highlands of the country (Yalden *et al.*, 1984; Hillman, 1986; Afework *et al.*, 2010). However, Bohor reed buck population from the southwestern flood plains and the extended wetland areas including the present study area were not represented.

Airports are mostly established in plain areas far from cities where other such development activities are restricted. As a result, extended grasslands and wetlands become the dominant landforms immediately surrounding most airports. These attract wildlife. Likewise, many of the unaltered habitats surrounding airports provide suitable conditions, including food, water and cover (Wendy *et al.*, 2000; Cleary and Dickey, 2010). At the same time, wildlife populations at airports are considered hazardous to the aviation industry because they collide with aircrafts and cause severe accident. Birds and mammals are among the most attracted airport wildlife species.

Evidence reveals that wildlife-aircraft strikes have been an issue since the earliest days of manned flight (MacKinnon, 2004). The first recorded human fatality resulting from a bird strike occurred in 1912 and since then, wildlife strikes have become an increasingly serious problem in aviation (Wendy *et al.*, 2000; MacKinnon, 2004). ICAO (2009), reported that collisions with wildlife cost the airline industry and the public approximately \$US 2 billion annually. Birds make up 96% of the reported strikes, mammals about 3% and reptiles less than 1% but the resulting damage from mammalian strike can be serious. Species such as otters, deer, coyotes, jackals, squirrels, dogs, foxes and mongooses are among frequently reported mammals that are common in most airports (Hesse *et al.*, 2009).

Land use patterns of the airports and the surrounding areas are among the major reason for attracting wildlife to airport (MacKinnon, 2004). Historically, Bohor reedbucks were the most abundant antelopes along the riverside plains of large perennial rivers of the area (including Ghibe, Gojeb and Awetu rivers) and along the extensive wetland plains formed by Kitto River. Currently, however, Jimma airport compound and the Kitto-Furdisa wetland plains seem the last stronghold refugia for Bohor reedbucks largely as a result of the land use patterns of the surrounding areas (grain and cattle farming and the extensive eucalyptus tree plantations which are strongly avoided by this animal). The whole airport compound is well fenced and highly guarded which may contribute for the congregation of reed buck in the present study area. However, unless they are managed properly, in light of the ever increasing aviation services and their population growth, both the hazardous incidences and the threats to the survival of these animals are inevitable.

The aim of the present study, therefore, was to investigate the population status of Bohor reed buck population at JAC, southwestern Ethiopia. The study also assessed the impact of habitat confinement, extensive human activity and high predation pressure on the activity rhythms of reedbucks and the potential hazards posed by these animals on the flight patterns.

**MATERIALS AND METHODS**

**Study area:** The study area is (JAC), located 2.5 km southwest of Jimma town, southwestern Ethiopia. The study area covers an area of approximately 2.4 km<sup>2</sup>, with the coordinate points 037°039'57"N, 37°48'59"E and altitude of 1703 m (Fig. 1). The swampy grassland habitat of JAC is dominated by few species of grasses including *Stipa keniensi*, *Hyparrhenia rufa*, *Sporobolus pyramidalis* and *Eulalia polyneura*. The small hills surrounding the drainage ditches are covered by dense shrubby thickets formed by few plant species like dwarf *Rhus glutinosa*, *Psidium guajava*, *Rubus steudneri*, *Vernonia auriculifera*, *Bidens* spp., *Maesa lanceolata*, *Carissa edulis*, *Calpurnia aurea*, *Pterolobium stellatum*, *Achyranthes aspera*, *Lantana trifolia*, *Maesa lanceolata* and *Solanum incanum* which, together with tall grasses, serve as a den and lamb hiding sites for Bohor reedbuck during breeding.

The study area receives rainfall between 1450-1800 mm, highest between June and August but the wet season extends to early November. The area also receives small and unpredicted rainfall within the dry season months (February-March). Besides, the extensive wetland formed by the perennial Kitto river bordering the airport from the north, northwestern and northeastern sides, it provides permanent moisture to the study area. The temperature of the study area is known to fluctuate significantly, however, mostly ranges between 12.3 and 28.5°C with mean daily temperature of 20°C (EMA, 2011).

