Colony Dynamics Of Bat Species (Chiroptera) In Chréa National Park (Algeria)

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Abstract
Bats are considered excellent indicator taxa of habitat quality because their populations are very sensitive to human alteration. The loss or human disturbance in the bat natural roosts causes man-made structures to become important alternative refuges by a great diversity of bat species. In the Chréa National Park in Algeria we studied the bat community in different human infrastructures throughout the N1 road from Chiffa to Medea. Count of bat colonies were carried out monthly from 2008 to 2017 in the most important roosts to known of bat dynamics population and their roost selection. Records of ultrasonic sounds and acoustic data analysis were also used to assess the presence of another non cave-dwelling bat species. We identified 10 bat species and we detected 7 principal refuges, which harbored plurispecific bat colonies. Six bat species, which are considered cave-dwelling bats in almost certain period of their biological cycle, they were exclusively linked to the human infrastructures such as tunnels or mines. Furthermore, the other bat species such as *Hypsugo savii* and *Tadarida teniotis* were also captured in tunnels, indicating that these bat species could use also these structures. Our study shows that human infrastructures were used as alternative natural roosts by most bat species, especially cave-dwelling bat species. Therefore, we strongly suggest that the human infrastructures should be considered protected refuges in National Park.

Key words: Algeria, Chiroptera, conservation, human infrastructures, population dynamics

INTRODUCTION

Bats are the second largest order of mammals with ~1300 species, accounting for approximately 21% of all mammalian species, inhabiting a multitude of ecological niches (Schipper *et al*. 2008). Algeria is the largest country in Africa and offers a wide variety of habitats for bat species such as Mediterranean and desert regions, mountainous chains, highland areas and ancient volcanic regions. Although Kowalski & Rzebik–Kowalska (1991) included bat order in the mammals of Algeria work, very little studies had been focused on the bats of Algeria, despite their major ecological role in the maintenance of ecosystems (Anciaux de Faveaux, 1976; Kowalski 1979; Gaisler 1983, 1984).

Algerian bats are represented by 26 species in 7 families; most of these are considered vulnerable in many countries of the world and are listed on the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species. Indeed, the ecological importance of bats is still ignored by the majority of the population and even by the authorities in charge of the management of fauna and flora. The main consequence of this state of affairs is that bats are not taken into account in the conservation and management plans of the fauna and flora in many countries where they are threatened or in decline (Ahmim 2018).

Bats are very sensitive to human-induced changes of ecosystems and are considered excellent indicator taxa of habitat quality. Furthermore, as consequence of the habitat loss and roost disturbances, bats more frequently use man-made refuges as alternatives to natural shelters such as mines, infrastructures (tunnels and bridges) or buildings (Jones *et al*. 2009). In this sense, these alternative roosts have special importance in the management and conservation of bat populations. Linear infrastructures such as railways and roads are known to have major negative impacts on species and ecosystem dynamics, modifying landscape structure through artificialization, habitat changes, alteration and fragmentation (Trombulak & Frissell 2000). Nonetheless, these infrastructures with their tunnels or bridges associates have also been shown to provide refuges or corridors to several bat species (Bach *et al*. 2004).

The goal of present study was investigate (1) bat diversity in Chréa National Park, in which no information of bat community was present and (2) annual dynamics population of several bat species in tunnels belonged to disused railway to cross North-South the Chréa National Park.

MATERIAL AND METHODS

Study site

The Chréa National Park is one of the largest national parks of Algeria. It is located at 60 km southwest of Algiers in Blida Province. The park is located in a mountainous area known as the Blidean Atlas between 280 and 1625 m.a.s.l. The park covers 5400 Ha including the Chiffa Gorges and the peak of Tamesguida classified in integral reserve, one of the few habitat areas in Algeria that support a sub-population of endangered Barbary macaque (*Macaca sylvanus*). The Chréa National Park is constituted principally by the substrate of easily friable schistose nature giving rise to a clay soil. The vegetation is a dense forest cover, composed mainly of tree and shrub formations. On both sides of the wades are common the Myrtle (*Myrtus communis*) and the Oleander (*Nerium oleander*) and the slopes are covered with Mastic tree (*Pistacia lentiscus*), Zeen (*Quercus suber*), oaks and Strawberry tree (*Arbutus unedo*). The presence of the Hackberry (*Celtis australis*) with Holm oak (*Quercus ilex*) and Wild Cherry (*Prunus avium*) is remarkable. Aleppo pine (*Pinus halepensis*) mixed with cedar (*Tetraclinis articulata*) covers a relatively large area (Migot 1987).

