

ORIGINAL ARTICLE

Forest bats in Southern Salamanca (Spain): rare or understudied? Insights from a highly diverse community

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ABSTRACT

Forest-dwelling bats are a poorly studied group in Iberia. Little information is available about their abundance, conservation status, and, for some regions, even their distribution. This is the case in the western sector of the Sistema Central mountain range, an interesting area from a biogeographical point of view that potentially could host rich bat communities. However, there is almost no published information about forest bats in the region. From 2017 to 2019 we carried out acoustic and mist-netting surveys in the province of Salamanca (Western Spain), intending to fill this gap in the faunistic knowledge of the area. Our work has revealed a very diverse bat community, reaching 19 species out of the 31 known in Iberia. We obtained new data for forest-specialist species, including many records of the rare *Myotis bechsteinii*, *Barbastella barbastellus* and *Nyctalus lasiopterus*. Most interestingly, we also found a high abundance of *Myotis mystacinus* which is rarely captured. This study provides novel information about the distribution, status, and ecology of bats in the forests of one western sector of Sistema Central and highlights the importance of the area for conserving these species in the Iberian context. The large number of new records emphasizes the lack of sampling in the region and the need to get better knowledge to develop informed management and conservation decisions.

INTRODUCTION

Mountain ranges are considered biodiversity hotspots in the majority of the world regions (Perrigo et al. 2019). In southern Europe, peninsulas have played an important role by creating an altitudinal gradient of environmental conditions that have hosted different species from the Western Palearctic, both during warm and cold periods of the Quaternary climatic oscillations (Bennett et al. 1991, Taberlet & Cheddadi 2002) and giving Mediterranean mountains a great interest for biodiversity conservation and research (Médail & Quézel 1999, Schmitt 2009).

This is true of the Sistema Central mountain range, located in the centre of the Iberian Peninsula. It is a transitional zone between colder and wetter supra-Mediterranean and warmer and drier meso-Mediterranean bioclimatic stages (Rivas-Martínez 1987). Therefore, this mountain range defines the distribution of several taxa which are restricted to the bioclimatic conditions on each side. For instance, it is the southern edge for several rodent species' distribution, such as *Microtus arvalis* (Pallas, 1778) and *Microtus lusitanicus* (Gerbe, 1879), and the northern limit of several thermophilous taxa, such as *Macrotodon brevis* (Günther, 1862) or *Drimia maritima* (L.) Stearn). Moreover,

the mountain range itself also provides climatic conditions to support Eurosiberian plants (e.g., *Lilium martagon* (L.)) and mountain-specialist animals (e.g., *Iberolacerta cyreni* (Müller & Hellmich, 1937)) (Castroviejo 1986, Palomo et al. 2007, Salvador 2014), including providing roosting sites for mountain specialist species. Therefore, Sistema Central represents a vital transitional zone where taxa from two different biogeographical regions can occur in sympatry resulting in diverse communities.

In the case of bats, Sistema Central represents the southwestern distribution limit of the recently described *Myotis crypticus* (Ruedi et al. 2019) and *Plecotus auritus* (Linnaeus, 1758). In addition, Sistema Central also represents the northern distribution range limit for a thermophilous species, *Eptesicus isabellinus* (Temminck, 1839) (Salicini et al. 2013, Santos et al. 2014, Juste et al. 2019).

Although many studies have been carried out in this mountain range on a variety of taxa (Bosch et al. 2001, Pardo & Gil 2005, Salvador et al. 2007), basic knowledge about distribution, conservation status and natural history of bats remains poor except for a few works (Fernández-Gutierrez 2002, de Paz et al. 2015, Hermida et al. 2018). This lack of information is particularly marked in the western part of

