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Environmental and geographic factors affecting the distribution of small mammals in an isolated Mediterranean mountain

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Abstract

The distribution patterns of a small mammal community were studied at Montseny (Catalonia, NE Spain), a high and isolated Mediterranean mountain that constitutes the southern limit of mid-European vegetal and animal communities. We collected information on 25 localities (119–1 140 m a. s. l.) and 16,916 small mammals in total (six Insectivora and ten Rodentia species) provided by the analysis of barn owl *Tyto alba* pellets. The relative abundance of the species was related to geographic (altitude, latitude and longitude) and environmental (rainfall and temperature) variables to establish patterns of distribution. Rainfall and temperature determined the distribution of most species, the former being inversely related to diversity, and being higher in lowland than in highland communities. This diversity trend is contrary to that found in the Pyrenees, the nearest mountain range. Five species inhabiting Pyrenean highlands are not present in the Montseny, probably due to its isolation and small area. This mountain range is the southern limit for the range of other five species. The interpretation of stepwise regression and factorial analysis, and a correlation matrix among species, enabled us to delineate three groups of species: those inhabiting preferentially Mediterranean areas (*S. etruscus*, *C. russula*, *E. quercinus*, *R. rattus*, *R. norvegicus*, *M. musculus*, *M. spretus*, *M. duodecimcostatus* and *A. sapidus*), those inhabiting preferentially mid-European ones (*T. europaea*, *S. minutus*, *S. araneus*, *A. sylvaticus*, *C. glareolus* and *M. agrestis*), and a single species with no clear preferences (*N. anomalus*).

Introduction

Several studies on small mammal communities have investigated spatial distribution and structure at the habitat level (Meserve 1976; Dueser and Shugart 1979; Rogovin et al. 1994), or along climatic and geographic gradients (McCoy and Connor 1980; Amori et al. 1984). Mountain ranges are appropriate sites to study these subjects since different habitats can be found in association with such gradients. Many of these questions have been studied in extensive mountain ranges (Bond et al. 1980; Abe 1982; Delibes 1985; Alcántara 1989; Moreno and Barbosa 1992), showing patterns of distribution on a large scale. Other factors, such as scale size, island size, and isolation (Brown 1971; McCoy and Connor 1980; Lomolino et al. 1989) can allow different interpretation of the distribution patterns of vertebrates.

Because of its situation, Montseny is a Mediterranean mountain with particular climatic and topographic characteristics that confers it a remarkable biogeographic interest (Miralles and Terradas 1986). Its geological isolation, altitudinal range, and nearness to the sea, determines its climatic variability as well as the presence of mid-European vegetable (DE BOLÒS 1983) and animal (PASCUAL and MONTORI 1983; ROCAMORA 1987) communities. In this area, these communities are represented by marginal populations restricted to special environmental conditions, and hence particular patterns of distribution can be expected.

In the present study we analyse the distribution and diversity of small mammals along climatic and geographic gradients in this small and isolated Mediterranean mountain range, comparing our results with those obtained in a nearby range (Pyrenees, GIL et al. 1986; GOSÁLBEZ 1987; MORENO and BARBOSA 1992) and in the Mediterranean region.

Study area

The study was carried out in the Montseny mountains and surrounding areas (Barcelona and Girona, Catalonia, NE Spain). Although the latitudinal and longitudinal ranks of the area are restricted (41°50′–41°33′N, 2°39′–2°06′W, 1 250 km^2), its topography and climatology varies markedly. The altitude of the localities sampled ranged between 119 and 1 140 m above sea level, and four bioclimatic strata are found, one of them in the Eurosiberian region (Montane humid) and the remainder in the Mediterranean region (RIVAS-MARTÍNEZ 1983). Figure 1 shows the topography of the study area and the situation of the sampled localities. As a result of the environmental and geographic variability we can describe four different zones: Mediterranean lowlands (S–SW), eastern humid lowlands (NE), central plateau (NW), and Mediterranean and mid-European highlands (N).

