Characterisation of the latest Aragonian - Early Vallesian (Late Miocene) in the Central Ebro Basin (NE Spain)

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The occurrence of *Ramys* cf. *perezi* in the Miocene sequences of the Central Ebro Basin allows to locate the Aragonian-Vallesian transition (Late Miocene) in the alluvial and lacustrine sequences which make up the upper part of the basin sediments in the Sierra Alcubierre. These new data determine the age of the upper genetic unit defined in the central basin sectors, and mark the relationships between the Ebro Basin faunal assemblages and those from other Spanish basins included in the Central Iberian palaeobiogeographic province (e.g. Teruel and Duero Basins).

Contents

Introduction

The Ebro Basin has been investigated by several research groups over the past years. A great deal of stratigraphical, sedimentological and palaeomastological studies have led to a better knowledge of the basin, and to a definition of the features and age of its sediments. However, most of the significant palaeomastological biostratigraphic results have been obtained in the eastern and western parts of the basin, whereas in the central sector the results are not so significant. This paper deals with the description of a fossil mammal assemblage from the new locality of San Caprasio in the central Ebro Basin. In spite of the limited number of taxons, this fossil assemblage is characteristic enough to allow a precise dating of the Upper Miocene sequences in the Sierra Alcubierre to the north of the Ebro river.

Geological setting

The Ebro Basin, in northeastern Spain, is one of the largest Cainozoic basins developed in the Iberian Plate. The basin is delimited by three mountain ranges (the Pyrenees, the Catalan Coastal Range and the Iberian Range, see Fig. 1), which experienced persistent tectonic activity throughout the Tertiary and influenced the basin evolution notably. The Pyrenees uplift was the main controlling factor of the Ebro Basin, which was the late foreland basin of the Pyrenean thrust-fold belt, and which attained its final structural identity during latest Eocene-Early Oligocene times. From the Oligocene to the Late Miocene the basin sedimentation was closely related with the late thrust sheet emplacements, folding and faulting that affected its tectonically active margins. During that time span the Ebro Basin was closed and filled by non-marine deposits. Large alluvial systems spread from the active tectonic basin margins and graded laterally into lacustrine-palustrine environments, which were predominant in the central basin zones. The Sierra Alcubierre, northeast of Zaragoza (Fig. 1), is one of the most important reliefs in the central sector of the Ebro Basin. The stratigraphic successions in the Alcubierre area are made up of distal alluvial and lacustrine-palustrine deposits.

Quirantes (1978) defined three main lithostratigraphical units in this part of the central Ebro Basin: the Zaragoza, Alcubierre and Sariñena Formations. The evaporitic Zaragoza Formation mainly consists of sequences dominated by nodular gypsum, that are developed extensively in the central part of the basin. This unit passes laterally into, and is overlain by, the Alcubierre Formation, a complex and varied lacustrine-alluvial unit, that consists of mudstones, marls and limestones. The outcrops of this unit form most of the cuesta reliefs in the studied area. Finally, the Sariñena Formation is composed of mudstones and sandstones that were deposited in fluvial plain environments. This unit records the sedimentation in the distal parts of the Pyrenean alluvial systems and grades laterally into the Zaragoza Formation and (partially) into the Alcubierre Formation.

Arenas et al. (1989), on the basis of the major sedimentary changes that affected the central basin zones, defined three genetic units (Tectosedimentary Units, TSU in the sense of González et al., 1988 and Pardo et al., 1988) in this area. The equivalence between the lithostratigraphic units defined by Quirantes (1978) and the genetic ones defined by Arenas et al. (1989) is shown in Fig. 1.

A synthetic stratigraphic section across the southern side of the Sierra Alcubierre (Fig. 2, see Fig. 1 for location) shows the major sedimentary changes that led to define the three genetic units. The transition from unit N-2 to unit N-3 is sharper than the one observed between N-1 and N-2 (Arenas et al., in press, b).

In this part of the Ebro Basin the lower genetic unit (N-1) consists nearly exclusively of white nodular gypsum beds, which include minor beige and yellow limestone beds and grey and green marly mudstones. The genetic unit N-2 mainly consists of carbonate deposits: grey to beige limestones with grey and green intercalated marls-mudstones. The upper genetic unit N-3 consists of terrigenous deposits (red to ochreous mudstones and grey to brownish sandstones), as well as of carbonate facies (grey-beige limestones and grey mudstones-marls).