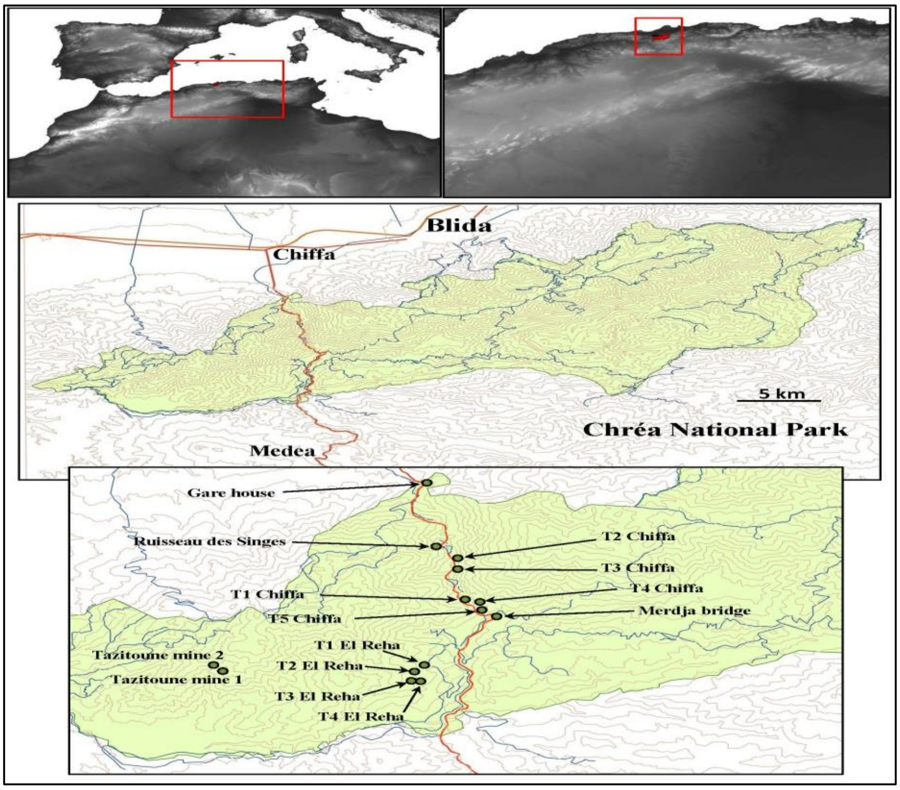

Figure 1. Location of Chréa National Park in Algeria with bat sampling localities.

The climate varies from sub-humid to humid depending on altitude and orientation. Average annual rainfall ranges from 700 to 900 mm, average temperatures are 18 to 28 °C in summer and 7 to 15 ° C in winter. Snow is relatively common on the summits (50 to 100 cm annually). This region is crossed by a road line of disused iron connecting the city of Blida to that of Medea. It crosses, by narrow channel, 12 linear kilometers in length, passing through 8 tunnels and 2 viaducts. It is currently decommissioned since 1990 (Anonyme 2000).

Sampling localities and collection data

From 2008 through 2017, six principal areas were selected within the Chréa National Park to bat research. We selected 14 localities to bat sampling situated near and throughout on main road which cross the north to south the National Park (Table 1, Fig. 1).

Table 1. Situation of localities sampled in Chréa National Park.

