

THE NATURAL COMMUNITIES OF SMALL MAMMALS (INSECTIVORES AND RODENTS) OF CATALONIA (SPAIN)

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This work is a contribution to the study of structure of natural communities of small mammals that live in Catalonia. The parameters that have been considered are: rainfall distribution, vegetation and general physiography of Catalonia. In the alpine and subalpine area, the most representative species are: *Talpa europaea*, *Marmota marmota*, *Arvicola terrestris*, *Microtus (P.) pyrenaicus*, *M. nivalis* and *M. arvalis*; in the mid-European and Atlantic lower mountain area: *Erinaceus europaeus*, *Sorex minutus*, *S. araneus*, *S. coronatus*, *Eliomys quercinus*, *Clethrionomys glareolus* and *Microtus agrestis*; and in the Mediterranean and sub-Mediterranean mountains and lowlands: *Erinaceus algirus*, *Suncus etruscus*, *Crocidura russula*, *Apodemus sylvaticus*, *Mus spretus* and *Microtus (P.) duodecimcostatus*. Other species, such as *Neomys fodiens*, *N. anomalus* and *Arvicola sapidus* show a water dependant distribution, and *Mus musculus*, *Rattus rattus* and *R. norvegicus* have a man-conditioned distribution.

Key-words: Small mammals, Natural communities, Catalonia, Spain.

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INTRODUCTION

The amount of information available on the presence and geographic distribution of the small mammals in Catalonia has increased significantly in the last ten years. Most studies to date on this subject refer to isolated records. The papers of CLARAMUNT et al. (1975), SANS-COMA (1975) on Mediterranean species and GOSÀLBEZ (1976) on Gliridae and Arvicolidae, are the first attempts to study the distribution of the species in respect to the environmental factors and the particular relationships between species and habitat. In 1983, LÓPEZ-FUSTER carried out a detailed study on the soricid species, and GOSÀLBEZ et al. (1985a) defined the geographic distribution of the majority of the species present in Catalonia, commenting on the characteristics of the habitats.

This work presents information concern-

ing the influence of the environment on the distribution of the species and the population of small mammals found in Catalonia, in relation to their particular specific requirements.

MATERIAL AND METHODS

This study is based in information taken from bibliography, together with owl pellet analysis and individuals captured. Distribution data is from: AGUILAR-AMAT (1924), AYARZAGÜENA et al. (1975), GOSÀLBEZ (1977), GOSÀLBEZ & CLARAMUNT (1982), GOSÀLBEZ et al. (1981, 1980(82), 1985a, 1985b, in press), BALCELLS (1964), CABRERA (1914, 1924), FONS et al. (1980), GRABULOSA & FELIX (1981), LÓPEZ-FUSTER et al. (1979, 1985), MILLER (1912), NADAL (1967), NADAL &

PALAU (1967), NIETHAMMER (1956, 1964), NOS (1960, 1961), PLANTADA I FONOLLEDA (1903), RIERA & BOADA (1972), RUIZ (1980 (82)), SANS-COMA (1979), SANS-COMA & MARGALEF (1982), SANS-COMA & NADAL-PUIGDEFABREGAS (1970), SANS-COMA et al. (1971) and VERICAD (1965, 1970).

Figure 1 shows the distribution of the biogeographical regions following the vegetation-types of Catalonia.

In figures 2, 3 and 4 the distribution of *Sorex minutus*, *S. araneus*, *S. coronatus*, *Clethrionomys glareolus*, *Microtus agrestis*, *M. nivalis*, *M. arvalis* and *Arvicola terrestris* in Catalonia is presented.

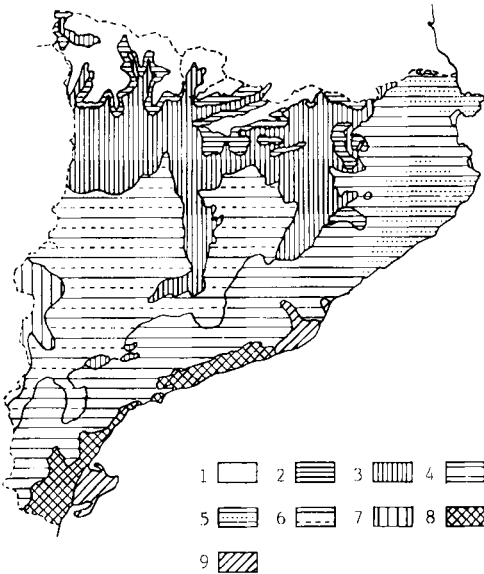


Fig. 1. Main vegetation-types of Catalonia. Alpine and subalpine high mountain area: 1. Alpine meadows and forest of mountain pine. Mid-European and Atlantic lower montane area; 2. Typical deciduous forests and scots pine forest with mosses. Mediterranean and sub-Mediterranean mountains and lowlands; 3. Semideciduous and scots pine forests; 4. Typical evergreen oak forests; 5. Groves of cork oak; 6. Continental evergreen oak groves; 7. Continental maquis; 8. Littoral maquis; 9. Deltaic areas; (Based on FOLCH & FRANQUESA, 1984).