The available sedimentological data on the studied sequences (Arenas et al., in

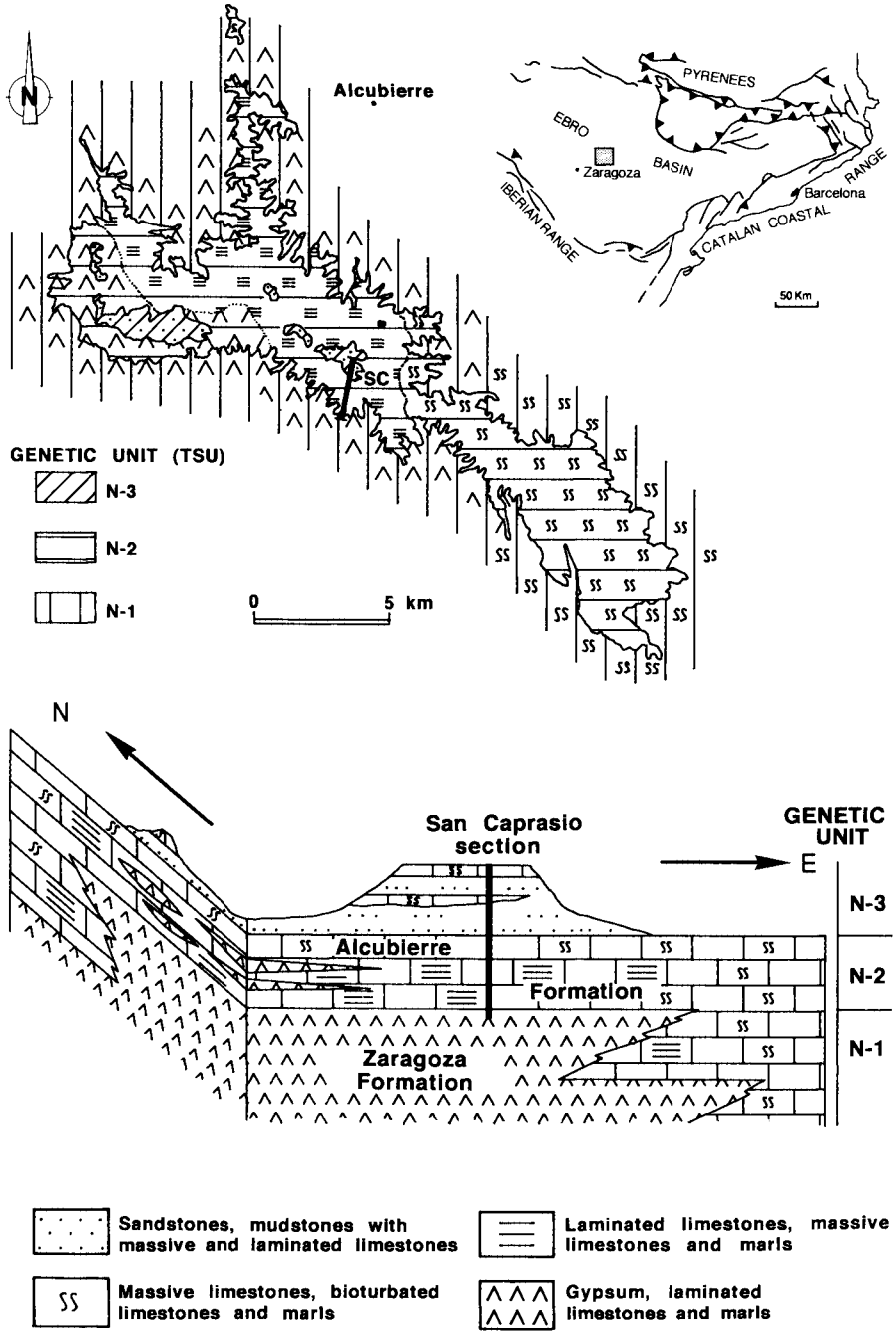

Fig. 1. A: Geological sketch showing the location of the Sierra Alcubierre and the areal distribution of the lithofacies which form the genetic units defined in the area. Note the location of the San Caprasio Section. B: Equivalence between the lithostratigraphic and genetic units defined in the Alcubierre Sierra (not on scale). See text for further explanation. Note the location of the San Caprasio section.