Localities (nº and names)		Geographical coordinates	Altitude
1	Gare house	36° 25' 05,6" N, 2° 45' 25,7" E	277
2	Ruisseau des Singes	36° 45' 00,9" N, 2° 45' 45,6" E	347
	Chiffa tunnels		
3	Tunnel 1	36° 22' 46,9" N, 2° 46' 13,5" E	327
4	Tunnel 2	36° 21' 39,9" N, 2° 45' 57,1" E	327
5	Tunnel 3	36° 23' 32,8" N, 2° 45' 57,5" E	295
6	Tunnel 4	36° 22' 44,6" N, 2° 46' 15,5" E	327
7	Tunnel 5	36° 22' 17,6" N, 2° 46' 15,1" E	333
8	Merdja bridge	36° 22' 33.5" N, 2° 46' 30.1" E	317

	Oued El Reha tunnels		
9	Tunnel 1	36° 19’ 57,2” N, 2° 44' 22,7” E	459
10	Tunnel 2	36° 19’ 52,3” N, 2° 44' 19,9” E	461
11	Tunnel 3	36° 19’ 48,5” N, 2° 44' 16,6” E	453
12	Tunnel 4	36° 19’ 48,5” N, 2° 44' 16,6” E	453
	Tazitoune mines		
13	Mines of Tazitoune 1	36° 20' 16,1" N, 2° 45' 18,1" E	676
14	Mines of Tazitoune 2	36° 20' 13,7" N, 2° 45' 10,3" E	692

Chiffa tunnels

Tunnels located in the railway line built by the French people at the beginning of the colonial era that connects the cities of Blida and Djelfa. It is constituted by 12 abandoned linear kilometers of length and it crosses the “Chiffa Gorges” passing through 8 tunnels and 2 viaducts. The railway line is currently decommissioned since 1990 (Anonyme 2000). We sampled five tunnels with length comprises between 0.6 and 1 km. They are wet for a period of the year, but sometimes they are completely dry in summer, when the flow of spring water, decreases sharply, especially for the tunnel T1. All five tunnels were relatively near between them. In four localities where the bat colonies were often presents (tunnels 1, 2, 3 and 4), we sampled these colonies each month (from April 2008 to April 2010 in the first locality and from November 2008 to April 2010 in two others localities). After from 2011 to 2017 these localities were sampled in almost one time each season (spring, summer, autumn and winter). Recorded temperatures were obtained in each occasion using mercury thermometer.

Oued El Reha tunnels

These were represented by four tunnels situated in parallel to the Tamesguida old CW8 road. The tunnel length ranged from 0.3 to 0.5 km. All tunnels were sampled in February 2009, September 2011 and May 2012.

Tazitoune mines

Mines were situated in Mount Mouzaia, located at the extreme southwest of the national park. In this area, there were old iron mines and a natural cave. We were able to explore two mines out of six. Their architecture is similar to that of a labyrinth. The Tazitoune n° 1 mine extends over a distance of 5 km while that Tazitoune n° 2 mine was smaller with 0.5 km in length. Both mines were relatively narrow and low (1.50 m tall and 1 m wide).

Tazitoune n° 1 was sampled in winter 2009, 2013 (December) and in spring 2014 (March and May) and autumn (November) 2015. Tazitoune n° 2 was sampled in spring (April) 2010 and summer (June) 2011, winter (December) 2013, spring (April and May) 2014 and autumn (November) 2015 and 2016.

Merdja bridge

Bridge crosses the Chiffa River and it located in N1 national road at 11 km from Chiffa.

Ruisseau des Singes

Old building patched up a few years ago to be transformed into a hotel-restaurant resembling a rural house. Two localities were sampled in May 2009.

Gare house

Old abandoned house where two cellars (~2 m^2) are frequented by bats. This building was situated near a bridge, which makes that bats take refuge between the basement of the house and the concrete openings below the bridge. This locality was sampled in spring (May 2009 and 2011), summer (June 2009, July 2008 and August 2009), autumn (September 2009 and 2011, November 2008 and 2011) and winter (January 2012).

Capture and detection methods

Tunnels and mines localities were sampled by prospection inside the underground structures. Bats were captured inside the roosts with long handled butterfly nets during the day or with mist nets at sunset, when they emerged to forage. Bats were transferred into individual cotton pouches for transportation and processing. Thick leather gloves were always worn when bats were handled. All bats were identified to species, based on the identification key to the bats of Europe (Dietz & Von Helversen, 2004). Individuals were sexed and aged as juveniles or adults based on the degree of epiphyseal fusion (Racey, 1974). Reproductive status of adult females was classified as pregnant or lactating, based on palpation of the abdomen and nipple condition (Racey 2009). Adult bats of *Rhinolophus ferrumequinum* were also ringed to investigate possible exchanges between tunnels.