Material and method

The sampling method used was the analysis of barn owl (*Tyto alba*) pellets. Pellets accurately reflect the owl's diet, and changes in the diet show real changes in the available small mammal community (CLARK and BUNCK 1991). In spite of some limitations (SAINT-GIRONS and SPITZ 1966; CLARK and BUNCK 1991),

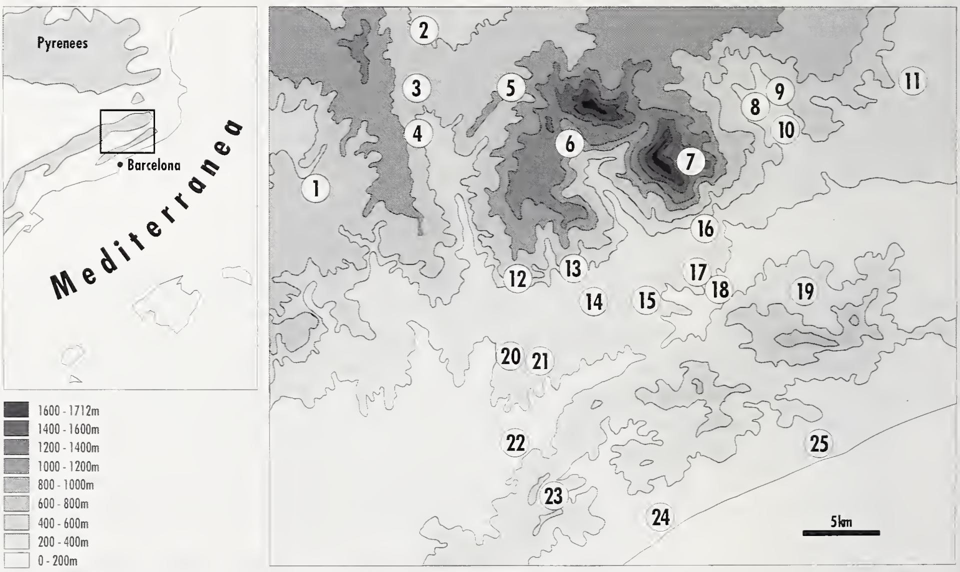

Fig. 1. Topography and situation of the study area and the 25 localities sampled. Localities 1–4: Central Plateau (NW); Localities 5–7: Mediterranean and mid-European highlands (N); Localities 8–11: Eastern humid lowlands (NE); Localities 12–25: Mediterranean lowlands (S–SW).

this method is useful for studying patterns of distribution of small mammal fauna and allows the comparison with other studies based on the same methodology (Alegre et al. 1989; Moreno and Barbosa 1992). Although the barn owl's diet shows annual and seasonal changes (Webster 1973; Marti 1973), these fluctuations are not significant since samples were taken over many years and different seasons (Moreno and Barbosa 1992). We gathered information from studies published in the area about the feeding habits of the barn owl (see Torre et al. 1996), and also included our own data. We collected information from 25 different localities and 16,916 small mammals in the four zones described. Percentages of occurrence of the species were homogenized equalizing sample sizes for all localities, and we then obtained percentages respect to the total number of individuals of each species found in all of the localities. This new data set of percentages relates closely to the data set before transformation (r_s values between 0.84 and 0.99, $p < 0.0001$).

The geographical variables of the sampled localities (altitude, latitude, and longitude) were taken from 1:50,000 cartography, and the climatic data (temperature and rainfall) were obtained from maps of the Parc Natural del Montseny as well as from the Centre Meteorològic de Barcelona. The geographical and climatological information allowed us to arrange the localities into four groups (see study area) which were characterized by their small mammal fauna. Possible differences between them were tested with ANOVA.

Before statistical analysis, percentages of species were arcsine transformed to equalize variances amongst them (Clark and Bunck 1991), and geoclimatic variables were $\log(X + 1)$ transformed (Zar 1984).

A factorial analysis was performed with the geographic and climatic variables in order to obtain independent orthogonal factors which could explain the observed variability. These factors, rotated by the varimax procedure, are interpreted as geographical and climatic gradients on which the distribution requirements of small mammals can be placed. The origin of the factorial space represents the average of the localities sampled in this study. The average situation (centroid) of every species was obtained following Carrascal and Tellería (1990). The average and standard deviation of the localities in the four geoclimatic zones were also calculated.

Diversity was calculated by Shannon-Wiener index (H′) and distribution breadth as $e^{H'}$.

A matrix of simple correlations was obtained among all the variables. Stepwise regression models were performed to determine which environmental or geographical variable primarily affected the presence of each species.

