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Updated distribution and local abundance of the endangered Cuvier's gazelle (Mammalia, Bovidae) in Algeria

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Abstract. The Maghreb endemic Cuvier's gazelle experienced a dramatic decline during the 20th century, both in distribution and abundance. After the syntheses published in the 1990's, we update the knowledge on the distribution and abundance of this species in Algeria from two independent sources: (1) field surveys, (2) answers to a questionnaire. The comparison of data collected 25 years after the last inventories suggests a slight reduction of the range, Cuvier's gazelles retreating to the optimum habitats along the south-western part of Algeria. Populations in Tiaret and M'sila governorates, which were particularly monitored, showed different ecology and dynamics.

Key words: *Gazella cuvieri*, survey, range, status

Introduction

Endemic to mountains and hills of the Atlas and neighbouring ranges of Maghreb, the Cuvier's gazelle (*Gazella cuvieri* Ogilby, 1841) inhabits steppes, maquis and open semi-arid Mediterraean forests (Cuzin 2003), from sea level to 3100 m in the High Atlas (Morocco, Cuzin F., pers. com.). Seasonal movements have been recorded, mainly where domestic flocks move to high altitude pastures in summer (Cuzin 2003). The specific status of this gazelle has been ascertained by recent genetic studies which revealed an unexpected genetic variability (Lerp et al. 2013, Silva et al. 2015). *G. cuvieri* is listed as Endangered (C2a(i)) in the IUCN Red List of Threatened Species (Mallon & Cuzin 2008). This classification is based upon a total population estimated at 1750-2950 (no subpopulation is known to contain more than 250 mature individuals), continuing decline and ongoing threats including overhunting and habitat degradation. After a severe decline during the 20th century, some populations are stable or even increasing (Mallon & Cuzin 2008).

In Algeria, the range of *G. cuvieri* extended north to the Mediterranean coast until about 1930 (Lavauden 1926, Joleaud 1929, Seurat 1930). The last surveys were carried out during the 1990's (De Smet 1989, 1991, Sellami et al. 1990, Boukrabouza 1998) (Fig. 1) and their results were used in subsequent papers (e.g. De Smet & Smith 2001, Beudels et al. 2006). Based on these data, the most recent synthesis (Beudels et al. 2013) reported that the Cuvier's gazelle was limited to the northern part of the country, being found neither in the north of the Tell Atlas nor south of the Saharan Atlas. The northern part of the range extended from Ouled Mimoun Tlemcen, Sidi Bel Abbès, Saida, Mascara, Tiaret, Tissemsilt to Relizane (Sellami et al. 1990). The southern part stretched along the Atlas Mountains from Ain Sefra and Mounts of Ksours near El Bayadh, Laghouat, Djebel Boukahil, Bousaâda, Djelfa to Biskra, Hodna plateau (Mergueb area at

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Fig. 1. Distribution of the Cuvier's gazelle (*Gazella cuvieri*) in Algeria in the nineties (from De Smet 1989, 1991 – grey; Sellami et al. 1990 – black).

M'sila), and south of the Aurès and Nemamcha Mountains reaching the governorates of Khenchela and Tebessa (De Smet 1989, 1991, Sellami et al. 1990).

Almost all the large national forests of Aleppo pines *Pinus halepensis* sheltered small populations, such as in Djebel Messâad (Benamor 2014) and it was also relatively common in the hills between Mascara, Relizane, Tiaret and Frenda, living in open countryside with a mosaic of grain crops and pasture lands at the top of the hills (Bounaceur et al. 2012, 2013, Beudels et al. 2013). Sellami et al. (1990) reported a total number of 400 individuals when De Smet (1991) estimated a number of 560 individuals: 235 individuals in the Tell Atlas, 140 individuals in the Saharan Atlas, 135 individuals in the eastern mountains and 50 individuals in the Mergueb area.

More than 20 years later the distribution and abundance of the Cuvier's gazelle instigated two surveys in order to fill a gap of knowledge, update the species status, and suggest improvements for its management and conservation. For this purpose these new data will be compared with the previous studies of De Smet (1989, 1991), Sellami et al. (1990) and Boukrabouza (1998), and a focus will be given to two governorates, Tiaret and M'sila.

Table 1. Field survey of *Gazella cuvieri* in 14 governorates of northern Algeria from March 2012 to April 2015: distances proceeded through by car and by foot (in km).