Principales tipos de vegetación de cataluña.

THE SMALL MAMMALS AND THEIR ENVIRONMENT

The distribution of small mammals is determined by historical and environmental factors. In Catalonia, from north to south and from east to west, graded physiographic and environmental variations are observed. These determine the differential distribution of the various insectivore and rodent species present. Broadly speaking, two large areas can be distinguished: the wet zone, with annual mean precipitations above 800 mm, and the Mediterranean zone, of an annual rainfall below 700-800 mm. According to FOLCH & FRANQUESA (1984), it is accepted that there are three large vegetation zones in Catalonia, with particular fauna characteristics, the alpine and subalpine high mountain area, the mid-European and Atlantic lower montane area, and the Mediterranean and sub-Mediterranean mountains and lowlands. Each zone is subdivided according to its characteristic vegetation-types, which determine the composition of the fauna.

1. Alpine and subalpine high mountain area

In Catalonia the high mountain zones cover areas above 2200-2400 m a.s.l. as well as the boreal-type high plains and meadows (*Carietalia curvulae*, *Sesleriatalia*). The subalpine mountain corresponds to areas between 1600-1800 m and 2200-2400, covered by fir and mountain pine forest (*Vaccinio-Piceetalia*). Such areas are found only in the Pyrenees and pre-Pyrenees.

Alpine meadows

In the high mountain areas, conditions are extreme and there are few species, only five (18% of those found in Catalonia) colonizing these areas. Here the boulder slides and stones play an important role as they provide shelter for some species. The most typical species of the alpine meadow is *Microtus arvalis*, (Common Vole) which can be

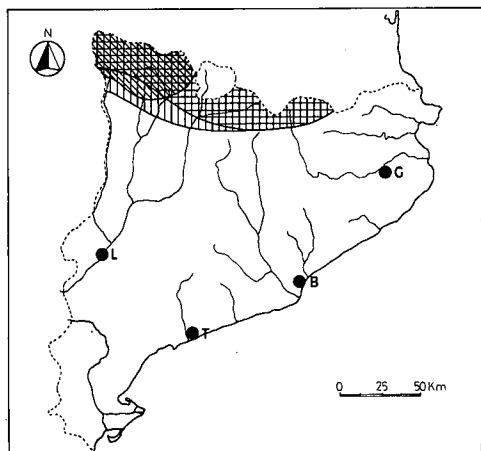


Fig. 2. Distribution of *Arvicola terrestris* (\\), *Microtus nivalis* (||) and *M. arvalis* (≡) in Catalonia.
Distribución de Arvicola terrestris (\\), *Microtus nivalis* (||) y *M. arvalis* (≡) en Cataluña.

found everywhere except areas where the texture of the terrain does not allow the construction of burrows.

Other characteristic species of the alpine meadow are *Talpa europaea* (Common Mole), *Arvicola terrestris* (Water Vole), and of late *Marmota marmota* (Marmot), which is now colonizing the area of the Vall d'Aran. These species are not limited by climatic factors in their expansion at these levels. As for the altitude, such as the case of *M. arvalis*, the main limiting factor is the ground texture, while in the case of *T. europaea* it is the animal biomass found in the soil. *Microtus nivalis* (Snow Vole) can also be found associated to the presence of rockslides and boulders.

Forest of mountain pine, fir and shrub lands of *Rhododendron*

Below the alpine meadow, the highest forests of mountain pine and fir appear. The ecotone between the mountain pine and the alpine meadow is generally dominated by the low shrub *Rhododendron ferrugineum* constituting a rather well-developed commu-

nity in the shrub lands. At these levels, the small mammal fauna increases in number and abundance of species. Twelve (44%) of the 27 species found in Catalonia are present. The bush vegetation provides good shelter. In the forests of mountains pine and shrub lands of *Rhododendron* the fauna is composed of all the Pyrenees species except for those with particular requirements. The habitual species are *Sorex minutus* (Lesser Shrew), *S. araneus* (Common Shrew), *S. coronatus* (Millet's Shrew), *Clethrionomys glareolus* (Bank Vole), *Microtus (Pitymys) pyrenaicus* (sensu NIETHAMMER & KRAPP, 1982) (Pyrenean Vole), and *M. agrestis* (Field Vole). Within the forest *Talpa europaea*, *Sciurus vulgaris* (Red Squirrel), *Eliomys quercinus* (Garden Dormouse) and *Apodemus sylvaticus* (Wood Mouse) are also found, although in lower densities. In the ecotone between the forest and meadow, following the stone walls, one finds especially *E. quercinus* and *M. (Pitymys) pyrenaicus*. Associated to the rockslides, which may penetrate into the forest, *E. quercinus* and *M. nivalis* are present. *Neomys fodiens* (Water Shrew) is frequently found at the margins of the rivers and streams.

