

Full Length Research Paper

Social organization of Barbary sheep (*Ammotragus lervia*) population in the Chambi National Park, Tunisia

BEN MIMOUN Jamel* and NOUIRA Saïd

Laboratory of Animal Ecology, Department of Biology, Faculty of Science, El Manar University, Tunisia.

Accepted 30 August, 2012

The Barbary sheep (*Ammotragus lervia*), "kabsh arwi" in Arabic, is a threatened wild endemic to North Africa. It was introduced in Chambi National Park of Tunisia in 1987. The study of the organization of Barbary sheep population was investigated 23 years after this introduction. The surveys were conducted during breeding and rutting seasons. The majority of herds sighted in Chambi National Park in Tunisia both during breeding and rutting seasons, were small. The average number of animals per herd, during breeding and rutting season, was 5.5. Males were more frequently encountered during autumn than in spring, in contrast with females and subadults which were equally estimated in both seasons. Four herd types were distinguished: bachelor, female, nursery and mixed. Nursery groups were the most common association during breeding but mixed groups are the most frequent ones in rutting season. Concerning habitat preference, arwis tended to prefer open lands during breeding season, but they did not show preference to any habitat in rutting season. The sex ratio was estimated of 55 males: 100 females in April 2009.

Key words: Aoudad, Barbary sheep (*Ammotragus lervia*), ungulates, herd size, group composition, habitat selection, Chambi, Tunisia.

INTRODUCTION

Ammotragus lervia (arwi, aoudad or Barbary sheep) is endemic to the mountainous regions of North Africa (Brentjes, 1980) throughout the Sahara region "South to about 14° near the Niger and through North Tchad and Sudan to the Red Sea" (Corbet, 1978). This species was poorly known, until its introduction to the United States of America in the late 1930s. This gave rise to its ecological and management studies (Ogren, 1965; Simpson, 1980). Knowledge of the species has been summarized by Cassinello (1998). Paradoxically, no published study can be found on its natural African lands apart from few works mainly dealing with its distribution research (de Smet, 1997; Le Houérou, 1992; Loggers et al., 1992; Clark, 1964). In Tunisia, the Barbary sheep or aoudad, is the only representative of the wild caprinids and is listed as

vulnerable in the IUCN Red list of threatened animals (IUCN, 2008). It's threatened mainly due to habitat loss, human population expansion and hunting pressure. The species is gregarious; it is made up of small family groups. The mean gestation period is 5.5 months and mating season peak occurs from September to November, so that breeding season tends to be focused in spring (Cassinello, 1998). Arwis are polygynous and precocial mammals (Habibi, 1987). Parturition occurred in March and April when adult females gave birth to a singleton or twins. The species is characterized by an absolute dominance hierarchy closely dependent on sex and maturity (Cassinello, 1995).

A re-introduction of Barbary sheep into the Djebel Chambi National Park began in 1987, when 10 animals originally from Kasserine were released into 1 ha enclosure and then into the rest of the park; some of these animals escaped in 1988 (Shackleton, 1997). Since then no research on this species has been carried out. The density of population in Chambi National Park was esti-

*Corresponding author. E-mail: jamelbmimoun@yahoo.fr. Fax: 0021671758752.

mated in the report of the DGF (2001) at almost 270 individuals. This estimation does not take into account the predation pressure applied by the golden jackal (*Canis aureus*) and hyena (*Hyena hyena*), and competition with the Cuvier's gazelle (*Gazella cuvieri*).

This paper is an attempt to study the basic characteristics of the Tunisian re-introduced population of Barbary sheep in the Chambi National Park; thus, an account of the species group composition, habitat preference and sex ratios. This study could be a starting point to investigate group behavior, animal dispersal and extension range for *A. lervia* in Chambi National Park to develop a conservation plan for this endangered species.

METHODOLOGY

The study area

The Republic of Tunisia occupies 154,530 km² on the Mediterranean coast between Algeria and Libya, in Africa. Djebel Chambi, the highest mountain in Tunisia (1544 m above sea level) and an extension of the Atlas Mountains, is situated in the center of the country. The park, which covers 6723 ha, is part of Tebessa massive forest that stretches between Kasserine and the Algerian frontier (35° 06' N to 08° 4.3 ' E) (Figure 1). There are no permanent rivers or streams in the park. Main habitats include mountainous areas. Three types of habitats were distinguished: open habitats, formed basically by *Juniperus phoenicea*, *Pistacia lentiscus*, *Stipa tenacissima*, *Globularia alypum*, *Rosmarinus officinalis* and *Artemisia campestris*, closed habitats, formed by forests of *Pinus halepensis*, *Quercus ilex* and *Quercus coccifera*, and mixed habitats.