Governorate	Distance by car	Distance by foot
Batna	85	5
Béchar	280	15
Biskra	210	11
Chlef	50	3
El Bayadh	110	8
Khenchela	90	4
Mascara	55	3
Naâma	150	5
Relizane	100	6
Saida	50	4
Sidi Bel Abbès	40	2
Tebessa	186	11
Tissemessilt	90	4
Tlemcen	70	3

Material and Methods

The present study on the distribution and abundance of the Cuvier's gazelle in Algeria relies on two independent sources: specific field surveys from March 2012 to April 2015 in 14 governorates and answers by local forest rangers to a questionnaire sent in October 2013 by the National Agency for Nature Conservation (ANN) and General Forest Department (DGF) in 32 governorates where the species has been formerly recorded. During field surveys we visited four to five times each of the 52 localities where the presence of gazelles was suspected in March-May and October-November. There, information was collected either by direct field sighting or by interviewing local shepherds, hunters, forest rangers and wildlife naturalists. Any positive information was verified by visiting areas where the Cuvier's gazelle was reported. All surveys were conducted by car or by foot by the same team of three persons seconded by local guides (Table 1). Following Abáigar et al. (2005), we recorded three types of field data: (1) direct observations or sightings using binoculars Barska 10×50 and a telescope ×20-60 in early morning and late afternoon, (2) photographs using a camera Canon (EOS 1200D 18-55 mm lens), (3) 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 gazelles are easily identifiable (piles of small faeces with elongated tip) and the Cuvier's gazelle is the only gazelle in the surveyed area. On the 27 governorates who answered the ANN-DGF questionnaire (supplementary material), 16 reported recent sightings of the Cuvier's gazelle including numbers of individuals and locations, and 11 reported none.

Both surveys collected information on the presence of the Cuvier's gazelle only, with GPS coordinates, and the observed numbers. GPS coordinates were processed using MapInfo v 8.0 and compared with those reported by De Smet (1989, 1991) and Sellami et al. (1990).

In order to get more knowledge on the development of

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Fig. 2. Distribution of the Cuvier's gazelle (*Gazella cuvieri*) in Algeria according to our field investigations (sighted groups of gazelles).



Fig. 3. Distribution of the Cuvier's gazelle (*Gazella cuvieri*) in Algeria according to ANN-DGF questionnaire (reported groups of gazelles).

Table 2. Monitoring of *Gazella cuvieri* by field transects in Tiaret and M'sila governorates (northern Algeria) between January 2012 and December 2014 (GPS co-ordinates are listed in Appendix 1).

		Transect length (km)	Maximum recorded number	Encounter rate ind/km
Tiaret	Rahouia: Ain El Kahla	10	13	1.30
	Guertoufa: Tourich	8	10	1.25
	Guertoufa: Mkhatia	4	8	2.00
	Guertoufa: Temda	12	8	0.67
	Oued Lili: Djebel Arar	5	5	1.00
	Oued Lili: Djebel Sidi Maârouf	7	7	1.00
	Mechraâ Sfa	8	9	1.13
	Frenda	6	12	2.00
	Nadorah	5	8	1.60
	Faidja	12	13	1.08
M'sila	Ain Kahla	6	0	0
	Bou Mellal	5	0	0
	Djebel Lossiki	4	0	0
	Djebel Messaâd	30	17	0.57
	Djebel Sellat	25	7	0.28
	El Dhemra	5	0	0
	El Dhokara	7	0	0
	El Jinibia	8	0	0
	Mergueb	25	0	0
	M'harga	21	5	0.24

populations, we monitored two distant localities from 2012 to 2014, near Tiaret in the west and M'sila in the east. In Tiaret governorate we sampled 10 transects by foot for a total distance of 77 km (Table 2) in the main habitats avoiding the vicinity of villages and intensively cultivated areas (Attum et al. 2014). In M'sila governorate we also sampled 10 transects by foot for a total distance of 136 km in suitable habitats (Table 2). This monitoring was conducted once per season (winter, spring and autumn) each year by direct observations and photographs in the conditions described above. Age and sex of the animals was estimated from body size, horn shape and size as often as possible. The distribution was also mapped using MapInfo v 8.0.

Results

Distribution of Cuvier's gazelle in Algeria

Due to the lack of answer to the ANN and DGF questionnaire from some governorates, both surveys revealed to be complementary (Appendices 1 and 2). We obtained 52 Cuvier's gazelle locations from our surveys (Fig. 2), while the questionnaire of ANN and DGF supplied the presence of this species in 40 locations (Fig. 3). These data show that the present southern distribution of the Cuvier's gazelle stretches

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from Ouarkziz Hamada, near Tindouf, in the west, to Nemamcha Mountains in the east; the northern range spreads from Magoura (Tlemcen) in the north-west to Tissemsilt in the Ouarsenis central mountains.

