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Inventory and distribution of the rodents in Aurès Mountains and Ziban oasis (Northeast of Algeria)

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Resumen

Inventario y distribución de los roedores de las Montañas Aurès y el oasis de Ziban (noreste de Argelia)

Nuestro estudio muestra un inventario de roedores del noroeste de Argelia. Tas especies se capturaron en dos regiones: Taouziant (Montañas Aurès) y Bouchagroune (oasis de Ziban). El periodo de muestreo duró diez mees en cada lugar: en Taouziant de febrero a nobiembre de 2014 y en Bouchagroune de septiembre de 2013 a junio de 2014. El método de trampeo en línea fue llevado a cabo mediante 40 jaulas-trampas instaladas en las regiones de estudio. Se capturaron ocho especies, que pertenecen a tres subfamilias y seis géneros. Tres especies se distribuyen en las dos regiones *Rattus rattus*, *Mus musculus* y *Gerbillus amoenus*. Tres especies se capturaron en los campos de cereal de Taouziant (*Rattus norvegicus*, *Meriones shawii* y *Jaculus jaculus*) y dos especies en el palmeral de Bouchagroune (*Psammomys obesus* y *Gerbillus gerbillus*).

Palabras clave: Inventario, Roedores, Trampeo, Taouziant, Bouchagroune, Argelia.

Abstract

Our study presents an inventory of rodents in Northeast of Algeria. The species were captured at two regions: Taouziant (Aurès Montain) and Bouchagroune (Ziban oasis). The sampling period takes ten months at each site: in Taouziant between February to November 2014 and in Bouchagroune, from September 2013 to June 2014. The method of trapping online was performed using 40 wire traps installed at the studied regions. Eight species were captured. They belong to three subfamilies and six genera. Three species occur in the two regions: *Rattus rattus*, *Mus musculus* and *Gerbillus amoenus*. Three species were captured in Taouziant cereal fields (*Rattus norvegicus*, *Meriones shawii* and *Jaculus jaculus*) and two species were found in Bouchagroune palm grove (*Psammomys obesus* and *Gerbillus gerbillus*).

Key words: Inventory, rodents, trapping, Taouziant, Bouchagroune, Algeria.

Introduction

Rodents have a natural geographic distribution that covers the whole world and occupy all types of environments and they represent more than 40% of mammals diversity.

Most African rodents are herbivorous-granivorous and some of them can cause significant crop damage (Hubert 1984; Granjon & Duplantier 2009). By destroying crops or modifying the soil by their burrowing systems and galleries, they are considered as pests (Singleton *et al.* 1999, 2003).

Some of these species are responsible for health problems for humans and domestic animals because they act as reservoirs of various pathogens, which they transmit directly or indirectly to humans such as cutaneous leishmaniasis in several regions in Algeria (Boudrissa *et al.* 2012 and Cherif *et al.* 2012). Bitam *et al.* (2008) detected the species Bartonella spp in different rodents, this bacterium is the causative agent of Bartonellosis disease. Enzootic plague has been reported by Malek *et al.* (2015). The prevalence of rickettsioses in febrile exanthemas in eastern Algeria is examined by Mokrani *et al.* (2012). Benredjem *et al.* (2014) investigate Lyme disease and tickborne rickettsioses transmitted by Ixodes ricinus ticks in northeastern Algeria.

Among the previous works carried out on rodents inventories in Algeria we quote: Kowalski & Rzebik-Kowalska (1991), Belabbas & Butet (1994), Hamdine (2000) and Hamdine *et al.* (2006), Khammes *et al.* (2006) and Khammes & Aulagnier (2007). More recently, the works of Adamou-Djerbaoui *et al.* (2010, 2011, 2013, 2015), Bachar & Belhamra (2012), Souttou *et al.* (2012), Beddiaf *et al.* (2013) and Hadjoudj *et al.* (2015). Despite all these works large areas of the country still remain to be prospected.

Our work aims at an inventory of rodents in two poorly known regions. The first is located in semi-arid region of the Aurès Mountains: Taouziant region (Khenchela Department, that was never explored for such purpose. The second is located in arid region of the Ziban: Bouchagroune region (Biskra Departement).