Table 1. Number of small mammal individuals found in barn owl pellets corresponding to the four environmental zones described (n = number of localities sampled in each zone).

SPECIES	Mediterranean lowlands (n = 14)	Humid lowlands (n = 4)	Central plateau (n = 4)	Highlands (n = 3)
Talpa europaea	2	2	0	0
Sorex minutus	1	24	1	6
Sorex araneus	0	0	0	1
Neomys anomalus	4	2	1	0
Suncus etruscus	210	30	91	7
Crocidura russula	3031	559	1139	135
Eliomys quercinus	3	2	0	0
Apodemus sylvaticus	2217	838	646	370
Rattus rattus	70	5	24	0
Rattus norvegicus	52	0	44	1
Mus musculus	147	3	38	2
Mus spretus	1393	104	489	58
Mus sp.	1896	283	664	9
Clethrionomys glareolus	107	94	8	18
Microtus duodecimcostatus	487	101	1356	73
Microtus agrestis	0	21	9	25
Arvicola sapidus	12	1	0	0
TOTAL	9632	2069	4510	705

Results

Information on 16 small-mammal species (six Insectivora and ten Rodentia) was recorded (Tab. 1).

Table 2. Results of the factorial analysis performed with the geographic and climatic variables from 25 localities of the Montseny area and level of significance of the correlations between variables and factors (* = p < 0.05; ** = p < 0.01; *** = p < 0.001; **** = p < 0.0001).

VARIABLE	FACTOR 1	FACTOR 2
Altitude	0.905****	–0.281
Rainfall	0.771****	0.590***
Temperature	–0.914****	0.017
Latitude	0.797****	0.149
Longitude	–0.260	0.950****
Eigenvalue	2.956	1.360
% Variance	59.1	27.2
Ac. % Variance	59.1	86.3

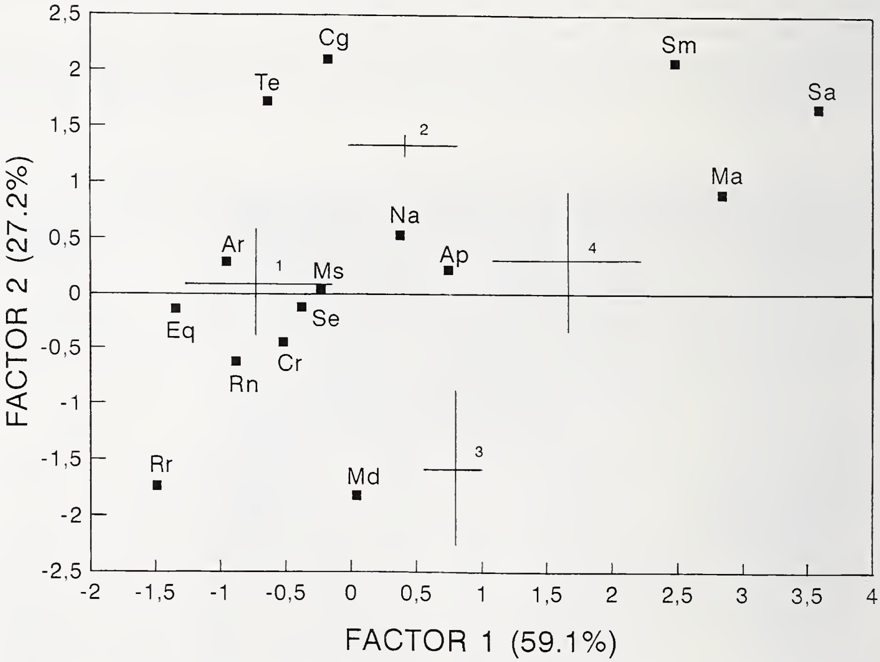

Fig. 2. Average situation of the species on the factorial space defined by factors one and two, and mean and s. d. of the four groups of localities sampled. Species: Te – *Talpa europea*; Sm – *Sorex minutus*; Sa – *Sorex araneus*; Na – *Neomys anomalus*; Se – *Suncus etruscus*; Cr – *Crocidura russula*; Eq – *Eliomys quercinus*; Ap – *Apodemus sylvaticus*; Rr – *Rattus rattus*; Rn – *Rattus norvegicus*; Ms – *Mus spretus* and *Mus musculus*; Cg – *Clethrionomys glareolus*; Ma – *Microtus agrestis*; Md – *Microtus duodecimcostatus*; Ar – *Arvicola sapidus*