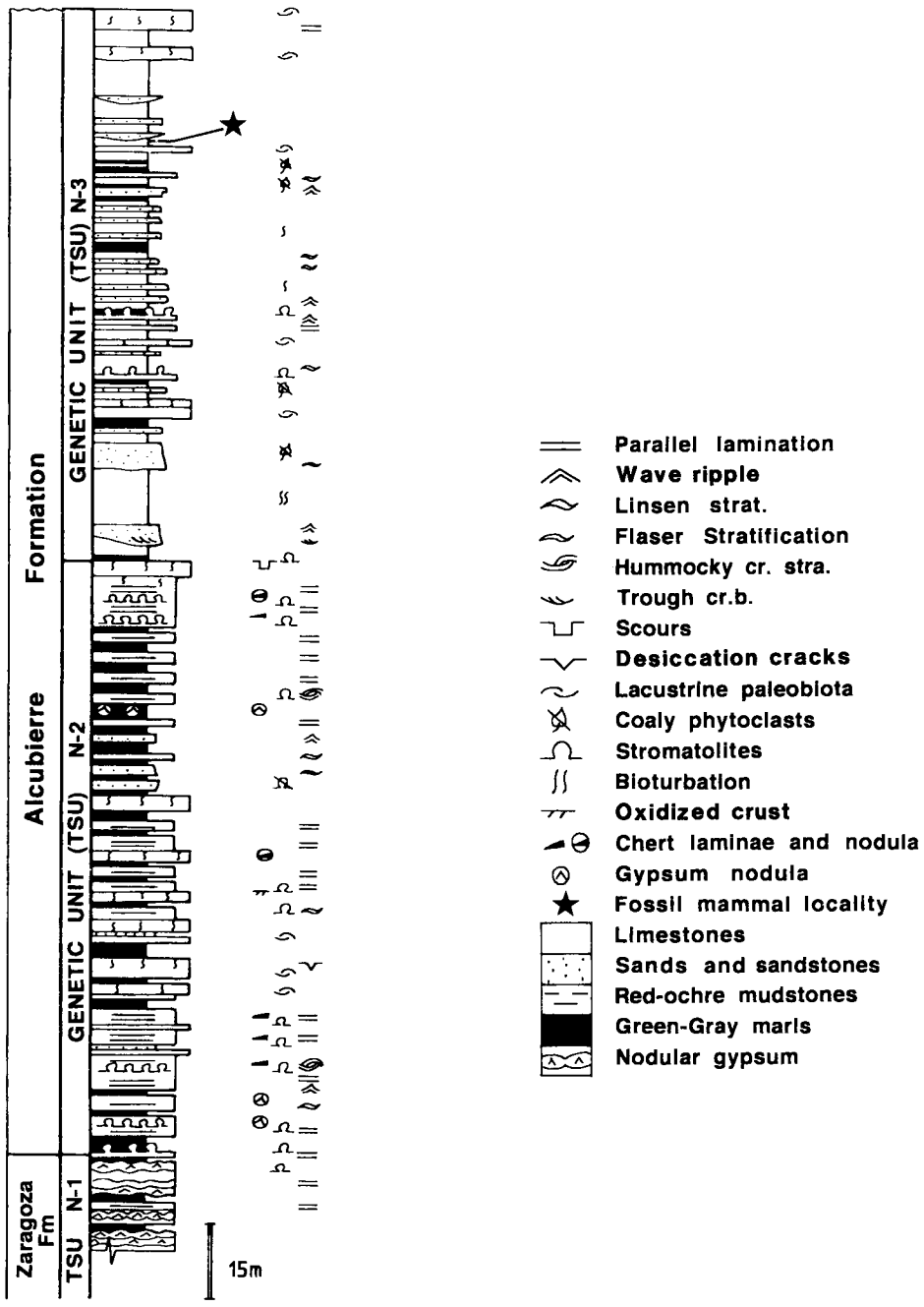

Fig. 2. Synthetic stratigraphic log in the southern side of the Sierra Alcubierre. Note the proposed boundaries for the genetic units and the location of the fossil locality of San Caprasio.

press, a and b) show a notable change of the palaeoenvironmental conditions from the lower to the upper genetic units. The lower unit N-1 was deposited in a shallow saline, mostly ephemeral lacustrine system, which often experienced intensive processes of evaporitic pumping. Inland saline sebkha conditions were dominant. The sedimentary record of the N-2 genetic unit shows a clear change in the palaeoenvironmental conditions, with a more positive balance between water influx and evaporation. This fact led to a more extensive carbonate sedimentation with well-developed marginal and inner lacustrine facies. The development of the N-3 deposits represents another palaeoenvironmental change: it was deposited in a distal channelised alluvial plain, where the lacustrine deposits were restricted either to the flood plain zones, or to those areas that were reached by the spreading of lacustrine zones, located to the south in central basin areas.

