

The Alpine marmot (*Marmota marmota* L.) in the Spanish Pyrenees

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Abstract

Studied the distribution and colonization process of Alpine marmot (*Marmota marmota* L.) in the Southern Pyrenees. Marmots became extinct at the end of the Pleistocene in the Pyrenees, and have been introduced since 1948 on the northern slope of the mountain range (France). More than 350 localizations have been recorded. Results show factors that have affected its expansion, such as: orographic barriers, mountain passes, habitat selection and human disturbance. Location is given in 2×2 km of the UTM squares, which indicates the existence of at least one colony. Colonies range from 1450 to 2900 m, more frequently between 1800 and 2400 m height. A positive correlation exists between the years of existence in each massif and the altitudinal range ($r = 0.89$, $p < 0.01$), and between the maximal height of the massif and the maximal height of the colonies ($r = 0.80$, $p < 0.01$).

Introduction

The Alpine marmot inhabited the Pyrenees during the Pleistocene (ALTUNA 1965; BESSON 1971; VILLALTA 1972). At the end of this period it only survived in the Alps (*Marmota marmota marmota*) and in the Carpatian mountains (*Marmota marmota latirostris*). After 1948 (COUTURIER 1955) several deliberate introductions were undertaken either by official organizations such as the Parc National des Pyrénées Occidentales (P. N. P. O.) or by hunters, which have continued to date (OLIVIER 1979; DUBREUIL 1989; NOVOA, pers. comm.).

There were various motives for these activities. COUTURIER (1955) attempted to reduce the impact of the golden eagle (*Aquila chrysaetos*) preying on the chamois (*Rupicapra pyrenaica pyrenaica*), while CHIMITS (1971) intended the marmot to be an alternative feeding source for the brown bear (*Ursus arctos*) and thus to lessen the latter's attacks on livestock (BUFFIERE 1988; CHAUMEIL 1988). The marmot became established in Spain since at least 1968 and is now widely distributed over the entire southern slope of the Pyrenees (GARCIA-GONZALEZ et al. 1985).

The aim of this paper is to describe the distribution of this species and to outline its colonising process. From this information it is expected that factors having conditioned the spread of this species can be elucidated.

Material and methods

The data for the colonies established on the Spanish slope have been obtained by means of inquiries, revision of bibliographical sources and mainly systematic investigation of the landscape. The inquiries were carried out on mountain people, livestock managers and above all the rangers of the various organizations responsible for wildlife management: Diputación General de Aragón (D. G. A.), Generalitat de Catalunya, Diputación Foral de Navarra (D. F. N.).

The surveys have revealed a great deal about the development of the colonizing process (CANUT et al. 1989; HERRERO et al. 1987). The bibliographical revision of OLIVIER's (1979) thesis has provided

information on the French deliberate introductions and on the first marmot localities in the Iberian Peninsula. Systematic exploration of the land was undertaken to test the validity of these inquiries. More than two hundred colonies have been visited since 1984, especially systematically in the summers of 1988 and 1989. In 1990 some new data were added. We have thus been able to gather information about the ecological features of the habitat.

On most of these expeditions we were accompanied by the afore-mentioned rangers. Location of colonies was made easier by the use of a dog. This method has been used with various ground squirrel species (ZWICKEL 1980) including *Marmota vancouverensis*. (MUNRO et al. 1985).

Results and discussion

The colonizing process

The analysis of historical and present-day Alpine marmot distribution on the southern slope of the Pyrenees enables us to deduce the factors, both physical and human, which have influenced its expansion (HERRERO et al. 1987). The Spanish locations where colonisation has taken place most closely correspond to the French areas where the introduction has been nearest to the border and/or most abundant. In many cases the marmot has only taken two or three years to establish on the Spanish territory (GONZALEZ-PRAT et al. 1989).

Dispersion is delayed but not prevented by high massifs or steep slopes, as they act as orographic barriers. Mountain passes provide passage ways leading to colonization of other slopes, especially those below 2400 m altitude. Habitat selection is also an important factor in the colonising process and the marmot's preference for southern slopes is extremely influential. The features of French northern slope being less suitable, have favoured the expansion throughout the Spanish Pyrenees.