The factorial analysis yielded a model with only two factors with eigenvalues greater than one, explaining together the 86.3% of variance (Tab. 2). The first factor correlated positively with altitude, rainfall and latitude, and negatively with temperature. The second factor was correlated with longitude and rainfall. The average situation of the species and the average situation and standard deviation of the four zones are represented in figure 2. These zones differed in the composition of the small mammal fauna (Tab. 3). A matrix of correlations between species enabled us to determine possible associations (Tab. 4). Species having significant correlations with factors showed clear patterns of distribution, their relative abundances increasing or decreasing along these multivariate gradients (Tab. 5). Species positively correlated with factor 1 (*Sorex minutus*, $p < 0.01$; *Sorex araneus*, $p < 0.01$; *Apodemus sylvaticus*, $p < 0.05$; *Microtus agrestis*, $p < 0.001$) showed an increase of their presence towards colder, higher, northern, and rainy localities, whereas species with negative correlations (*Crocidura russula*, $p < 0.01$; *Rattus rattus*, $p < 0.05$; genus *Mus*, $p < 0.001$)

Table 3. Mean and s. d. values of geography, climatology, diversity, richness, and small-mammal composition (rare species excluded) of the four groups of localities considered. Differences between them tested with ANOVA and level of significance (see Tab. 2)

VARIABLE	GROUP 1 (n = 14)	GROUP 2 (n = 4)	GROUP 3 (n = 4)	GROUP 4 (n = 3)	ANOVA F and P
Altitude	240	290	609.5	973.3	56.6
	(85.7)	(100)	(84.2)	(152.7)	****
Rainfall	710	906	705.3	1 024.6	12.84
	(73.6)	(96.6)	(40)	(198.8)	****
Temperature	14.9	13.2	12.2	10.3	22.61
	(0.5)	(1.06)	(0.86)	(2.3)	****
Latitude	41°39′	41°48′	41°48′	41°47′	20.9
					****
Longitude	2°24′	2°33′	2°11′	2°22′	16.63
					****
Sorex	0.14	15.78	0.51	10.83	12.64
minutus	(0.54)	(12.71)	(1.02)	(4.21)	****
Suncus	4.13	3.95	4.87	1.36	0.88
etruscus	(2.85)	(2.16)	(4.37)	(2.36)	
Crocidura	4.45	3.95	3.72	1.9	3.29
russula	(1.32)	(1.22)	(0.59)	(1.76)	*
Apodemus	3.15	5.16	2.05	8.56	12.62
sylvaticus	(0.87)	(2.39)	(0.75)	(3.36)	****
Rattus	5.70	0.4	4.45	0	2.17
rattus	(5.65)	(0.8)	(3.60)	(0)	
Rattus	5.1	0	6.52	0.53	0.93
norvegicus	(8.14)	(0)	(8.13)	(0.82)	
Mus spp.	5.24	3.2	3.47	1.3	6.72
	(1.59)	(1.29)	(1.5)	(1.15)	**
Clethrionomys	3.86	8.9	0.1	2.96	2.29
glareolus	(5.42)	(4.92)	(0.2)	(4.14)	
Microtus	2.67	1.7	12.05	2.1	7.51
duodecimcost.	(3.97)	(0.86)	(4.67)	(3.21)	***
Microtus	0	7.42	1.45	21.4	13.57
agrestis	(0)	(10.1)	(1.09)	(12.54)	****
DIVERSITY	1.94	1.99	2.08	1.43	2.57
	(0.15)	(0.29)	(0.12)	(0.89)	
RICHNESS	8.71	10	9	6	1.08
	(1.54)	(0.81)	(1.63)	(1.73)	

Table 4. Correlation matrix among the small mammal species (+ positive correlation, – negative correlation) and level of significance (see Tab. 2); mnemonics as in Fig. 2.

