

Diversity and Richness of Rodent Communities in Various Landscapes of Touggourt Area (Southeast Algeria)

Moussa Hadjoudj¹, Karim Souttou², Salaheddine Doumandji³

¹ Scientific and Technical Research Centre for Arid Areas (C.R.S.T.R.A), NR N°3 Ain Sahara Nezla – BP 360 Touggourt, RP 30200, Ouargla, Algeria; E-mail: mhadjoudj@gmail.com

² University of Djelfa, Facult Sci. Natu. Vie, Department of Agropastoralism, Algeria; E-mail: kasouttou@yahoo.fr

³ Department of Zoology, National Agronomicsuperior School, El Harrach, Algiers, Algeria; E-mail: dmndjislhdn@yahoo.fr

Abstract: Our study presents the species diversity of rodent communities from palm groves and sand dunes in a desert area (Touggourt, Southeast Algeria). Samples were collected from four stations: two sites of sand dunes and two sites of palm groves. The method of random trapping was performed using 24 cages of Besançon Technique Service (BTS) installed at each station. All captured species were of the family Muridae and belonged to two subfamilies: Murinae and Gerbillinae. The most common species at all stations was *Gerbillus nanus* (31 specimens), followed by *Rattus rattus* (23 specimens) and *Gerbillus tarabuli* (18 specimens). The murine species *Rattus rattus* and *Mus spretus* were found at agriculture sites (palm groves) while the Gerbillinae *Gerbillus nanus*, *Gerbillus gerbillus* and *Gerbillus tarabuli* preferred natural environments (sand dunes) where the soil was light and sandy.

Keywords: Palm groves, rodent, sand dunes, Southeast Algeria, Touggourt, arid environment

Introduction

In Africa, small mammals represent approximately 80% of current diversity of mammals and rodents alone constitute about the half of it (DENYS 2011). Rodents are the largest order of all mammals, not only in number of species but also in number of populations (CHALINE, MEIN 1979, CARLETON AND GUY 2005). OUZAOUIT (2000) reported that this order was the most diverse in terms of morphological, physical ability and different environments occupied by these animals. In Algeria, rodents were previously studied: KOWALSKI, RZEBIK-KOWALSKA (1991) studied their distribution; HAMDINE, POITEVIN (1994) – the ecology of *Apodemus sylvaticus* in the national park of Djurdjura; KHIDES *et al.* (2002) – the abundance of *Apodemus sylvaticus* and *Mus spretus* from different habitats in Great Kabylia (Algeria); HAMDINE *et al.* (2006) – the distribution of Gerbillinae in two regions of Algerian Sahara at El-Goléa and Beni-Abbes; BEBBA *et al.* (2008) – the distribution of Murinae in the region of Oued Righ (Algerian Sahara) and HADJOUJ *et al.* (2009) – the distribution of rodents in Touggourt area (Algerian

Sahara). Furthermore, KHAMMES, AULAGNIER (2007) studied the dietary preferences of *Apodemus sylvaticus* from three different biotopes: bush, arboreal and soil. More detailed were the studies in the Tiaret region: ADAMOUD-DJERBAOUI *et al.* (2008) analysed the diet of *Meriones shawii* through microscopic analysis of feces and in El Bayadh, where DJELAILA *et al.* (2010) explored the diet of *Meriones shawii* analysing stomach content.

The aim of the present study was to describe the ecological features of the species of rodents from the Touggourt region, thus attempting to complement the previous knowledge on the mammals of Algeria (KOWALSKI, RZEBIK-KOWALSKA 1991).

Material and Methods

Study areas and sample sites

Our study has been conducted in the Touggourt area (Southeast Algeria), 33°02' – 33°12' N, 5°59' – 6°14' E (Fig.1), altitude 75 m a. s. l.) (DUBOST,

2002). The daily temperature ranges from a mean minimum of 11.7°C in January to a mean maximum of 35.1°C in July. The average annual rainfall is 155.7 mm. The climate in the area is characterised by a long dry season from February to December and a rainy season in January. The speed of wind varies between 10.3 m/s (37 km/h) in June and 19.5 m/s (70.2 km/h) in March.

Four sampling sites were selected:

(1) El Mostakbel, 6 km north of Touggourt (Fig. 1), a natural habitat with herbaceous vegetation. It was characterised by low density of palm groves and houses. The vegetation was dominated by herbaceous plants: “aggaia” *Zygophyllum album* Linné, “zita” *Limoniastrum guyonianum* Dur. and “damran” *Traganum nudatum* Del.

