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Taxonomic review of *Arvicola terrestris* (Linnaeus, 1758) (Rodentia, Arvicolidae) in the Iberian Peninsula

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Abstract. In this study a comparative biometrical analysis among different populations of *Arvicola terrestris* from central and southwestern Europe has been carried out. The analyzed samples are the following: 32 specimens from the Massif Central (France), 40 from Switzerland and Liechtenstein, 82 from Ribadesella (Asturias, Spain) and 150 from the Valle de Arán (Lérida, Spain). Parting from the results and considering chorological aspects, the following conclusions can be deduced: The populations from the Massif Central are confirmed to belong to the subspecies *A. t. exitus* (understood as *A. t. scherman*). The populations from the Pyrenees and the Massif Central should remain subspecifically independant. The Pyrenean populations of *A. terrestris*, compared to the Cantabrian ones, show significantly bigger skull and mandible, and a series of morphological differences. These traits, plus the fact that they are geographically independent, allows us to differentiate two subspecies in the Iberian Peninsula. Since the first description ever made of *A. t. monticola* de Sélys-Longchamps, 1838 corresponds to a sample coming from the French side of the Pyrenees, this denomination is kept for the populations dwelling in this range of mountains, and a new subspecies *A. t. cantabriae* n. subsp. is named for the populations distributed along the Cantabrian range of mountains, from the Sierra de los Ancares (Lugo) to northwestern Vizcaya.

Key words. Mammalia, Rodentia, Arvicolidae, *Arvicola terrestris*, taxonomy, Spain.

Introduction

Presently, the existence of one unique subspecies of *Arvicola terrestris* (*A. t. monticola*) in the Iberian Peninsula is accepted (Niethammer, 1964; Heim de Balsac & de Beaufort, 1969; Vericad, 1970; Garzón-Heydt et al., 1971; Engels, 1975; Gosálbez, 1976; Reichstein, 1982). Within this territory *A. terrestris* has a distribution area extending from eastern Galicia to northwestern Catalonia (Fig. 1). Although a continuous colonization has taken place in this area (Reichstein, 1982), the most recent data on the chorology of the species in Spain (Castién, 1984; Álvarez et al., 1985) confirm that such a distribution area is divided into three individualized groups of populations (Ventura, 1988). Thus, from west to east there is, in the first place, one going from the Sierra de los Ancares (Lugo) to northwestern Vizcaya. Then, there is a small one occupying northeastern Guipúzcoa and, finally, there are the populations distributed from northeastern Navarra to the Valle de Arán (Lérida) and its surrounding areas (Fig. 1).

The lack of detailed morphological and biometric studies on the Iberian populations of this species determines that the systematic problem in this territory is centered in the settlement of the real taxonomic identity of the different groups of populations mentioned above, as much as the determination of the possible relationships existing among those and the closest populations of *A. t. exitus* (Miller, 1912; Hinton, 1926; Cantuel, 1943; Didier, 1943; Heim de Balsac & Guislain, 1955; Reich-

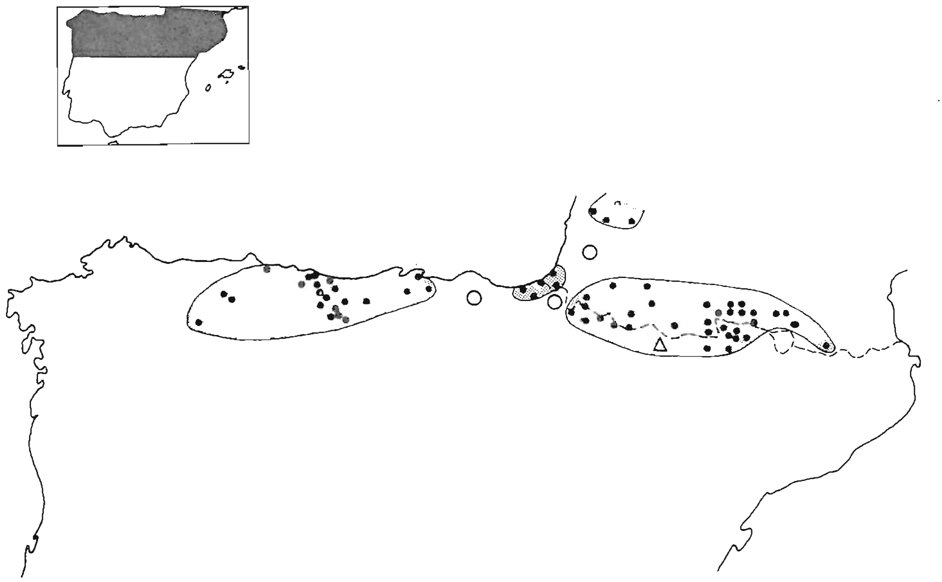

Fig. 1: Geographical distribution of *Arvicola terrestris* in the Iberian Peninsula. (○): absence of the species; (Δ): probable presence.

stein, 1963; Spitz & Morel, 1972; Le Louarn & Saint-Girons, 1977; Baudoin, 1984); although according to different authors (Spitz & Morel, 1972; Morel, 1981) the subspecies *exitus* has at present lost its taxonomic identity when reaching a synonymy with *A. t. scherman*. With the aim of placing these populations geopgraphically in an accurate way, as well as avoiding possible taxonomic mistakes with respect to other northern populations, in the present study it has been chosen to keep the classical subspecific denomination of *A. t. exitus*.

The systematic and taxonomy of the Iberian populations still present many features that must be clarified; specially, if the last published data about the distribution of *A. terrestris* in the Iberian Peninsula are taken into account. This study aims to carry out a biometric characterization of the Iberian populations of this species coming from the Cantabrian range of mountains and the Catalonian Pyrenees and evaluates, comparing the different groups, the homogeneity *A. terrestris* has in this territory. Likewise, the degree of relationship between each one of these populations and those dwelling in the Alps and the Massif Central has been evaluted.