The original record from the Ouarkziz Hamada, at the border with Morocco, extends the distribution in the Sahara. Slightly in the north, we observed groups of gazelles in seven hamada and mountain localities near Béchar where their presence was regular from Kenadsa to Beni Ounif. In the Saharan Atlas, gazelles were reported only from El Bayadh, none was observed north of Laghouat. To the north of Atlas, small groups were observed in the steppe and Aleppo pine Senalba Forest (Djelfa), as well as in mixed forests of Djebel Messaâd, south to Bousaâda (M'sila). The answer to the questionnaire mentioned only two individuals near Mergueb Nature Reserve, and we found a small population in the Djebel Sellat 50 km south from the reserve. An important population was recorded in mixed forests (*Pinus halepensis*, *Juniperus phoenicea*, *Quercus ilex*) of Djebel Boukahil in M'sila governorate too. Cuvier's gazelle was also mentioned in six locations from Biskra, near Ras El Miaâd, to the Aurès: Bitam, Kimel and Djebel Metlili (Batna), Bouhmama and Chechar (Khenchela), and the Nemamcha Mountains (Tebessa).

In the north-western part of the country, the gazelle range extended over agricultural lands, mixed forest of *Pinus halepensis*, *Quercus ilex* and *Quercus suber* and Mediterranean bush, from Magoura (at the border with Morocco) to Sidi Bel Abbès through Tlemcen. Populations occurred in open forests from Saida to Mascara, including the Benichograne Mountains. In the high plateaux covered with wheat fields and grasslands, there were also observed in Tiaret, along the Ouarsesnis Mountains (Tissemsilt), and in the south of Chlef and Relizane governorates. The two later localities are the most northern present records of Cuvier's gazelle in Algeria.

Distribution and abundance in Tiaret and M'sila governorates

In Tiaret governorate, populations of the Cuvier's gazelle from Rahouia and Oued Lili are connected with those from Relizane and Tissemessilt. They are quite abundant in the north of the governorate near Guertoufa, Oued Lili, Rahouia, Mechraâ Sfa and Frenda (with 0.67 to 2.00 animals/km). Two more localities were recorded in the south at Djebel Nador, Faidja and Nadorah (1.08-1.60 animals/km).

In M'sila governorate, Cuvier's gazelles were only recorded in the south of the governorate (Fig. 3), with lower densities: Djebel Sellat, to the south to the Nature Reserve of Mergueb, M'harga, at the border of Batna governorate with Djebel Metlili, and Djebel Messaâd. The later population is connected with that of Djebel Boukahil, at the south-east of the governorate, which is estimated between 180 to 200 individuals in this "insecure area".

Discussion

Algerian distribution

The updated distribution of the Cuvier's gazelle does not differ a lot from the previous surveys in the nineties (De Smet 1989, 1991, Sellami et al. 1990, Boukrabouza 1998). On the contrary the species is far more widespread in the north-western Algeria than formerly believed (De Smet 1991). For the first time we report its presence in Tindouf governorate according to data of DGF (2013). A study conducted on Argan tree (*Argania spinosa*) forest of Tindouf also reported the presence of the Cuvier's gazelle in the Hamada of Tindouf (Baumer & Zeraïa 1999). These records are probably related to the neighbouring Moroccan populations, toward the north and the west (Aulagnier et al. 2001, Cuzin 2003, Gil-Sánchez et al. 2014).

After a gap due to a poor accessibility, the distribution stretches along the Sahara Atlas, from Béchar – Ain Sefra where De Smet (1991) reported 30 individuals, however no gazelle was recently observed in El Bayadh – Brezina and Aflou – Laghouat (De Smet 1991), except two animals near Sidi Taifour (El Bayadh, ANN-DGF 2014). In this area, where we received few answers to the questionnaire from Naâma and El Bayadh governorates, and none from Laghouat, there could be a recent extirpation by hunters and/or misidentification of dorcas gazelles (*Gazella dorcas*), a species reported there by Fellous (2013). The former common status reported by Beudels et al. (2006) in this area should be investigated further.

In accordance with Sellami et al. (1990) and De Smet (1991), the Cuvier's gazelle is still present in Aleppo forests of the Senalba Mountains, Djebel Messaâd and Djebel Boukahil. No prospection was conducted in the Djebel Sahari hunting reserve and Guelt es Stel where the species was reported by the previous authors. Gazelles retreated from previously occupied hilly areas of M'sila to refuge along Djebel Sellat (Benamor & Bounaceur 2014). They are now rare in the Mergueb Nature Reserve where Sellami (1998) completed his PhD thesis on ecology and diet of this species. Supposedly connected with Djebel Boukahil, we recorded an unreported population at Ras el Miaâd,

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in the north-west of Biskra. The Belezma National Park (Djebel Metlili) also shelters a small population whose diet was studied by Arbouche et al. (2012). In the south of Aurès and Nemamcha Mountains, several populations are still living in semi-arid and arid reliefs. More north, Cuvier's gazelles inhabit Aleppo pine forests including Tebessa forest where De Smet (1991) reported 80 individuals in at least nine localities (Sellami et al. 1990). These populations were possibly connected with their counterparts in the Chaâmbi National Park Tunisia (Smith et al. 2001, Abáigar et al. 2005).