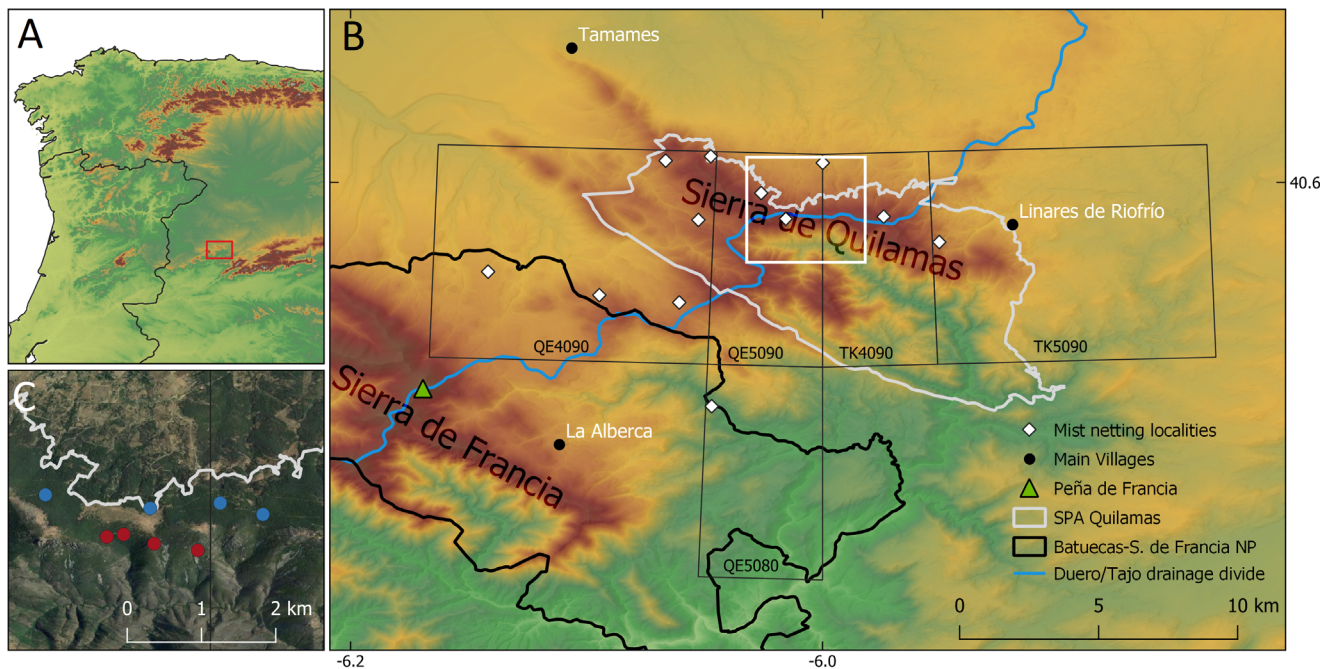


Fig. 1 - Map of the study area. A) Location of the study area within the Iberian Peninsula, red rectangle: extent of B. B) Overview of the study area showing the locations of mist netting (white diamond). White rectangle: extent of C. C) Detailed view of the Sierra de Quilamas showing the locations of ultrasonic calls recording in the north (blue) and south (red) slopes.

the range, where most of the available data only includes information about cave-dwelling species (Palomo et al. 2007, Hernández-Taberero 2010).

In this work, we aim to provide novel information about the distribution, ecology and status of the bats in middle-elevation forests in the south of Salamanca province (Spain, W Iberia). We outline the results of three seasons (2017-2019) of bat monitoring using both mist-netting and ultrasonic call recordings. To our knowledge, this represents the first local-scale assessment of a community of forest bats in the western sector of Sistema Central.

MATERIALS AND METHODS

Study area

Fieldwork was carried out in the south of Salamanca Province (Castile and Leon, Spain), located in the western part of Sistema Central. The range is dominated by granitic and metamorphic materials which provide a siliceous substrate. Peak Almanzor (2592 m), in the central part of the range, is the highest summit. The study area comprises the Quilamas range Special Protection Area (Red Natura 2000-ES4150108), and the highest point is the peak Cervero (1463 m.). The surrounding areas comprise Las Batuecas-Sierra de Francia Natural park and open oak woodlands located between these mountainous areas (Fig. 1). The climate in the area is temperate, with a mean annual temperature of 12.5°C and an average precipitation of 800-1000 mm. The mean annual number of days with minimum temperatures under 0°C varies in the area from 80 to 100, while the maximum temperature is equal to or above 25°C for an average of 110 days per year (AEMET-IM 2011). Wet zones are dominated by deciduous *Quercus pyrenaica* Willd. forests with some patches of *Castanea sativa* Mill., while

evergreen oak *Quercus rotundifolia* Lam. is the dominant tree species in the dry environments (Ruiz-Labourdette et al. 2013). Mist net sampling was carried out in late 2017 and during the summers of 2018 and 2019, while ultrasonic calls were recorded in 2018. Sampling localities cover 5 UTM 10x10 quadrants (Fig. 1; 29TQE49, 29TQE59, 29TQE58, 30TTK49 & 30TTK59).