Material and methods

Study area

The study was carried out in two geographically and climatically different regions (Fig. 1).

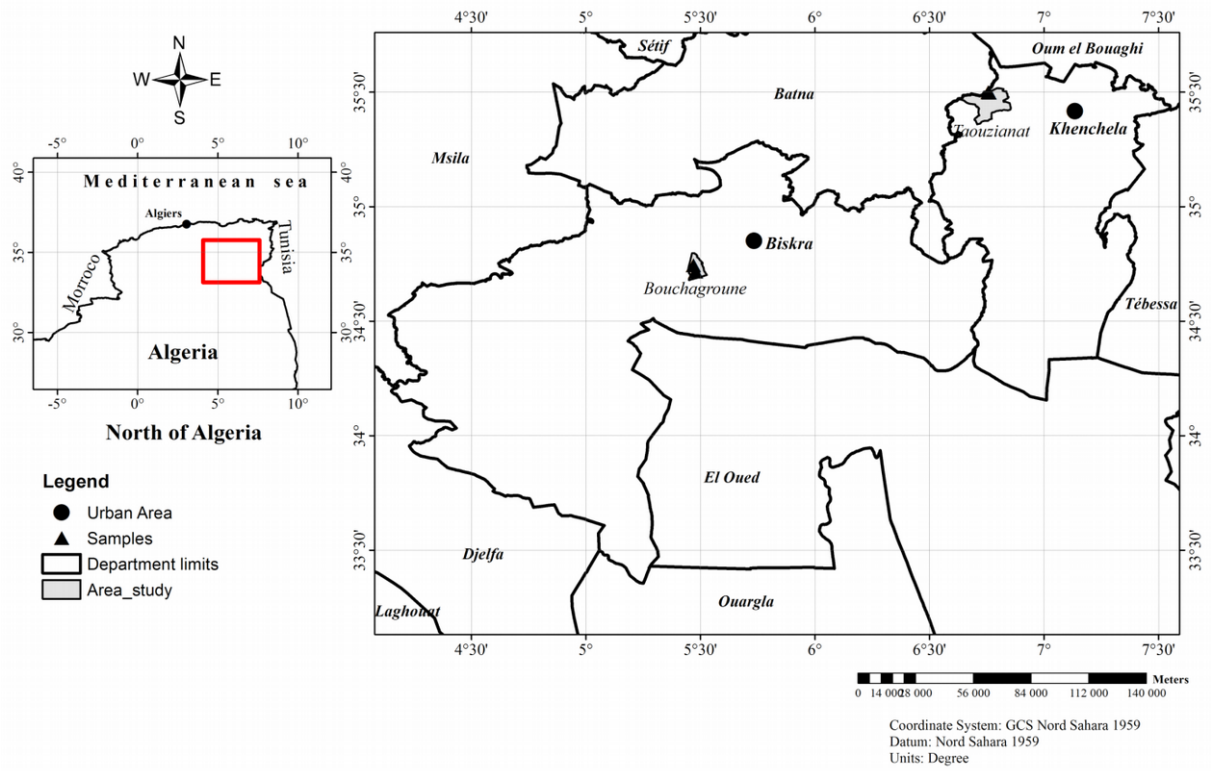

Figura 1. Áreas de estudio: localidades de Taouziant y Bouchagroune.
Figure 1. Study areas: Taouziant and Bouchagroune localities.

Departement	Locality	Geographical coordinates		Exploration period	Habitat specificities
Khenchela	Taouziant	35°29'52.8"N 6°45'34.3"E	968 MASL	February to November 2014	Cereal fields and peripheral zone
Biskra	Bouchagroune	34°42'56.8"N 5°28'40.8"E	132 MASL	September 2013 to June 2014	Palm grove, dates storage area and peripheral zone

Tabla 1. Localidades encuestadas en el área de estudio, coordenadas geográficas, período de exploración y especificidades del hábitat
Table 1. Localities surveyed in the study area, geographical coordinates, exploration period and habitat specificities