(2) Sidi Mehdi, 4 km east of Touggourt, a natural habitat characterised by herbaceous vegetation: *Zygophyllum album*, *Limoniastrum guyonianum* and *Traganum nudatum*.

(3) Bahia, cultivated fields (4 ha) with palm trees (mostly date palms). Several other species of crop plants were tomato *Solanum lycopersicum*, mint *Mentha aquatica* and lettuce *Lactuca sativa*, as well as fruit plants such as common grape vines *Vitis vinifera*, olives *Olea europea*, blackthorns *Prunus spinosa* and apple trees *Malus pumila*. This study site was characterised by substantial presence of al-

falfa fields *Medicago sativa*. The presence of wild plants was common in Bahia, such as the common reed *Phragmites australis* (Cav.) and the field bindweed *Convolvulus arvensis* Linnaeus.

(4) Ranou, 6 km south of Touggourt, date palm groves (103 ha). This study site had several species of wild plants: common reed *Phragmites australis*, field bindweed *Convolvulus arvensis*, hemlock *Conium maculatum* Linnaeus, chrysanthus *Chrysanthemum myconis* Linnaeus and *Aster squamatus* Linnaeus.

Bahia and Ranou sites represented semi-open areas characterised by three categories of plants: arborescent plants (date palm *Phoenix dactylifera* L.); shrubby plants such as the common grape vine *Vitis vinifera* and the olive *Olea europea*; and herbaceous plants represented by various crop and wild species. The presence of these plant categories created an suitable microclimate for various animals such as insects (Formicidae, Coleoptera, etc.) and birds (the European turtle dove *Streptopelia turtur* and the Barn owl *Tyto alba*). The other two sites, Sidi Mehdi and El Mostakbel sand dunes represented open areas characterised by herbaceous plants of Zygophyllaceae and Chenopodiaceae. The climate in these areas was arid. As for animal species in these locations, we found insects (Tenebrionidae and Formicidae), some birds and mammals such as Fennec fox *Vulpes zerda*.

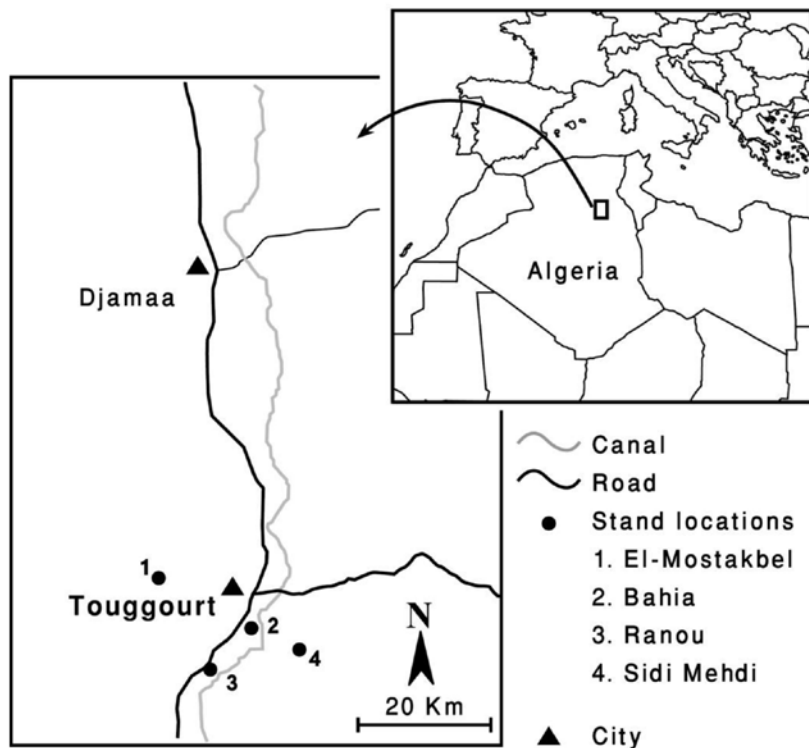


Fig.1. Map of geographic situation of Touggourt area (Southeast Algeria) and the situation of sampling sites.