Jimma Airport is among the oldest airports in the Ethiopian aviation history, established in 1964 and with 1234 average flights annually transporting over 22,000 passengers. Recently, however, the airport has been given an upgrading priority to an international standard with all facilities to host international flights. The upgrading program incorporates the expansion of the compound that doubles the previous area.

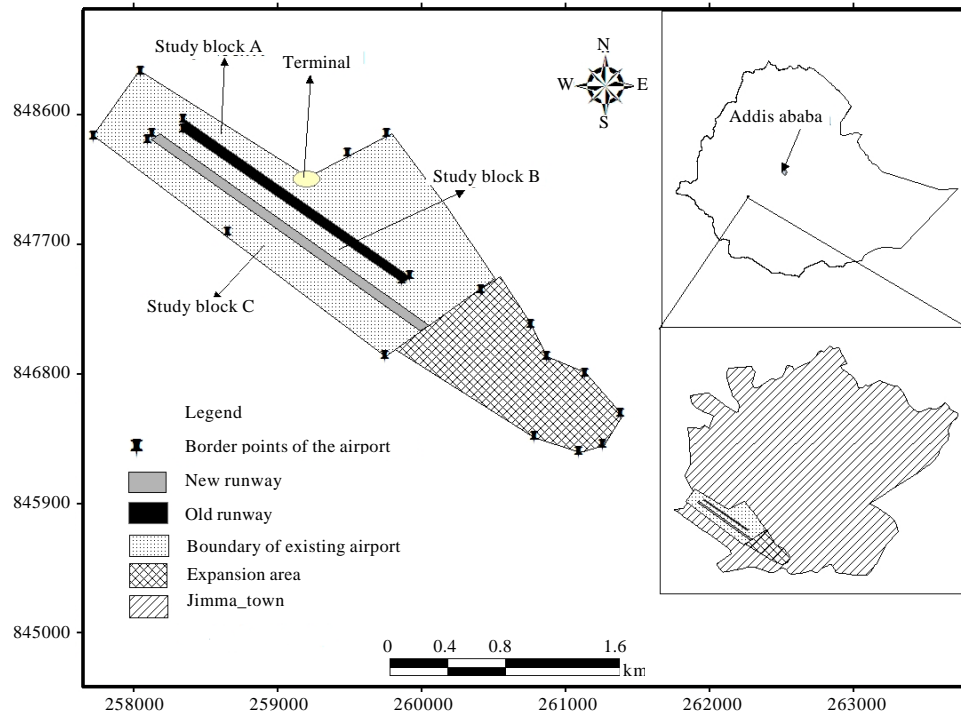


Fig. 1: Map of Ethiopia showing the study area

**Methods:** Quantitative data for the study of population size, sex ratio, age structure and activity patterns of Bohor reedduck population of JAC were gathered for two seasons (January-April for the dry and August to September, 2011 for the wet seasons). The area of JAC was conveniently divided into three blocks. The left and the right side of the main terminal area up to the edge of the old runway was block A (255 m wide by 3000 m long), the area between the old and the new runway was block B (200 m wide by 3000 m long) and the area between the new runway and the southern border fence was assigned block C (235 m wide and 3000 m long) (Fig. 1).

**Population size:** Owing to the small size of the study area, total count method was employed to enumerate the population size of Bohor reedduck (Norton-Griffiths, 1978; Sutherland, 1996). Census was carried out during the wet and dry seasons. For both seasons, counting was performed twice a day between 06:30 and 08:00 h during morning and between 16:30 and 18:00 h during late afternoon. Two individuals (the counter and the recorder) were assigned for each counting block and counting commenced at the same time. There was no incidence of double counting because reedducks moving into runways from any counting blocks were included into the previous block. Binoculars were used during counting.

Group size of Bohor reedducks was determined and recorded before being sub-divided into sex and age classes (Caro, 1999; Afework *et al.*, 2010). All observed individuals in a group were sexed and their age determined on the basis of their body size, presence or absence of horn, size of horn and pelage colour (Estes, 1991; Kingdom, 1997; Afework *et al.*, 2010).