Bat captures

Bats were captured using monofilament and polyester nets close to within-forest water points, where bat activity is concentrated in Mediterranean environments (Lisón & Calvo 2014). Nets had four pockets and the length ranged from 3 to 12 m by 2.5 m in height. A total of 30 sampling nights were carried out in 12 localities (Table 1, Fig. 1B) from September 2017 to August 2019. These represented 3 nights in 2017, 20 in 2018, and 7 in 2019, accumulating to 140.3 hours of open mist-nets and an average of 40.6 m of net per night. The size and number of nets used varied between localities due to spatial limitations, and sampling effort was calculated as net-meters*hour, accumulating a total of 6207.1 net-m*hours. Capture success ((individuals/sampling effort)*1000) was calculated for every species (Nogueras et al. 2010, Olaya-Rodríguez et al. 2019) and it was used as a proxy for their relative abundance in the study area. All the sampling was done between April and October, but 20 out of 30 were carried out from June to August when bat activity is highest (Dietz & Kiefer 2016). Most of the mist-netting localities were in *Quercus pyrenaica* forest, a few were in *Q. rotundifolia* or *C. sativa* patches, and two were in open areas covered by low shrubby vegetation. The water bodies sampled were mainly artificial ponds for free-ranging livestock. Rivers, concrete water tanks, and flyway-like trails were also sampled (Table 1, Fig. 2).

Table 1 - Locality characteristics and capture data. Habitat: “Qpyr” (forests of *Quercus pyrenaica*), “Qrot” (forest of *Quercus rotundifolia*), “Csat” (patch of *Castanea sativa* within a larger *Q. pyrenaica* forest), “Open” (predomination of low shrubby vegetation in the surroundings of the sampling point). Type: “Pond” (artificial pond made for livestock, usually within the course of a seasonal small stream), “Pool” (small and rectangular concrete water reservoir shorter than 25 m), “Tank” (concrete tank for livestock, narrower than 1 m and shorter than 4 m), “River” (one locality, middle elevation mountain river) and “Trail” (vegetation tunnel within the forest and close to a narrow stream, nets were set up closing the flyway).

Locality	Habitat	Type	UTM _{10x10}	Altitude	Nights	Hours	No. indivs	No. sp
Fuente del Campo	Qpyr	Tank	30TTK49	1255	1	5	9	3
Casas del Conde	Qpyr	River	29TQE58	596	1	5	12	6
Charca Cereceda	Qpyr	Pond	29TQE49	1090	1	5	22	7
Charca Las Endrineras	Qpyr	Pond	29TQE49	998	1	7.5	36	11
Fuente El Carrero	Open	Pool	29TQE49	1149	2	6	14	8
Fuente Castaño	Qpyr	Pond	29TQE49	693	1	9	58	8
La Honfría	Csat	Trail	30TTK59	1055	2	6	41	7
Las Fuentes	Qpyr	Pond	29TQE59	1171	8	34.4	98	11
Peña Venero	Qrot	Tank	29TQE59	1178	2	8.3	3	2
Piscina de Navarredonda	Qpyr	Pool	30TTK49	1010	5	20.5	20	8
Arroyo de la Mina	Open	Pond	29TQE49	1085	3	13.6	33	5
Rodera de los Mosquitos	Qpyr	Pond	29TQE49	1138	3	20	27	9
Totals					30	140,3	373	19

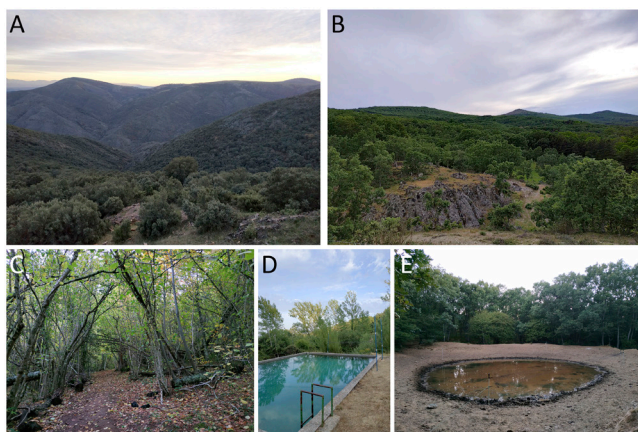


Fig. 2 - Landscapes of the study area. Upper row: Forests of the Sierra de Quilamas: A) Southern slope, showing the evergreen *Quercus rotundifolia* forest; B) Deciduous forest of *Quercus pyrenaica* on the northern slope. Lower row: examples of mist netting locality types; C) Vegetation tunnel; D) Artificial pool; E) Human-made pond for cattle within *Quercus pyrenaica* forest.