Sampling techniques

This study was based on capturing rodents during 31 months (July 2007 – January 2010). We used snap traps BTS (10 x 10 x 30 cm) following Besançon Technique Service, France and baited with date (FICHET-CALVET *et al.* 1999, BEN HAMOU *et al.* 2006).

The capture of rodents was implemented in July – October 2007 and February 2008 at Bahia palm grove. At this location, 24 snap traps BTS have been used to sum up to 360 trap-nights. At El Mostakbel sand dunes, the sampling continued two months, February – March 2008 (24 snap traps BTS, 240 trap-nights). At Sidi Mehdi sand dunes, 24 snap traps BTS were used (960 trap-nights) during 8 months (October 2007 – April 2008). At Ranou palm grove, 24 snap traps BTS (1440 trap-nights) were used in February 2009 – January 2010 (12 months of trapping). Between 15 to 20 visits were organised each month. Traps were baited and set between 17:00 and 19:00 h for five consecutive nights per month. They were checked between 07:00 and 09:00 h the next day.

Each captured small mammal was preliminary identified, sexed, weighed and measured externally, euthanised and fixed in 10% formaldehyde solution. Identification and collection of reproductive condition data were completed in the laboratory. Five standard external measurements were recorded from each specimen: total length (TL), tail length (T), hind foot length without the claw (HF) and ear length (E). Additionally, we reported the body weight (W) (OGUGE 2004) for each sample (See appendix, Table 3). All specimens were deposited in the collection of the Superior National Agricultural School of Algeria (ENSA), Department of Agricultural and Forest Zoology.

Data analysis

Our analysis was based on the species richness S which represented the number of species captured on each station over the course of a trapping session (CARO 2001, HORN *et al.* 2012). Additionally, the relative abundance index was estimated: [number of specimens captured / (number of traps x number of nights)] x 100 (GOMEZ 2006). Therefore, the frequency of capturing a species was presented as the percentage ratio of the number of captured individuals for this species and the total number of captured individuals of all species from a station (HAMDINE, POITEVIN 1994, HAMDINE *et al.* 2006). In order to describe the diversity in the small mammal community we used also the Shannon-Wiener Index ($H' = -\sum P_i * \log_2(P_i)$), where $P_i = n_i/N$). H' increases with S , but in reality does not exceed 5.0 in biological communi-

ties (KREBS 1998). The evenness index (E) indicates how the species are distributed in the community, and is derived from H' ($E = H' / \ln S$) (OGUGE 2004, DENYS 2005, FAURIE *et al.* 2006, HORN *et al.* 2012). The values range from 0 (one dominant species) to 1 (all species equally represented in the community).

Results and Discussion

We collected 96 rodent specimens. Five species belonging to three genera of murid rodents were recorded. The specimens captured were distributed as follows; 32 specimens of the black rat *Rattus rattus* (Linnaeus, 1758), three specimens of the Algerian mouse *Mus spretus* (Lataste, 1883), 31 specimens of the Balochistan gerbil *Gerbillus nanus* (Blandford, 1875), ten specimens of the lesser gerbil *G. gerbillus* (Olivier, 1801) and 20 specimens of the tarabul's gerbil *G. tarabuli* (Thomas, 1902).

From the sand dunes of Sidi Mehdi and El Mostakbel, species only of the subfamily Gerbillinae were captured: *Gerbillus nanus*, *G. gerbillus* and *G. tarabuli* (Table 1). The Balochistan gerbil *Gerbillus nanus* was dominant in this environment with 31 specimens ($F = 72.1\%$; $IA\% = 3.2\%$). It was followed by the lesser gerbil *Gerbillus gerbillus* with nine specimens ($F = 20.9\%$; $IA\% = 0.9\%$) and the tarabul's gerbil *Gerbillus tarabuli* with three specimens ($F = 7\%$; $IA\% = 0.3\%$). From El Mostakbel sand dunes, the tarabul's gerbil *Gerbillus tarabuli* was the most captured species with 17 specimens ($F = 94.4\%$; $IA\% = 7.1\%$). Our study showed that Gerbills species preferred natural landscape with sandy soils and abundant vegetation consisting of plants of the families Zygophyllaceae, Chenopodiaceae and Plumbaginaceae. HAMDINE *et al.* (2006) found the same species at Juifa (arid area in Southwest Algeria), with *Gerbillus tarabuli* occupying the first place. The same authors captured only the gerbilline species *Gerbillus nanus* from the Belbachir area. The stations of Juifa and Belbachir were characterised by abundant vegetation (Zygophyllaceae and Chenopodiaceae). The present work confirmed the findings of HAMDINE *et al.* (2006).