The surveys of animals

A total of 70 h of direct observation of animals were made during April and October 2009. Surveys were carried out in Chambi National Park during seven successive days in each breeding and rutting season, in order to examine the characteristics of the population of arwis which inhabit these mountains. Observations were made from a distance ranging from 100 to 1500 m. A 7×35 binocular and a (20 to 45) × 60 spotting telescope were used for observation. The following variables were registered: time of day, location, habitat, group composition according to the age class classification by Cassinello (1997) and animal activity. Four different types of groups were registered in Chambi Tunisian National Park: male or bachelor groups (adult males only), female groups (adult females only), nursery groups (adult females and their calves/juveniles) and mixed groups (adults of both sexes with or without calves/juveniles). To analyze our results in this study, non-parametric statistical tests (Siegel, 1956) were used. In fact, Mann-Whitney (U) and Kruskal Wallis (K) tests were applied when comparing means, depending on whether the variable factor contained two or more than two levels. Non-significant P-values are indicated in the text by "ns".

RESULTS

Group size and composition

During April and October, a total of 42 herds were observed (Table 1). Most of the groups sighted both

during breeding (89.65%) and rutting season (84.61%) were small (1 to 10 individuals, Figure 2); although the differences between seasons were not significant (Mann-Whitney U= 2; U' = 1.67; ns).

In breeding (K = 5.51; df = 2; ns) and in rutting season (K = 2.56; df = 2; ns), both males, females and subadults were equally observed. The frequency of animals observed in breeding and rutting season did not differ statistically (U = 164.5; U' = 168; ns); although males were more frequently encountered during autumn than in spring (U = 112.5; U' = 188.5; P = 0.023), in contrast with females (U = 185; U' = 188.5; ns) and subadults (U = 199; U' = 188.5; ns), which were equally detected in both seasons (Figure 3). Nursery groups are the most common association during breeding (K = 30.24; df = 3; P < 0.0001) and mixed groups are the most frequent association in rutting season (K = 33.15; df = 3; P < 0.0001). Both male groups and nursery groups were registered only in the breeding season (Figure 4).

Habitat preference

In Chambi National Park of Tunisia, the abundance of individuals in the three types of habitats does not show an evident interaction between sex and habitat. Considering data of two seasons (Table 2), either adult males (K = 2.66; df = 2; ns), adult females (K = 2.57; df = 2; ns) nor subadults (K = 5.26; df = 2; ns) seem to predominate in any habitat. In breeding season (K = 19.57; df = 2; P < 0.0001), the animals significantly selected the open land, but they did not show preference for any habitat in rutting season (K = 5.45; df = 2; ns). Both in rutting season (K = 2.49; df = 2; ns) and in breeding season, adult males seemed to predominate in any particular habitat but no males were observed in closed habitat in breeding season. Adult females were most frequently observed in breeding season (Figure 5) in open habitat than in mixed and closed ones (K = 11.063; df = 2; P = 0.004). In rutting season (Figure 6), they were most frequently observed in closed habitat than in mixed and open ones (K = 6.99; df = 2; P = 0.03). Subadult animals were more frequently observed during breeding season in mixed habitat (K = 9.18; df = 2; P = 0.01) but there is no habitat preference in rutting season (K = 2.47; df = 2; ns).

Concerning group composition, nursery groups in breeding season, were more frequently observed in mixed habitats with an average number of 6.43 ± 51 individuals per herd than in open ones: 4.43 ± 0.97 (Figure 7). In rutting season (Figure 8), mixed groups were more frequently observed in closed habitats than in mixed and/or open ones; although the sample size did not allow running any statistical test.

Sex ratios

The sex ratios of Barbary sheep reported during April

Table 1. Number of herds and animals sighted in Tunisia Chambi National Park. The mean (\pm SE) number of individuals per herd is shown in parenthesis.

