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Is There a Future for the Last Populations of Aoudad (*Ammotragus lervia*) in Northern Algeria?

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Authors' Contribution

FB conceived and designed the study. FB, NB and AA collected field data. FZB analyzed the data. SA established protocol of field data. FB and SA wrote the article.

Key words

Captive breeding, Poaching, Barbary sheep.

ABSTRACT

Very small natural populations of aoudad or barbary sheep remained in northern Algeria. Areas where aoudad has been previously reported were surveyed from 2012 to 2015 in spring and autumn. Animals were recorded at only four localities in the north-eastern part of the mountains, south of Tebessa, Batna, M'Sila and north east of Biskra, and only one in the western part south of Tiaret. Sighted groups included 1 to 11 individuals. The main threats to this species are reported, captive breeding is suggested as a tool for conservation.

INTRODUCTION

Aoudad or barbary sheep, *Ammotragus lervia* (Pallas, 1777) is endemic to the mountain regions of North Africa throughout the Sahara (Brentjes, 1980). Formerly widespread in any rugged and mountainous terrain from desert to open forest in Maghreb (Alados and Shackleton, 1997; Cassinello, 1998), aoudad is a polytypic species. However subspecies and their boundaries should be reassessed (Cassinello, 2013), particularly between the northern *A. lervia lervia* and the Saharan *A. lervia sahariensis* (Rotschild, 1913). While this species has been successfully introduced in Texas (Ogren, 1965; Simpson, 1980; Gray, 1985) and in Spain where it has expanded over the south-east of the country (Cassinello, 2000; Cassinello *et al.*, 2004), native populations experienced a dramatic decline so Aoudad is classified Vulnerable in the Red List of the International Union of Conservation of Nature (Cassinello *et al.*, 2008). It is also listed in Appendix II of the Conventionon International Trade in Endangered Species of Wild Fauna and Flora (CITES).

In Algeria, Joleaud (1927, 1928) described the northern limit of distribution when aoudad was still present in the Tell Atlas (Seurat, 1930). Then De Smet (1989) drew an updated map on the basis of a questionnaire survey. The northern range was restricted to the Saharan Atlas, with isolated populations in Djebel Messaâd near Bousaâda, in and around the Aurès, including Djebel Metlili near Ghardaia, and Nemamcha Mountains to the south of Tebessa (Kowalski and Rzebik-Kowalska, 1991). In the south, aoudad lived in the mountain areas of Algerian Sahara from Djebel Amour to the Tassili n'Ajjers (De Smet, 1989; 1997a; Kowalski and Rzebik-Kowalska, 1991). No estimate of population size was provided by De Smet (1997a), however only presence of small populations was suspected in the north. At last, this author reported an ongoing re-introduction in the Moutas Hunting Reserve near Tlemcen in the Tell Atlas.

In order to update this information and draw up an effective conservation plan for this species, we surveyed areas where aoudads have been reported, identified the main threats to the remaining populations and appraised the results of recent conservation efforts.

MATERIALS AND METHODS

A specific survey was conducted in Algeria from 2012 to 2015 in five governorates north of Sahara. Two field campaigns were carried out each year in March-May and October-November at each site where aoudad had been reported in the most recent literature (De Smet, 1989; Kowalski and Rzebik-Kowalska, 1991). There, information was collected either by direct field sighting

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or by interviewing local shepherds, hunters, forest rangers and wildlife naturalists. For field surveys each mountain site was divided in sample squares (20 x 20 km) distributed over the area. Within each square five 45min-transects separated by 1.5-2 km were randomly selected in rural areas and travelled by car on trails of by foot according to accessibility and logistics. The sampled distances were 100 km and 15 km, respectively, in Tebessa governorate, 50 km and 10 km in Batna, 55 km and 17 km in Biskra, 75 km and 18 km in M'Sila and 65 km and 25 km in Tiaret.

All surveys were conducted by the same team (FB and NB). We recorded two types of field data sources: (1) direct observations or sightings using binoculars early in the morning and in late afternoon, (2) indirect signs, such as tracks, isolated dung piles and latrines at any time of the day. For the later, possible confusions with goats and sheep were avoided because latrines of aoudad are larger than those of livestock.