We observed that trapping was more elevated in the sand dunes of Sidi Mehdi area, which were characterised by the presence of vegetation (i.e. *Zygophyllum album* and *Traganum nudatum*) and sandy soils. At this station, the most abundant was the Balochistan gerbil *Gerbillus nanus*, followed by the small gerbil, the lesser gerbil *G. gerbillus* and the tarabul's gerbil *G. tarabuli*. KOWALSKI, RZEBIK-KOWALSKA (1991) in their work on the mammals of Algeria noted that *G. nanus* preferred the desert

area with relatively deep soil and abundant vegetation, and also the wetland area such as in the valleys (“wadi”). In our study, *G. nanus* was captured from the bottom of wadis and oasis. Our results were comparable with the ones of KOWALSKI, RZEBIK-KOWALSKA (1991). Similarly, HAMDINE *et al.* (2006) indicated that *G. nanus* and other gerbilline preferred environments characterised by dense vegetation (mainly Chenopodiaceae) and clay soil from other localities in El Golea. AULAGNIER, THEVENOT (1986) reported that this species inhabited all the desert regions from Blouchiston to the Atlantic coast of North Africa, through Arabia and Sahara. In the Middle East, the species occupies habitats dominated by the Chenopodiaceae, Zygophyllaceae and Gramineae (HAMDINE *et al.* 2006).

The second species captured from the ground area of Sidi Mehdi in Touggourt area was the lesser gerbil *Gerbillus gerbillus*. The previous studies indicated that small gerbil preferred dune areas and sand oasis at the foot of the Erg dunes (Peter 1961, KOWALSKI, RZEBIK-KOWALSKA 1991).

On the other hand, the tarabul’s gerbil *Gerbillus tarabuli* appeared to be widespread in the sand dunes of El Mostakbel with 17 specimens compared to Sidi Mehdi (one specimen). A previous work in the area of Beni Abbes found that this species had its ecological optimum in Erg (HAMDINE *et al.* 2006). Nevertheless, in Morocco, this gerbil preferred the coastal dunes of the western Atlantic coast (AULAGNIER, THEVENOT 1986), while in Tunisia it was linked to low light sandy soil (BERNARD 1969).

The palm grove of Bahia and Ranou were characterised by the presence of only two species;

the black rat *Rattus rattus* with 23 specimens (F = 88.5%; IA % = 1.6%) and the Algerian mouse *Mus spretus* with three specimens (F = 11.5 %; IA % = 0.2%). In Bahia palm grove, only the black rat *Rattus rattus* was captured, with 9 specimens (F = 100%) and (IA = 2.5%). Our results differed from those of KOWALSKI, RZEBIK-KOWALSKA (1991). These authors did not find the black rat (*Rattus rattus*) in the Algerian oasis (KOWALSKI, RZEBIK-KOWALSKA 1991).

In their book on mammals of Algeria, KOWALSKI, RZEBIK-KOWALSKA (1991) reported the presence of the Algerian mouse *Mus spretus* only from Northern Algeria. However, this species was not identified in the Algerian oasis by these authors.

Previous works in four palm groves in Touggourt area (BEBBA *et al.* 2008, BEBBA, BAZIZ 2009) indicated the presence of murine species. They described the presence of *Rattus rattus*, *Mus spretus* and *Mus musculus*. The last species was captured by those authors in habitats differing from those of the Algerian mouse *Mus spretus*. AULAGNIER, THEVENOT (1986) also reported that *Mus spretus* did not occur in syntopy with *Mus domesticus*.