Month	Number of herds sighted	Number of Arwis sighted	Number of males sighted	Number of females sighted	Number of subadults sighted
April	29	151 (5.21 \pm 3.54)	33 (1.14 \pm 1.79)	60 (2.07 \pm 1.49)	58 (2.00 \pm 2.46)
October	13	80 (6.15 \pm 4.56)	32 (2.46 \pm 2.10)	28 (2.15 \pm 1.14)	20 (1.54 \pm 1.81)
Total	42	231 (5.5 \pm 3.85)	65 (1.56 \pm 1.96)	88 (2.09 \pm 1.37)	78 (1.86 \pm 2.27)

Table 2. Number of arwis encountered in the three types of habitats distinguished in Tunisia Chambi National Park during rutting and breeding season. The mean (\pm SE) number of individuals per herd is shown in parenthesis.

Habitat	Total	Adult males	Adult females	Subadults
Open habitat	79 (4.94 \pm 3.71)	17 (1.06 \pm 1.73)	36 (2.25 \pm 1.98)	26 (1.62 \pm 1.82)
Closed habitat	50 (5.55 \pm 4.66)	16 (1.78 \pm 2.39)	21 (2.33 \pm 1.32)	13 (1.44 \pm 1.67)
Mixed habitat	102 (6 \pm 4.12)	32 (1.88 \pm 1.99)	31 (1.82 \pm 1.13)	39 (2.49 \pm 2.57)



Figure 1. Location of Chambi National Park (Kasserine–Tunisia).

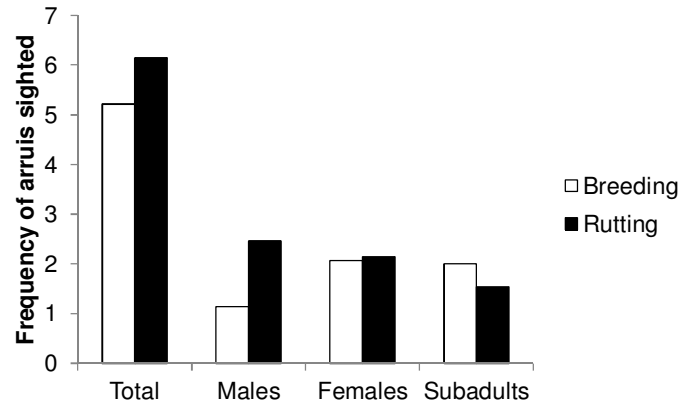


Figure 3. Frequency of arwis sighted in Tunisia Chambi National Park during breeding and rutting season, distinguishing adult males, adult females and subadults.

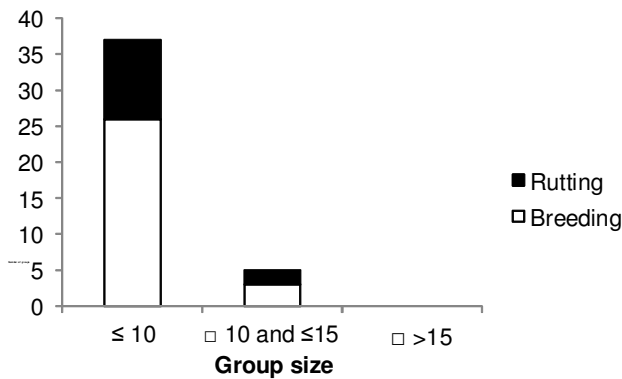


Figure 2. Group size (number of individuals) of the 42 herds sighted in Tunisia Chambi National Park during April and October 2009.

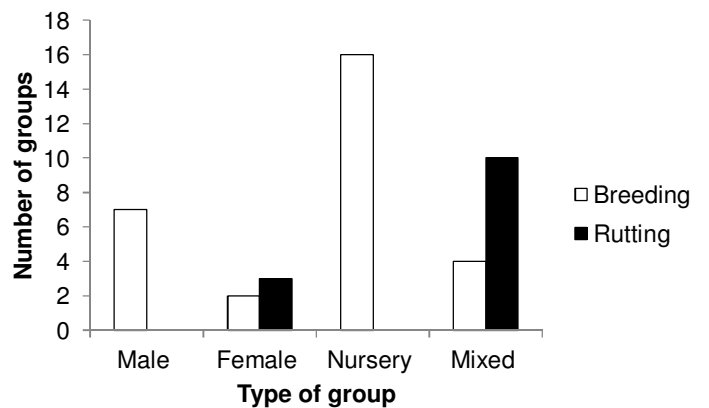


Figure 4. Number of different sex groups sighted during breeding and rutting season in Tunisia Chambi National Park.

