

# Reproductive period and group structure variety in the Barbary ground squirrel *Atlantoxerus getulus*

Preliminary results

Patrick Gouat

Issam-Eddine Yahyaoui

## Introduction

Socioecology is the comparative study of social structure in relation to ecology (CROOK, 1970). Its main focus is to gain insight on how social structures and contrasts in ecology are correlated, by way of comparisons between closely related species (CROOK, 1965; CROOK and GARTLAN, 1966; JARMAN, 1974).

This comparative approach has been efficiently used in North American ground dwelling squirrels (MURIE and MICHENER, 1984). Ground squirrels (i.e. marmots, prairie dogs and spermophiles) occupy a wide variety of habitats in North America, from Arctic tundra to desert, and they display different social structures. MICHENER (1983) described five grades of social structure which form a continuum of sociality from asocial to egalitarian polygynous harems. ARMITAGE (1981) concluded, from a comparative study of 18 species of ground dwelling squirrels, that the more social species are characterized by a large body size combined with a short growing season and that sociality has evolved through the formation of groups of related females.

The comparison of different species nevertheless raises several statistical problems (see review in GITTLEMAN and DECKER, 1994). An alternative approach is to compare only two closely related species living in different habitats as suggested by FELSENSTEIN (1985). This method has been applied in two species of ground squirrels of the *Spermophilus Ictidomys* sub-genus and has emphasized behavioral adaptations to desert environment (LIVOREIL *et al.*, 1993; YAYHAOUI *et al.*, 1995; GOUAT *et al.*, 1996; MANDIER and GOUAT, 1996). It is also possible to study the variability in social structure between different populations of a given species. General rules established through inter-specific comparisons may explain intraspecific differences (BARASH, 1973; 1974, but see ARMITAGE, 1977). Intraspecific variations in the social structure of wild vertebrates in relation with habitat differences proved to be an heuristic approach in different species (LOTT, 1984; WAAS, 1990; FERRON, 1991). Intuitively, species occupying a large range of habitats are thought to be the most appropriate species to explore the relationships between ecological constraints and social behaviour.

The Barbary ground squirrel, *Atlantoxerus getulus* (Linnaeus, 1758), is an endemic species from Morocco and Algeria. If the presence of rocky shelters is a requisite to make a site convenient for occupation, the Barbary ground squirrel occupies a wide variety of habitats from alpine meadows (up to 3000 m a.s.l.) to desert (SAINT GIRONS and PETTER, 1965; AULAGNIER and THÉVENOT, 1986). In order to determine if the Barbary ground squirrel is a suitable species for socioecological studies, this paper presents preliminary results on the reproductive period and on the group structure among sites scattered on the species geographical range in Morocco.

## Methods

### *Location of the sites*

Sites are classified according to their location on the three principal mountain ranges of Morocco: High Atlas, AntiAtlas and Middle Atlas (fig. 1).