The obtained diversity values H' and H'_{max} varied among all the sample sites in this work. The Shannon-Weaver index H' was 0.52 bits and H'_{max} was 1 bits for palm grove site in Ranou. At Bahia, the value of H' was 0, because the black rat *Rattus rattus* was the only species found from this site (Table 2). The diversity H' for the sand dunes of Sidi Mehdi was 1.08 bits and H'_{max} value was 1.58 bits, while at the sand dunes of El Mostakbel, H' was 0.31 bits and H'_{max} was 1 bits (Table 2). Near to Touggourt area, namely in Oued Souf region, ALIA

Table 1. Species richness (n), frequency (F%) and relative abundance index (IA%) for the species of rodents captured in each station

Station	Index	Species					Total	Traps nights
		<i>Rattus rattus</i>	<i>Mus spretus</i>	<i>Gerbillus gerbillus</i>	<i>Gerbillus tarabuli</i>	<i>Gerbillus nanus</i>		
Ranou palm grove	n	23	3	0	0	0	26	1440
	F	88.5	11.5	0	0	0	100	
	IA	1.6	0.2	0	0	0	1.8	
Bahia palm groves	n	9	0	0	0	0	9	360
	F	100	0	0	0	0	100	
	IA	2.5	0	0	0	0	2.5	
Sidi Mehdi Sand dune	n	0	0	9	3	31	43	960
	F	0	0	20.9	7	72.1	100	
	IA	0	0	0.9	0.3	3.2	4.4	
El Mostakbel Sand dune	n	0	0	1	17	0	18	240
	F	0	0	5.6	94.4	0	100	
	IA	0	0	0.4	7.1	0	7.5	

Table 2. Results of Shannon-Weaver index (H') and Evenness (E) for the studied stations

Parameters	Ranou date palm	Bahia date palm	Sidi Mehdi Sand dune	El Mostakbel Sand dune
H' (bits)	0.52	0	1.08	0.31
H' max (bits)	1	0	1.58	1
E	0.52	-	0.68	0.31

Table 3. Weight and corporal measure of rodents species recorded in Touggourt area

Rodents species		Weights (g)	TL (mm)	T (mm)	HF (mm)	E (mm)
Rattus rattus	Min	50	105	122	28	10
	Max	167	195	229	33	30
	Mean	105.5	155.59	187.66	31.78	17.34
Mus spretus	Min	15	55	60	15	9
	Max	20	95	83	18	10
	Mean	18.33	80	75.33	17	9.67
G. nanus	Min	12.1	63	100	19	6
	Max	23.49	81	133	25	10.5
	Mean	16.91	72.35	117.97	20.87	9.02
G. gerbillus	Min	18	75	75	27	8
	Max	30.9	99	140.1	31	11
	Mean	23.63	85	127.21	29	9.95
G. tarabulli	Min	11.5	61	91	24	7
	Max	54.4	110	170	31	12
	Mean	26.26	86.3	125.15	28.2	9.23

TL: Total length; T: length of tail; HF: hind foot length without claw; E: ear length; Min: Minimum; Max: Maximum

et al. (2014) mentioned the values of diversity for three palm groves at Ghamra ($H' = 2.16$ bits, $H'_{\max} = 2.58$ bits), Hassi Khalifa ($H' = 2.39$ bits, $H'_{\max} = 3$ bits) and Ouermess ($H' = 2.36$ bits, $H'_{\max} = 3$ bits). The values reported in this study were smaller than those mentioned by ALIA *et al.* (2014). In the steppe area in Djelfa (300 km north of Touggourt), SOUTTOU *et al.* (2012) reported higher diversity ($H' = 1.81$ bits, $H'_{\max} = 3$ bits) than that recorded by the present study.

The evenness values were similar for the palm groves of Ranou ($E = 0.52$) and the sand dunes of Sidi Mehdi ($E = 0.68$). These values were close to 1, which implied that the staffing of species tend to be balanced between them. However, at El Mostakbel, the evenness value ($E = 0.31$) was close to 0 because of the dominance of the tarabul's gerbil *G. tarabuli* (17 specimens). SOUTTOU *et al.* (2012) reported an evenness value ($E = 0.6$) similar with that obtained in this work from steppe area in Taâdmit (Djelfa). A previous work in Oued Souf region, ALIA *et al.* (2014) noted similar evenness values for three sta-

tions: Ghamra ($E = 0.83$), Hassi Khalifa ($E = 0.8$) and Ouermess ($E = 0.79$). These values were close to 1, which imply that the staffing of species tend to be balanced between them. The results obtained by this study are coherent with those by SOUTTOU *et al.* (2012) and ALIA *et al.* (2014).

Conclusion

A total of 96 specimens of rodents were captured from Touggourt area. In the palm groves, two species were captured, the black rat *Rattus rattus* (32 specimens) and the Algerian mouse *Mus spretus* (three specimens); these species have not been reported by previous studies in the oasis area of Touggourt. However, three species of gerbils were captured in the sand dune area of Touggourt, the Balochistan gerbil *Gerbillus nanus* (31 specimens), the lesser gerbil *G. gerbillus* (10 specimens) and the tarabul's gerbil *G. tarabuli* (20 specimens). These species prefer natural environments, characterised by dense herbaceous vegetation.