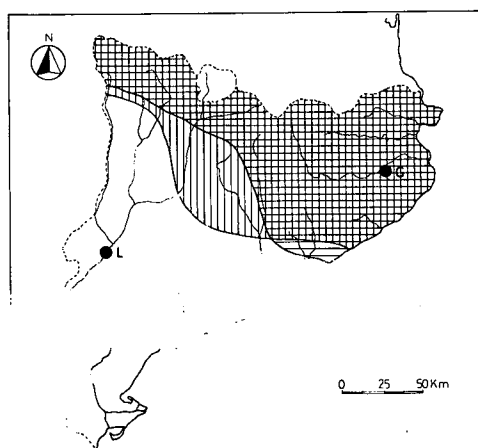


Fig. 3. Distribution of *Clethrionomys glareolus* (≡) and *Microtus agrestis* (||) in Catalonia.
Distribución de Clethrionomys glareolus (≡) y *Microtus agrestis* (||) en Cataluña.

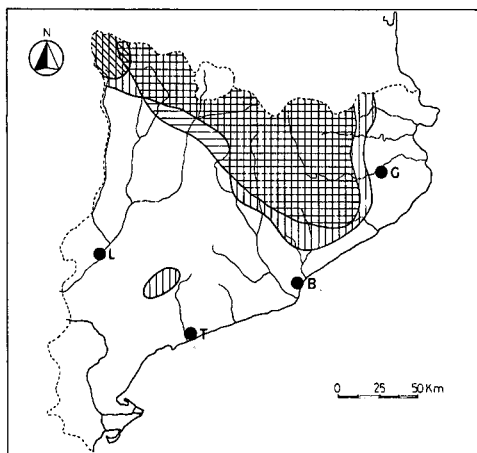


Fig. 4. Distribution of *Sorex minutus* (|||), *S. araneus* (≡) and *S. coronatus* (\\) in Catalonia. Distribución de *Sorex minutus* (|||), *S. araneus* (≡) y *S. coronatus* (\\) en Cataluña.

Mountain pine forests usually commence at the river margins and a sequence of fauna is observed towards the peaks. First the river banks with occasional large boulders among the margin vegetation are found. This type of environment favours the presence of aquatic species such as *N. fodiens* and *Galemys pyrenaicus* (Pyrenean Desman) (even though highly probable, the occurrence of this species has not been confirmed). On the other hand, in this area of contact between forest and river *Apodemus sylvaticus*, which does not penetrate into the forests area, is found with *Eliomys quercinus*, *C. glareolus*, *M. pyrenaicus* and *M. agrestis* although in lesser numbers. Normally, in close contact with the forest, or even within, there are stone walls which are colonized principally by *E. quercinus*, although other species such as *A. sylvaticus*, *C. glareolus* and species of genus *Sorex* can also be found living there. Before the forest, either in a narrow band parallel to the river or in clumps, there is an abundant grass layer, made up of gramineans and a considerable moss layer, that make up a loose mat of vegetation. This is an ideal site for the soricids although *C. glareolus*, *M. (Pitymys) pyrenaicus* and *M. agrestis* are

also found. Once within the forest *A. sylvaticus*, though still present, is less frequent, *E. quercinus* remains, always associated to the stone walls. The soricids can be found, somewhat dependant on the presence of abundant moss. The dominants are *C. glareolus* and *M. agrestis*. This is the composition throughout the forest while ascending and until the tree layer is replaced by the bush community of *Rhododendron* where *C. glareolus* is the dominant species, in contact with the alpine meadow colonized by *M. arvalis* (GOSALBEZ et al., 1979).

The forests of fir are, as a rule, poor in fauna. The scarce development of the grass layer does not favour the establishment of micromammal species which are found, however, in the ecotone of forest and meadow.

2. Mid-European and Atlantic lower montane areas

This area is found at higher altitudes than the Mediterranean and sub-Mediterranean areas, and below the alpine and subalpine mountains. The mid-European or Atlantic climate conditions determine the development of a vegetation with a predominance of temperate deciduous forests comparable to those found in the humid regions of Europe. The Pyrenees and pre-Pyrenees areas between 900 and 1600 m a.s.l. are of this type (FOLCH & FRANQUESA, 1984). The forests of beech, oaks (*Quercus petraea* and *Q. robur*), birch, hazelnut, scots pine, montane meadows, shrub lands and thickets will be considered.

Typical deciduous forests, hazelnut groves, scots pine forests, montane meadows, shrub lands and thickets

The deciduous forest is one of the most favorable environments for small mammals. Fourteen (48%) of the 27 species found in Catalunya are forest-specific and on the whole, 20 species are present in the zone.

The faunistic composition is determined by the climate, humid and not as cold as in the previous group, which enables the establishment of an abundant bush layer. The typical forest (basically oak) species are *Erinaceus europaeus* (European Hedgehog), *Sorex minutus*, *S. araneus*, *S. coronatus*, *Sciurus vulgaris*, *Eliomys quercinus*, *Glis glis* (Edible Dormouse) *Clethrionomys glareolus*, *Microtus (Pitymys) pyrenaicus* and *M. agrestis*. *Apodemus sylvaticus* is also present although this is not its optimum type of forest. *Talpa europaea* forms scarce populations with few individuals. *N. fodiens* is found associated to running water, and *M. nivalis* where rock-slides penetrate into the woods.