Moreover, a questionnaire on local knowledge (presence/absence, behaviour, habitat in relation with human activity and threats) was sent to forest rangers, wildlife associations and hunters federations of all governorates including part of the Saharan Atlas to report on the presence/absence of aoudad in their area. Any positive information was verified by visiting areas where aoudad was reported. We searched for tracks and latrines in all biotopes favourable to this species.

Only areas where we recorded obvious signs of presence of Aoudad were considered, coordinates were achieved using a GPS (GARMIN-Etrex 10) and the number of animals was recorded when possible. We were able to distinguish both sexes and two age classes (adult *vs* juvenile). Data were mapped using MapInfo v 8.0 software and compared with those reported by De Smet (1989) (Fig. 1).

In Tiaret area a monitoring was conducted monthly from January 2014 to March 2015 in the south-west of the governorate with the help of the Sougueur forest conservation agency (Mr Abdi and colleagues).

Threats affecting this species were assessed by conducting an open inquiry among local people, hunters and forest service, and nature protection organization, and by visiting local markets. Whenever possible, photographs were taken to certify the reliability of the information.

RESULTS

Distribution

We recorded only five remaining small populations of aoudad in the northern Saharan Atlas, mainly in the eastern part (Table I, Fig. 1). Groups of 7 to 11 individuals were sighted in April 2014 and January 2015 north of Negrine (south of Tebessa governorate) at the border with Tunisia. The area lying at 500-600 m effects a transition between Saharan margins mainly covered by *Hammada scoparia* and a steppe dominated by *Aristida pungens.*

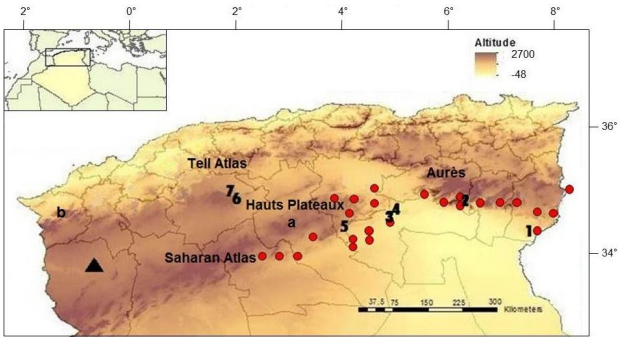

Fig. 1. Distribution of the Aoudad (*Ammotragus lervia*) in Algeria north of Sahara according to De Smet (1989, red circles) and our 2012-2015 survey (numbers: see Table I). The two reserves hosting this species are also plotted on the map (a: Djelfa Hunting Reserve, b: Moutas Hunting Reserve). The triangle locates Djebel Antar in Mcheria mountains.

In South of Aurès Mountains near Djebel Kimel (at the border of Biskra and Batna governorates) we sighted one group of 5 individuals during summer 2013 between 1500 and 1700 m in an alpha steppe spangled with Phoenicean juniper, *Juniperus phoenicea*, and Aleppo pine, *Pinus halepensis.* Local people confirmed that species was abundant in the 1980s but populations decreased dramatically due to poaching and destruction of habitat by nomads installed in isolated areas.

Two small populations were supposed to live in the northwestern part of Biskra governorate. At Djebel Ksoum two females and one male were observed in March 2013. The habitat is characterized by a rather low altitude (550 to 570 m), with vegetation dominated by *Artemisia herba-alba*, *A. campestris*, *Stipa tenacissima*, *Thymus ciliatus*, *Limoniastrum* sp., *Diplotaxis harra.* Nomads occupy the valley from October to March-April. East of Djebel Ksoum hunters reported the presence of few animals at Djebel Hamar Khaddou in a similar habitat in April 2014.