The Khenchela region, located in the South-east of Constantine at the foothill of the Aurès Mountains, shows agricultural and natural landscapes. The average maximum temperature, 34.9 °C, occurs in July and the minimum is in January, 1.85 °C. The annual precipitation is 508.83 mm. This region is classified in the semi-arid climatic zone. The trapping station is located at 4 km to the west of the city of Taouziant (Table 1). The traps are deposited in the agricultural fields (cereals: barley, durum wheat and soft wheat) and in the peripherals (pastoral zone) which counts several plant species among which *Artemisia herba-alba* Asso, *Ziziphus lotus* (L.) Lam. and *Retama raetam* (Forssk.) Webb & Berthel.

The region of Biskra, known as Ziban, is an oasis. It is located at the Southern foothills of the Saharan Atlas. Its northern limit is made up of high mountains that attenuate the extension of the influences of the humid Mediterranean climate and gives the region an arid character towards the Sahara in the south.

The region of Biskra, known as Ziban, is an oasis. It is located on the southern foothills of the Saharan Atlas. Its northern limit is made up of high mountains that attenuate the extension of the influences of the humid Mediterranean climate and gives the region an arid character towards the Sahara in the south. The average maximum temperature is observed in August with 41.38 °C, the minimum during January with 8.26 °C. Precipitation during the study period is 125.4 mm, while in the ten years (2004-2014) it is 128mm. The trapping station is located in the commune of Bouchagroune (Table 1). The traps are deposited in the palm grove, dates storage zone and in the peripherals (steppe zone). It is covered by several species of plants: *Macrochloa tenacissima* (L.) Kunth, *Atriplex halimus* L., *A. herba-alba*.

Sampling

During 10 months: from February to November 2014 in Taouziant and September 2013 to June 2014 in Bouchagroune (Table 1) we performed trapping sessions in these two localities. The plots in the study sites were chosen based on indices of presence of rodents (active burrows, droppings, etc.) and according to the arrangement plots in relation with roads access and the presence of an officer surveillance.

In our inventory, we used 40 wire traps in each site, the mousetrap is BTS type (Besançon Technique Service, France) with the following measures; length: 30 cm, width 14 cm, height 12 cm). They were placed for three consecutive nights on two 100 m lines and spaced 35 m apart. The space between the mousetraps of each line was 05 m (Avenant & Cavallini 2007; Adamou-Djerbaoui *et al.* 2015).

Each month, the baited mousetrap were installed in the afternoon and left for three consecutive nights and were collected every morning (Adamou-Djerbaoui *et al.* 2015, Dupuy *et al.* 2007). The total number of trap nights in the two study regions was 2400 trap nights:

2400 trap nights = [40 mousetraps x 2 sites x (3 nights / month)] x 10 months

The traps were baited by the sheep grease or bread with tuna and dates (Zaime & Pascal 1988, Denys *et al.* 2015).

Each live captured specimen was placed in a labelled box in order to determine the species and to avoid possible contamination of zoonoses in these micromammals.

Trapping Effort, Abundance Index (IA)

Trapping effort is the number of rodents caught / 100 trap nights (Avenant & Cavallini 2007). According to Hamdine (2000), the index of abundance "success of trapping" is given by the following formula:

$$IA = Ni / (NNT) \times 100$$

Ni: Number of specimens caught for different species;
NNT: Number of night-traps = number of nights x number of traps.

Analysis of rodent fauna

The alived captured specimens were carried to the laboratory and euthanized. Each specimen was weighted (body mass in g) and the standard exter-

nal measurements recorded: body length with head (BH), length of tail (T), hind foot length (HF) and ear length (E) were also taken in mm. The determination was made using the identification keys of Bernard (1970), Aulagnier & Thevenot (1986), Granjon & Duplantier (2009) and Couzi (2011).

Species abundance, species diversity and community composition & structure

To evaluate the species abundance, species diversity and the differences in community composition and structure at each site, data were analyzed using PAST software (Paleontological Statistics; Version 2.17). The indexes used to examine rodent community were: species richness (S), relative abundance (RA), dominance (D), Shannon diversity index (H), Simpson Diversity index (1-D) and evenness (E). These indices are useful for a comparison between populations of two geographically distant regions.