The forests of scots pine (*Pinus sylvestris*), with moss and *Buxus sempervirens* in the more humid areas and with *Arctostaphylos uva-ursi* in the drier zones, together with the oak forests have the richest fauna of this zone.

At high altitudes, the small mammal fauna of the scots pine forest is similar to that of mountain pine forests. The sole exception may be *M. (Pitymys) pyrenaicus* which has not yet been detected. The tendency for *M. agrestis* to be more frequent than *C. glareolus*, and the increasing frequency of *A. sylvaticus* is observed in the scots pine community when compared to that of mountain pine. Both indicate a progressive change to more temperate conditions. The typical montane forest is that of scots pine and *Buxus*. The fauna composition differs whether the forest is located in the montane region or if it is in close contact with the sub-Mediterranean zone. The montane areas present *A. sylvaticus*, *C. glareolus* and *M. agrestis*. The soricids (*S. minutus* and *S. araneus*) become progressively scarcer while descending in altitude. Meanwhile, *A. sylvaticus* is progressively more abundant than the other species as the environmental conditions take on Mediterranean characteristics (GOSÀLBEZ, et al., 1979).

The xeric scots pine groves with *Arctostaphylos uva-ursi* have fewer animals than the more humid groves with *Buxus*. The fact

that the bush layer is lacking, limits the presence of some species. *S. araneus*, *E. quercinus*, *A. sylvaticus* and *M. agrestis* are the typical species found here.

While in the subalpine forests of mountain pine (*Pinus nigra* ssp. *uncinata*) the small mammals are found living in the edges and clear areas, the distribution in the humid deciduous forests is more uniform. The forests of beech are an exception, were because of the scarce underbrush, there are few animal species, which usually are found at the edges. Rock piles or stone walls contribute favourably to the presence of practically all species of small mammals, as they provide shelter and breeding sites.

The scots pine forest in contact with the sub-Mediterranean zone presents *A. sylvaticus* as dominant species, and occasionally *C. glareolus* and *M. agrestis* in small numbers. *E. quercinus* appears associated to stone walls.

The hazelnut groves present fewer species than the forests. The most abundant species is *C. glareolus*, accompanied by *A. sylvaticus*.

The birch forests are not usually very dense and are frequently located on rocky terrains. The fauna is not abundant and the main species is *C. glareolus* in low densities.

The shrub lands of *Rhododendron* and thickets cover large areas of this zone. In their contact with woodlands, the fauna characteristic of the forests, is abundant. Further away from the woods only those species with greater adaptive capacity remain, such as *A. sylvaticus*, *C. glareolus* and *M. agrestis*. Therefore these areas can be considered faunistically poor. Among the shrub lands of *Rhododendron* the communities of *Sarothamnus scoparius* and of fern (*Pteridium aquilinum*) have more species. In the more humid areas they harbor individuals of the genus *Sorex*.

The presence of *Sciurus vulgaris*, associated to wooded patches, especially coniferous forests although also found in groves of beech and, possibly in those of oak as well, should be added to the species already mentioned. PURROY & REY (1974) record the

squirrel as present in oak groves (*Quercus sessilifolia*) of Olaldea (Navarra).

In the rainy lower montane region the grass communities make up the dry-grass fields, the humid and sub-humid pastures, and the meadows located between 600 and 1600 m. The dominant species of these meadows are *A. terrestris* in the area of the Vall d'Aran and Boí, *M. arvalis* at altitudes above 900 m, and *T. europaea* of uniform distribution with population nuclei of varying importance depending on the type of terrain.

The edges of the meadow are more important than the meadow itself, which presents typically hypogeous forms. The meadows, in contact with the forest are usually bordered with stone walls covered by abundant grassy vegetation. Most of the typical forest species are found here, such as: *S. minutus*, *S. araneus*, *E. quercinus*, *A. sylvaticus*, *C. glareolus* and *M. agrestis*, in greater densities than in the woods.

3. Mediterranean and sub-Mediterranean mountains and lowlands

Below 800-1000 m a.s.l. the climate is sub-Mediterranean and Mediterranean. The dominant vegetation in this zone is that of: semideciduous forests of *Quercus pubescens* and *Q. faginea*, which at altitudes between 600 and 1600 m mark the transition from Mediterranean to Eurosiberian vegetation (FOLCH & FRANQUESA, 1984), evergreen oak groves of montane (*Quercetum mediterraneo montanum*) and typical (*Q. ilicis galloprovinciale*) evergreen oak groves with yarrow, groves of cork oak (*Q. i. g. suberotosum*), groves of continental evergreen oak (*Quercetum rotundifoliae*), pine groves of *Pinus halepensis*, *P. pinea* and *P. pinaster*, continental (*Rhamo-Quercetum cocciferae*) and littoral (*Quercetum lentiscetum*) maquis communities, and underthickets such as "brolles" and garigues (*Quercetum cocciferae*). Throughout this zone there are frequent cultivated fields with weed and rude-

ral communities.