To sample non cave-dwelling bat species, we used Pettersson D280x ultrasound detector (Pettersson Electronic AB, Uppsala, Sweden) to record echolocation calls. Ultrasonic sounds were recorded with heterodyne and time expansion system directly to computer during five minutes. To analyze these recordings we used Bat Sound software (Pettersson Electronic AB, Uppsala, Sweden) and for identification bat spectrograms we followed the methodology described by Russo and Jones (2002).

Statistical Analyses

We evaluate the seasonal variability of colony size in five localities. The colony size was estimated at each sampling time (month) and for each species found in the roost from direct census conducted inside the refuge or when bats had left the roost to forage at night. When the colonies were large, we calculated the area occupied by a little group of ~10 individuals and then we calculate the total area occupied by bats. Finally, from of these two areas we estimated of colony size. Because of small sampled size of several bat species, we analyze only the colony size variation of *Rhinolophus ferrumequinum* and *Miniopterus schreibersii*. We used a generalized linear-mixed model and assumed a Poisson distribution to investigate the relationships among colony size (response variable) and month as explanatory variables. To reduce the factor levels in the variable month, we created the variable season, which included spring (March, April and May), summer (June, July and August), autumn (September, October and November) and winter (December, January and February). All the models considered for the analysis included the fixed additive effects of season variable and the random effects of year.

We also investigate the variability of internal roosts temperatures in relation two factors (locality and season). In this case, we used a one way ANOVA models. Linear model was used to analyze relationship between internal and external temperatures.

All analyses were conducted using the R package version 2.14.2 (R Core Development Team 2008). Models were run with the 'glmer' function in 'lme4', using the Laplace approximation of the maximum-likelihood and a logit link function. Likelihood ratio tests between models were calculated using the R-function 'anova'. Multiple comparisons between factor levels were obtained using the 'multcomp' function from the R package.

RESULTS

Bat species

All bats species observed are presents in European Mediterranean region. Ten bat species from four families were found in Chréa National Park. We observed bats in eleven of fourteen localities sampled (78 %). However, in other localities such as the tunnel 2 of Oued El Reha, bats were not observed but the presence of guano indicated that bats also occupied these localities. The most frequent bat species were *Rhinolophus ferrumequinum* and *Rhinolophus hipposideros*, which they were observed in 7 and 8 localities, respectively (Table 2). The large colonies observed were constituted by *R. ferrumequinum* and *Miniopterus schreibersii* although number of individuals varied by season and locality. Tazitoune mines showed larger colonies of *R. ferrumequinum* and *Myotis punicus* in spring while solitary individuals were observed at rest of year. *Rhinolophus euryale*, *Rhinolophus blasii* and *R. hipposideros* were also observed with low number of individuals (< 5) in two mines (Table 2). The winter was the season where were observed larger colonies of *R. ferrumequinum* and *M. schreibersii* in Chiffa tunnels.

Merdja bridge and Ruisseau des Singes were two localities with a high number of bat species and with similar bat communities (Table 2). However, no roosts were observed and all bat species were detected by ultrasonic sounds indicating that these localities should be used as foraging areas. Finally, in Gare house locality, only one bat species was observed (*R. hipposideros*). This species was present with low number of individuals (< 10) during all year, except winter.

Table 2. Bat species in the Chréa National Park. Localities are numbered as Table 1. Presence (+) of bat species by captured/observation (c) or ultrasound detection (s).