Results

Trapping success

We obtained 142 rodents for a total of 2400 nights, which represents a trapping success of 5.91%. The success of trapping varies from 3.33% in the Taouziant and 2.58% in the Bouchagroune (Table 2).

Rodent fauna

Among the 142 rodent specimens collected we found a diversity of 8 species from 6 genera and tree subfamilies: Murinae, Gerbillinae and Dipodinae (Table 3).

Murinae were the most frequently collected and included three species representing two genera accounting for 50.70 % of the total number captured. Gerbillinae were represented by four species including three genera and represented 34.51 % of the total. The Dipodinae are represented by a single taxon which reaches 14.79 % of the total rodent captured.

The number of the captured species was almost different at both sites: 6 at cereal fields of Taouziant and 5 at palm grove of Bouchagroune (Table 3). Three species were found at both sites (Black rat *Rattus rattus* (L., 1758), House mouse *Mus musculus* L., 1758 and Pleasant Gerbil *Gerbillus amoenus* (de Winton, 1902)), three other species were found only at cereal fields of Taouziant locality (Brown rat *Rattus norvegicus* (Berkenhout, 1769), Shaw's Jird *Meriones shawii* (Duvernoy, 1842) and Lesser Egyptian jerboa *Jaculus jaculus* (L., 1758)) and two supplementary species were captured only at palm grove of Bouchagroune locality (Sand Rats *Psammomys obesus* Cretzschmar, 1828 and Lesser Egyptian gerbil *Gerbillus gerbillus* (Olivier, 1801)).

In cereal fields of Taouziant locality, *R. rattus* and *J. jaculus* are the most abundant species, representing respectively 28.75% and 26.25%. *P. obesus* is the most abundant species in the palm grove of Bouchagroune locality with 35.48%, *R. rattus* and *M. musculus* followed in that order with 27.42% and 17.74% respectively.

The physical features are shown in the table 4.

Species diversity

The diversity indexes and the evenness of rodents captured in the two localities studied (Table 5) showed that the index of dominance (D) varies from 0 to 1. Its values in our study were 0.21 vs 0.25. They are related respectively to cereal fields of Taouziant and palm grove of Bouchagroune localities. However the Simpson Diversity Index (1-D) shows 0.79 vs 0.75 in the same localities at the opposite of the dominance index, where D takes on values between zero and one, 1-D provides a proportional measure of diversity that is much less sensitive to species richness (Magurran 2004).

Locality	TN	NC	NC /TN %
Taouziant (Cereal fields)	2400	80	**3.33**
Bouchagroune (Palme grove)	2400	62	**2.58**
Both regions	4800	142	**5.91**

Tabla 2. Esfuerzo de captura por localidad. TN: noches de trampeo; NC: número de capturas; NC/TN: tasa de éxito de captura, en porcentaje.

Table 2. Trapping effort per locality. TN: trap nights; NC: number of captures; Ratio NC/TN: trapping success in percentage.

	Taouziant (Cereal fields)	Bouchagroune (Palme grove)
Taxa (S)	6	5
Individuals (N)	80	62
Dominance (D)	0,21	0,25
Simpson Diversity (1-D)	0,79	0,75
Shannon (H)	1,68	1,48
Evenness (E)	0,89	0,88

Tabla 5. Índices de diversidad y uniformidad de roedores para las dos localidades estudiadas.

Table 5. Diversity indexes and evenness of rodents for the two localities studied.