The most important population was recorded in Djebel Boukahil (south of M'Sila, next to Djelfa and Laghouat governorates), a mountain ranging between 1415 and 1675 m. Aoudad live there in a large insecure territory which was not possible to survey including plains stretched at 800-1000 m. Vegetation is dominated

Table I.- Sightings of the aoudad (*Ammotragus lervia*) recorded in Algeria north of Sahara in 2012-2015.

Governorates	Localities	GPS Coordinates		No. of males	No. of females
		Latitude	Longitude		
Tebessa	Negrine	34.410614	7.724843	4	7
Batna	Djebel Kimel	35.077345	6.500565	2	3
Biskra	Djebel Ksoum	34.838542	5.019183	-	3
	Djebel Hamar Khaddou	34.951612	5.144590	1	-
M'Sila	Djebel Boukahil	34.555417	4.176150	3	5
Tiaret	Djebel Chamekh: El Bezaz	35.019746	2.011470	1	-
	Djebel Chamekh: Chebka	35.207404	1.857375	-	3

by *Stipa tenacissima, Lygeum spartum, Artemisia herba-alba, Aristida pungens* and *Arthrophytum scoparium*.

In western Algeria, we recorded one small isolated population for the first time in Nador mountains at El Bezaz and at Chebka (Djebel Chamekh) (south of Tiaret governorate). Two females and one male have been monitored for 12 months in these isolated mountains offering a suitable rocky habitat ranging up to 1508 m and covered with Aleppo pine and Phoenicean juniper for El Bezaz. At Chebka altitude is about 1475 m and vegetation is dominated by *Steppa tenassima* sparsed by some small evergreen oaks, *Quercus ilex*, thuyas, *Tetraclinis articulata*, and mastics, *Pistacia lentiscus*.

Threats

Poaching is ongoing in Algeria, individuals are still hunted for trophies, such as the last male captured near Djebel Antar (above Mcheria, Naäma governorate), drugs (male pellets are given aphrodisiac attributes), etc), Aoudad meat is very enjoyed for its delicacy and hunters come from nearby areas for killing this species, using traps designed to capture individuals. Stuffed specimens can even be found for sale in tourist markets, such as in Bousaâda, Taghit, Ghardaia).

Among the indirect threats, habitat loss is the most important. Aoudad is repelled to the most remote mountain areas by competition with increasing flocks of nomads, disturbance and even attacks of free-ranging dogs. Quarrying in mountains and road construction are other sources of displacement and habitat degradation. Repelled in remote areas, animals are easier to catch by poachers.

DISCUSSION

According to scientific expeditions during the XIXth century (Gervais, 1848; Aucapitaine, 1856; Loche, 1858, 1867; Colomb, 1858; Tristram, 1860), aoudad was widely distributed in northern Algeria. However, when Joleaud (1927, 1928) mapped its distribution the species had already disappeared from localities previously reported by these authors. Although still present in the northern parts of the Saharan Atlas in the region of Aïn Ben Khelil and Sidi Abid mountains next to the Moroccan border (Joleaud, 1927, 1928), our investigations are in agreement with De Smet (1989), no traces of aoudad have recently been reported in these areas. The most recent record there is the male killed in the Mcheria mountains in the 1980s and kept by an NGO.

As a result of our survey most parts of north-western Algeria are not favourable to this species any longer. The major discovery was the relict population that we found in Nador mountains, in the south of Tiaret governorate, where Abdi (2014) studied local gazelles. None previous author mentioned aoudad in this area; the nearest recent records were reported in 1985 from the governorate of Djelfa (Kowalski and Rzebik-Kowalska, 1991). Indeed the presence of *Ammotragus lervia* at Tiaret is known by local people and recorded in rock engravings (Abdi, 2014). We hypothesize that these isolated mountains acted as refuges for wandering aoudads coming from the Saharan Atlas. However it should be noted that a project was planned in 1988 in this area for the conservation of wildlife, mainly Aoudad and Cuvier's gazelle. Watchtowers were even installed, but they are now ruined.

Aoudad has long been reported in the region of Sidi El Hosni M'Ghilla known for its cliffs and rugged terrain but, according to statements, the last indigenous individuals have disappeared in the eighties.