	Localities													
Bat species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Rhinolophidae														
Rhinolophus ferrumequinum	-	$+^{s}$	$+^{c}$	$+^{c}$	$+^{c}$	$+^{c}$	$+^{c}$	$+^{s}$	$+^{c}$	-	-	-	$+^{c}$	$+^{c}$
Rhinolophus hipposideros	$+^{c}$	-	$+^{c}$	$+^{c}$	$+^{c}$	$+^{c}$	$+^{c}$	-	-	-	-	-	-	$+^{c}$
Rhinolophus euryale	-	-	$+^{c}$	-	-	$+^{c}$	-	-	-	-	-	-	$+^{c}$	$+^{c}$
Rhinolophus blasii	-	-	-	-	-	-	-	-	-	-	-	-	$+^{c}$	-
Miniopteridae														
Miniopterus schreibersi	-	-	$+^{c}$	$+^{c}$	$+^{c}$	-	-	-	-	-	-	-	-	-
Vespertilionidae														
Pipistrellus pipistrellus	-	$+^{s}$	$+^{s}$	$+^{s}$	$+^{s}$	-	-	$+^{s}$	-	-	-	-	-	-
Pipistrellus kuhlii	-	$+^{s}$	-	-	-	-	-	$+^{s}$	-	-	-	-	-	-
Hypsugo savii	-	$+^{s}$	$+^{c}$	-	-	-	-	-	-	-	-	-	-	-
Myotis punicus	-	$+^{s}$	-	$+^{c}$	$+^{c}$	-	-	$+^{s}$	$+^{c}$	-	-	-	$+^{c}$	$+^{c}$
Molossidae														
Tadarida teniotis	-	-	$+^{c}$	-	-	$+^{c}$	-	-	-	-	-	-	-	-
Total number of bat species	1	5	7	5	5	4	2	4	2	0*	0	0	4	4

* *Guano presence*

Chiffa tunnels microclimates

The internal roosts temperatures were strongly correlationated with external temperatures (β = 0.56 ± 0.05, P < 0.001, r^2 = 0.71).

Internal temperatures showed that the tunnel 2 and 3 were significantly colder (14.32 ± 0.67 and 14.16 ± 0.65 ºC, respectively) than tunnel 5 (18.06 ± 1.09 ºC) (t = 3.16, P = 0.015; t = 3.29, P = 0.010) throughout all year. Tunnels 1 and 3 showed similar mild temperatures although no significant differences were founded in comparison with other tunnels. Similar variability and thermal amplitude was observed in the five tunnels but was greater in tunnel 5 (Δ 12.42 ºC) (Table 3).

In winter and autumn seasons, the tunnel 2 and 3 was colder than other ones sites although no significant differences were obtained. Also, spring and summer temperatures were similar between tunnels. However, in summer, internal temperatures of tunnel 5 were significantly warmer than tunnel 3 (t = 3.03, P = 0.033).

Seasonal variation of internal temperatures was observed being the winter the colder season. However, internal temperatures in winter at tunnel 3 were not significant different than spring and autumn season (t = -1.64, P = 0.37; t = -2.17, P = 0.15, respectively). Winter temperatures in tunnel 4 were also not significantly different in comparison with spring (t = -1.54, P = 0.43). Internal temperatures were significantly higher in summer in each tunnel but not differences were found between spring and autumn seasons (Table 3).

Table 3. Internal temperatures of Chiffa tunnels (mean ± SE) by season.

	Site				
Season	Tunnel 1	Tunnel 2	Tunnel 3	Tunnel 4	Tunnel 5
spring	15.79 ± 0.78	14.45 ± 0.60	13.60 ± 0.87	14.00 ± 0.89	16.80 ± 1.11
summer	20.13 ± 0.79	20.28 ± 1.38	18.94 ± 1.10	22.17 ± 1.51	24.67 ± 0.21
autumn	16.61 ± 1.01	13.77 ± 0.97	14.23 ± 1.40	16.71 ± 0.99	18.33 ± 1.73
winter	12.10 ± 0.74	10.33 ± 0.68	10.96 ± 0.62	11.42 ± 0.48	12.25 ± 0.54
Mean	**16.17 ± 0.56**	**14.32 ± 0.67**	**14.16 ± 0.65**	**16.10 ± 0.90**	**18.06 ± 1.09**