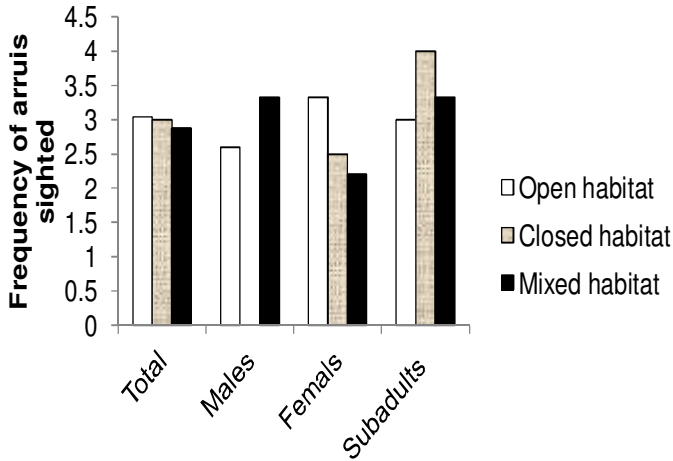


Figure 5. Frequency of arwis sighted in three types of habitats during breeding season.

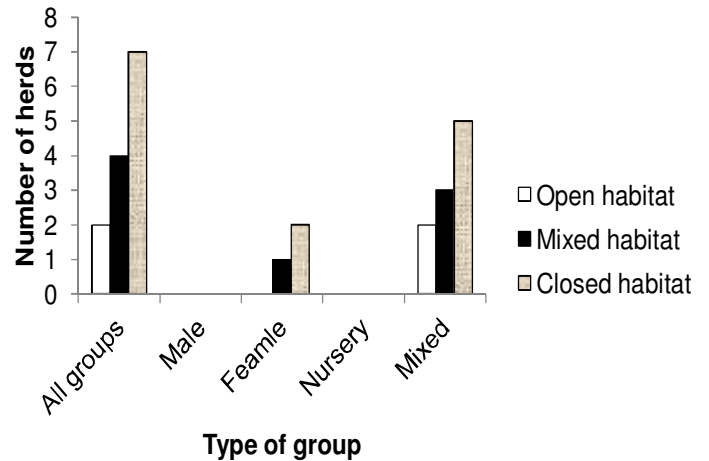


Figure 8. Number of herds of different sex groups encountered in the three types of habitats distinguished in Chambi National Park during Rutting season.

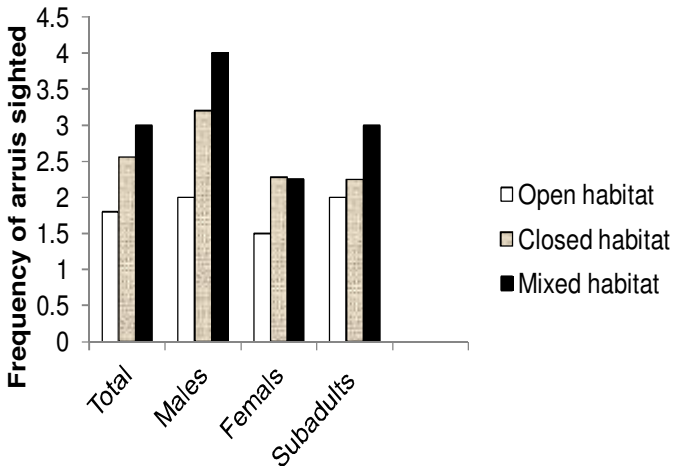


Figure 6. Frequency of arwis sighted in three types of habitats during rutting season.