Material and methods

This study is based on the biometric and morphological comparison of the following samples of *A. terrestris*: 32 specimens (14 ♂ and 18 ♀) from Ally (Cantal, Massif Central, France) we were donated by Dr. E. L. Petavy (Université Claude Bernard, Lyon, France); 40 specimens (18 ♂ and 22 ♀) from Switzerland (Bassins and Interlaken) and Liechtenstein (Vaduz and Schaan) proceeding from the Alexander Koenig Museum collection (Bonn, Western Germany); 82 specimens (40 ♂ and 42 ♀) from Ribadesella (Asturias, Spain) that were donated by D. M. Braña (Sanidad Vegetal, Asturias); 150 specimens (68 ♂ and 82 ♀) we were able to capture during 1983 and 1984 in the Valle de Arán (Lérida, Spain).

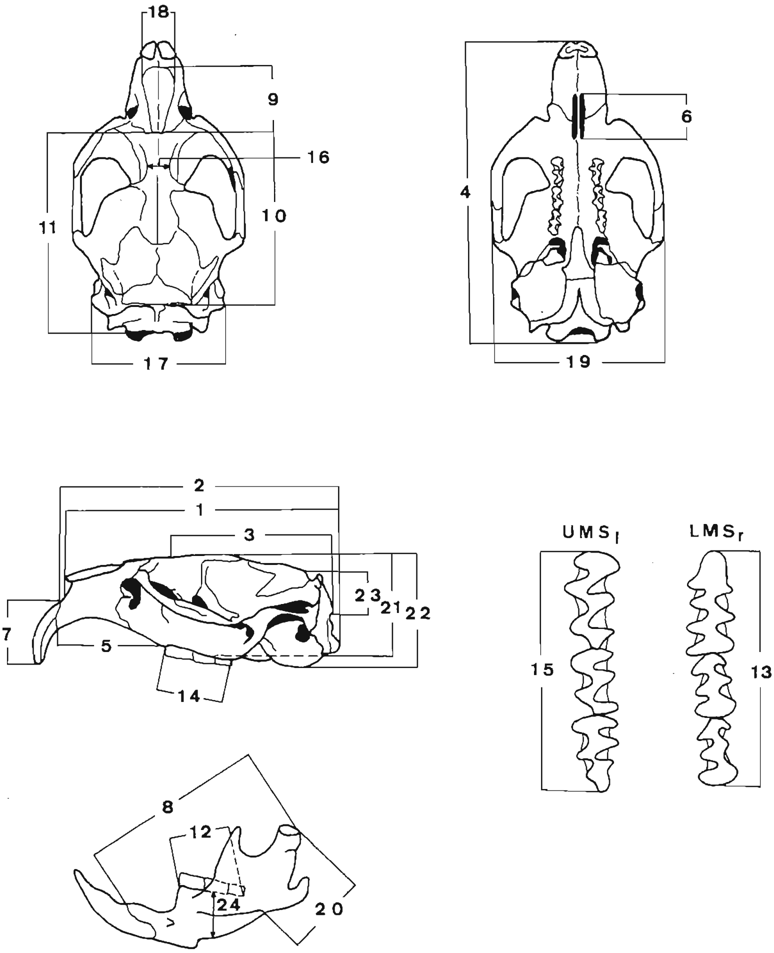

Fig. 2: Cranial and mandibular parameters measured in *Arvicola terrestris*. 1. CBLa: Condylobasal length according to the Comisión de Biometría (II Coloquio Español de Mastozoología, León, 1972); 2. CBLb: Condylobasal length according Niethammer & Krapp (1978); 3: CL: Cranium length; 4. CIL: Condyloincisive length; 5. UDL: Length of the upper diastema; 6. IFL: Length of the incisive foramen. 7. UIL: Length of the upper incisive; 8. ML: Mandible length; 9. NL: Nasal length; 10. NIL: Nasal-Interparietal length; 11. NOL: Nasal-Occipital length; 12. LMSa: Lower molar series from the alveoles; 13. LMSc: Lower molar series from the dental crowns; 14. UMSa: Upper molar series from the alveoles; 15. UMSc: Upper molar series from the dental crowns; 16. IOW: Interorbital width; 17. OW: Occipital width; 18. NW: Nasal width; 19. ZW: Zigomatic width; 20. AH: Articular height; 21. CH: Cranium height; 22. CHb: Cranium height from the tympanic bullas; 23. IFH: Interparietal-Foramen Magnum height; 24. MHM$_2$: Mandible height taken at M$_2$.

Most of the definitions for these measurements correspond to the ones explained by Niethammer & Krapp (1978) except from CBLa (Comisión de Biometría, II Coloquio Español de Mastozoología, León, 1972), UIL, NIL, NOL, IFH (Warmerdam, 1982) and MHM$_2$ (Engels, 1975).

The comparative analysis has been performed with four somatic (HBL: head-body length; TL: tail length; RFL: rear foot length; EL: ear length), nineteen cranial and five mandibular parameters (Fig. 2).

Parting from the morphological and metrical characteristics of the skull and after considering, when possible, biological and somatometrical criteria, those specimens considered immature, have been barred from the initial samples. As a result of these observations in the samples from the Valle de Arán (VA), Massiv Central (MC) and Alps (Switzerland and Liechtenstein) (AL) the specimens with a CBL ≧31.0 mm and a UDL ≧11.0 mm have been selected. Considering that the specimens from Asturias (AS) are somewhat smaller, the established critical values have also been lesser: CBLb ≧30.5 mm and UDL ≧10.0 mm.