Dynamics population of bat species in Chiffa tunnels

The tunnels 1 and 3 harboured a similar colony size of *R. ferrumequinum* (377 ± 41 and 293 ± 40 individuals, respectively) while in tunnel 2 the colony size was smaller (88 ± 17 individuals). Tunnels 4 and 5 harboured occasionally few solitary individuals. The number of individuals fluctuated strongly depending of seasons in tunnels 1, 2 and 3 (Table 4, Fig. 2). The number of *R. ferrumequinum* was higher during winter period in tunnel 2 and 3 but not in tunnel 1. After winter, the number of *R. ferrumequinum* was decreasing to summer, where the colony size was relatively small in all tunnels except the tunnel 3. In autumn (before hibernation) the colony size increased in tunnel 1 and 2 but not in tunnel 3. In spring, summer and winter large colonies were observed in tunnels 1 and 3. However, in autumn season, the colony size of tunnel 1 increased strongly and was very larger in comparison to tunnels 2 and 3 (z = -59.48, P < 0.001; z = -47.93, P < 0.001, respectively). Tunnels 2 and 4 showed smaller colony size in all seasons (all comparisons having P < 0.001) (Table 4).

Table 4. Number of *Rhinolophus ferrumequinum* and *Miniopterus schreibersii* (mean ± SE) by roost and season.

Rhinolophus ferrumequinum				
	Site			
Season	Tunnel 1	Tunnel 2	Tunnel 3	Tunnel 4
spring	346.50 ± 87.47	52.25 ± 23.25	312.70 ± 100.56	8.67 ± 3.38
summer	222.85 ± 78.21	10.30 ± 5.50	290.36 ± 83.07	2.29 ± 0.36
autumn	571.33 ± 71.98	74.43 ± 33.16	173.86 ± 42.82	4.50 ± 1.43
winter	335.62 ± 70.35	177.29 ± 34.94	409.38 ± 90.10	5.60 ± 1.29
Mean	**377.13 ± 41.44**	**87.93 ± 17.58**	**293.27 ± 40.21**	**4.62 ± 0.79**

Miniopterus schreibersii				
	Site			
Season	Tunnel 1	Tunnel 2	Tunnel 3	Tunnel 4
spring	15.00 ± 8.78	52.00 ± 35.23	13.38 ± 5.66	
summer			3.20 ± 1.74	1.00 ± 0.00
autumn	27.70 ± 11.66	4.25 ± 1.36	12.90 ± 6.06	
winter	31.22 ± 12.74	54.83 ± 29.37	256.33 ± 156.57	
Mean	**25.11 ± 6.48**	**30.53 ± 12.70**	**61.72 ± 35.57**	**1.00 ± 0.00**

Two individuals captured and ringed in tunnel 1 in May 2008 were recaptured in December 2008 and June 2008 in the tunnels 3 and 4, respectively. Another individual ringed in tunnel 3 during May 2009 was also recaptured in the same month in tunnel 1 indicating that exchange of individuals between tunnels was frequent.

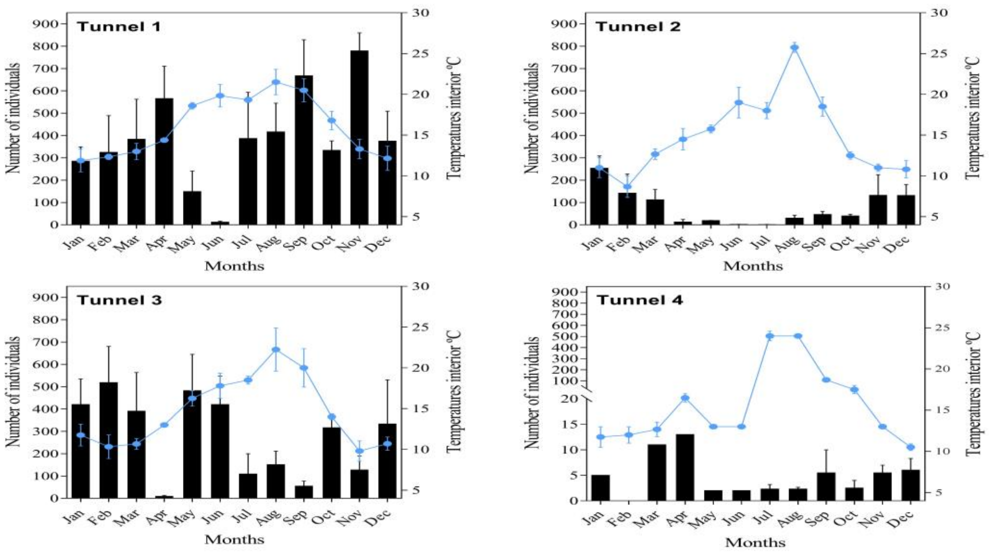

Figure 2. Mean (± SE) of colony size of *Rhinolophus ferrumequinum* during the year in four localities.