Subfamilies	Species	Taouziant		Bouchagroune	
		N	*RA %*	*N*	*RA %*
Murinae	*Rattus rattus* (L., 1758)	23	28,75	17	27,42
	Rattus norvegicus (Berkenhout, 1769)	8	10,00	**0**	**0**
	Mus musculus L., 1758	13	16,25	11	17,74
Gerbillinae	*Psammomys obesus* Cretzschmar, 1828	**0**	**0**	22	35,48
	Meriones shawii (Duvernoy, 1842)	9	11,25	**0**	**0**
	Gerbillus gerbillus (Olivier, 1801)	**0**	**0**	7	11,29
	Gerbillus amoenus (de Winton, 1902)	6	7,50	5	8,06
Dipodinae	*Jaculus jaculus* (Linnaeus, 1758)	21	26,25	**0**	**0**
Total individuals	**142**	**80**		**62**	
Total richness	**8**	**6**		**5**	

Tabla 3. Especies de roedores recogidas. Número y abundancia relativa (*RA%*) en las localidades de Taouziant y Bouchagroune.
Table 3. Rodent species collected. Number and relative abundance (*RA %*) at Taouziant and Bouchagroune localities.

Cereal fields of Taouziant

Rodents species		Weights (g)	BH (mm)	T (mm)	HF (mm)	E (mm)
Ratt rattus (n=23)	Min	45,68	111	121	27	18
	Max	175,29	180,4	213	35	24,1
	Mean	112,06	148,41	174,61	30,09	20,82
Jaculus jaculus (n=21)	Min	86,25	106	176	59,89	18,7
	Max	141,6	126,8	227,4	70,7	24
	Mean	117,55	118,65	213,09	66,5	21,94
Mus musculus (n=13)	Min	10,85	66	71	15,1	11,8
	Max	26,2	89	99	18,3	14
	Mean	17,32	78,63	86,13	16,05	12,7
Meriones shawii (n=09)	Min	77,4	137,69	123,3	32,04	15,14
	Max	151,39	171,28	151,16	36,37	19,28
	Mean	109,13	157,6	141,5	33,56	16,96
Rattus norvegicus (n=08)	Min	166,1	242	203	39,5	20,1
	Max	212	266	209	42	21,6
	Mean	185,05	252,04	206,03	40,74	20,66
Gerbillus amoenus (n=06)	Min	14,14	71,75	105,09	21,09	11,17
	Max	20,04	84,61	124,92	22,64	12,64
	Mean	17,335	77,36	113,25	21,90	11,71

Palm grove of Bouchagroune

Rodents species		Weights (g)	BH (mm)	T (mm)	HF (mm)	E (mm)
Psammomys obesus (n=22)	Min	69,7	128,3	114,7	30,2	10,04
	Max	172,1	136,2	128,4	34	12,4
	Mean	102,9	132,36	119,45	31,62	11,28
Rattus rattus (n=17)	Min	43,87	123,1	155	30,4	20,7
	Max	209,3	192,8	236,1	38,6	29,8
	Mean	131,11	162,29	205,5	34,24	25,91
Mu musculus (n=11)	Min	10,3	69	71	15	11,9
	Max	18,8	86	95	19,2	14
	Mean	14,3	77,82	83,59	16,13	12,62
Gerbillus gerbillus (n=07)	Min	18	71	113,4	27,75	11,6
	Max	24,7	90	140	29,1	15,7
	Mean	20,17	77,86	129,37	28,35	12,96
Gerbillus amoenus (n=05)	Min	13	70	101	21,41	11,48
	Max	17,95	80	117	23,48	13
	Mean	15,27	74,998	108,24	22,332	12,116

n: number of specimen

Tabla 4. Peso y medidas externas de las especies de roedores registradas en campos de cereal de Taouziant y palmeral de Bouchagroune.
Table 4. Weight and external measurements of rodents species recorded in cereal fields of Taouziant and palm grove of Bouchagroune.

Concerning the Shannon index, its values are generally low with 1.68 bits in cereal fields of Taouziant and 1.48 bits in palm grove of Bouchagroune which reflect a moderate diversity of rodent at these two localities. The evenness values at both sites are similar: 0.89 in Taouziant vs 0.88 in Bouchagroune and reflects the same distribution of the rodent in the two localities studied. It tends towards unity so it reflects that the species have a regular distribution (Marcon 2013).

Discussion

This study is the first in the Aurès region, it provides a new checklist of rodent species and update information about biological known in Ziban region.