Data processing was done in the Calculus Center of the University of Barcelona (computer IBM 3083/XE01). To carry out the analysis, the normality of the distribution of the variables as well as the homogeneity of the variances have been assumed. The significance of the differences between two sample means has been calculated by applying the t-Student test or the statistical d (Parker, 1981). In the case of more than two samples an analysis of the variance (Anova) (Dixon, 1983) has been applied. If the differences detected were significant, multiple comparisons between pairs of samples following Tukey's method (Dixon, 1983) were carried out. Parting from the Tukey's rank (Sokal & Rohlf, 1979), the differences among the averages through the Student-Newman-Keuls test (Dixon, 1983) have been comparatively evaluated.

The differentiation degree among different samples, taking into account the whole of analyzed variables, were evaluated with a multivariant analysis of the variance (Manova) (Davidson & Toporek, 1983). The graphic representation of the samples along the axes with maximum discriminating power (Cuadras, 1981) has been done through a canonical analysis of populations (CANP program, designed by Dr. J. Ocaña, Department of Biostatistics, Faculty of Biology, University of Barcelona). For two samples, a discriminant canonical analysis (Jennrich & Sampson, 1983) was used to obtain a function that would allow to differentiate the specimens from each population starting on a certain number of variables (Cuadras, 1981).

Results and discussion

The values of the descriptive statistics of the analyzed variables in each sample are shown in Table 1. The statistical comparison of the average values for each parameter, in all the samples under study, shows that morphometric differences between VA and AS in the d-test are significant ($p < 0.01$) in all parameters except EL. In all four samples test-F shows significant craniometric differences ($p < 0.01$) in all the measurements. The comparison between pairs of samples (Table 2) clearly states marked differences between AS and VA. The first one shows significantly inferior values in all cases, except for NW and LMSa in which the relationship lacks statistical significance. On the contrary, the biometric divergences existing between MC and AL are scarce, being able to distinguish significative differences in CH, AH and, specially, in NL, CHb and ZW. The multiple comparisons between the latter ones and the Iberian samples also reveal a clear biometric differentiation affecting most of the analyzed variables.

In comparing the sample averages (Table 2) it can be deduced that, in general, the Pyrenean sample shows, for all the considered cranial and mandibular parameters, superior means than the rest of the studied samples. Only IFL, IOW and NW are higher in AL, while AH and MHM_2 are higher in MC. The specimens coming from Asturias are, considering their means, those showing smaller skull measurements with the exception of UMSc, UMSa, LMSc, LMSa and ZW whose minimal values correspond to AL (for the first three parameters) and MC (for the other ones). These populations present intermediate skull and mandible sizes in comparison with the Iberian populations.

To evaluate the affinity among the different populations for each one of the considered cranial and mandibular parameters, the Student-Newman-Keuls test has been used (Table 2). The final results have been represented on diagrams, underlining those samples whose averages are not significantly heterogeneous. The diagrams point out scarce biometric affinities between VA and AS, given that, in general, they both show the highest and lowest values of the analyzed samples. This circumstance is obvious when special attention is paid to parameters that make reference to diverse cranial and mandibular lengths. On the other hand, skull similarities between MC and AL are also evident in most measurements.

The relationships between these last populations and the ones coming from the Iberian Peninsula vary according to the parameters we are considering; nevertheless, the analysis reveals, in a high percentage of cases, the independence of skull measurements between both samples.

Although results are widely commented at the end of this study, we must mention here that the observations done on this point openly question the biometric homogeneity among the different forms attributed to the subspecies *A. t. monticola* up to this moment, because the degree of differentiation detected between the samples coming from Asturias and the Pyrenees is even higher than the differentiation each one of them shows with respect to *A. t. exitus* from the Alps and the Massif Central. Also, we can easily deduce from the results the obvious similarity the metrical values of skull and mandible show among these last populations.

With the aim of corroborating such observations, a general evaluation of diverse cranial and mandibular parameters has been carried out with a canonical analysis of populations. The variables used in it are: CBLb, CL, UDL, IFL, NL, UMSa, CH, IOW, NW, OW, AH, ML, LMSa and MHM_2.

The eigenvalues of the matrices of covariances among populations in respect to the matrices of covariances inside the populations, as well as the percentage of variability accumulated for each one of the canonical axes, are:

Eigenvalues:	2.05	6.19	0.86
Accumulated percentage:	63.30	95.46	100

Given that the two first axes practically absorb all the variability we have estimated them to be enough for the graphic representation of the populations.

The correlations between the observed and the canonical variables are shown in Table 3. Looking at the first canonical axis (V_1) (axis with maximum discriminating power, accumulating 63.30 % of variability) we can see that CH and, in a lesser degree, UDL and NL are the variables showing a maximum value in V_1 and, therefore, most influence the discrimination among populations.

The canonical coordinates of the centroid and the radius of the confidential regions (calculated with a coefficient of reliability of a 90 %) of each sample, are shown in Table 4. As we can deduce from the canonical representation (Figure 3), AL and MC show relatively close centroids as well as a wide overlapping of their confidential regions. VA is clearly separated from these samples although looking at the first canonical axis, the proximity between them is clear. The specimens from Asturias are, nevertheless, clearly separated from the other samples. This isolation

Table 1: Measurements (in mm) of *Arvicola terrestris*. AL: Alps; MC: Massif Central; VA: Valle de Arán; AS: Asturias.