The Schreibers' bat (*M. schreibersii*) was also recorded in all five tunnels throughout all year although generally they were observed solitary individuals or in small groups (< 80 individuals). However, higher numbers of individuals were observed in spring and winter, especially in February 2010 where 900 individuals were observed in tunnel 3 (Table 4, Fig. 3). This sudden increase of individuals could indicate that *M. schreibersii* used these roosts as intermediary refuges in their seasonal displacements.

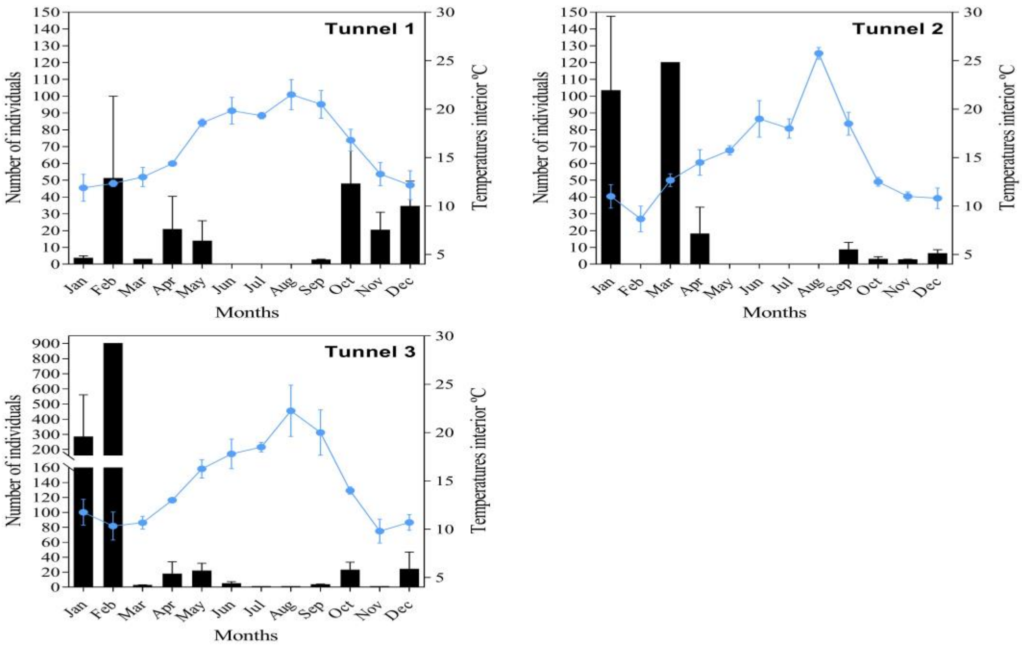

Figure 3. Mean (± SE) of colony size of *Miniopterus schreibersii* during the year in three localities.

R. hipposideros were recorded in all five tunnels although they were more frequents in tunnel 1 and 3. The higher numbers of individuals were observed in autumn and winter periods.

Solitary individuals of *M. punicus* were observed occasionally in tunnels 2, 3 and 4 between June and October although they were more frequent in autumn season.

DISCUSSION

This study reveals for first time the bat diversity in Chréa National Park and the importance of artificial man-made structures to conservation bat population. The number of bat species observed corresponds to 38% of overall bat diversity in Algeria. However, the great extension and diversity of habitats in Chréa National Park suggested that bat diversity could be higher. The most bat species found in the Park belonged to troglofilic species because of higher sampling effort realized in tunnels and mines. Similar bat composition was found in two others studies realized in north Algeria with a specific sampling of underground structures (Mokrani *et al*. 2018; Farfar *et al*. 2017).