In the western part of Algeria the Cuvier's gazelle was recorded in all localities reported by Sellami et al. (1990) and De Smet (1991) in Aleppo pine forests of governorates of Saida, Sidi Bel Abbès and Tlemcen (except between Sfisef and Sidi Bellebas where human activities dramatically increased), and open habitats of governorates of Chlef, Relizane, Tiaret, Tissemsilt and Mascara. In addition, we recorded its presence at Boukadir near Chelif, Sidi Lazerg near Zemmora, and at Remka, Ain Tarik, Seffah, Mendes, with groups of 8 to 20 individuals in February 2015. The reappearance near Theniet el Had (De Smet 1991) was confirmed in the southern slopes of the national park (Fersiouane Canton). In the Tissemsilt region, gazelles were observed together with domestic sheep (Bounaceur et al. 2012). The northernmost records of these authors were possibly inaccurately mapped. This gazelle was reported for the first time south of the Tlemcen Mountains near the border with Morocco, where individuals have been recently sighted.

Abundance in Tiaret and M'sila governorates

Data collected between 2006 and 2013 showed that the Cuvier's gazelle was widely distributed in the north of Tiaret governorate (Bounaceur et al. 2015). De Smet (1991) reported 100 individuals for Tiaret – Frenda – Tighenif and 30 individuals for Djebel Nador. Our records are very similar, except that populations of Tighenif (Mascara governorate) were not included. We think that populations are even increasing in open areas of wheat fields (Bounaceur et al. 2012, 2013), a comprehensive study of population dynamics in the Tiaret region is ongoing. The Cuvier's gazelle benefits of special status from the local human population, hunting and poaching are precluded because this species is considered inviolable and local myths favour population growth (Bounaceur et al. 2013).

In M'sila governorate, this gazelle is declining, mainly in the Mergueb Nature Reserve where 50 individuals were reported by De Smet (1991), and only two by ANN-DGF (2014). While Sellami & Bouredjli (1992) were able to study their social structure, including harems, it seems that gazelles are now absent from vast areas regularly occupied by nomads and hunters. This reserve is impacted by overgrazing, habitat degradation and disturbance by dogs (Boudjadja et al. 2010). We suggest that direct mortality factors, such as poaching, decrease of food availability by concurrence with domestic flocks, accelerated a local extinction. Considering the nomadic behaviour of Cuvier's gazelles (Beudels et al. 2013) some animals likely retreated in the neighbouring mountains such as Djebel Sellat. In the south, at Djebel Messaâd some populations have been recorded by Benamor (2014) who studied the species distribution and local diet.

The Cuvier's gazelle was legally protected in Algeria in 1975 (ministerial decree n°83-509 about 20th August 1983), but poaching is ongoing. However, better protection inside reserves and law enforcement improved the status of this species in the recent years. Thus, its distribution did not reduce much during the last 25 years and most populations remained stable but some decreased lot. Their status can be very different among and within regions as we showed in our two examples. Human impact on both animals and habitats, including fragmentation inducing isolation of small subpopulations and loss of genetic exchanges, can be deleterious and conservation should be promoted at different levels. New populations of the Cuvier's gazelle were recorded at the border with Morocco, mainly as a result of an increasing field work. Studies on this endangered species should include surveys in remote areas and comprehensive investigations based on the most recent modelling.

Combining the sources and without considering the remote and insecure areas, more than 600 Cuvier's gazelles were sighted, which is close to the number of 560 individuals estimated by De Smet (1991). However local regression and even extirpation were documented, so the status of Algerian population of *G. cuvieri* including no sub-population containing more than 250 mature individuals and a continuing decline should remain "endangered" (C2a(i)).

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Supplementary online material

Appendix 1. Location and abundance of the Cuvier's gazelle (*Gazella cuvieri* Ogilby, 1841) in Algeria according to our survey from 2012 to 2015 (http://www.ivb.cz/folia_zoologica/supplemetarymaterials/bounaceur_et_al._appendix1.doc).

Appendix 2. Location and abundance of the Cuvier's gazelle (*Gazella cuvieri* Ogilby, 1841) in Algeria according to the ANN-DGF (National Agency for Conservation of Nature-General Directorate of Forestry) survey from 2012 to 2014 (information provided by FC: Forest Conservation, NP: National Park, UCD: Unit for conservation and development, HR: Hunting Reserve). Most of data are listed in ANN-DGF (2014) (http://www.ivb.cz/folia_zoologica/supplemetarymaterials/bounaceur_et_al._appendix2.doc).

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