		n	$\bar{x}$	s	min.	max.
HBL	VA	133	156.50	9.938	132.0	175.0
	AS	59	140.72	7.488	122.0	159.5
TL	VA	133	68.76	4.981	54.0	80.5
	AS	59	59.61	4.614	49.0	71.0
RFL	VA	133	28.27	0.901	22.5	29.5
	AS	59	24.07	0.887	22.0	26.0
EL	VA	133	12.22	0.777	10.0	14.0
	AS	59	12.38	0.887	11.0	14.0
CBLa	AL	37	32.63	1.185	30.2	35.6
	MC	28	32.82	1.172	31.1	35.3
	VA	134	34.10	1.461	30.8	36.6
	AS	60	31.38	0.834	30.1	33.6
CBLb	AL	37	33.08	1.242	31.1	36.2
	MC	28	33.45	1.305	31.5	36.0
	VA	134	34.54	1.576	31.1	37.2
	AS	59	31.76	0.906	30.5	33.9
CL	AL	36	19.86	0.686	18.0	21.2
	MC	28	19.86	0.730	18.5	21.6
	VA	140	20.51	0.802	18.7	22.6
	AS	59	19.73	0.546	18.7	21.2
CIL	AL	31	34.70	1.304	32.4	37.5
	MC	26	34.82	1.412	32.7	37.8
	VA	132	36.12	1.761	32.2	38.9
	AS	59	33.25	1.079	30.8	36.0
UDL	AL	38	12.26	0.514	11.4	13.3
	MC	50	12.51	0.799	11.2	14.3
	VA	136	12.75	0.739	11.1	14.4
	AS	60	11.40	0.445	10.3	12.5
IFL	AL	38	5.06	0.443	4.2	6.2
	MC	54	4.97	0.429	3.8	5.8
	VA	137	4.85	0.396	3.7	6.2
	AS	60	4.51	0.347	3.8	5.4
UIL	AL	31	7.85	0.662	6.7	9.5
	MC	39	7.42	0.672	6.4	8.9
	VA	135	8.18	0.772	6.0	9.9
	AS	54	6.32	0.710	5.0	7.6
NL	AL	38	9.31	0.558	8.2	10.7
	MC	44	9.74	0.634	8.6	11.1
	VA	134	9.97	0.558	8.4	11.0
	AS	60	8.83	0.397	7.9	9.7
NIL	AL	38	20.06	0.685	18.3	21.7
	MC	32	20.32	0.769	18.5	21.8
	VA	136	20.91	0.671	19.6	22.8
	AS	60	19.63	0.502	18.4	21.1
NOL	AL	36	23.05	0.763	21.0	25.2
	MC	30	23.21	0.838	21.1	25.2
	VA	136	23.95	0.819	22.2	25.7
	AS	60	22.52	0.534	21.2	23.7

		n	$\overline{x}$	s	min.	max.
UMSa	AL	37	8.07	0.317	7.4	8.8
	MC	58	8.11	0.435	7.3	9.0
	VA	142	8.47	0.330	7.6	9.2
	AS	60	8.16	0.254	7.7	8.9
UMSc	AL	37	7.80	0.332	7.0	8.5
	MC	58	7.83	0.453	6.9	8.9
	VA	141	8.20	0.370	7.2	9.1
	AS	60	7.93	0.249	7.5	8.7
CH	AL	38	10.08	0.419	9.4	11.3
	MC	28	10.37	0.485	9.4	11.3
	VA	139	10.64	0.452	9.5	11.9
	AS	59	9.50	0.301	9.0	10.2
CHb	AL	31	11.86	0.463	10.8	12.9
	MC	24	12.37	0.418	11.7	13.1
	VA	133	12.66	0.438	10.8	14.0
	AS	59	11.80	0.337	11.1	12.4
IFH	AL	36	4.70	0.417	3.8	5.7
	MC	40	4.69	0.468	3.4	5.8
	VA	140	5.04	0.557	3.9	6.6
	AS	60	4.46	0.361	3.7	5.3
IOW	AL	38	4.45	0.274	3.6	5.0
	MC	35	4.36	0.351	3.7	5.2
	VA	141	4.40	0.231	3.4	5.0
	AS	59	4.23	0.180	3.8	4.7
NW	AL	38	3.85	0.234	3.4	4.4
	MC	51	3.81	0.324	3.1	4.3
	VA	136	3.58	0.249	3.1	4.1
	AS	60	3.49	0.185	3.2	4.1
OW	AL	36	15.77	0.648	14.6	17.1
	MC	36	15.95	0.602	14.6	17.1
	VA	137	16.42	0.765	14.6	17.9
	AS	59	15.21	0.546	14.0	16.6
ZW	AL	29	21.68	1.049	19.8	23.6
	MC	21	20.11	1.220	18.1	23.0
	VA	129	22.04	1.147	19.2	24.3
	AS	57	20.15	0.668	18.7	21.9
ML	AL	38	22.76	0.724	21.6	24.3
	MC	51	23.18	1.256	20.0	25.1
	VA	142	23.71	1.030	21.5	25.7
	AS	59	22.30	0.702	20.8	24.0
LMSa	AL	38	8.27	0.387	7.4	9.0
	MC	59	8.15	0.451	7.2	9.1
	VA	142	8.42	0.341	7.7	9.2
	AS	60	8.32	0.306	7.6	9.1
LMSc	AL	38	7.99	0.390	7.2	8.8
	MC	58	8.00	0.461	7.1	9.0
	VA	142	8.30	0.343	7.6	9.2
	AS	60	8.13	0.312	7.5	9.0
AH	AL	38	11.05	0.468	10.3	12.1
	MC	55	11.39	0.697	9.8	12.5
	VA	142	11.26	0.651	9.7	13.0
	AS	60	10.88	0.436	9.9	12.1
MHM_2	AL	38	5.02	0.307	4.6	5.9
	MC	60	5.03	0.380	4.0	5.8
	VA	142	4.94	0.294	4.2	5.6
	AS	60	4.74	0.229	4.3	5.4

Table 2: Individual comparisons between pairs of samples according to Tukey's method in *Arvicola terrestris*. AL: Alps; MC: Massif Central; VA: Valle de Arán; AS: Asturias. +: $p < 0.05$; ++: $p < 0.01$; 0: not significative differences; —: without data. S-N-K: results of the Student-Newman-Keuls test.