This diversity of environments is not necessarily accompanied by a corresponding high animal diversity. The number of species goes from 22 (81% of the species found in Catalonia) in the Atlantic and mid-European montane region, to 20 (74%). The specific composition presents a Mediterranean tendency, and the mid-European species gradually disappear going from the semideciduous forest belt (in contact with the typical deciduous montane forests) towards the lowlands where the fauna is of strictly Mediterranean requirements. A decrease in diversity of species is implied.

Groves of xeric oak and montane evergreen oak

The semideciduous forests (groves of xeric oak) and montane evergreen oak groves are the transition from the species of mid-European to those of Mediterranean requirements. For this reason the specific diversity is high. Twelve (44%) of the species found in Catalonia are present, made up of species with both types of requirements, for some of whom it is the upper, and for others the bottom limit of their area of distribution. All the montane species are present except for *Sorex coronatus*, *M. (Pitymys) pyrenaeicus* (which have stricter requirements), and in Catalonia *M. nivalis*. The following Mediterranean species are added: *Erinaceus algericus*, *Crocidura russula*, and *Rattus rattus* (in its wild state). The small mammal fauna is favoured by the presence of a well-developed undergrowth level of bushes in the woodlands, and of walls or piles of stones. In these forests, *Buxus sempervirens* and small-sized plants such as *Hepatica nobilis*, or grasses also contribute in the formation of the appropriate habitat-type. The main differences affecting the micromammal presence, within these forests, are related to the orientation: the density is greater in the shade than in the sun. This is especially true for the members of the genus *Sorex*, and in than in the relative proportion of *C. glareolus*

(more frequent in the shady sides) and *M. agrestis*.

Typical evergreen oak, cork oak and littoral pine forests

The zone of typical evergreen oak groves (littoral type), of evergreen oak with yarrow, the groves of cork oak and pines present clear Mediterranean characteristics, with ubiquitous species such as *E. quercinus* and *A. sylvaticus*, others of general but conditional distribution such as *T. europaea*, *Neomys anomalus* (Miller's Water Shrew), *R. rattus*, *R. norvegicus* (Brown Rat), *M. musculus* (House Mouse) and *Arvicola sapidus* (Miller's Water Vole) and species that reveal the existence of Mediterranean environmental conditions, such as *E. algirus*, *Suncus etruscus*, *C. russula* and *Mus spretus* (Mediterranean Mouse). In total there are eight (30% of the 27 found in Catalonia) characteristic species of this area, and a total of 14 (52%) can be found. The sole species with mid-European requirements is *M. agrestis*, with a high capacity of adaptation, whose area of distribution is much wider than what is considered wet Catalonia.

The most representative species are *A. sylvaticus*, which finds here its optimum environment, *C. russula*, and in the more xeric evergreen and cork oak groves, *S. etruscus* (Pygmy Shrew).

The faunistic abundance of this zone varies according to the conditions of humidity, underthicket development and orientation. The fauna tends to be more abundant in the shady sides and besides running waters. In very sunny areas there tend to be very small populations, made up almost exclusively by *A. sylvaticus*. In this type of woodland the low stone walls and thickets, which usually appear in the limits with farmlands, are very important and have the role of nuclei of concentration for the fauna.

The groves of cork oak and pines are usually xeric environments with scarce animal populations. The dominant species are *A. sylvaticus* and also *C. russula*, *S. etruscus*

and *M. spretus* somewhat dependant on the presence of stone walls, and abundant grass vegetation.

These communities occupy the lowlands and form a wide coastal band, which acts as a border between the semideciduous forests and the coast of northern half of Catalonia, and between the continental-type evergreen oak groves and littoral maquis communities of the southern half.

The continental evergreen oak groves, maquis communities and garigues

The groves of continental evergreen oak characteristically present poorly developed shrub and herbaceous levels, and cover the lower part of the pre-Pyrenees, part of the Central Plateau, and the continental region in Catalonia. The environmental conditions are harsh, and the rainfall is very low, under 600-700 mm annually. The fauna is typically Mediterranean.

Five (18%) species with clear Mediterranean-type requirements are found here, *S. etruscus*, *C. russula*, *E. quercinus*, *A. sylvaticus* and *M. spretus*. In certain parts of the southern pre-Pyrenees, some populations of *Talpa europaea* are found, and *Erinaceus europaeus* in the humid zones that border with the evergreen oak groves and xeric oaks.

The maquis is a tall (3-4 m) and dense sclerophyll shrub community. It is frequent throughout the Mediterranean region and covers the westernmost part of the continental area in Catalonia and the littoral band to the south of the Llobregat River. The environmental conditions are completely Mediterranean and the small mammal populations are made up of species with these requirements. These are *S. etruscus*, *C. russula*, *E. quercinus*, *A. sylvaticus* and *M. spretus*. The presence of piles or low walls of stone favour the establishment of stable populations, which, on the other hand, can rarely be found outside these parts.