**Activity patterns:** Groups of Bohr reedducks were tracked to record their diurnal and nocturnal activity patterns. Behaviour was recorded by modified scan observations (Altmann, 1974; Martin and Bateson, 1993; Funston *et al.*, 1994). Accordingly, a group was rapidly scanned once every 2 min (for diurnal) and every 10 min (for nocturnal) activities. All individually performed activities during the scanning instant was recorded and quantified as a group activity. Based on the location of their preferred grazing and bedding sites, observations were carried out either from the three security guard towers, a sand pile, hilly areas, by climbing on appropriate eucalyptus tree or by tracking on foot with appropriate distance (between 10 and 200 m). For the diurnal activity patterns, the group was observed from 06:00 to 18:00 h during the dry and wet seasons. Nocturnal activity patterns were observed between 18:00 and 06:00 h using spot lights after habituating them for (Ikeda *et al.*, 1982).

For observations at distances <100 m, the behaviour pattern was observed and recorded as feeding, lying down, ruminating, walking, standing at rest, grooming, vigilance and other activities such as defecation/urination, ritual plays, soil licking, fighting/chasing, drinking, suckling, courtship (sniffing and mounting) (Ryan and Jordaan, 2005; Afework *et al.*, 2010). When observations took place at distances >100 m, some invisible activities such as ruminating behaviour was not recorded but included as lying inactive or standing at rest. Due to the difficulties of viewing at night, nocturnal behavioural categories were restricted to standing, walking, feeding and lying active (eyes shining to the spot light) or inactive, lying eyes closed (did not shine to the spot light). Observations of each day were compiled as the total number of different activities performed for twelve 1-h periods; i.e., 06:00-07:00, 07:00-08:00 and 17:00-18:00 h (Seddon and Ismail, 2002; Afework *et al.*, 2010) and the proportion of each activity in relation to the total activities was computed. The dominant plant species of the area was identified in the National Herbarium of the Addis Ababa University.

**Runway count:** Wildlife hazard assessment begun with runway count (MacKinnon, 2004; Cleary and Dickey, 2010). This is to count the number of individuals which cross, occur on or over the runway on a frequent basis in a given time. The number of Bohor reedbucks crossing the old runway from any direction and time was recorded between 05:00 and 19:00 h from an appropriate recording position.

**Statistical analysis:** Data on the population abundance, status and activity patterns were analyzed using appropriate statistical package, such as SPSS version 13.0.

**RESULTS**

A total of 204 and 237 animals were counted during the dry and wet seasons, respectively. Few individuals were incorporated during the wet season, however, the population size variation between the seasons was not significant ( $\chi^2 = 2.47$ , at 1 df,  $p > 0.05$ ). The proportion of adult reedbucks of JAC was higher than the lower age categories, however, the difference was significant only for the dry season (14.28 at 1 df,  $p < 0.01$ ). For both seasons census, sex ratios of Bohor reedback population of the JAC were slightly biased towards females, however, the difference was not significant (0.40 and 0.15 for dry and wet seasons respectively,  $p > 0.05$ ) (Table 1).

High number of sub-adult and juvenile male and female reedbucks was recruited during the wet season and the difference was significant ( $p < 0.05$ ) (Table 1). Bohor reedbucks showed a distinct movement pattern. More individuals were counted in blocks A and B during the morning census sessions. However, more number was recorded from block C during the late afternoon count. There was a slight tendency of adult female and male reedbucks to prefer study block B, however, in all cases and both seasons, there was no significant difference for block preference in their diurnal activity (Table 2). The density of Bohor reedback in this study area was 85 and 98.75 individuals  $\text{km}^{-2}$  during the dry and wet seasons, respectively.

Females accounted for 50.9 and 48.5% of the total population of Bohor reedbucks at JAC during the dry and wet seasons, respectively and the difference was insignificant ( $p > 0.05$ ). Adult Bohor reedbucks comprised 55.2 and 63.2% during the wet and dry seasons, respectively. The adult to sub-adult ratio was 2.2:1.0 and 1.79:1.0 for the dry and wet season census, respectively and the difference was significant ( $p < 0.05$ ). The sub-adult group contributed 28.4 and 30.8% individuals to the total population during the dry and wet seasons, respectively. Juveniles contributed 8.3 and 13.9% for dry and wet seasons, respectively (Table 2).