	AS-VA	AS-MC	AS-AL	VA-MC	VA-AL	MC-AL	S-N-K $<\bar{x}<$
HBL	++	—	—	—	—	—	AS VA
TL	++	—	—	—	—	—	AS VA
RFL	++	—	—	—	—	—	AS VA
EL	++	—	—	—	—	—	AS VA
CBLa	++	++	++	++	++	0	AS AL MC VA
CBLb	++	++	++	++	++	0	AS AL MC VA
CL	++	0	0	++	++	0	AS AL MC VA
CIL	++	++	++	++	++	0	AS AL MC VA
UDL	++	++	++	0	++	0	AS AL MC VA
IFL	++	++	++	0	+	0	AS VA MC AL
UIL	++	++	++	++	0	0	AS MC AL VA
NL	++	++	++	0	++	++	AS AL MC VA
NIL	++	++	++	++	++	0	AS AL MC VA
NOL	++	++	++	++	++	0	AS AL MC VA
UMSa	++	0	0	++	++	0	AL MC AS VA
UMSc	++	0	0	++	++	0	AL MC AS VA
CH	++	++	++	+	++	+	AS AL MC VA
CHb	++	++	0	++	++	++	AS AL MC VA
IFH	++	0	0	++	++	0	AS MC AL VA
IOW	++	+	++	0	0	0	AS MC VA AL
NW	0	++	++	++	++	0	AS VA MC AL
OW	++	++	++	++	++	0	AS AL MC VA
ZW	++	0	++	++	0	++	MC AS AL VA
ML	++	++	0	++	++	0	AS AL MC VA
LMSa	0	0	0	++	0	0	MC AL AS VA
LMSc	+	0	0	++	++	0	AL MC AS VA
AH	++	++	0	0	0	+	AS AL VA MC
MHM_2	++	++	++	0	0	0	AS VA AL MC

Table 3: Correlation between the observable (rows) and the canonical variables (columns) in *Arvicola terrestris.*

	V_1	V_2	V_3
CBLb	0.39	—0.26	0.14
CL	0.15	—0.22	0.19
UDL	0.48	—0.11	0.11
IFL	0.25	0.15	0.39
NL	0.47	—0.29	—0.20
UMSc	0.04	—0.39	0.04
CH	0.61	—0.30	0.05
IOW	0.16	0.11	0.36
NW	0.26	0.44	0.05
OW	0.36	—0.24	0.26
ML	0.31	—0.26	—0.04
LMSc	—0.03	—0.32	0.22
AH	0.21	—0.02	—0.27
MHM_2	—0.09	—0.06	0.08

Table 4: Canonical coordinates of the centroid and the radius of the confidential regions of each analyzed sample of *Arvicola terrestris.* AL: Alps; MC: Massif Central; VA: Valle de Arán; AS: Asturias.

sample	N	V_1	V_2	V_3	radius
AL	29	11.69	—6.57	13.97	0.68
MC	17	12.66	—7.26	12.71	1.17
VA	111	12.50	—9.86	13.58	0.46
AS	50	8.37	—8.23	13.23	0.68
Total	207	11.31	—7.98	13.37	

is higher with respect to the sample belonging to the same subspecies (VA). Due to this circumstance, the populations belonging to a *A. t. exitus* occupy in the diagram an intermediate position with respect to the Iberian samples, being, nevertheless, somewhat nearer to VA than to AS. The canonical diagram also shows that the disposition of the samples is, in general, coincidental with the geographical distribution of the different populations. Taking this circumstance into account and looking at the obtained metrical values (Table 1), it is possible to deduce an increase of the skull size going south that reaches highest values in the Pyrenean populations. Within the Iberian Peninsula, the western populations show smaller skull and mandible sizes.

Looking at the taxonomic position of the populations and according to the results obtained in all the different types of analysis, the following considerations can be made:

The vinculation between MC and AL is evident because of the proximity of their centroids and the overlapping of the confidential areas in the canonical analysis. These results show a very clear similarity in skull size between these samples, which has been deduced parting from the scarce significant differences detected in comparing the average values of the whole of the considered parameters.

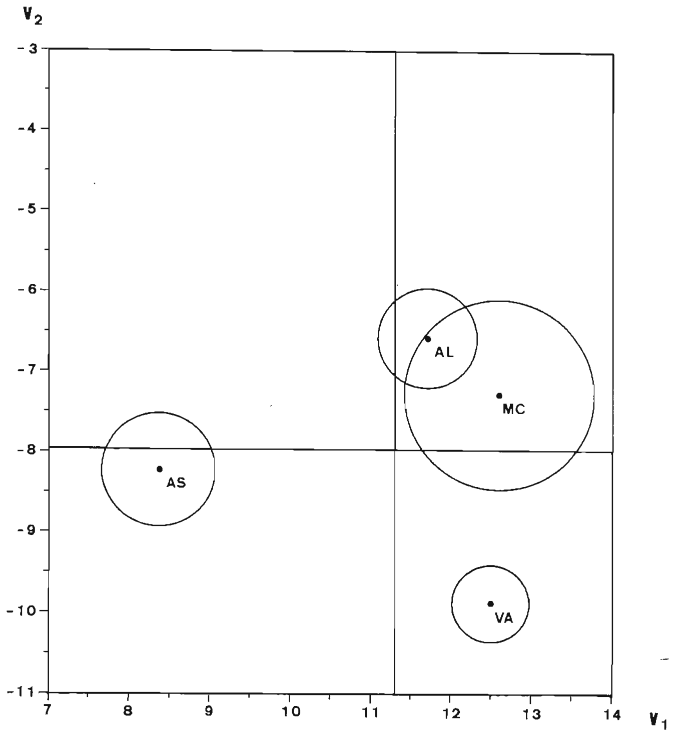

Fig. 3: Canonical representation of the analyzed samples of *Arvicola terrestris*. AL: Alps; MC: Massif Central; VA: Valle de Arán; AS: Asturias.

Such results induce to attribute the specimens from the Massif Central to the subspecies *A. t. exitus* (meaning *A. t. scherman*), results that widely coincide with the present conception of morphological groups established in France by Spitz & Morel (1972), and generally accepted in the last reviews of *A. terrestris* of this country (Le Louarn & Saint-Girons, 1977; Baudoin, 1984).