The garigue is a bush-formation of *Quercus coccifera*, which though rarely reaching 1 m in height, may be impenetrable. For

the fauna, these are the most extreme Mediterranean conditions, with very little rainfall and hot summers. Very few small mammals adapt to life in these conditions. *M. spretus*, very well adapted to the lack of water, is the dominant species. The garigue itself is practically devoid of inhabitants and the species present are dependant on the low walls or piles of stones providing shelter. *S. etruscus* and *C. russula* appear, especially at the edges of the garigue where in contact with abandoned fields. The area of distribution of *E. quercinus* is not clearly defined. *A. sylvaticus*, though present, is not frequent. The interior of the garigue is devoid of small mammal inhabitants.

Weed and ruderal communities

This type of vegetation appears in man-influenced areas, roadsides and abandoned fields. It usually follows a linear distribution along the low stone walls, the field edges, and banks of irrigation, canals and ditches. For the fauna it represents an appropriate shelter. Characteristic species of these environments are *C. russula*, *A. sylvaticus* and *M. spretus*. In field areas with well-established irrigation networks, where reed-communities are abundant, *Rattus norvegicus* is observed, and though less frequently, *R. rattus*. In such places, and especially where thickets and grasses abound, *C. russula* is the most frequent species. In farmed land, especially of forage and fruit orchards, *Microtus (Pitymys) duodecimcostatus*, (sensu NIETHAMMER & KRAPP, 1982) (Mediterranean Pine Vole) is frequently present. In conclusion, the small mammal fauna of the ruderal communities is made up of *S. etruscus*, preferably along the low stone walls surrounding abandoned fields and orchards. *C. russula* is present in areas with thickets and herbaceous vegetation. *A. sylvaticus* is not very abundant and is preferably associated to the presence of low stone walls. *R. rattus* is found close to urban nuclei and related to water canals with reeds and thickets. *R. norvegicus* has similar requirements

to those of *R. rattus*, but though more independent of man's presence, is more frequently found in association with irrigated fields or areas with abundance of available food. *M. (Pitymys) duodecimcostatus* is present in farmlands and leads an underground life.

The Ebro Delta is a particular case, as it does not follow this general distribution. In the Delta, the area that corresponds to the plio-quaternary discontinuity is occupied by vegetable gardens reaching the Ebro River banks. The greater part of this area is dedicated to the monoculture of rice, though in small areas surrounding the lagoons, there are some helophytic plants. Rice farming implies annual cycles of land use, i. e. flooding, farming, draining, which make this part of the Delta unstable for animal populations. The absence of *M. (Pitymys) duodecimcostatus* is easily understood given its underground life-style, as is that of *A. sylvaticus* which requires more ground cover. This last species is very infrequent and when it does appear it is in the vegetable garden area, and near the banks among the river margin vegetation. The most frequent species are in fact *C. russula*, *R. norvegicus* and *M. musculus*. *C. russula* and *M. musculus* live along the sides of roads, ditches, rice fields and lagoons. *R. norvegicus* is present throughout occupying the irrigation canals around all types of farmed land. *R. rattus* is found inside human constructions and is rare outside. It is present isolated nuclei on the banks of the Ebro River between the rushes and the scare orange orchards. The most noteworthy aspect is that *M. spretus* is replaced by *M. musculus*, a commensal species which returns to wild state in the Delta. This phenomenon is characteristic of humid farmed areas such as the Camargue (France).

4. Species with aquatic requirements

The distribution of some species is dependant on the presence of running water or stable mass of water, i. e. *Neomys fodiens*, *N. anomalus* and *Arvicola sapidus*. Their

appearance in the different vegetation areas does not depend on the characteristics of the area, but instead on the types of aquatic systems present, their conditions and the abundance of fauna, in the case of *Neomys*, or the characteristics of the banks and the herbaceous vegetation found there. The determinant factors of the differential distribution with altitudes of the two species of *Neomys* are still not known. It is even more intriguing because the distribution is inverse on the northern slope of the Pyrenees, According to FONS et al. (1980), *N. fodiens* reaches the sea in the area of Provence (ORSINI, 1978), while *N. anomalus* has been recorded in the Carlit Mountains, and in France only in cool regions and mostly in high altitudes.

5. Man-related species

The commensal species, *M. musculus*, *R. rattus* and *R. norvegicus*, reveal an area of distribution that is totally influenced by man. They can be found outside buildings in the lowlands but approaching the Pyrenees they are increasingly dependant on the presence of human constructions. *M. musculus* and *R. norvegicus* cannot be found in the exterior regions other than the Mediterranean lowlands, where they are associated to farmed land. *M. musculus* can be found throughout inhabited parts of Catalonia. In contrast, *R. norvegicus*, when reaching the Pyrenees, loses all colonizing potential and is replaced by *R. rattus*. This species, which can live in the wild, not necessarily associated to the presence of man, has been captured in areas of semideciduous forests and groves of montane evergreen oak. With increasing altitude it becomes entirely man-dependant and may occupy human constructions at considerable altitudes in the Pyrenees, where it and *M. musculus* remain as the commensal species.

The presence of these species in the different vegetation levels is totally conditioned to the presence of man.