The nets were either set up over the water, in a V or Z shape, or along the water’s edge when the water was deep. In addition, dirt roads and other potential flyways around the water point were closed with ground-level nets and a double-height net when there was enough space. Net configuration and guidelines used to extract entangled bats from the nets have been carefully described in Kunz & Parsons (2009). Mist nets were opened at dusk and were closed when activity decreased, often between 2:00 and 4:00 am. Captured individuals were identified using keys in Dietz & Kiefer (2016), and bats of the *Myotis nattereri* (Kuhl, 1817) complex were determined based on Juste et al. (2019). When the determination was doubtful, wing punches were collected for molecular identification. Basic biometry, weight, reproductive status, and dental wear were recorded for every individual. The breeding status of bats in

the area was also assessed based on the reproductive status of females: not breeding, pregnant, or lactating. All of these features were measured following Haarsma (2008).

Echolocation call recording and analysis

In June 2018, two SM2-BAT ultrasound recorders (Wildlife Acoustics Inc.) were used to record bat activity independently from the mist netting surveys. Acoustic sampling was focused on the middle elevation range Sierra de Quilamas (Fig. 1C). Recording stations were established in two different habitats: deciduous *Quercus pyrenaica* forests, which dominate the northern slope, and sclerophyll evergreen *Q. rotundifolia* on the southern slope (Fig. 2).

A total of eight recording localities were surveyed, four on each slope of the Sierra, separated by three kilometres (Fig. 1C). Recorders were placed on tree trunks between 2.5 and 3.5 metres above the ground and were configured to record during two consecutive nights, with the following parameters: gain 12db, sample rate 256 kHz, minimum trigger frequency 12 kHz, and trigger level 12db. Recording commenced for nine hours each night, starting at 22:00 (20 minutes after sunset) and finishing at 7:00 (20 minutes after sunrise), accounting for an effort of 16 recorders*night. Each sequence of echolocation calls in a five-second recording was considered one bat pass. In order to maximize bat detection in both habitats, recorders were set up at the edge of small forest clearings, where forest bat foraging activity is higher (Guixé & Camprodon 2018). Ultrasonic calls were automatically identified using Kaleidoscope PRO 5.3.9 with Bat Classifiers Europe 5.1 (Wildlife Acoustics Inc). The identifications were manually checked to improve the results as recommended by previous studies (Rydell et al. 2017, López-Baucells et al. 2019) based on Russo & Jones (2002), Lisón (2011), Russ (2012), and Barataud (2015). Calls were identified to species level whenever possible. Due to the substantial overlap in call parameters (Barataud 2015),

recordings of the genera *Plecotus* and *Myotis* were never identified to species level and were clustered into phonic groups. *Myotis* calls were separated into large (*M. myotis* and *M. blythii*) and small (the rest of the species in the genus).

The activity of each species or phonic group in each habitat was calculated as the mean number of bat passes per night at each recording station. Differences in detectability were addressed using the coefficients for open and semi-open areas proposed by Barataud (2015).

RESULTS AND DISCUSSION

A total of 19 bat species were detected in the study area. During the 30 nights of netting, 373 individuals of 18 species were captured, and an additional species, *Tadarida teniotis* (Rafinesque, 1814), was only detected acoustically by its echolocation calls (Table 2). The overall capture success was 60.01 ((individuals/net-m*h)*1000). Molecular techniques confirmed the species identification where identification was difficult in the field. Only eight species demonstrated evidence of breeding in the study area, as determined by the presence of pregnant or lactating females. However, post-lactating females were caught for an additional four species (Table 2). Previously, whether a species was present in the area was unknown for most species, especially the forest specialists. In total, we provide 26 new records (one species in a UTM 10x10 quadrant) compared to previously published data (Fernández-Gutierrez 2002, Palomo et al. 2007, Hernández-Taberero 2010, Hermida et al. 2018).

The data obtained during this study highlights how the Quilamas Special Protection Area and Las Batuecas-Sierra de Francia Natural Park and their surroundings may be critical for the conservation of forest specialist bats in the context of western Iberia. Of particular importance, we located a well-preserved population of the globally vulnerable species *Nyctalus lasiopterus* (Alcalde et al. 2016), which we confirmed to be breeding in the area. We also found high relative abundance and breeding populations of the forest-specialist *Barbastella barbastellus*, chosen as the European bat of the year 2020-2021 by BatLife Europe (www.batlife-europe.info). *Myotis bechsteinii*, a specialist tree-dweller and one of the rarest and most endangered bats in the Iberian Peninsula (Carro 2007), seems to be scarce but well distributed in the study area. *Myotis mystacinus*, which is also an endangered species that is not frequently caught in Iberia (Nogueras et al. 2013, Molleda & Fombellida 2018), seems to be surprisingly abundant. Other forest-associated species such as *Plecotus auritus* and *Nyctalus leisleri* were frequently found in the forests across the study area. Moreover, among the 19 different species detected in the area, seven of them are catalogued as “Vulnerable” in the Spanish Endangered Species Catalogue (Table 2) (RDL 139/2011).