The differences detected in the size of the skull and, consequently, the spacing out of the centroids and the independence of the confidential regions that VA and MC show in the canonical representation, as well as the geographical isolation between them, induces us to keep the subspecific independence of the Pyrenean forms with respect to the populations attributed to *A. t. exitus*. Nevertheless, the canonical analysis shows there is a closer relationship between the Pyrenean forms of *A. terrestris* and *A. t. exitus* from the Massif Central, than the relationship existing between those and the populations from the northwestern part of Spain. These results give a logical explanation to the diverse interpretations that can be found in the bibliography on the taxonomic identity of the populations from the Massif Central (Miller, 1912; Hinton, 1926; Cantuel, 1943; Didier, 1943; Reichstein, 1963).

The distance that AS shows in the canonical diagram with respect to the other samples and, specially, with respect to the Pyrenean one, induces us to review the taxonomic status of the Iberian populations. The extreme position they adopt in the canonical representation is a clear evidence of the marked biometric differences existing between both. Thus, while the specimens from VA show greater skull and mandible sizes, AS show, for most of the considered parameters, the lowest average values, being even lower than the values of *A. t. exitus*, which is considered to the present, to be the smallest subspecies of *A. terrestris*. With respect to the somatic values (not included in the canonical analysis), it must be pointed out that the Pyrenean specimens show, compared to those from Asturias, significantly higher average values (Table 2).

Such results demand a detailed evaluation of the biometric differences among the populations which would allow to distinguish, in a more or less accurate way, each one of the Iberian samples we studied and would clearify the characteristics that prove to have a higher discriminating power. For this, a discriminating canonical analysis was carried out between AS and VA, parting from the following variables: CBLb, CL, CIL, UDL, IFL, UIL, NL, NIL, NOL, UMSa, CH, CHb,IFH, IOW, OW, NW, ZW, AH, ML, LMSa, MHM_2. In this analysis we have included the juvenile specimens. Based on these variables a discriminant function was designed according to the method exposed by Jennrich & Sampson (1983).

Once the analysis was concluded, the selected variables according to their discriminant power were: CH, LMSa, NL, IOW, AH, UIL, UMSa and NIL.

Later on, each specimen was classified based on the obtained canonical coefficients for every variable, in each of the corresponding groups (Jennrich & Sampson, 1983). The results obtained from this analysis are shown as a classification matrix in which the number of specimens classified in each group and the percentage of correct classifications are detailed:

	correct percentage	Asturias group	V. Aran group
Asturias	100	67	0
V. Aran	98.4	2	124
Total	99.0	69	124

As can be observed, the percentage of discrimination obtained based on the mentioned variables is 99 %. The distribution of the number of specimens for each sample over the canonical axis is shown in Figure 4. The standardized coefficient for the canonical variables gave the following results: UIL = —0.38705; NL = —0.86919; NIL = —0.30276; UMSa = —1.48083; CH = —2.04494; IOW = —1.62351; AH = 0.95963; LMSa = 3.01348; constant = 21.75069. The evaluated canonical variables over the averages of each group are: Asturias: 2.87903; Valle de Arán: —1.53091.

The obtained discriminant canonical function is the following: $d = -0.38705 \cdot UIL - 0.86919 \cdot NL - 0.30276 \cdot NIL - 1.48083 \cdot UMSa - 2.04494 \cdot CH - 1.62351 \cdot IOW + 0.95963 \cdot AH + 3.01348 \cdot LMSa + 21.75069$.

The determination criteria is a geometrical one: the canonical coordinates have been taken for the individual average of each group (Valle de Arán: $k_1 = -1.53091$; Asturias: $k_2 = 2.87903$). A specimen is assigned to the canonical group whose individual value is closer to the average value of the group. Given that the canonical variable is adjusted so that the variances among groups are the same, when the function is evaluated for the introduction of a new specimen, if $d < 0.67406$ ((k_1 +

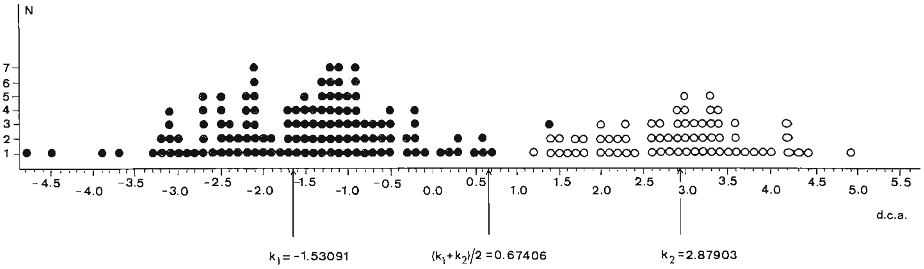

Fig. 4: Distribution of the specimens of *Arvicola terrestris* from the Valle de Arán (●) and Asturias (○) in the discriminant canonical axis (d. c. a.). k1, k2: canonical variables evaluated over the averages of each group.

k2)/2), then it must be considered to belong to the Pyrenean and if d >0.67406 it must be included in the population from Asturias. The overlapping in the distribution on the canonical axis is due to the presence of juvenile specimens in the Pyrenean sample.

As can be deduced from the results, the discrimination between the Iberian populations attributed at present to *A. t. monticola* is very clear. Based on the very accentuated divergences between both in the variables UIL, NL, NIL, UMSa, CH, IOW, AH and LMSa it is possible to differentiate the specimens from Asturias from the Pyrenean ones, due to the significantly higher sizes that the latter show in the mentioned parameters.

In the Iberian Peninsula, there is a decrease in size towards the west. Such a variation, nevertheless, the proven absence of the species in a large part of the Basque Country and in the northwest of Navarra as well, determines, as was mentioned before, the division of the areas where *A. terrestris* dwells in three independent groups of populations.