In the eastern mountains north to the Sahara, most records reported by De Smet (1989) were not confirmed, and only four remaining small to very small populations have been recently located. The isolated population of Djebel Messaâd near Boussaâda (De Smet, 1989) was extirpated, the last male being killed in 1985.

With the exception of Djebel Boukahil which possibly hosts the largest number of aoudad in the area, most previously reported populations (De Smet, 1989) dramatically decreased with only three animals sighted at

Djebel Ksoum, one or two at Djebel Hamar Khaddou and five at Djebel Kimel. No sign of presence could be found in the locality of Kantara although it represents the typical habitat for the species; the strong human impact of this region probably got rid of the remnant populations.

We did not record any presence in mountains of Nemamcha and Tebessa despite possible exchanges through the Algerian-Tunisian border with the semi-captive populations of Jebel Chaâmbi (Ben Mimoun and Nouira (2012). We only confirmed the presence of a small population which may cross the border in the Negrine region at the extreme south-east.

Overall, the range and population size of aoudad are very small in northern Algeria, a status which is similar in Tunisia (De Smet, 1997b; Ben Mimoun and Nouira, 2012; Ben Mimoun *et al*. 2016), but not in Morocco where the species is more widely distributed north to the Sahara (Loggers *et al*., 1992; Aulagnier and Thévenot, 1997; Cuzin, 2003).

Conservation issues

Ammotragus lervia was officially protected in Algeria in 1975 by "décret 83 du 08 août 1983 relatif à la protection des espèces d'animaux sauvages non domestiques". However, aoudad suffers from ongoing hunting (or poaching) pressure, disturbance and habitat loss which have led most populations of northern Algeria to become extinct or on the verge of extinction. To counteract a dramatic decline and likely extirpation, several measures should be simultaneously undertaken: reinforcement of legislation, forming of local conservation committees (Raza *et al.*, 2015), education programs, creation of protected areas, and reintroduction in the most suitable areas.

Aoudad occur in two protected areas, but both are located in southern Algeria: Tassili n'Ajjer and Ahaggar national parks (Illizi and Tammenserrasset gouvernorate respectively). We did not confirm the presence reported by De Smet (1997a) in Belezma National Park where the species became extinct 30 years ago according to local people. Djebel Aissa State Forest, in El Ksour mountains, part of the Saharan Atlas, could host a Saharan population. De Smet (1997a) suggested to establish more reserves and re-introduce aoudad into Djelfa Hunting Reserve (20,000 ha) located in the High Plateaux (34°40'N, 3°15'E) and into two enclosures (Torrich, 35 ha, Boumerder 13 ha) of Moutas Hunting Reserve (400 ha near Tlemcen) in the extreme north-west Algeria (34°52'N, l°15'E). In Djelfa Hunting Reserve, from two individuals in 1993 the population was recently estimated to reach 24 animals. In Torrich six individuals from Algiers' zoo and El Hamma enclosure have been released from 2006 to 2008 to reach 15 individuals in 2012. In Boumerder, 11 individuals from Torrich were released in 2009 to reach 21 animals in 2012. Now, authorities of this reserve plan to open the whole protected area to offer more space to the aoudad population.

Based on this ongoing success, a reserve should be established to protect the remaining population north of Negrine and also near Bechar where poaching is threatening the last numerous population of northern Sahara.

CONCLUSIONS

With only five remaining small populations of aoudad north to the Sahara, mainly in the east, survival of Aoudad is almost hopeless in northern Algeria. As a result of our surveys most parts of the territory are not favourable to this species any longer. The major discovery was the relict population that we found in Nador mountains, in the south of Tiaret governorate. *Ammotragus lervia* has been legally protected from 1975, but poaching is ongoing. Human impact on both animals and habitats induces isolation of small populations and loss of genetic exchanges. Conservation should be promoted at different levels: better protection inside reserves, law enforcement and education. Further studies should include surveys in remote areas, genetic studies and ecological modelling to identify additional protected areas where animals could be reintroduced.

Statement of conflict of interest

Authors have declared no conflict of interest.

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