Acknowledgments: We are very grateful to the two anonymous reviewers and to Doctor Merzouki Youcef (University of Bourdj BouArreridj, Algeria), Doctor Manaa Abdeslam (University of

Telemcen, Algeria) and Doctor Sekour Mekhlouf (University of Ouargla, Algeria) for their help. We also express our gratitude to Doctor Benhaddya Hicham, Lahcini Ali and Doctor Halis Youcef.

References

- ADAMOU-DJERBAOUI M., B. BAZIZ, A. H. CHABB 2008. Etude du régime alimentaire d'un rongeur *Meriones shawii* Duvernoy par l'analyse microscopique des fèces. 3^{ème} Journées Prot. Vég., 6-7 avril 2008, Dép. Zool. agri. for., Inst. nati. agro., El Harrach, p. 65.
- ALIA Z., M. SEKOUR, N. TENNECH, K. SOUTTOU 2014. Contribution à l'étude de la faune nuisible des cultures notamment les rongeurs sur quelques milieux agricoles dans la région du Souf (Algerie). Séminaire National : Biodiversité faunistique, 07, 08 et 09 décembre 2014, Dép. Zool. agri. for., Eco. Nati.. Sup. Agro., El Harrach.
- AULAGNIER S., M. THEVENOT 1986. Catalogue des mammifères sauvages du Maroc. – *Trav. inst. sci. sér. zool.*, Rabat, 164 p.
- BEBBA K., B. BAZIZ 2009. Les micromammifères dans la vallée d'Oued Righ. – *Séminaire International : Biodiversité faunistique en zones arides et semi-arides, 22-24 novembre 2009, Fac. sci. vie, terre, Univ. Kasdi Merbah, Ouargla*, p. 16.
- BEBBA K., M. HADJOU DJI, B. BAZIZ, M. SEKOUR, K. SOUTTOU 2008. Les Murinae d'Oued Righ. 3^{ème} Journées Prot. Vég., 6–7 avril 2008, Dép. Zool. agri. for., Inst. nati. agro., El Harrach, p. 67.
- BEN HAMOU M., S. BEN ABDERRAZAK, S. FRIGUI, N. CHATTI, R. BEN ISMAIL 2006. Evidence for the existence of two distinct species: *Psammomys obesus* and *Psammomys vexillaris* within the sand rats (Rodentia, Gerbillinae), reservoirs of cutaneous leishmaniasis in Tunisia. – *Infection, Genetics and Evolution*, 6, 301-308.
- BERNARD J. 1969. Les mammifères de Tunisie et des régions voisines. – *Bull. Fac. Agr. Tunis*, N° 24 et 25, 159 p.
- CARLETON M. D., G. M. GUY 2005. «Order rodentia.» – In: WILSON D. E., & REEDER, D. M. (Eds.): *Mammal species of the world: a taxonomic and geographic reference*. JHU Press, 745-752.
- CARO T.M. 2001. Species richness and abundance of small mammals inside and outside an African national park. – *Biological Conservation*, 98: 251-257.
- CHALINE J., P. MEIN 1979. Les rongeurs et l'évolution. Ed. Doin, Paris, 235 p.
- DENYS C., E. LECOMPTE, E. CALVET, M.D. CAMARA, A. DORE, K. KOULEMOU, F. KOUROUMA, B. SOROPOGUI, O. SYLLA, B. ALLALI-KOUADIO, S. KOUASSI-KAN, C. AKOUA-KOFFI, J. TER MEULEN, L. KOIVOGUI 2005. Community analysis of Muridae (Mammalia, Rodentia) diversity in Guinea: A special emphasis on *Mastomys* species and Lassa fever distributions. – *African biodiversity*, 339-350.
- DENYS C. 2011. Rodents. Paleontology and geology of laetoli: Human evolution in context, Vol. 2: 15-53.
- DJELAILA Y., F. NEFFAH-BAZIZ, S. DOUMANDJI 2010. Régime trophique de *Meriones shawii* dans une zone steppique de la région d'El Bayadh. Journées nati. Prot. Vég., 19-21 avril 2010, Dép. Zool. agri. for., Inst. nati. agro., El Harrach, p. 119