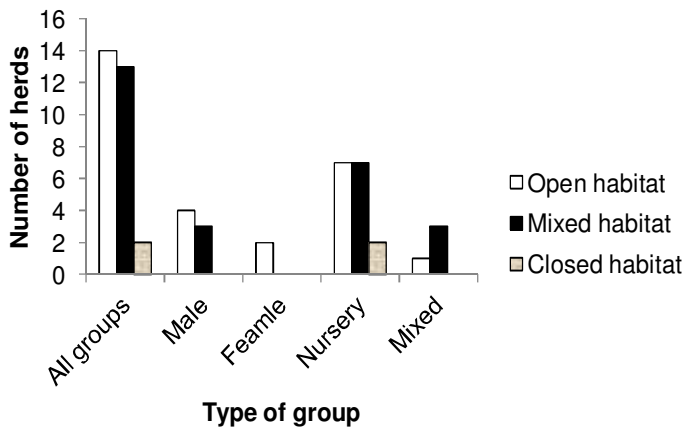


Figure 7. Number of herds of different sex groups encountered in the three types of habitats distinguished in Tunisia Chambi National Park during breeding season.

2009 in the Tunisian Chambi National Park was estimated at 55 males : 100 females.

DISCUSSION

Group size and composition

Small herds formed by less than 10 animals, were the trend observed during our surveys as in a previous study carried out in Spain by Cassinello (1999) and González-Candela and León-Vizcaino (1999). The reduced size of the herds seemed to be related to the forage restraint as was indicated by Toigo et al. (1996).

Our results concerning age-sex classes of arwi population in Chambi National Park followed those obtained by Cassinello (1999), in which males were more frequently encountered during autumn season than in spring season but females and subadults were equally estimated in both seasons.

As shown in a previous study carried out in the south-east of Spain by Cassinello (1999), four different groups were registered: bachelor groups, female groups, nursery groups and mixed groups. In Texas population studied by Gray and Simpson (1982), two other group types could be distinguished, that is, solitary and juvenile.

Nursery groups are the most common association during breeding but mixed groups are the most frequent ones in rutting season as in the study carried out in the Guadalupe Mountains in Texas by Dickinson and Simpson (1979), Solbert (1980) and Gray and Simpson (1982), and in Sierra Espuña by Cassinello (1999). This result seemed to be related to reproductive behavior; in fact, rutting season is the period when adult males appropriated estrus females and spring season is the period of parturition when adult males segregated from female bands (Habibi, 1987).

Habitat preference

Our results were in accordance with those conducted in the central coast of California (Johnston, 1980) and in the south-east of Spain (Cassinello, 1999) where arwis tended to prefer open lands during breeding season. Concerning the rutting season, arwis in our study did not show preference to any habitat in contrast with studies carried out in the central coast of California (Johnston, 1980) and in the south-east of Spain (Cassinello, 1999) where arwis tended to prefer covered lands during rutting season. This fact might be explained in our study by mild autumn temperatures and insufficiency of precipitation in Chambi National Park which helps to increase the home range animals in search of food resources.

Both in breeding and rutting seasons, adult males seem to predominate in any particular habitat, in contrast with the study conducted in the south-east of Spain by Cassinello (1999) where they were less frequently sighted in open habitats than in mixed ones. Female adults were most frequently observed in breeding season in open habitat than in mixed and closed ones but in rutting season they were most frequently observed in closed habitat than in mixed and open ones in contrast with the result of Cassinello (1999), in the south-east of Spain, in which female adults seem to predominate in any particular habitat. Concerning subadult animals, they were more frequently observed, in our study, during the breeding season in mixed habitat, in contrast with the result of Cassinello (1999) in which these animals seemed to predominate in any particular habitat.

Sex ratios

The sex ratios estimated for the Tunisian Chambi National Park population in this study is similar to the one found by Dickinson and Simpson (1979) at the Rio Hondo Vally of Southern New Mexico (58 males : 100 females) and higher than 15 : 100 that Barrett (1980) found for the Hearst Ranch in California and of (20 to 40) : 100 found by Gray and Simpson (1983) in Texas.

ACKNOWLEDGEMENTS

The author would like to thank the forest directors for their understanding and for facilitating my access to the park of Chambi, and the park employees for their voluntary collaboration.

REFERENCES

Barrett RH (1980). History of the Hearst Ranch Barbary sheep herd. In: Simpson CD (ed.), Symposium on ecology and management of Barbary sheep. Tech. Univ. Press, Lubbock, Texas, pp. 46-50.