**Herd size and composition:** The herd size of Bohor reedback at JAC ranged between 2 and 13 individuals and the mean was  $3.6 \pm 0.95$  and  $3.3 \pm 0.8$  for wet and dry seasons, respectively. However, the difference in herd size between seasons was not significant ( $p > 0.05$ ) (Table 2). Bohor reedbucks

Table 1: Comparison of age and sex categories of Bohor reedback population during wet and dry seasons

Season	Age and sex category							Total
	AM	AF	SAM	SAF	JM	JF	JU	
Dry	63±5.2	66±7.2	28±3.2	30±1.0	4±00	8±2.6	5±00	204±7.9
Wet	68±7.5	63±4.3	35±4.0	38±4.9	9±1.7	14±1.5	10±2.0	237±8.5
Percent	30.0	29.0	14.2	15.4	3.0	5.0	3.4	
$\chi^2$ (df=1)	0.18*	0.06*	0.76*	0.94*	1.92*	1.56*	1.66*	2.47*

Values Mean±SD, AM: Adult male, AF: Adult female, SAM: Sub-adult male, SAF: Sub-adult female, JM: Juvenile male, JF: Juvenile female, JU: Juvenile unidentified, \*Values are not significantly different at  $p > 0.05$

Table 2: Comparison of Bohor reedbucks from different census blocks at JAC between two seasons

Season	Study blocks	Group size	Total count							Total
			AM	AF	SAM	SAF	JM	JF	JU	
Wet	A	3.1	19	20	6	9	4	6	-	64
	B	4.7	26	30	10	11	-	1	-	78
	C	3.0	18	16	12	10	-	1	5	62
$\chi^2$ (df = 2)		1.10*	1.80*	8.35 <sup>o</sup>	2.11*	0.2*				2.22*
Dry	A	4.2	26	23	8	7	2	5	4	75
	B	3.2	28	24	11	16	5	6	5	95
	C	2.5	14	16	16	15	2	3	1	67
$\chi^2$ (df = 2)		0.43*	5.07*	1.80*	2.80*	3.77*	1.9*	1.00*	4.2*	5.26*

AM: Adult male, AF: Adult female, SAM: Sub-adult male, SAF: Sub-adult female, JM: Juvenile male, JF: Juvenile female, JU: Juvenile unidentified, \*Values are not significantly different at  $p > 0.05$ , <sup>o</sup>Value is significantly different at  $p < 0.05$

usually formed four different groups. A harem formed by a dominant male, comprising 2-4 adults and 2-3 sub-adult females and a few juveniles. Occasionally, 3-6 bachelor adults and 2-5 sub-adult females join and form a group. Sub-adult males (2-12 individuals) usually formed a separate group and occupied marginal areas, both during feeding and night resting areas. Older male reedbucks of the area were mostly lonely but occasionally form groups of 2 to 4 individuals and occupy marginal areas, away from the sub-adult male groups. Harem forming males were extremely intolerant to intruding males. Regardless of the composition, however, the herds of this semi-ranchered reedback population were loose and dispersion or re-grouping was very common particularly towards the early evening.

**Diurnal activity:** A total of 720 and 1080 (every 2 min) scan sampling yielded 1791 and 2157 Bohor reedback diurnal activities both for the dry and wet seasons, respectively. Table 3 summarizes the diurnal activities of Bohor reedbucks, of which, feeding was dominant followed by lying down. Standing at rest, urination/defecation, soil licking, courtship displays (sniffing and mounting), chasing/fighting, suckling/young licking, body stretching, neck or body shaking and bush or ground hornings were among the minor activities performed by the reedbucks during both seasons.