- DUBOST D. 2002. Ecologie, aménagement et développement agricole des oasis algériennes. Ed. Centre rech. sci. techn. rég. arides (C.R.S.T.R.A.), Biskra, 423 p.
- FICHET-CALVET E., I. JOMAA, P. GIRAUDOUX, R.W. ASHFORD 1999. Estimation of sand rat *Psammomys obesus* abundance by using surface indices. – *Acta Theriologica*, 44 (4): 353-362.
- FAURIE C., C. FERRA, P. MEDORI, J. DEVAUX, J.L. HEMPTINNE 2006. Ecologie : Approche scientifique et pratique. Lavoisier, Paris, 376 p.
- GOMEZ VILLAFANE I.E., M. BUSH 2007. Spatial and temporal patterns of brown rat (*Rattus norvegicus*) abundance variation in poultry farms. – *Mammalian Biology*, 72 (2): 364-371.
- HADJOU DJI M., A. MANAA, W. DERDOUKH, A. GUERZOU, K. SOUTTOU, M. SEKOUR, S. DOUMANDJI 2009. Les rongeurs de la région de Touggourt. Séminaire internat. : Biodiversité faunistique en zones arides et semi-arides, 22-24 novembre 2009, Fac. sci. vie, terre, Univ. Kasdi Merbah, Ouargla, p. 17
- HAMDINE W., F. POITEVIN 1994. Données préliminaires sur l'écologie du Mulot sylvestre *Apodemus sylvaticus* Linné, 1758, dans la région de Tala-guilef, parc national du Djurdjura, Algérie. – *Rev. Ecol. (Terre et Vie)*, 49: 181-186.
- HAMDINE W., F. KHAMMAR, T. GERNIGON 2006. Distribution des Gerbillidés dans les milieux arides d'El – Goléa et de Béni – Abbès (Algérie). – *Soc. Hist. natu. Afrique du Nord*, 73: 45-55.
- HORN K.J., B.R. MC MILLAN S.B. ST CLAIR 2012. Expansive fire in desert shrubland reduces abundance and species diversity of small mammals. – *Journal of environments*, 77: 54-58.
- KHAMMES N., S. AULAGNIER 2007. Diet of the wood mouse *Apodemus sylvaticus* in three biotops of Kabylie of Djurdjura (Algeria). – *Folia Zoologica*, 56 (3) : 243-252.
- KHIDAS K., N. KHAMMES, S. KHELLOUFI, S. LEK, S. AULAGNIER 2002. Abundance of the wood mouse *Apodemus sylvaticus* and the algerian mouse *Mus spretus* (Rodentia, Muridae) in different habitats of the Northern Algeria. – *Mammalian Biology*, 67: 34-41.
- KOWALSKI K., B. RZEBIK-KOWALSKA 1991. Mammals of Algeria. Ed. Ossolineum, Wroklaw, 353 p.
- KREBS J.C. 1998. Ecological methodology, 2nd Edition edn. Harper & Row, New York, 620 p.
- OGUGE N., R. HUTTERER, R. ODHIAMBO, W. VERHEYEN 2004. Diversity and structure of shrew communities in montane forests of southeast Kenya. – *Mammalian Biology*, 69 (5): 289-301.
- OUZAOUIT A., B. ID MESSAOUD 2000. Etude de l'activité reproduction des rongeurs aux champs : cas de la Mérione de Shaw au Maroc. Séminaire national sur la surveillance et la lutte contre les rongeurs, 7-8 juin 2000, Serv. lutte antivec., Marrakech :32-36.
- OSBORN D.J., I. HELMYI 1986. The contemporary land mammals of Egypt (including Sanai). Fieldiana Zoology, N° 5, 530 p.
- PETTER F. 1961 Répartition géographique et écologique des rongeurs désertiques (du Sahara occidental à l'Iran oriental), – *Mammalia*, 219 p.
- SOUTTOU K., M. SEKOUR, K. GOUSSIM, M. HADJOU DJI, O. GUEZOU, S. DOUMANDJI, C. DENYS 2012. Paramètres écologiques des rongeurs recensés dans un milieu semi aride à Djelfa (Algérie). – *Algerian journal of arid environment*, II (2): 28-41

Received: 29.08.2014

Accepted: 23.06.2015