Considering the definition of subspecies given by Mayr (1969) ("A subspecies is an aggregate of phenotypically similar populations of a species, inhabiting a geographic subdivision of a range of a species") it can be observed that the conditions given by this author are accomplished in the Iberian populations of *A. terrestris* according to what has been exposed (phenotypical differentiation — read biometric — and geographical independence). Thus, the existence of two differentiated morphological groups can be admitted and should be considered as different subspecies.

With the aim of complementing the biometrical observations, we have proceeded to carefully examine the morphology of the skull of the specimens of *A. terrestris* from Asturias and the Valle de Arán. The comparative study carried out with adult specimens has allowed to detect a series of morphological differences that were constant in the studied samples.

Such traits can be seen in Figure 5 and are the following:

— The specimens from Asturias have, in comparison to those from the Pyrenees, a squamous forming a large square-angle protrusion in the superior margin of the postorbitary region. The Pyrenean specimens also have a small protuberance approximately in the middle of this region (Fig. 5 a). This trait clearly manifests itself in the

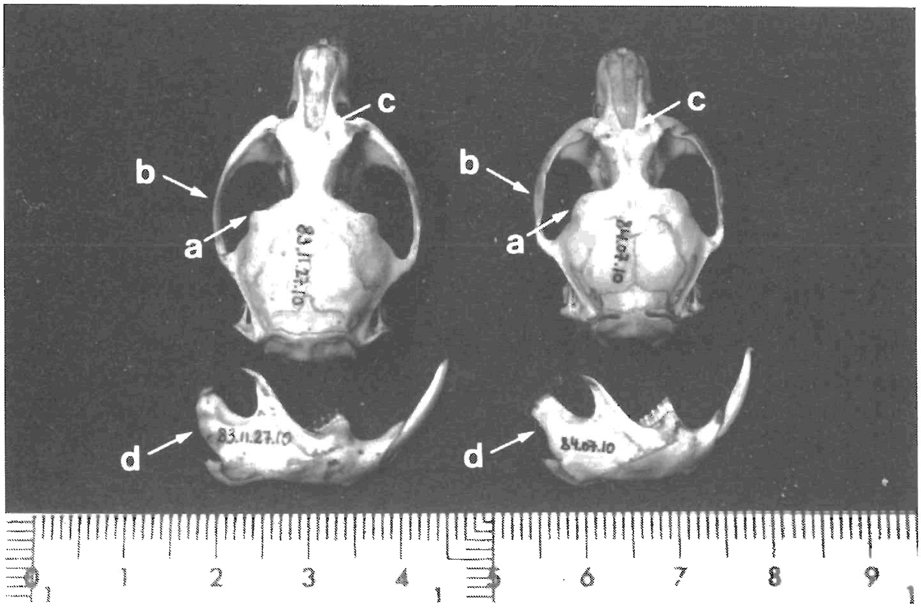

Fig. 5: Cranium and mandible of *Arvicola terrestris* from the Valle de Arán (left) and Asturias (right). Explanation in text.

whole sample and constitutes a basic criteria when the morphological differentiation of the skull must be established between both populations.

— The Pyrenean specimens have the zigomatics more arched in comparison to the sample from Asturias, given that in the latter, a lateral flattening of the arches can be observed in the areas more distant from the skull axis. This circumstance gives the specimens from the Iberian northwest an apparently rectangular skull outline compared to the ones from the Valle de Arán, showing a more rounded outline (Fig. 5b). This morphology is also constant in all the specimens under study.

— The proximal margin of the nasals is straight in the Asturian specimens and pointed in the Pyrenean ones (Fig. 5c).

— The specimens from Asturias have the articular branch of the mandible with a wider base in comparison to those from the Pyrenees. Likewise, while in these latter the shape of the upper half of this branch is clearly irregular, in the Asturian specimens this part has a rectangular shape (Fig. 5d). This feature together with the one pointed out in the previous section show, unlike the two first ones, a higher individual variability in both samples.

All these differential features strengthen the observations explained previously referring to the division of the Iberian populations of *A. terrestris* in two independent subspecific unities, given that, together with zoogeographical considerations and discriminating criteria of a biometrical order, there are a series of morphological features at cranial and mandibular level that allow to clearly distinguish the samples corresponding to the population groups attributed to this point to the same subspecies.

Table 5: Measurements (in mm) of the holotype and the paratypes of *Arvicola terrestris* n. subsp. from Ribadesella (Asturias, Spain).

number	sex	HBL	TL	RFL	EL	CBLa	CBLb	CL	CIL	UDL	IFL	UIL	NL	NIL	NOL
84.07.10	♂	142.0	60.0	25.0	12.0	31.8	32.0	19.1	33.1	11.1	4.9	7.0	9.3	18.8	22.0
84.07.11	♂	134.0	62.0	25.0	11.0	31.2	31.2	20.1	32.8	11.3	4.7	7.5	8.7	19.8	22.6
84.07.16	♂	136.0	54.0	24.0	12.0	30.5	30.9	19.5	32.1	10.9	4.8	6.7	8.4	19.6	22.3
84.07.24	♂	157.0	70.0	24.0	11.0	33.6	33.9	20.0	35.8	11.9	5.4	7.0	9.1	20.2	23.4
84.07.26	♀	140.0	59.5	24.0	13.0	30.1	30.3	19.7	31.5	10.3	4.6	5.3	8.2	19.2	22.3
84.07.27	♀	153.5	65.0	25.0	13.0	33.2	33.9	20.6	34.9	11.7	4.9	5.6	9.4	21.1	23.7
84.07.28	♀	145.0	63.0	23.0	12.0	31.9	32.0	19.7	34.2	12.2	5.1	7.2	9.1	19.4	22.2
84.07.06	♂	127.0	44.0	22.0	11.0	28.5	28.7	18.4	30.1	10.3	4.6	6.6	8.1	18.3	20.8
84.08.20	♀	122.0	50.0	24.0	13.0	29.2	29.7	18.5	30.6	10.6	4.0	5.3	8.1	18.8	21.4
84.08.26	♀	126.0	45.0	22.0	13.0	28.8	29.0	17.9	30.2	10.2	3.7	6.5	8.4	18.3	20.7