The highest rates of activity were recorded in the *Quercus pyrenaica* (northern) side (Fig. 3), highlighting the importance of this habitat for conserving forest-dwelling bat communities in supra-Mediterranean ecosystems. However, our work provides a preliminary survey of an issue which deserves much more in-depth research in the

future. Moreover, the use of animal-tracking techniques can explore spatial ecology and habitat use by bats in finer detail, providing an excellent baseline for evidence-based conservation (Hays et al. 2019, Katzner & Arlettaz 2020). Many studies of this kind have been carried out on bats in other parts of the world (Arlettaz 1999, Ashrafi et al. 2013, Dekeukeleire et al. 2016, Jones et al. 2017, Conenna et al. 2019). However, few tracking studies have focused on species in Mediterranean ecosystems (Popa-Lisseanu et al. 2009, Napal et al. 2010, Goiti et al. 2011, López-Baucells et al. 2021, Tena & Tellería 2021). Such studies would provide basic information that can support better decision-making in terms of habitat management and biodiversity conservation.

Little data is available in the literature for the abundance of forest-dwelling bats in Mediterranean ecosystems since intensive long-term mark-recapture studies are needed (Kunz & Parsons 2009). In Table 2, we provide relative abundances based on the number of captures and sampling effort to provide a rough idea of the status of the species captured in this study. Comparing the values obtained with data published for other Mediterranean environments, it seems that forest specialist bats such as *Barbastella barbastellus*, *Nyctalus leisleri*, *N. lasiopterus*, *Myotis bechsteinii*, and *M. mystacinus* occur in high abundances in the study area, similar or higher to those in Cazorla (Jaen, SE Spain) where some of the best populations of forest-dwelling bats in Iberia are reported (Nogueras et al. 2010, Ibáñez et al. 2012, Guixé & Camprodon 2018) or Valsain, in the Sistema Central (de Paz et al. 2017). However, these are very rough estimations. Therefore, further detailed studies of forest bat population dynamics and abundance in Mediterranean ecosystems are needed to understand the impact of past and present human activities on these species and to improve the conservation strategies.

Species accounts

Despite the high species richness of the bat community in the study area, we focus on the forest specialist species in more detail since they depend on forested areas and therefore are the most susceptible to changes in the landscape. We have classified the species based on their assessment in the Spanish Catalogue of Endangered Species.

Vulnerable Species (Endangered Species Spanish Catalogue)

Myotis bechsteinii (Kuhl, 1817)

Very few records for this species were available in the Province of Salamanca (Hernández-Taberero 2010). The latest record (Hermida et al. 2018) was located in the only UTM 10x10 km quadrant of the study area where we failed to find it. In forests located in Extremadura, relatively close to those studied, it is abundant (Napal et al. 2009). The few scattered records obtained in this work suggest this is a common species occurring in low densities across the study area. Of the eight individuals captured across the seven different localities, only one was a female, and it did not show clear signs of recent breeding (Table 2). All the records were obtained within *Q. pyrenaica* forests, the most utilized habitat for forest bats in the Mediterranean forests of Western Iberia (Napal et al. 2010). The species