During the dry season, diurnal activity commenced early (between 05:30 and 06:00 h). Feeding activity began early, intensified between 08:00 and 11:00 h and ceased between 12:00-15:00 h. This is the time used for lying down and rumination. Feeding restarted after 16:00 and continued up to late 20:00 h. During the wet season, diurnal activity began between 07:30 and 9:30 h, particularly when night rain continued up to the morning time. During this season, feeding mostly began between 08:30 and 09:30, intensified between 10:00 and 14:00 h and mostly ceased between 15:00 and 16:00 h when they lied down and ruminated. Feeding restarted slowly from 17:30 h and continued up to 22:00 h. Environmental factors such as rain and human activities such as movement around their grazing areas were observed to affect the diurnal activities and the time budget of reedbucks at JAC. Wet season morning activities seem to be affected by swamp flies that attack every open and bare body parts. As part of their diurnal activity, reedbucks of JAC regularly move from one block (such as bedding site) to the other (such as grazing or watering sites) which may involve crossing the runways. The diurnal runway count showed that at any time of the day reedbucks crossed the runway (in average 6 individuals,  $\pm 3.0$ ), however, three peak times are

evident; early morning (46) mid-day (23) and early evening (55) (Fig. 2). Before landing and takeoff of aircrafts, security scouts prevent reedbucks from entering the runway.

**Nocturnal activities:** A total of 144 dry and 216 wet seasons scan sampling (every 10 min interval) yielded 873 and 793 activities, respectively. Of these, 31.4% (dry) and 40.8% (wet) season nocturnal activities involved inactive lying, characterized by a complete resting where they lay head curled back to tail, forming an oval shape (Bohor reedbuck style). Active lying was the second major activity to which they allocate considerable time, 14.6 and 18% for the dry and wet seasons, respectively. This activity lasted short (between 20:00 and 22:00 and 21:00 and 23:00 for the dry and wet seasons, respectively) and was characterized by physically lying down but eyes open and shining against the spot lights. Feeding (15.8 and 13.1%) and walking (with 11.2 and 11.22%) for the dry and wet seasons, respectively were other activities performed before the long inactive night rest (between 22:00 and 05:30 and 23:00 and 7:30 h during dry and wet seasons, respectively). This activity ceased after 20:00 and 22:00 h during the dry and wet seasons, respectively. Feeding and walking activities were proportionally high from early to late evening. Several minor activities performed by reedbucks before they enter the inactive state were pooled into "others" (Table 4).

Table 3: Comparison of diurnal activity pattern of Bohor reedbuck at JAC between seasons

Activity	Season	
	Wet	Dry
	Relative proportion (%) (n = 2157)	Relative proportion (%) (n = 1791)
Feeding	31.4	29.8
Lying down	19.0	18.4
Ruminating	11.6	12.8
Walking	11.0	12.5
Standing at rest	6.7	3.9
Grooming	7.1	6.4
Vigilance	4.2	8.3
Others*	9.0	7.9

\*Defecation/urination, ritual plays, soil licking, fighting/chasing, suckling, drinking, courtship/sniffing

Table 4: Comparison of nocturnal activity pattern of Bohor reedbuck at JAC between two seasons

Activity	Season	
	Wet	Dry
	Relative proportion (%) (n = 793)	Relative proportion (%) (n = 873)
Lying inactive(eyes closed)	40.8	31.8
Lying active (eyes open)	14.6	18.0
Feeding	13.1	15.8
Walking/running	11.2	11.2
Whistling	4.4	4.3
Ritual play	3.8	5.4
Ruminating	3.5	4.0
*Others	8.4	7.6

\*Grooming, vigilance, standing at rest, suckling, defecation/urination and fighting/chasing



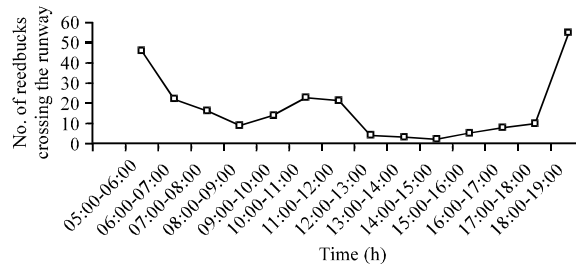


Fig. 2: No. of Bohor reedbucks that crossed the runway at JAC

The majority (84%) of the reedbucks rest the night within areas fewer than 200 m radius of the main terminal, block A (Fig. 1), most around security guard tower, old hangar and the police camp. The remaining reedduck groups rest the night on and around sand piles stored for the new runway construction which was heavily guarded (block C). Few isolated reedduck groups rest their night in the long dense grasses and tickets towards the middle and the eastern corner of central block (B). In the morning, however, reedbucks from block A and C cross the runways to their morning grazing ground (block B). During the nocturnal observation, encounters with other carnivores including spotted hyaena, serval cats, common jackals, mongooses and African civets were very high.