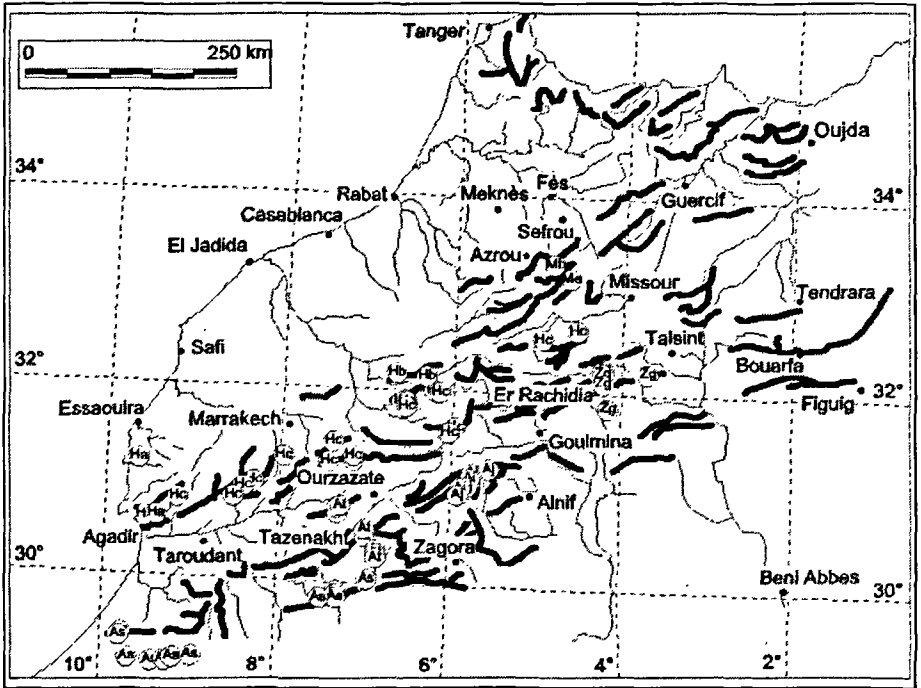


Figure 1

Distribution of the observation sites in Morocco. Sites are located by open circles and two letters according to the different regions. Ha: Atlantic range of High Atlas; Ha: central part of High Atlas; Hb: Bin el Ouidane region; Mb: Boulemane region of Middle Atlas, Me: Enjil region of Middle Atlas; Zg: lower part of wadis Ziz and Guir; As: South-western part of AntiAtlas, At: Tazenakht region of Anti-Atlas; Aj: Jbel Sahro region of AntiAtlas.

Inside High Atlas sites, three sub-units have been distinguished. Central High Atlas encompassed 19 sites, with elevation ranging from 1000 m to 2000 m a.s.l. Snow is usually present during winter. The two other sub-units are composed of low-elevation sites located near the Atlantic coast or in a more central place (Bin el Ouidane). These sites are characterized by the presence of *Euphorbia resinifera* and the absence of snow during winter.

On the eastern part of the High Atlas, two important "wadis" flow to the South and to the Sahara desert, wadi Ziz and wadi Guir, crossing the eastern range of the AntiAtlas. Four sites were located in the lower parts of these two wadis.

Sites of the AntiAtlas have been divided into three sub-units. Sites of the South-West and Tazenakht regions are located in desert habitat. The third sub-unit is located in Jbel Sahro, a volcanic and high-elevated massif. Due to the scarcity of precipitation, snow is rare during winter, but minimum temperatures fall below zero at that period.

Barbary ground squirrels are not abundant in the Middle Atlas. Only two sites have been observed, both of them located in the eastern part of the Middle Atlas.

### *Data collection*

In order to collect data on the social structure of the Barbary ground squirrel, we have prospected sites during five different periods of the year:

- May: from May 1st to May 6th 1991.
- December: from December 26th 1991 to January 2nd 1992.
- April: from April 18th to May 4th 1994.
- March: from March 11th to March 30th 1995.
- July: from July 11th to August 10th 1996.

All sites were not observed at each of the five periods (tabl. 1).

Group composition was assessed by direct observation using binoculars (10 x 50) or a telescope (20-50 x 63). Depending on the site, observation lasted from 2 hours up to a complete diurnal period. Using this method, one can recognize adults from young animals of less than three months of age. Among adults, lactating females, females at the end of gestation, and sometimes males when tests are in a scrotal position may be identified.

		Nb of sites	Altitude in m min. – max.	December	March	April	May	July
ANTI-ATLAS	South-West	12	525 – 950	–	–	young	–	–
	Tazenakht	8	720 – 1700	adults	preg. fem.	young	adults	adults
	Jbel Sahro	7	1390 – 2400	–	adults	–	adults	young
ZIZ and GUIR	Lower part	4	900 – 1300	–	–	young	adults	adults
HIGH ATLAS	Atlantic	3	150 – 340	adults	–	adults	–	–
	Bin El Ouidane	2	860 – 870	adults	–	young	–	–
	Central	19	1020 – 2080	adults	–	adults	adults	young
MIDDLE ATLAS	Boulemane	1	1590	–	–	–	–	young
	Enjil	1	1850	young	–	–	–	–

Table 1

Presence of young on sites of different regions as observed during the five periods.

Number of sites and minimum and maximum elevations are given for each region.

*Young*: lactating females and young were observed at least in one site;

*preg. fem.*: no young was observed, and a pregnant female was observed at least in one of the sites;

*adults*: only adults were observed on all sites of a given region;

– : no observation was made in this region at that period.