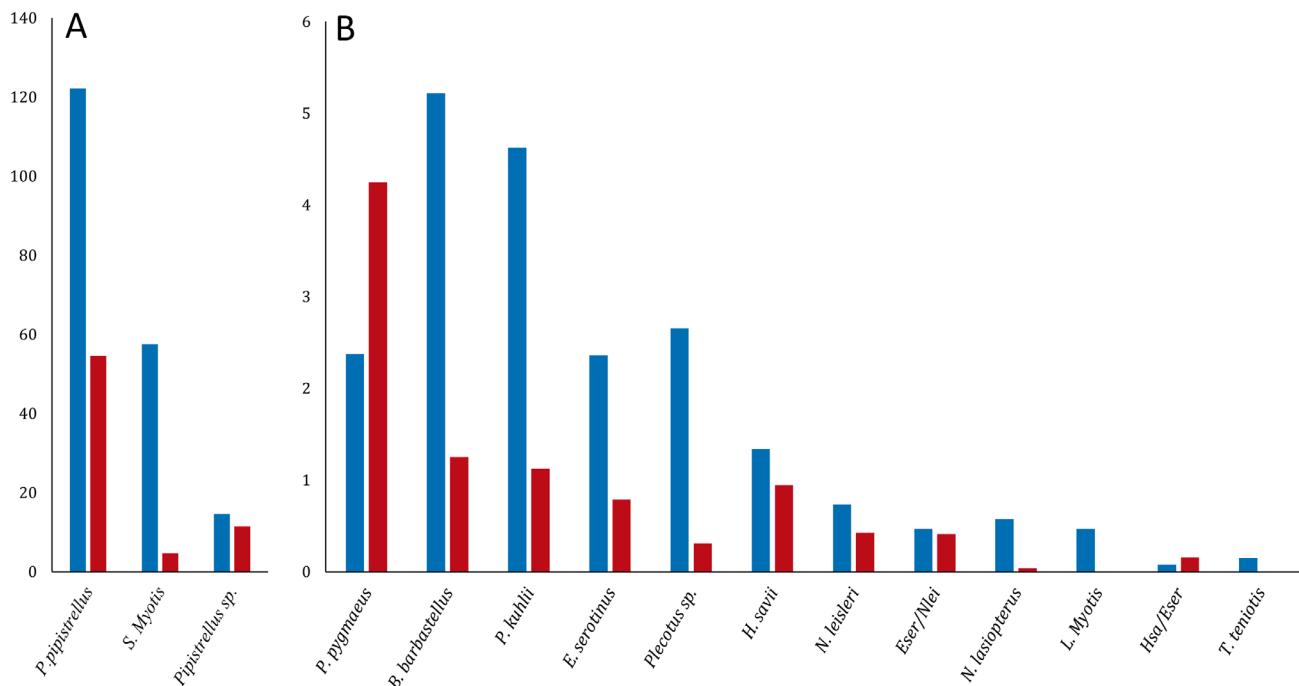


Fig. 3 - Activity of the different species or phonic groups calculated as the average number of bat passes detected by each station per night, transformed using Barataud (2015) indices for open and semi-open habitats. Blue bars: northern slope, red bars: southern. A) species/groups with total activity over 20 mean bat passes detected by each station per night; B) species/groups with total activity under 20 mean bat passes detected by each station per night.

is known to be particularly dependent on mature forests (Napal et al. 2010, Guixé & Camprodon 2018) and it was found in forest patches where older trees are scattered among regenerating ones. However, it was also captured in localities where the dominant vegetation was composed of sprouting and very compacted *Q. pyrenaica*. Hence, although no breeding colonies have been found yet, the species does not seem to be limited to the scarce old-growth forests, and more intensive sampling will likely find the species to be more widely distributed in the deciduous forests of Salamanca province than previously thought. *M. bechsteinii* is considered Vulnerable in the Spanish Catalogue of Endangered Species, being one of the most endangered forest-dwelling bat species in Iberia.

Myotis mystacinus (Kuhl, 1817)

Records of this species in the western part of the Sistema Central are very scarce. There are only a few locations registered in the literature for the province of Salamanca, one of them within our study area (Fernández-Gutierrez 2002, Palomo et al. 2007, Hernández-Tabernero 2010). It is found in a wide variety of European habitats, while in Mediterranean regions, it occupies mainly montane forests (Nogueras et al. 2013, Dietz & Kiefer 2016). *M. mystacinus* is one of the scarcest species detected using mist-netting in the Iberian Peninsula (Alcalde et al. 2008, Nogueras et al. 2010, Hermida et al. 2012, Nogueras et al. 2013, de Paz et al. 2015, 2017, Hermida et al. 2018, Molleda & Fombellida 2018). However, it was the most frequently caught *Myotis* spp. during the present study (Table 2). Reproduction of the species in the area was already known (Fernández-Gutierrez 2002), but only two post-lactating females were captured at this time. The relative abundance (Table 2) of

the species in this area is much higher than those reported for other areas of Iberia (Nogueras et al. 2010, 2013). However, unfortunately, this kind of data is rarely provided in publications, making the comparison quite difficult. Nevertheless, this area seems to be especially important for this species in the Iberian context, and more studies should be carried out considering that it is listed as Vulnerable in the Spanish Catalogue of Endangered Species (RDL 139/2011).

Nyctalus lasiopterus (Schreber, 1780)

This is the largest bat in Europe. It is a tree-dwelling species which is dependent on well-preserved forest (Guixé & Camprodon 2018). Records across the Iberian Peninsula are scattered and often associated with mountain ranges (Juste 2007). It has been reported very few times in the western part of Sistema Central, with two quadrants in the Province of Salamanca that overlap with our study area (Fernández-Gutierrez 2002, Hernández-Tabernero 2010). Our data suggests it is a relatively common species widespread across the area, with 40 bats captured between 2018 and 2019 (Table 2). Breeding seems to occur in the area since one pregnant (early June) and 15 post-lactating (late August) females were caught. In addition, a large group (33 bats) of post-lactating females, juveniles, and adult males were captured during one night of mist-netting, which highlights the importance of artificial forest ponds for this species. The acoustic activity of *N. lasiopterus* (note that *Nyctalus noctula* was not captured) in the Sierra de Quilamas was relatively low and was much higher in the northern slope forests (Fig. 4). This pattern deserves detailed investigation since *N. lasiopterus* is a high-altitude flyer able to travel very long distances each night (Popa-Lisseanu et al. 2009).