Human presence and the construction of infrastructures has made marmot colonization difficult, according to what has been discovered by the explorations. Tranquillity having been restored, however, some previously disturbed areas are quickly reoccupied.

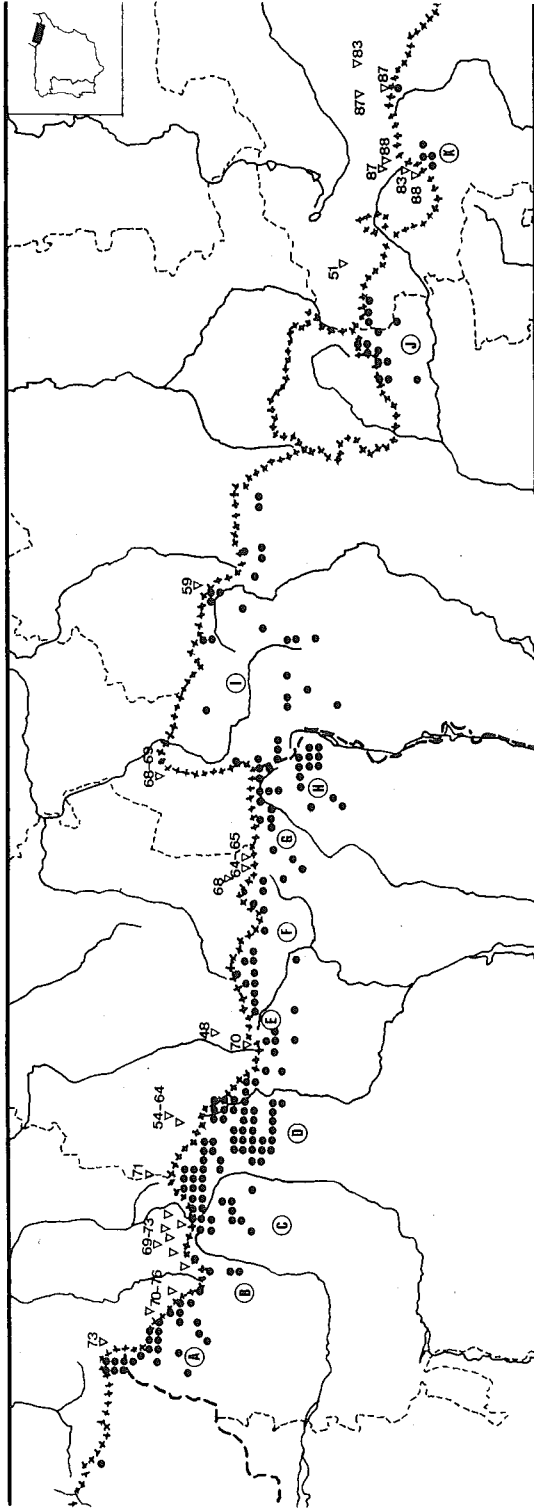
Current distribution

The Figure shows the current distribution of the marmot over the southern Pyrenees, taken from points superimposed on a UTM grid of 2 km side. Therefore marmots can be found in at least 190 squares of 4 km² (11 % of the area between 1600 and 2400 m). The height ranges between 1800 and 2400 m altitude, although there are extreme localities at 1450 and 2900 m (HERRERO and GARCIA-SERRANO 1989).

The most westerly point was of a marmot in spring dispersion. The area between this one and the nearest localities has not been specifically explored.