SPECIES	SM	SA	SE	CR	AP	RR	RN	MS	MM	MT
Apodemus sylvaticus	+***	+***		–****						
Rattus rattus	–**				–**					
Rattus norvegicus	–*									
Mus spretus		–**	+*	+**	–**					
Mus musculus	–**		+**	+*	–**	+*	+**	+**		
Mus total	–*	–***	+*	+**	–**			+****	+****	
Clethrionomys glareolus						–**				
Microtus agrestis	+***	+**		–***	+****	–*		–***	–****	–****
M. duodecimcostatus					–*					

showed an increase towards warmer, lower, southern and drier localities. Species positively correlated with factor 2 (*Sorex minutus*, $p < 0.01$; *Apodemus sylvaticus*, $p < 0.01$; *Clethrionomys glareolus*, $p < 0.001$) showed an increase in their abundances towards eastern and rainy localities, whereas species with negative correlations (*Rattus rattus*, $p < 0.01$; *Microtus duodecimcostatus*, $p < 0.001$) showed an increase towards western and drier localities.

The average situation (centroids) of the species on the factorial space also revealed trends of distribution (Fig. 2). The species placed close to the origin of the factorial space can be considered as widespread. This conclusion arose from the relationship between distribution breadth and the euclidean distance of each species to the origin of the space ($r = -0.53$, $p < 0.05$, $n = 15$).

Four species displayed the greatest values of distribution breadth (>2): *C. russula*, *A. sylvaticus*, genus *Mus* and *S. etruscus*. The minimum values (<1.6) were recorded for rare species: *S. araneus*, *E. quercinus*, *T. europaea* and *N. anomalus* (Tab. 6).

The stepwise regression analysis revealed the primary variable affecting the distribution of each species and the species' diversity (Tab. 6). The climatic variables (tempera-

Table 5. Average situation of the small mammal species on both factors, correlation coefficients between the abundances and factors, and level of significance of such correlations (see Tab. 2).

SPECIES	F1	F2	rF1	rF2
Talpa europaea	-0.64	1.72	–0.12	0.32
Sorex minutus	2.48	2.08	0.56**	0.49**
Sorex araneus	3.59	1.67	0.47**	0.22
Neomys anomalus	0.38	0.53	0.06	0.10
Suncus etruscus	–0.38	–0.12	–0.21	–0.05
Crocidura russula	–0.52	–0.44	–0.53**	–0.17
Eliomys quercinus	–1.34	–0.14	–0.24	–0.02
Apodemus sylvaticus	0.75	0.22	0.45*	0.48**
Rattus rattus	–1.49	–1.74	–0.46*	–0.55**
Rattus norvegicus	–0.88	–0.62	–0.25	–0.16
Mus spp.	–0.23	0.04	–0.65***	–0.06
Clethrionomys glareolus	–0.18	2.10	–0.08	0.64***
Microtus agrestis	2.85	0.90	0.63***	0.18
M. duodecimcostatus	0.04	–1.82	–0.02	–0.6***
Arvicola sapidus	–0.95	0.29	–0.23	0.06
Insectivora			0.44*	0.24
Rodentia			–0.44*	–0.24
Diversity			–0.64**	–0.45

Table 6. First variable selected, t-value, level of significance (see Tab. 2) and percentage of variance explained by the stepwise regression models performed with the small mammal species abundances as dependent variables and the geographic and climatic variables as independent ones (n = 25 except for *M. spretus*, *M. musculus* and diversity with n = 13). Distribution breadth ($e^{H'}$) for the species is also shown.

SPECIES	VARIABLE	t-VALUE	% VAR	BREADTH
Talpa europaea				1.32
Sorex minutus	Rainfall	5.05****	50	1.76
Sorex araneus	Rainfall	3.44**	31	1
Neomys anomalus				1.55
Suncus etruscus	Temperature	3.85**	35	2.04
Crocidura russula	Temperature	3.50**	32	2.10
Eliomys quercinus				1.27
Apodemus sylvaticus	Rainfall	4.18***	40	2.08
Rattus rattus	Rainfall	–4.26***	41	1.92
Rattus norvegicus				1.82
Mus spretus	Altitude	–2.64*	74	
Mus musculus	Temperature	+4.94***	75	
Mus total	Temperature	+4.45***	44	2.07
Clethrionomys glareolus	Longitude	4.06***	39	1.93
Microtus agrestis	Temperature	–3.86***	36	1.70
M. duodecimcostatus	Longitude	–3.83***	36	1.92
Arvicola sapidus				1.72
INSECTIVORA	Latitude	3.17**	27	
RODENTIA	Temperature	2.46*	17	
DIVERSITY	Rainfall	–5.51***	71	

ture and rainfall) explained the distribution of most of the species (eight species), whereas the geographic ones only explained the distribution of three species. Five species were independent of environmental variables.