Despite an effort of trapping with 2400 nights

traps, the total number of specimens captured during this study remains intermediate (5.91%). In a same type of study, the highest rate was obtained in Touggourt area by Hadjoudj *et al.* (2011) with 5.48% and the lowest rate is reported in Tiaret region by Adamou-Djerbaoui *et al.* (2015), with 1.4%. In Beni-Abbes region, Hamdine (2000) trapped a total of 177 rodents for 5815 trap nights (3.04%). The success of trapping was dependent on the localities studied, which appear to be agricultural zones and which led to the presence of rodents subservient to these environments.

The eight rodent species captured belong into Gerbillinae (four species), Murinae (three species) and Dipodinae (1 species).

The more abundant species were *R. rattus* and *J. jaculus* in cereal fields of Taouziant locality but at palm grove of Bouchagroune site, *P. obesus* and R. rattus were the most abundant ones, this could reflect differences in aridity and the local presence of Chenopodiaceae that *Psammomys* favors. Our results of richness at Aurès Mountains (six species) and Ziban (five species) are in general similar to those found by Souttou *et al.* (2012) in Djelfa region where they report seven species. Also Hadjoudj *et al.* (2011, 2015) shown the similar trapping success and used the same type of traps, which have reported the presence of five species in Touggourt (Saharan region).

Diversity indices provide more information than simply the number of species present. They serve as valuable tools that enable biologists to quantify diversity in a community and describe its numerical structure (Magurran 1988). The most commonly used indices are based on the estimation of relative abundance of species in samples (Heip *et al.* 1998). The value of the Shannon index obtained in the cereal fields of Taouziant and the palm grove of Bouchagroune is respectively 1.68 bits and 1.48 bits. This value is lower than that found by Souttou *et al.* (2012) in Djelfa region (1.81 bits) perhaps due to area of study (irrigated farm), method of capture and number of specimens.

The Simpson Diversity index illustrates an important number of the species and the Shannon index values indicate a moderate diversity of rodent at these two sites in Aurès Mountains and Ziban oasis. The distribution of specimens over species is equitable.

The specimens of *R. rattus* were caught in the vicinity of the agricultural storehouse in the two studied localities. The species were mentioned by Adamou-Djerbaoui *et al.* (2015) in the region of Tiaret located in the northwest highlands of Algeria, with 24 specimens. In the palm groves of Touggourt, an Algerian oasis of the Sahara situated at an altitude of 75 MASL, Hadjoudj *et al.* (2015) trapped 23 specimens. In Morocco, Stoetzel *et al.* (2010, 2012) & Denys *et al.* (2015) confirmed the existence of this rodent in central and coastal Morocco.

Concerning the house mouse (*M. musculus*), its specimens were captured near the agricultural crop storage in the two areas of study. In the semi-arid environment, Adamou-Djerbaoui *et al.* (2015) reported the presence of the species in Tiaret region with 8 specimens, Souttou *et al.* (2012) note the existence of this rodent in Djelfa (6,3%). Badiaf *et al.* (2013) caught 6 specimens in Djanet region; an extreme southeast of Algeria with an altitude of 1094 MASL. Khammes *et al.* (2006) found this species in the Kabylie of Djurdjura and in Morocco, Stoetzel *et al.* (2012) and Denys *et al.* (2015) reported the presence of this rodent respectively at 9% and 5%. In this study, we did not find the Algerian mouse *Mus spretus* Lataste, 1883, its absence can be conditioned by climatic circumstances and altitude. Khidas *et al.* (1999) in Kabylie of Djurdjura (northern Algeria) showing that *M. spretus* cannot stand above altitudes more than 700 MASL and that climate is another determining factor of its presence as the mild climate. The cereal fields of the Touaziant region have an altitude above 900 MASL with a cold climate, but the region of the Bouchagroune palm grove has a dry climate. This may justify the absence of *M. spretus*.