CONCLUSIONS

In Catalonia the precipitation enables the distinction of two large areas: wet Catalonia, with average annual rainfalls over 800 mm, and dry Catalonia, with averages under these amounts. This circumstance, accompanied by the physiographic variations and the ensuing variations in temperature and vegetation, in turn enable the formation of two different groups of small mammal species: the strict or mainly Mediterranean type and those of mid-European-type requirements.

Some species are limited to one of these zones, others disregard the boundaries in one direction or the other, and finally some of them have areas of distribution that do not depend mainly on these factors and instead are conditioned by the presence of rivers or water-bodies or of man.

Of the 27 Insectivore and Rodent species that are found in Catalonia (*Galemys pyrenaicus* is not included as its presence, though probable, has not been confirmed), 15 (55%) live in the alpine and subalpine high mountain area, 22 (81%) in the Atlantic and mid-European lower montane area, and 20 (74%) in the Mediterranean and sub-Mediterranean mountains and lowlands (table 1). The intermediate zones has most species, as is to be expected because, not having a characteristic fauna of its own, it harbors individuals from the more extreme zones which here find adequate life-conditions.

In the alpine and subalpine high mountain area, the most representatives species are: *T. europaea*, *M. marmota*, *A. terrestris*, *M. pyrenaicus*, *M. nivalis* and *M. arvalis*. All of these except for *M. nivalis* and *M. (Pitymys) pyrenaicus* (which can have an ambivalent nature) dig burrows in the meadows, contributing to the renewal of the terrain. In the mid-European and Atlantic lower mountain area the characteristic species are: *E. europaeus*, *S. minutus*, *S. araneus*, *S. coronatus*, *E. quercinus*, *C. glareolus* and *M. agrestis*. Finally, the Mediterranean and sub-Mediterranean mountains and lowlands are occupied by species which come from

Species	Alpine and subalpine high mountain area > 1600 m	Mid-European and Atlantic lower mountain area 900-1600 m	Mediterranean and sub-Mediterranean mountains and lowlands < 800-1000 m	Alpine meadows	Forests of mountain pine and shrub lands of <i>Rhododendron</i>	Montane meadows	Typical deciduous forest and scots pine groves	Semi-deciduous forest and montane evergreen oak groves	Typical evergreen oak, cork oak and littoral pine forests	Continental evergreen oaks groves maquis and garigues	Weed and ruderal communities	Aquatic environments	Man-related environments	Hipogeous environments
<i>Erinaceus europaeus</i>	-	●	○	-	-	-	●	●	●	●	●	-	-	-
<i>Erinaceus algirus</i>	-	-	●	-	-	-	-	-	-	-	-	-	-	-
<i>Talpa europaea</i>	●	-	●	●	●	●	●	●	●	●	●	●	-	●
<i>Sorex minutus</i>	●	●	●	-	●	-	●	●	-	-	-	-	-	-
<i>Sorex araneus</i>	●	●	●	-	●	-	●	●	-	-	-	-	-	-
<i>Sorex coronatus</i>	●	●	-	-	●	-	●	●	-	-	-	-	-	-
<i>Neomys fodiens</i>	●	●	-	-	○	-	○	-	-	-	-	●	-	-
<i>Neomys anomalus</i>	-	●	●	-	-	-	○	○	○	○	○	○	-	-
<i>Suncus etruscus</i>	-	-	●	-	-	-	-	●	●	●	●	●	-	-
<i>Crocidura russula</i>	-	-	●	-	-	-	-	●	●	●	●	●	-	-
<i>Sciurus vulgaris</i>	●	●	●	-	-	-	●	●	-	-	-	-	-	-
<i>Marmota marmota</i>	●	-	-	●	-	-	-	-	-	-	-	-	-	-
<i>Eliomys quercinus</i>	●	●	●	-	●	-	●	●	●	●	-	-	-	-
<i>Glis glis</i>	-	●	●	-	-	-	●	●	●	●	-	-	-	-
<i>Apodemus sylvaticus</i>	●	●	●	-	●	-	●	●	●	●	●	●	-	-
<i>Rattus rattus</i>	-	●	●	-	-	-	○	●	○	○	●	-	●	-
<i>Rattus norvegicus</i>	-	●	●	-	-	-	○	○	○	○	○	-	●	-
<i>Mus musculus</i>	-	●	●	-	-	-	○	○	○	○	●	-	●	-
<i>Mus spretus</i>	-	●	●	-	-	-	-	●	●	●	●	-	-	-
<i>Clethrionomys glareolus</i>	●	●	●	-	●	-	●	●	-	-	-	-	-	-
<i>Arvicola terrestris</i>	●	●	-	●	-	●	-	-	-	-	-	-	-	●
<i>Arvicola sapidus</i>	●	●	●	-	-	-	○	○	○	○	○	●	-	-
<i>Microtus (P.) pyrenaicus</i>	●	-	-	-	●	-	-	-	-	-	-	-	-	-
<i>Microtus (P.) duodecimcostatus</i>	-	-	●	-	-	-	-	-	-	-	●	-	-	●
<i>Microtus nivalis</i>	●	●	-	●	●	-	●	-	-	-	-	-	-	-
<i>Microtus arvalis</i>	●	●	-	●	-	●	-	-	-	-	-	-	-	-
<i>Microtus agrestis</i>	●	●	●	-	●	-	●	●	●	-	-	-	-	-

Table 1. Relationship between small mammal species (Insectivores and Rodents) and vegetation-types of Catalonia: ● Presence; ○ Conditional presence; - Absence.