The number of species of Insectivora increased with latitude, while the number of species of Rodentia increased with temperature. Diversity was negatively affected by rainfall (Tab. 6) and altitude (Tab. 5).

The position of the species in the space defined by factorial analysis and their correlations with factors, together with the stepwise regression analysis and the relationships among the species, allowed us to define three groups of species:

1. Species inhabiting preferentially Mediterranean zones: *S. etruscus*, *C. russula*, *E. quercinus*, *R. rattus*, *R. norvegicus*, *M. musculus*, *M. spretus*, *A. sapidus*, and *M. duodecimcostatus*.
2. Species inhabiting preferentially mid-European zones: *S. minutus*, *S. araneus*, *M. agrestis*, *T. europaea*, *A. sylvaticus* and *C. glareolus*. The first three species were more strict in distribution requirements, whereas the others displayed significant penetration into the Mediterranean region (Tab. 3).
3. Species with no clear preferences: *N. anomalus*.

Discussion

In general, Mediterranean communities have lower values of diversity and richness than mid-European ones (Herrera 1974; Iza et al. 1985; González and Román 1988). However, in the Montseny diversity was lower in the mid-European characterized localities.

This apparent contradiction can be explained by the higher elevation and the relative small extensions of the mid-European habitats: number of species and diversity decrease with altitude (Abe 1982; Delibes 1985; Patterson et al. 1989) due to the island effect of mountains (McArthur 1972; Lomolino et al. 1989; Gorman 1991). These results contrast with the distribution patterns found in the Pyrenees, where diversity increases with altitude (Moreno and Barbosa 1992). Climatic and geographic factors could be interacting with taxa under consideration, leading to opposing results (Owen 1990). The five montane species found in the Pyrenees (*Neomys fodiens*, *Sorex coronatus*, *Microtus nivalis*, *M. pyrenaicus*, and *M. arvalis*; Gil et al. 1986; Moreno and Barbosa 1992) are absent in the nearby Montseny, probably due to its current isolation and few suitable areas to inhabit, which could lead to extinctions following the Pleistocene and the lack of further recolonizations (Brown 1971; Lomolino et al. 1989). This fact could explain the higher diversity in highland areas of the Pyrenees. Other five mid-European species (*Talpa europaea*, *Sorex minutus*, *S. araneus*, *Clethrionomys glareolus*, and *Microtus agrestis*) are also present in the Montseny, where they are at the southern limit of their distribution in NE Iberia.

The limited number of montane species in the Montseny could also explain why altitude only affects the distribution of one species, in spite of the important altitudinal range of the localities sampled (more than 1 000 m), while altitude affected many species in higher Spanish mountains (Delibes 1985; Alcántara 1989; Moreno and Barbosa 1992).

In spite of the restricted latitudinal rank, the number of Insectivora species increased with latitude, following the general pattern found in larger mountain ranges (Moreno and Barbosa 1992). However, latitude did not affect the distribution of any particular species, while this variable affected the distribution of some species in the Pyrenees (Moreno and Barbosa 1992).

Longitude conditioned the distribution of *M. duodecimcostatus* and *C. glareolus* in opposing ways, according to the Mediterranean requirements of the former (Libois et al. 1983; Gosálbez 1987; González and Román 1988) and the Eurosiberian distribution of the latter (Iza et al. 1985; Gosálbez 1987; González and Román 1988). However, *C. glareolus* showed important penetrations into Mediterranean habitats in this area.