## Results

### *Reproductive period*

Data are summarized by geographic sub-regions in table 1. The reproductive period was assessed by the presence of young animals in at least one of the sites observed at a given period. The presence of a pregnant female was unambiguous in only one observation at a site of the Tazenakht region in AntiAtlas on March 26th. Five males were courting this female and were chasing each others. This observation tends to prove that a post-partum oestrus occurs in the Barbary ground squirrel and that two successive litters are possible in a same reproductive season. Nevertheless, the presence of young animals does not last for a long period. In the most regularly investigated Tazenakht

	ANTI - ATLAS			ZIZ and GUIR	HIGH ATLAS	MIDDLE ATLAS	
	South-West	Tazenakht	Jbel Sahro	Lower part	Central	Boulemane	Enjil
1 female and young	2	2	1		2		1
2 females and young	2	2		1	1		
Colony of families	1						
Males, females, young				1		1	
1 adult	2	1		1			
2 adults or more	2	2					

■ Table 2

Group composition during the reproductive period. The number of sites per region in which each type of group was observed is given.

region, young animals were observed only in April. A similar result was found in the central High Atlas but young were observed in July only. Reproduction appears to be highly seasonal but seems to occur at two different periods according to the geographic location. In high altitude sites of the High Atlas (central part) and of the AntiAtlas (Jbel Sahro), young were observed in July, while in lower altitude sites of AntiAtlas (South-West region and Tazenakht region) as in the wadis Ziz and Guir sites and Bin El Ouidane sites in High Atlas, reproductive period occurred in April.

In the Middle Atlas the situation is far less clear and more data are needed. In the Boulemane site, young were observed in July, while in Enjil juveniles were observed in December. According to their body mass, these juveniles may have been born in mid-autumn.

### *Group composition*

During the reproductive period, group composition differs greatly, even between sites of a given region (tabl. 2). The most simple family unit is composed of a single female with her young. The next step occurs when two females share their litters in a common rocky shelter. At the time of our observations, young had already emerged from the

natal nest and were able to move around independently. We have no direct observation of two females sharing a common natal nest, even if two females were observed together just before the reproductive season. These family units may form colonies. In two sites, the social group was more complex and included several lactating females (at least three) with their young, and at least one male.

## Discussion

These preliminary results revealed that the Barbary ground squirrel displays a high variability in reproductive period and group composition.

The period of reproduction differs dramatically according to the elevation of the site. In the high-altitude sites, both in High Atlas and AntiAtlas, reproduction occurs in summer while in other sites reproduction takes place in spring. Our fragmented data may give a distorted vision of the variability, and reproductive period variation may occur within a continuum. Nevertheless, such a range of intraspecific variability is unusual. For example, in the gundi, *Ctenodactylus gundi*, a diurnal rodent living in similar habitats (GOUAT and GOUAT, 1982; 1983), the range of variation in reproductive period between high-altitude and desert colonies does not exceed one month (GOUAT, 1985; 1988; 1991). In non-hibernating rodents, seasonal breeding is thought to be mainly determined by day-length variation. In the Barbary ground squirrel, temperature and food availability, primarily insects, may be key factors to initiate reproduction.

Variability in group composition during the reproductive season is high, but contrary to the reproductive period, no clear link with habitat was revealed by our data. The difference between sites of a given region may cover the complete range of variation observed. This social variety may contribute to the ecological success of this species as is shown by the diversity of habitats occupied. Proximal factors, both social and ecological, may explain variations in social structures as shown in the yellow-bellied marmot (ARMITAGE, 1973; 1975; 1977; 1982; ANDERSEN *et al.*, 1976; FRASE and ARMITAGE, 1984). Longitudinal observations are clearly needed to determine the key

factors of this variability. As in other species of ground squirrels, the formation of groups of females appears to be basis of an increase in the level of sociality (MICHENER, 1983). The range of variability observed in *Atlantoxerus getulus* however, exceeds what is described in each of the other ground-dwelling squirrel species (FERRON, 1991).

The Barbary ground squirrel has been found to occupy a wide variety of habitats. In addition, a substantial variety of social structures was observed in this species. The relationships between ecological constraints and social structures are far from being understood; *Atlantoxerus getulus* however, already appears to be a suitable biological model for further socioecological studies.

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