**Special adaptations of Bohor reedbucks:** Bohor reedduck population of JAC exhibited a diversified anti-predatory behaviour. The cryptic nature, when they lay undetectably in tall grasses and tickets even tolerating the severe bites from swarms of army ants. Over 90% observed reedbucks ( $n = 82$  observations), laid faces opposite to each other. When they detect danger approaching to the group, they repeatedly produce high pitched alarming whistles. During the two season observations, the mean number of nocturnal whistle was  $8 (\pm 3 \text{ SE})$ , mostly between 19:00 and 21:00 h, in the evening and 05:00 and 06:00 h, in the early morning. The day time whistles were low pitched, few in number, associated with short bouncing and seems to invite ritual plays. Passing the night in areas where human activities were very high (around the terminal and sand piles) was the other anti-predatory strategy. Bohor reedbucks of JAC were observed lying comfortably in half flood filled bedding site. Sound from airplane did not disturb reedbucks, instead they were observed actively staring at and being attracted to the planes.

**Reproductive conditions:** During the present study, fully pregnant, lactating and estrous reedbucks were commonly observed during both seasons. Adult males actively defend the harem comprising receptive female/s. Pregnant females were usually observed feeding, lying and moving lonely. Mothers were observed hiding and guarding calf in hidden areas in tall grasses or in dense thickets along the edge of hilly ground. Mothers and lambs meet only during the late evening and stay the whole night together. In some quiet morning time, lambs were observed walking out and feeding with their mothers. In the absence of their mothers, young were observed perfectly camouflaging with their environment. When harassed, however, they produce harsh sound where the mother and all other reedbucks flock suddenly into the area.

**Threats:** Predation pressure from hyaenas, serval cats, common jackals and several groups of roaming dogs are the most important threats. Snares set by local farmers; hunting, excessive

human activities and the reduction of over 50% of the former grazing and breeding areas as a result of the construction activities of the new runway and terminal.

**Other commonly observed mammals:** Other animals commonly observed in Jimma airport compound are spotted hyaena (*Crocuta crocuta*), Mongoose (*Mungos mungo*), the African civet (*Civettictis civetta*), Common jackals (*Canis aureus*) and Serval cats (*Felis serval*). The rodent sampling trial produced two rodent species, the soft furred mice (*Lophuromys flavipunctatus*) and the multimamete rat (*Mastomys natalensis*).

## DISCUSSION

The land use patterns of the surrounding area and better security of the airport may be the main reasons for the concentration of Bohor reedbucks in the confined swampy grassland habitat of Jimma airport compound. Behavioural and ecological studies for Bohor reedbuck are scarce (Kingdom, 1997). The population dynamics of Bohor reedbuck in this semi-isolated population of the area is unknown. However, from the two season observations, the population showed about 16% increase. The present population size for this closed habitat may not seem beyond the carrying capacity. However, when compared with the reported Bohor reedbuck densities elsewhere (e.g. between 10.8 and 28.2 km<sup>-2</sup> from Bale Mountains National Park, Ethiopia (Afework *et al.*, 2010); between 14 and 21 individuals km<sup>-2</sup> from Serengeti (Nowak, 1999); 5 individuals per linear kilometer of valley bottom areas from Tanzania (Kingdom, 1997), the density from the present study area was relatively very high (85 and 98.75 km<sup>-2</sup> for the dry and wet seasons, respectively).