The climatic variables seemed to explain the distribution of the small mammals better than the geographic ones. Rainfall negatively conditioned the distribution of *R. rattus* and favoured *S. minutus*, *S. araneus*, and *A. sylvaticus*. The increase of *S. minutus* with rainfall has already been explained (Iza et al. 1985; Gosálbez 1987; González and Román 1988; Moreno and Barbosa 1992), and reached the highest mean values of occurrence in the humid eastern region. *S. araneus* was primarily conditioned by rainfall (Spitz and Saint-Girons 1969; Gosálbez 1987) but altitude also seemed to be important, preferring cold and rainy highlands. This pattern differs from that of the Pyrenees (Gosálbez 1987), probably because suitable habitats for the species are restricted to high altitudes in the Montseny. Finally, *A. sylvaticus* showed an increase of abundance from dry and temperate localities to rainy and cold ones. Our results agree with Moreno and Barbosa (1992) and Iza et al. (1985), but opposing patterns were also found (Delibes 1985; González and Román 1988). The generalist character of this species (Alcántara 1989; Gosálbez 1987) could explain these differences.

Temperature positively affected the number of Rodentia species found in the area, as well as the distribution of four particular species (*M. agrestis*, *S. estruscus*, *C. russula*, and *M. musculus*). The former was affected negatively, thus being restricted to higher elevations (coinciding with other mountains, Dueñas and Peris, 1985; Delibes 1985; Moreno and Barbosa 1992), while in some regions of northeastern Iberia it is even found at sea level (Gosálbez 1987). *S. etruscus*, *C. russula* and the genus *Mus* tended to occupy lowland areas because of their elevated temperatures, agreeing with their supposed Mediterranean requirements (Spitz and Saint-Girons 1969; Libois et al. 1983; Gosálbez 1987).

Five species (*T. europaea*, *N. anomalus*, *E. quercinus*, *R. norvegicus*, and *A. sapidus*) did not show any relation with either geographic or with climatic variables. Although the presence of *T. europaea* was greater in the humid eastern region suggesting thus mid-European trends, the soil characteristics could greatly determine its distribution (Gosálbez 1987). In spite of the small number of records for *E. quercinus*, *R. norvegicus*, and *A. sapidus*, they showed a weak Mediterranean distribution. However, no geographic or climatic requirements were previously found (Gosálbez 1987; González and Román 1988; Moreno and Barbosa 1992). Finally, our results confirm that *N. anomalus* should be conditioned by other factors, such as the hydrographic network characteristics, rather than geographic or climatic ones (Torre and Tella 1994).

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Zusammenfassung

Verbreitungsbedingende Umweltfaktoren für Kleinsäuger in einem isolierten mediterranen Gebirge

Es wurde die Verbreitung der Kleinsäuger im Montseny-Gebirge (Catalonia, Nordwestspanien) untersucht. Es handelt sich um ein isoliertes mediterranes Gebirge, welches die südliche Grenze der mitteleuropäischenFauna und Flora darstellt. Das Untersuchungsmaterial stammt aus 25 Stellen (von 119 bis 1140 m über dem Meeresspiegel) und umfaßt 16916 Kleinsäuger (sechs Insectivora- und zehn Rodentia-Arten), die aus der Analyse von Schleiereulengewöllen stammen. Das Vorkommen (relative Abundanz) der verschiedenen Arten wurde mit Umweltfaktoren (Höhe, Breiten- und Längengrad, Regenfall und Temperatur) verglichen. Regenfall und Temperatur beeinflussen die Verbreitung der meisten Arten, wobei Regenfall negativ mit der Diversität verbunden ist, welche in den tieferen Regionen höhere Werte zeigt. Diese Tendenz ist anders als in den Pyrenäen, der nahesten großen Gebirgskette. Vier typische Arten aus höheren Lagen der Pyrenäen sind nicht im Montseny anzutreffen, möglicherweise aufgrund der isolierten Lage. Der Montseny bildet die südliche Grenze der Verbreitung von fünf Säugetierarten. Durch eine stufenweise Regression, factorielle Analyse und einer Korrelationsmatrix konnten drei Artengruppen unterschieden werden: Diejenigen die mediterrane Biotope bevorzugen (*S. etruscus*, *C. russula*, *E. quercinus*, *R. rattus*, *R. norvegicus*, *M. musculus*, *M. spretus*, *M. duodecimcostatus* und *A. sapidus*), solche, die mitteleuropäische Biotope vorziehen (*T. europaea*, *S. minutus*, *S. araneus*, *A. sylvaticus*, *C. glareolus* und *M. agrestis*) und zuletzt eine einzige Art (*Neomys anomalus*), die keine klaren Vorzüge zeigt.

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