Roosts are the one most important resource known to influence the distribution and abundance of bats (Kunz 1982; Furey & Racey 2016). The majority of bat species roost inside natural refuges such as caves (*M. schreibersii*), tree holes (*Nyctalus leisleri*) and rock crevices (*Tadarida teniotis*). However, the loss of natural roosts as consequence of increased urbanization, conversion of natural landscapes to agriculture, forest fires and management of forests, obligate to bats use human-made structures as alternatives to natural shelters. In both cases, roost selection depends on seasonal requirements and is largely influenced by microclimatic factors such as internal roost temperature and humidity (Fenton and Rautenbach 1986; Churchill 1991), the proximity of the roost to suitable foraging and drinking areas (Entwistle *et al.* 1997) and the surrounding environment (Wunder and Carey 1996). Because these requirements changing depending of physiological needs of individuals across year (Dietz *et al.* 2009), bats change of roost to search the optimal conditions for each season. In our study, the differences in microclimate conditions of three roosts conditioned their utilization by bats throughout the seasons. Large colonies were observed in winter in all three tunnels indicating than rang of internal temperatures were optimal to hibernation. Kowalski et *al*. (1986) suggested that *R. ferrumequinum* prefers cool roosts during winters in Algeria and hibernating sites in Europe showed similar temperatures ranged 3 to 13 ºC (Ransome 1968, 1971; Webb Speakman & Racey 1996). However, the lower colony size observed in roost 2 could be due to a smaller length of tunnel, which would cause an elevated wind circulation and lower humidity. In contrast, the low number of individuals in summer suggest than internal temperatures should be not favorable by maternity colonies, as they require warm roosts to speed up the development of embryos during the period of pregnancy (Dietz *et al.* 2009). In this sense, individuals of *R. ferrumequinum* observed in summer could correspond to males or non-breeding females while other possible roosts (unknown by us) harbored reproductive females.

The large seasonal variability of colony size observed and some exchange of individuals between roosts indicate translocations of individuals among the three tunnels. These exchanges could be frequents between roosts placed near, especially in spring and autumn, where the individuals of *R. ferrumequinum* would seek optimal internal temperatures depending their requirements. However, in our study, almost two roosts (tunnels 1 and 3) harbored *R. ferrumequinum* during all year indicating than microclimate conditions were favored by their requirements. This species shared roosts with other bat species, which the most frequent was *M. schreibersii*. Like Kowalski *et al*. (1986) we also recorded this species in association with *R. ferrumequinum*.

Contrarily, the Schreibers' bat used the tunnels as equinoctial roosts, which are important in their seasonal displacements. Migration routes are unknown in Algeria but possibly this species make displacements between summer and winter roosts like in Europe (Serra-Cobo *et al*. 1998). The hibernation sites are characterized by temperatures ranged between 4 – 11.5 ºC (van der Merwe, 1973) and stables. Taking into account that the rivers seem to be landmarks in the navigation of the *M. schreibersii* and also path to be followed in migration flights (Serra-Cobo *et al*. 2000), the Chiffa gorges can be a path in the seasonal movements of this species. The low number of *M. schreibersii* could indicate that temperatures could not be optimal to hibernation or alternative roosts are present in the area.

Furthermore, no dwelling-caves bat species such as *Hypsugo savii* and *T. teniotis* could use these artificial structures as temporal roosts in their biological cycle.

The results show the importance of Chiffa tunnels for bats and the need to protect their bat colonies including this locality in the conservation and management plans of fauna. Our results suggest that Chréa National Park is an important region that harbors an elevated number of bat species. However, more bat studies are necessaries to complete the bat diversity in this Park. Furthermore, this study also reveals that human infrastructures like a disused railway and their tunnels should be considered by managers as elements having a potential role in maintaining of bat populations.

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CONFLICT OF INTERESTS

The authors declare that they have no conflict of interest.

AUTHOR CONTRIBUTIONS

Conceived and designed the project: JS-C, NM, MB. Performed fieldwork: NM, JS-C, ML-R. Performed the analysis: ML-R. Wrote the paper: ML-R, JS-C, NM.

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