The Table shows the first year of marmot presence, the number of colonies and the altitudinal range occupied by this animal throughout the southern slope of the Pyrenees with differentiated geographical sectors. A positive correlation between maximum altitude of the massif and maximum altitude of marmot colonies can be seen ($r = 0.8067$, $p < 0.01$). Between the maximum height of the massif and the minimum altitude of colonies, however, there is no significant relationship ($r = 0.375$, $p < 0.1$). There is, therefore, a natural upper limit conditioned by there being an occupiable habitat that is higher in relation to the height of the massif. The lower limit (tolerance interval of an average of $1813 \text{ m} \pm 227 \text{ m}$) does not depend on the height of the massif. One conditioning factor could be human activity (livestock, forestry), which has lowered the natural limit above tree-line, and has widened the supraforestral pastureland (subalpine alpinized level) and therefore the ideal habitat for the marmot. This upper forest limit has been established heterogeneously depending on the specific exploitation of the valley.

The age of the first marmot locality for each massif is positively correlated to the



Distribution of Alpine marmot in southern Pyrenees (Spain). Location is given in 2×2 km UTM scale. Triangles and numbers indicate the site and year of the first introduction in France. Letters indicate the sector mentioned in the table. The border is drawn with crosses

**First observed date, number of colonies and altitudes of marmot colony
recorded in southern Pyrenees**

Letters in brackets correspond with the sectors represented in the figure

Massifs and max. height	1st date presence	Max. height	Min. height	Number of colonies
Massif of Anie, Alanos, Peña Forca 2504 m (A)	> 1980	1900	1500	29
Massif of Bisaurin and Sa of Aisa 2676 m (B)	> 1970	2280	1400	39
Aragón-Gállego watershed 2886 m (C)	> 1970	2200	1700	12
Gállego-Ara watershed 3144 m (D)	1968	2700	1500	150
Monte Perdido Massif 3355 m (E)	1978	2500	1900	10
Cinca and Cinqueta valleys 3174 m (F)	1968	2650	1450	16
Posets 3371 m (G)	1978	2400	2000	18
Maladeta Massif 3404 m (H)	1967	2900	1850	40
Pallars 3015 m (I)	1975	2375	2000	18
Cerdanya 3143 m (J)	1982	2700	2450	19
Nuria 2910 m (K)	1984	2250	2200	5

altitudinal range (maximum versus minimum height) occupied at present ($r = 0.8941$, $p < 0.001$), although this is not the case with the number of colonies observed in these ranges ($r = 0.43$, $p > 0.1$), or the altitudinal range with the number of colonies ($r = 0.59$, $p > 0.05$).

This may indicate that the marmot has tended to increase its expansion, colonising the whole potentially occupiable altitudinal range. Some massifs have been shown to be particularly advantageous, especially the Gállego-Ara watershed, sector D, whereas others are less suitable for habitation. This heterogeneous colonisation is most likely the reason for a lack of correlation between the altitudinal range and the number of colonies. The colonisation process has not yet finished and there are various massifs which are likely to become occupied soon, such as Cotiella and Turbón.

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Zusammenfassung

Die Murmeltiere (Marmota marmota L.) in den spanischen Pyrenäen

Untersucht wurde die fortschreitende Besiedlung und Ausbreitung des Murmeltieres in den südlichen Pyrenäen. Murmeltiere starben in den Pyrenäen am Ende des Pleistozäns aus und wurden seit 1948 auf der nördlichen französischen Seite wieder eingeführt. Über 350 Beobachtungsdaten gingen in die Untersuchung ein. Die Ergebnisse zeigen, daß Faktoren wie orografische Barrieren, Gebirgspässe, Wahl des Lebensraumes und Störungen durch den Menschen die Ausbreitung des Murmeltieres beeinflusst haben. Die Daten sind in Quadraten von 2 × 2 km (UTM-Gitter) angegeben, worin sich mindestens eine Kolonie befindet. Die Kolonien reichen von 1450 m bis 2900 m Höhe, sind jedoch häufiger zwischen 1800 m und 2400 m Höhe.

Es besteht ein positiver Zusammenhang zwischen Zeitdauer der Anwesenheit der Tiere und ihrer Besiedelung der Höhenstufen in jedem Bergmassiv ($r = 0.89$, $p < 0.01$) sowie zwischen Maximalhöhe des Massives und Höhe über NN der angesiedelten Kolonien ($r = 0.80$, $p < 0.01$).

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