- Brentjes B (1980). The Barbary sheep in ancient North Africa. In: Simpson CD (ed.), Symposium on ecology and management of Barbary sheep. Tech. Univ. Press, Lubbock, Texas, pp. 25-26.
- Cassinello J (1995). Factors modifying female social ranks in *Ammotragus*. Appl. Anim. Behav. Sci. 45:175-180.
- Cassinello J (1997). Sex and age classes in Spanish population of arwi (*Ammotragus lervia*). Relationship with the management of free-ranging populations. Bol. Inst. Almer. Ciencias. 14:171-178 [in Spanish with English summary].
- Cassinello J (1998). *Ammotragus lervia*: a review on systematics, biology, ecology and distribution. Annales Zoologici Fennici. 35:149-162.
- Cassinello J (1999). *Ammotragus* free-ranging population in the south-east of Spain: a necessary first account. Biod. Conserv. 9:887-900.
- Clark JL (1964). The great arc of the wild sheep. University of Oklahoma Press, Norman. p. 247.
- Corbet GB (1978). The mammals of the Palearctic region: a taxonomic review. Cornell Univ. Press, Ithaca. p. 314.
- de Smet K (1997). Tunisia. In Shackleton, D. M. (ed), Wild Sheep and Goats and Their Relatives: Status Survey and Conservation Action plan for Caprinae. IUCN, Gland, Switzerland, pp. 45-47.
- DGF (2001). Stratégie Nationale Tunisienne pour la conservation et la restauration des antilopes sahélo-sahariennes et leurs habitats (2001-2020). Direction Générale des Forêts, Ministère de l'Agriculture. p. 29.
- Dickinson TG, Simpson CD (1979). Notes on population dynamics and site selection of Barbary sheep on the Hondo-Guadalupe range. p. 16-20. In: TG Dickinson and CD Simpson (ed.), Dispersal and establishment of Barbary sheep in the southern Great Plains. Final Rep. U.S. Dep. Agric., For. Serv., Rocky Mtn. For. And Range Exp. Stn., Coop. Aid Agreement. Tech. Univ. Lubbock, Texas, pp. 16-826.
- González-Candela M, León-Vizcaino L (1999). Sarna sarcóptica en la población de arwi (*Ammotragus lervia*) del parque Regional de Sierra Espuña (Murcia) Galemys. [in Spanish]. 11(2):43-58.
- Gray GG, Simpson CD (1982). Group dynamics of free-ranging Barbary sheep in Texas. J. Wildl. Manage. 46:1096-1101.
- Gray GG, Simpson CD (1983). Population characteristics of free-ranging Barbary sheep in Texas. Wildl. Manage. 47:954-962.
- Habibi K (1987). Behaviour of aoudad (*Ammotragus lervia*) during the rutting season. Mammalia 51:497-513.
- IUCN (2008). The red list of threatened animals. IUCN Publications Service, Cambridge.
- Johnston DS (1980). Habitat utilization and daily activities of Barbary sheep. In: Simpson CD (ed.), Symposium on ecology and management of Barbary sheep. Tech. Univ. press, Lubbock, Texas, pp. 51-58.
- Le Houérou HN (1992). Outline of the biological history of the Sahara. J. Arid Environ. 22:3-30.
- Loggers CO, Thévenot M, Aulagnier S (1992). Status and distribution of Moroccan wild ungulates. Biol. Conserv. 59:9-18.
- Ogren H (1965). Barbary sheep. New Mexico Department of Game and Fish Bulletin, Santa Fe. 13:1-117.
- Shackleton DM (ed.) (1997). Wild Sheep and Goats and Their Relatives: Status Survey and Conservation Action plan for Caprinae. IUCN, Gland, Switzerland. p. 382.
- Siegel S (1956). Non-parametric statistics for the behavioral sciences. McGraw-Hill Book Co., New York. p. 312.
- Simpson CD (ed.) (1980). Symposium on ecology and management of Barbary sheep. Texas Tech. Univ. press, Lubbock. p. 110.
- Solbert AGK (1980). Social organization and behaviour of aoudad (*Ammotragus lervia* Pallas) in Texas. In Simpson CD (ed.), Symposium on ecology and management of Barbary sheep. Tech. Univ. press, Lubbock, Texas, pp. 66-72.
- Toigo C, Gaillard JM, Michallet J (1996). La taille des groupes : un bio-indicateur de l'effectif des populations des bouquetins des Alpes (*Capra ibex ibex*). Mammalia 3:463-472.