The age structure of Bohor reedbuck of JAC is biased towards adults. This trend is harmful for the long future dynamics of the population. However, since they are among the long living ungulates, future population replacement may not be affected. Besides, the presence of other small free ranging population of reedbucks around Kitto-Furdisa and Kofe wetland plains (about 1.5 km west of the present study area) is a promising potential. Adult individuals were observed moving among these three habitats, particularly after the southern fence was dismantled. This mixing up of individuals from different populations also has genetic significance to avoid inbreeding, a critical problem for such closed population.

In the present study area, the male to female sex ratio of adult and sub-adult age groups was almost proportional (1:1). Since the breeding behaviour of Bohor reedbuck is harem forming (Skinner and Smithers, 1990; Taylor, 2004), there may be great competition among adult males to organize, defend or take over the harem. In the JAC reedbuck population, observing adult males with broken horn(s) was common. Those males who successfully secured harem were observed spending most of their time for vigilance, chasing or fighting with intruder males. This behavioural activity greatly reduces their feeding time and energy which may affect the overall fitness of these animals to defend the harem for the successive breeding opportunities.

Permanently defined and defended territory for harem forming dominant males is not known in reedbucks of JAC. When such males confront with bachelor intruders, they fight to the end until the defeated retreats. This behavioural observation contradicts with the reports from Kingdom (1997), that states the occurrence of repeated fight and temporal stand offs between adult males of defined territories. Some behavioral plasticity, such as loose territoriality, was reported to occur when certain reedbuck population attains high density (Estes, 1991). Under such condition, even family groupings breakdown and the whole aggregation seems to become a single macro-herd. The currently documented high density of reedbucks in the confined habitat of JAC may have contributed for the loss of such behaviour.

Bohor reedbucks are known to form groups of different individual compositions. This include herds formed by the association of 2-3 immature males, those formed by territorial male with 3-7 females and juveniles Estes (1991), these and groups formed by bachelor females (Afework *et al.*, 2010) and those formed by 1-3 older bachelor males (Taylor, 2004) were all reported. The observed group forming behaviour of reedbuck in the present study area was in agreement with these reports.

Several workers (Estes, 1991; Kingdom, 1997; Nowak, 1999) reported the exclusive nocturnal habit of Bohor reedbucks. Other workers (Roberts and Dunbar, 1991) accept their nocturnal behaviour but specified certain environmental factors, such as habitat fragmentation and the shortage of food, that forced them to extend their activity at least to certain time of the day (early morning and late afternoon). However, the semi-ranchled Bohor reedbuck population of JAC is completely diurnal and allocated most of the night for resting (active or inactive lying).

Feeding was the major diurnal activity of bohor reedbucks during both seasons of the present study. However, there was temporal variation between the seasons. The night and morning rain condition during the wet season was observed to alter the diurnal activity pattern. Likewise, Roberts and Dunbar (1991) reported the effects of rainfall and temperature on the behavioural ecology, such as altering their diurnal activity patterns.

It was stated that wild animals avoid localities where human activities are frequent and high (Balakrishnan and Ndhlovu, 1992). This generalization seems partly challenged by the semi-ranchled Bohor reedbuck of JAC. Over 85% of these animals regularly flock to the airport terminal areas with more concentration towards security tower, where night patrolling personnel were frequenting. Most of the remaining groups pass the night by climbing on the sand pile that has over 16 m from the ground and under the crusher, all of which were heavily guarded. These animals seem long recognized that, stopping any night activity and staying closer to areas with higher human activity secured them more from predator attacks. When some isolated marginal individuals were threatened by predators, after repeated whistling, they were observed retreating towards and closer to the terminal area.

Details of nocturnal activity was hard to detect and reedbucks stop their activity for a while when they see spotlight. Patterns of rumination by ungulates were reported to closely correlate with resting period occurring intermittently between feeding bout and peak when animals retire (Norton, 1981; Mloszewskmi, 1983; Beekman and Prins, 1989). For the reedbuck of JAC, the time gap between lying active and inactive sleeping may be allocated for cud chewing.