R. norvegicus in our inventory was reported only in Khenchela region (Aurès Mountains). Compared to the works reported by Adamou-Djerbaoui *et al.* (2015) the presence of this species was signalled in Tiaret (semi arid region). This author notes its preference for such humid areas. However, Souttou *et al.* (2012) and Stoetzel *et al.* (2012) have not noted the presence of this species in the humid areas of their study areas. *M. shawii* was captured in a cereal fields of Taouziant, this rodent is recognized as a pest of crops (Bernard 1970, Adamou-Djerbaoui *et al.* 2011, 2013). It occurs many crops loss in the High Plateaux of Algerian cereal areas (Adamou-Djerbaoui *et al.* 2010, 2011,2015, Souttou *et al.* 2012) were it was recorded in very high proportions

ranging from: 25.74% to 68.80%. Sekour *et al.* (2014) reported the presence of the Shaw's Jird in the Owl's diet in two steppe regions (M'Sila and Djelfa) located on the high plains of Algeria, with a high rate (between 31.90% and 76.60%). In central and coastal Morocco, Stoetzel *et al.* (2012) and Denys *et al.* (2015) have reported the presence of this rodent, but in rather low percentage. According to the same authors this is due to the wetter climatic conditions, during their trapping sessions or the use of pesticides. This is the case of cereal fields of Taouziant. *J. jaculus* was trapped only in Khenchela area. It is a foothill of the Aurès Mountains which presents a stony light soil. According to Shenbrot & Krasnov (2004) this species is also found in valleys and rocky meadows, but usually prefers flat plains with rare vegetation which explains the high number of catches in the spontaneous zone of Khenchela region. Up to now *P. obesus* was detected in the palm grove of Bouchagroune and Adamou-Djerbaoui *et al.* (2015) have reported its presence in Tiaret region. Amirat *et al.* (1977) and Omari *et al.* (2007) used specimens of *P. obesus* captured in Beni-Abbes region (Bechar departement). Zaime & Pascal (1988) have reported the presence of the sand rat in Goulimine region southwest of Morocco and Ben Hamou *et al.* (2006) have reported it in central and southern Tunisia.

G. gerbillus was trapped only in palm grove of Bouchagroune (Biskra region). Souttou *et al.* (2012), Baddiaf *et al.* (2013) and Hadjoudj *et al.* (2015) reported the presence *G. gerbillus* in their respectively study areas: Djelfa, Djanet and Touggourt. Amirat *et al.* (1977) used in their research specimens of *G. gerbillus* from Beni-Abbes region (Bechar department). The geographic range of this species is found throughout the desert and predesert regions of northern Africa (Granjon, 2016).

G. amoenus was captured in many places of Algeria (Kowalski & Kowalska 1991) and more recently was reported by Souttou *et al.* (2012), Baddiaf *et al.* (2013) and Hadjoudj *et al.* (2015) in Djelfa, Djanet and Touggourt. Zaime & Pascal (1988); have reported its presence in Morocco. This species has an exclusively North African distribution (Ndiaye *et al.* 2013).

In the literature, some species have been captured in many areas of Algeria (Hadjoudj *et al.* 2015, Adamou-Djerbaoui *et al.* 2015, Kowalski & Kowalska 1991), but not in our study areas as *Meriones lybicus* Lichtenstein, 1823, *Meriones crassus* Sundevall, 1842 and *Jaculus orientalis* Erxleben, 1777. This can be explained in two ways. The first could be a mediocre efficiency of the baits used (bread, dates) and the low trapping effort. The second, corresponds to very low densities of the species mentioned in the prospected regions (Dobigny 2009).

The study found that both regions were abundant in specific rodent species. *R. rattus* is the most abundant. This state can be related to the important human frequentation and degradation of some habitats. However, *P. obesus* is the most present species in the palme grove of Bouchagroune; its presence in this region is related by the abundance of *A. halimus* (Chenopodiaceae), while *J. jaculus* was only reported in the cereal fields of Taouziant. The other species are less present in the study sites.

In the Aurès and Ziban region, it would seem that altitude and the arid or semi-arid climate, would be a combination of ecological factors which largely determine the distribution and the diversity of the rodents in Algeria. This ecological barrier would imply possible taxonomic and ecological variations.

Biometric, morphological and genetic measurements are needed to highlight the extent of these variations, their modalities and the possible existence of new subspecies.

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