		UMSa	UMSc	CH	CHb	IFH	IOW	NW	OW	ZW	ML	LMSa	LMSc	AH	MHM_2
84.07.10	♂	8.4	8.0	9.6	11.7	4.5	4.1	3.4	15.4	20.6	22.4	8.4	8.2	11.3	5.0
84.07.11	♂	8.4	8.2	9.6	12.0	4.7	4.3	3.3	15.2	20.4	22.3	8.4	8.2	10.9	4.6
84.07.16	♂	7.7	7.7	9.1	11.3	4.0	4.3	3.4	15.0	19.7	21.2	7.8	7.5	10.3	4.6
84.07.24	♂	8.9	8.7	10.2	12.3	4.7	4.4	3.7	16.3	21.8	23.6	9.1	8.8	11.5	5.1
84.07.26	♀	8.2	7.8	9.3	11.2	4.6	4.3	3.2	14.3	19.2	21.3	8.1	8.1	10.4	4.7
84.07.27	♀	8.5	8.3	10.0	12.1	4.6	4.1	3.6	16.2	21.0	23.1	8.6	8.6	11.0	5.0
84.07.28	♀	8.3	8.1	9.3	11.7	4.2	4.0	3.8	15.7	20.9	23.1	8.6	8.4	11.1	4.7
84.07.06	♂	7.9	7.6	9.0	11.3	4.0	4.3	3.1	13.4	18.0	20.1	7.9	7.8	9.3	4.0
84.08.20	♀	7.8	7.7	9.1	11.2	3.9	4.3	3.2	14.2	18.6	20.6	7.9	7.5	10.0	4.4
84.08.26	♀	7.5	7.3	8.7	11.0	3.5	4.2	3.1	13.5	18.4	20.3	7.5	7.5	9.9	4.4

According to these considerations we consider appropriately to divide the Iberian populations grouped at present under the common denomination of *A. t. monticola* in two independent subspecific unities. Given that the name *monticola* was given for the first time by de Sélys-Longchamps (1838) to a sample from St. Bertrand de Comminge (Hautes-Pyrenées, France), this denomination may be kept for the Pyrenean populations. The populations distributed along the Cantabrian range of mountains as far as Galicia, are attributed to:

Arvicola terrestris cantabriae n. subsp.

Holotype: Nr. 87.07.10, ♂ (skull), adult; surrounding areas of Ribadesella (Asturias, Spain), leg. M. Braña, July 1984. Measurements in Table 5.

Paratypes: Nrs. 84.07.11, 84.07.16 and 84.07.24, 3 ♂ (skull), adults; Nrs. 84.07.26, 84.07.27 and 84.07.28, 3 ♀ (skull), adults; Nr. 84.07.06, 1 ♂ (skull), juvenile; all same data as holotype. Nrs. 84.08.20 and 84.08.26, 2 ♀ (skull), juveniles, August 1984. Measurements in Table 5.

The holotype and the paratypes are stored in the Department of Animal Biology (Vertebrates), Faculty of Biology, University of Barcelona. Paratype Nr. 84.07.26 is stored in the Museum Alexander Koenig, Bonn (ZFMK 89.58).

Diagnosis: Distinguished from *A. t. monticola* by its smaller body, skull and mandible. In the skull, the squamous forms a large square-angle protrusion in the superior margin of the postorbitary region (Fig. 5 a), the zygomatic arches are lateraly flattened (Fig. 5 b) and the rear margin of the nasal forms a square-angle in relation to the internasal suture (Fig. 5 c). The articular branch of the mandible has a wider base and its upper half has a rectangular shape (Fig. 5 d).

Measurements: Table 1.
Distribution: Cantabrian range of mountains, from the Sierra de los Ancares (Lugo) to northwestern Vizcaya.
Etymology: Corresponds to the distribution area.

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Zusammenfassung

Es wurde eine morphometrisch vergleichende Untersuchung zwischen verschiedenen Populationen der Ostschermaus *Arvicola terrestris* aus Mittel- und Südwesteuropa durchgeführt. Es standen 304 Exemplare zur Verfügung: 32 aus dem französischen Zentralmassiv, 40 aus der Schweiz und Liechtenstein, 82 aus Ribadesella (Asturias, Spanien), 150 aus dem Valle de Arán (Lérida, Spanien). Daraus lassen sich folgende Schlüsse ziehen. 1. Die Populationen aus dem französischen Zentralmassiv gehören tatsächlich zur Unterart *A. t. exitus* bzw. *A. t. scherman.* 2. Die Populationen aus den Pyrenäen sind unterartlich gegenüber jenen aus dem französischen Zentralmassiv getrennt. 3. Die pyrenäischen Populationen zeigen signifikant größere Körper- und Schädelmaße als jene aus der Kantabrischen Gebirgskette. Außerdem lassen sich beide Populationsgruppen anhand von morphologischen Merkmalen recht gut unterscheiden. Es kommt noch dazu, daß beide Gruppen allopatrisch sind. Somit ist es gerechtfertigt, das Vorkommen von zwei verschiedenen Unterarten der Ostschermaus auf der iberischen Halbinsel zu erkennen. Jene aus den Pyrenäen muß *A. t. monticola* de Sélys-Longchamps, 1838 genannt werden. Jene aus der Kantabrischen Gebirgskette wird hier neu benannt: *A. t. cantabriae* n. subsp. Ihr Verbreitungsgebiet erstreckt sich vom nordwestlichen Teil Vizcayas bis zur Sierra de los Ancares (Lugo).

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