Species included in the Catalogue (without a specific category)

***Barbastella barbastellus* (Schreber, 1774)**

This forest-specialist species was captured in the three main types of forest habitat sampled (Table 1). In addition, one individual was also caught in a pool located in an open area. However, according to the acoustic sampling (Fig. 4), the species seems to be more commonly associated with the deciduous *Q. pyrenaica*, which likely provides more dead trees with crevices behind bark which it predominantly uses for roosting (e.g. Guixé & Camprodon 2018). Therefore, the species would likely be favoured by the large extents of regenerating *Q. pyrenaica* forest in the study area and surroundings (Camisón et al. 2015). Out of the 29 individuals caught, 12 females showed evidence of reproduction (Table 2). Pregnant females were caught in mid June, while lactating ones were caught until early August. In terms of abundance, it seems to be a relatively common and locally abundant species with established breeding populations, at least in the *Q. pyrenaica* forests, where all breeding females were captured. These findings are important due to the scarcity of information about the species in the Province of Salamanca (Fernández-Gutiérrez 2002, Palomo et al. 2007, Hernández-Taberner 2010, Hermida et al. 2018).

***Myotis escaleraei* Cabrera, 1904**

This Iberian endemic, together with the recently described *Myotis crypticus* Ruedi et al. 2019, used to be considered conspecific with *Myotis nattereri* (Kuhl, 1817) until recent works revealed the complex evolutionary history and cryptic diversity within the group (Salicini et al. 2013, Juste et al. 2019). Hence, most of the records available for the region are published as *M. nattereri* (Fernández-Gutiérrez 2002, Palomo et al. 2007, Hernández-Taberner 2010). *M. crypticus* occurs in the mountain forests of central and northern Iberia and it has not been found in Salamanca. In contrast, *M. escaleraei* typically roosts and breeds in caves and is considered to be more affiliated with Mediterranean habitats (Ibáñez et al. 2006). All the species within the *M. nattereri* complex which we captured were identified by molecular tools as *M. escaleraei*. To our knowledge, they are the first confirmed records for the province after the taxonomic rearrangement. It seems to be a rare species in the study area and we found no evidence of breeding (Table 2).

***Nyctalus leisleri* (Kuhl, 1817)**

This tree-dwelling bat is well distributed along most mountain ranges in the Iberian Peninsula (Palomo et al. 2007). It has been recorded several times in Salamanca (Palomo et al. 2007, Hernández-Taberner 2010), and the most recent records overlap with one of the quadrants sampled in this work (Hermida et al. 2018). Despite being a common species in our study area, with 26 captures in eight different localities, males were much more abundant. Only one lactating and one post-lactating female were caught (Table 2). According to the acoustic sampling, the species demonstrated a slight preference for *Q. pyrenaica* forest.



Fig. 4 - From the left to the right: upper row, *Myotis bechsteinii* and *Nyctalus lasiopterus*; bottom row, *Myotis mystacinus* and *Plecotus auritus*. Photographs: Jorge Sereno-Cadierno

***Plecotus auritus* (Linnaeus, 1758) and *Plecotus austriacus* (Fischer, 1829)**

Both species have been recorded several times in the Province of Salamanca (Fernández-Gutiérrez 2002, Palomo et al. 2007, Hernández-Taberner 2010) and were caught frequently during this study (Table 2), suggesting that both are common in the study area, especially *P. auritus* with 44 individuals captured. We captured females for both species at different stages of reproduction (Table 2). Pregnant females of both species were caught in early June, while lactating bats were captured from mid-June to early August. However, it seems that *P. austriacus* extended the lactation period into late summer during our study. All breeding *P. auritus* females examined in late July were classified as post-lactating, while lactating *P. austriacus* were found until early August. Fine-scale habitat partitioning has been proven as the primary mechanism allowing these ecologically similar species to coexist, as *P. auritus* is more commonly affiliated with closed forests and *P. austriacus* to more open habitats (Razgour et al. 2011). This could explain why *P. auritus* were more frequently caught despite being close to its southern distribution range limit. As a phonic group, they showed relatively high activity, especially in the deciduous *Q. pyrenaica* forest of the northern slope (Fig. 4). *Plecotus* spp. are easily caught in the study area and more intensive sampling during the complete breeding season could help clarify the temporal breeding patterns between these two species.