Relación entre especies de micromamíferos (Insectívoros y Roedores) y tipos de vegetación de Cataluña: ● Presencia; ○ Presencia condicional; - Ausencia.

higher levels, are in their limiting southern border, as well as by species of strictly Mediterranean requirements. The most representative species are *E. algirus*, *S. etruscus*, *C.*

russula, *A. sylvaticus*, *M. spretus* and *M. (Pitymys) duodecimcostatus*.

It is difficult to decide which species of the 27 found in Catalonia can be used as

ecological indicators. Indeed, only *M. marmota* can be considered characteristic and exclusive of the alpine and subalpine high mountain area. *M. arvalis*, although found mostly in alpine and subalpine meadows in Catalonia, can also be present in meadows of lower altitudes. No species can be considered characteristic and exclusive of the mid-European and Atlantic lower mountain area. All those present live in upper or lower levels, and some are common to all. In the Mediterranean and sub-Mediterranean mountains and lowlands, the species found are those with strictly Mediterranean requirements and the following species can be considered characteristic and representative: *E. algirus*, *S. etruscus*, *M. spretus* and *M. duodecimcostatus*. For some species the geographic distribution depends on particular conditions. The presence of rivers or permanent masses of water determine the presence of *N. fodiens*, *N. anomalus* and *A. sapidus*, while the distribution of *R. rattus*, *R. norvegicus* and *M. musculus* is man-conditioned.

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SUMMARY

In the present paper the natural communities of small mammals of Catalonia are studied in reference to the environmental requirements of each species and in relation to the distribution of rainfall, vegetation and general physiography of Catalonia. The environments considered are the alpine and subalpine high mountain area, the mid-European and Atlantic lower montane area, and the Mediterranean and sub-Mediterranean mountains and lowlands. A group of species with aquatic requirements, and another of species that are commensals of man are also considered, as their distribution does not follow the general pattern observed.

In the alpine and subalpine high mountain area,

the most representative species are: *T. europaea*, *M. marmota*, *A. terrestris*, *M. (P.) pyrenaicus*, *M. nivalis* and *M. arvalis*; in the mid-European and Atlantic lower montane area: *E. europaeus*, *S. minutus*, *S. araneus*, *S. coronatus*, *E. quercinus*, *C. glareolus*, and *M. agrestis*; and in the Mediterranean and sub-Mediterranean mountains and lowlands: *E. algirus*, *S. etruscus*, *C. russula*, *A. sylvaticus*, *M. spretus* and *M. (P.) duodecimcostatus*.

Among all species in Catalonia, only *M. marmota* can be considered typical of the alpine and subalpine high mountain area, as it cannot be found in any of the other mentioned zones. In the area of Mediterranean characteristics *E. algirus*, *S. etruscus*, *M. spretus* and *M. (P.) duodecimcostatus* are representative of this type of conditions. None of the remaining small mammal species of Catalonia can be considered exclusive of the mentioned areas.

RESUMEN

Las comunidades naturales de micromamíferos (Insectívoros y Roedores) de Cataluña.— En el presente trabajo se estudian las comunidades naturales de micromamíferos que existen en Cataluña, en base a los requerimientos ambientales de las especies en relación a la distribución de la pluviosidad, de la vegetación y de la fisiografía general de Cataluña. Los medios considerados son: la alta montaña alpina y subalpina, la montaña media centroeuropea y atlántica y la montaña y tierras bajas submediterráneas y mediterráneas. También se considera un grupo de especies de requerimientos acuáticos y otro de especies comensales del hombre cuya distribución no sigue las pautas generales de las demás especies.

En la alta montaña alpina y subalpina las especies más representativas son *T. europaea*, *M. marmota*, *A. terrestris*, *M. (P.) pyrenaicus*, *M. nivalis* y *M. arvalis*; en la montaña media medioeuropea y atlántica: *E. europaeus*, *S. minutus*, *S. araneus*, *S. coronatus*, *E. quercinus*, *C. glareolus* y *M. agrestis*, y en las tierras bajas submediterráneas y mediterráneas: *E. algirus*, *S. etruscus*, *C. russula*, *A. sylvaticus*, *M. spretus* y *M. duodecimcostatus*.

De las especies presentes en Cataluña sólo *M. marmota* puede ser considerada característica de la alta montaña alpina y subalpina, en el sentido de que no se presenta en ninguna de las otras zonas comentadas. *E. algirus*, *S. etruscus*, *M. spretus* y *M. (P.) duodecimcostatus* son especies propias y representativas de la zona de características mediterráneas. Ninguna de las otras especies de micromamíferos presentes en Cataluña pueden ser consideradas exclusiva de cualquiera de las zonas indicadas.

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