Globally, wildlife strikes have killed more than 219 people and destroyed over 200 aircraft since 1988. Bird strikes accounted for 97% of the hazards, followed by mammals (3%) (Wendy *et al.*, 2000; Cleary and Dickey, 2010). Bohor reedbuck of JAC may be among the few recorded larger mammals with such a high concentration living in harmony in the area completely forbidden for other animals and Jimma airport may also be the only one to tolerate with minimal mechanical barriers. They cross the runway at any time of the day, however, the three recorded movement peaks provides good insight to schedule airport activities accordingly or to give special considerations during these peaks.

During the past 47 years of aviation services of Jimma airport, there was no reported accident due to reedbucks. The airport management well aware of this and assign uniformed field scouts before landing, during the stay and during takeoff of aircrafts, for which reedbucks are well habituated. However, in the long run, the potential of becoming a hazard to the aviation service of the area, particularly when the air traffic load increases, will be predicted.

Kingdom (1997) reported variation in amplitude, length and style of leaps; variation in the number of blasts and pitch of whistles for various unclear purposes. In the present observation, whistles for various purposes, such as to alarm danger and those for social ritual purposes vary considerably in their tone, amplitude, the associated activities and duration.

Black backed jackals, caracal, striped hyaena, leopard and cheetah were reported to predate on reedbucks (Irby, 1979; Roberts and Dunbar, 1991; Taylor, 2004). In the present study area, during nocturnal observation, on average 8 ( $\pm 3.5$ ) long and continuous whistles were recorded per night, all seem in response to predators and correlated with the time of hyaenas crossing the airport compound to the town or back to their dens. Complete freezing is a major predator avoidance strategy of Bohor reedbucks and related ungulates (Jarman, 1974; Irby, 1981; Taylor, 2004). In addition to these, Bohor reedbucks of JAC employ lying position (facing in opposite direction) that may increase scanning wide field of vision. The other strategy was to pass the night in areas where human activities were high.

Bohor reedbucks strongly avoid forested areas and they are poorly adapted to jump, run and escape danger (Estes, 1991; Kingdom, 1997). Local inhabitants of Jimma airport area employ this behaviour of the animal for hunting purposes. When they see them outside the airport compound, they chase them to the nearby eucalyptus tree forest, where they simply grasp their legs from behind. During this study, it was observed that Bohor reedbucks were strongly attracted towards brightly coloured objects including fabrics and shiny materials. Poachers also employ this behaviour of the animal for hunting purposes. When they see them outside the airport compound, while some individuals intentionally suspend brightly coloured fabrics (deep red, white or yellow) in front of the animal, the other group approaches and grasp their hind legs from behind. Both activities of the farmers are accompanied by dogs.

There is a limited study on the breeding behaviour of Bohor reedbucks. However, Estes (1991) and Kingdom (1997) reported that Bohor reedbucks do not possess strict breeding season but generally predicted to peak during the rainy season. During both seasons of the present study, pregnant, calving, lactating and estrous Bohor reedbucks were commonly observed. The population size and age composition of Bohor reedback of this area may creates good opportunity to conduct a detailed long term study on population ecology, breeding and behavioural aspects of the species.

Recent expansion of the JAC compound (double of the previous size) provides additional ranging, grazing and breeding area for Bohor reedbucks of the area. The Kito-Furdisa extensive wetland plain, under the newly established Technology Campus of the Jimma University, harbours good sized wild Bohor reedback population. This plain is closely situated (1.5 km west) to JAC and there is limited physical barrier between the two. Joining these two populations with corridor and establishing Bohor reedback sanctuary is recommended to safeguard the survival of these endemic and conservation dependent endemic sub species and make economic and esthetic use of their presence.

## **CONCLUSION**

Bohor reedback population of JAC is unique in its habitat selection and in having behavioural activities largely modified by the environment. JAC probably is among the few aviation institutions in the world that is willing to compromise the impacts and the welfare of the wild animal. This exemplary practice taught all others about the positive attitudes toward wildlife, they demonstrated that with minimum management intervention (such as guarding scouts) and modification of the habitats (e.g., by using game fence), the possibility of using wildlife for several other purposes such

as tourist attraction, game ranching and wildlife meat production. The Bohor reedbuck population of JAC has good size and age composition to conduct further ecological and behavioural studies of the species, the information that are meager at present.

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