Generalist Species

As well as the interesting findings for forest-dwelling species, we also found new records and high abundances of more generalist species. Among these species, we have recorded *Hypsugo savii*, *Pipistrellus pipistrellus*, *P. pygmaeus*, *P. kuhlii*, *Eptesicus serotinus*, *Myotis daubentonii*, and *Tadarida teniotis*. Less common and even endangered species such as *Myotis myotis*, *Myotis blythii*, and *Myotis emarginatus* were also detected. In addition, a single juvenile female *Rhinolophus ferrumequinum*, a cave-dwelling species, was also captured. The information about these species is summarized in Table 2.

Table 2 - Species detected in the present study. Summary of the data collected, including the number of captures, reproduction status (Ind: undetermined; Preg: pregnant; Lac: lactating; P.L.: post-lactating), localities with presence (net=netting station, rec=recording station. Recording stations marked as ^a and ^b refer respectively to the same data because *Myotis* spp. and *Plecotus* spp. calls were identified to genus level.), relative abundance as per species capture success (individuals/net-meters*hours)*1000 and Threat Category according to different catalogues (SCES: Spanish Catalogue of Endangered Species; IUCN G: IUCN category globally; IUCN E: IUCN category for Europe). Species marked with an “^m” include individuals that were molecularly identified.

Species	Captured bats			Reproduction			Method		Relative Abundance	Threat Category		
	Total	♂	♀	Ind	Preg	Lac	P.L.	Net		Rec	SCES	IUCN G
<i>Barbastella barbastellus</i>	29	8	19	2	6	3	3	6	7		NT	VU
<i>Eptesicus serotinus</i> ^m	2	1	1				1	2	6		LC	LC
<i>Hypsugo savii</i>	59	38	20	1	9	9		4	8		LC	LC
<i>Myotis bechsteinii</i>	8	6	1	1				6	6 ^a	VU	NT	VU
<i>Myotis blythii</i>	1	1						1	6 ^a	VU	LC	NT
<i>Myotis d. daubentonii</i> ^m	3	2	1				1	2	6 ^a		LC	LC
<i>Myotis d. nathalinae</i> ^m	1	1						1	6 ^a		LC	LC
<i>Myotis emarginatus</i>	1	1						1	6 ^a	VU	LC	LC
<i>Myotis escaleraei</i> ^m	10	9	1					5	6 ^a		LC	LC
<i>Myotis myotis</i> ^m	6	6						5	6 ^a	VU	LC	LC
<i>Myotis mystacinus</i> ^m	26	18	8					6	6 ^a	VU	LC	LC
<i>Nyctalus lasiopterus</i>	40	15	25		1			3	6	VU	VU	DD
<i>Nyctalus leisleri</i>	26	19	7					8	6		LC	LC
<i>Pipistrellus kuhlii</i> ^m	1		1					1	4		LC	LC
<i>Pipistrellus pipistrellus</i> ^m	74	40	29	5	4	1		12	8		LC	LC
<i>Pipistrellus pygmaeus</i> ^m	24	12	9	3	1			4	7		LC	LC
<i>Plecotus auritus</i> ^m	44	12	32		3	1	13	8	6 ^b		LC	LC
<i>Plecotus austriacus</i> ^m	17	5	12		3	2		6	6 ^b		NT	LC
<i>Rhinolophus ferrumequinum</i>	1		1					1		VU	LC	NT
<i>Tadarida teniotis</i>									4		LC	LC
Total	373											60.01

CONCLUSIONS

1. This work highlights how Quilamas Special Protection Area and Las Batuecas-Sierra de Francia Natural Park are important areas for tree-dwelling bats within the Iberian context and underlines the importance of *Quercus pyrenaica* forests. Moreover, the number of new records we obtained highlights how understudied bats are in the region.
2. Forests in the western sector of the Sistema Central host important populations of endangered forest bats, such as *Nyctalus lasiopterus*, *Myotis bechsteini*, and *Barbastella barbastellus*. Among them, we note the exceptionally high abundance of *Myotis mystacinus*.
3. The presence of large and stable populations of eurosiberian species like *Plecotus auritus* and *Myotis mystacinus* in Mediterranean forests highlights the value of Sistema Central to biodiversity as a biogeographical transition zone.
4. Urgent research is needed in human-modified Mediterranean forests to better understand the ecology of bats that depend on their conservation.

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