Palaeocurrent trends recorded in the three genetic units, as well as mineralogical contents in their terrigenous deposits, point to the Pyrenean zone as the major source area of the terrigenous materials fed into the basin. Moreover, the changes of the palaeoenvironmental conditions are related to a change towards a more positive water balance which could in turn be related to a climatic change that would be synchronical with a major general southward shifting of the depositional system.

The fossiliferous locality of San Caprasio

The fossil mammal locality of San Caprasio is located at the SW corner of sheet no. 356 (Lanaja) of the Topographical Map of Spain 1:50 000. It is found in one of the last bends of the local road from Alcubierre to the San Caprasio Chapel, close to the triangulation point (812 m). The approximate UTM coordinates of the sampled point are: 30TYM108219.

The fossil site is located in a section of alternating brown, red and grey mudstones, and grey sandstones with thin limestone intercalations (Fig. 3). The mudstones often display burrowing and mottling. The mammal fossil remains were obtained from a brown and greyish mudstone bed with coaly vegetal debris. The fossiliferous bed overlays a set of beige limestones, that form a conspicuous morphological step in the relief. These limestones are charophyte and ostracode bearing calcimicrite sand wackestones with low to moderate vertical burrowing and moldic porosity. These facies are a record of sedimentation in shallow carbonate dominated lakes and marginal lacustrine-palustrine zones, influenced by terrigenous contributions from terminal alluvial zones.

Systematic descriptions

Megacricetodon sp.
Fig. 3

Material and measurements — 1 M_2, 1.21 × 0.97 mm.

Description — Long labial anterolophid which attains the labial wall of the protoconid. The lingual anterolophid is absent. Very short mesolophid. A small labial

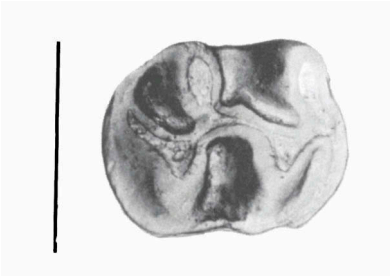

Fig. 3. *Megacricetodon* sp., M_2 dext., ALC-212-01 (scale = 1 mm).

cingulum is observed between protoconid and hypoconid. The posterosinusid is closed by the posterolophid.

Discussion — The M_2 from Alcubierre-212 coincides in size and morphology with some of the large-sized species of *Megacricetodon* present in the Late Aragonian and Early Vallesian levels of the Vallès-Penedès, Calatayud-Daroca and Duero Basins (*Megacricetodon crusafonti-Megacricetodon ibericus* lineage). Nevertheless, in the Early Vallesian of Nombrevilla a species of medium size, *Megacricetodon similis*, is present too (Freudenthal, 1968). The assignment of the specimen from Alcubierre-212 to the latter species cannot be excluded.

Family Gliridae Thomas, 1897
Genus *Ramys* García Moreno & López Martínez, 1986

Ramys cf. *perezi* Alvarez-Sierra, 1986
Fig. 4 a-b

Material and measurements (in mm) — 1 P_4, 0.87 × 0.96; 1 M_2, 1.34 × 1.30; 1 M^2, 1.34 × -.

Description

P_4 — This tooth displays a rounded outline. The trigonid is highly reduced, with small irregular ridges. The labial end of the mesolophid is inflated and directed forward. Long posterior extra ridge. Like in the mesolophid, the anterior end of the posterolophid is inflated and directed forward.

M_2 — The tooth crown presents five main ridges and four extra ridges. Anterolophid labially isolated. The labial end of the metalophid is curved forward. Well-developed sinuous anterior extra ridge. The centrolophid is long and its labial end is directed forward. Lingually, two small extra ridges can be observed, one on each side of the centrolophid. As in the case of the metalophid, the labial end of the mesolophid is inflated and curved forward. There is no trace of a labial connection of this ridge with the centrolophid or with the metalophid. Long posterior extra ridge, equal in length to the main ridges.

M^2 — The occlusal pattern of this tooth is formed by 6 main ridges: anteroloph, protoloph, anterior centroloph, metaloph, posterior centroloph, and posteroloph. The anteroloph is isolated. No extra ridges are observed between the anteroloph and the protoloph. Y-shaped protocone, placed in a very backward position. Long anterior

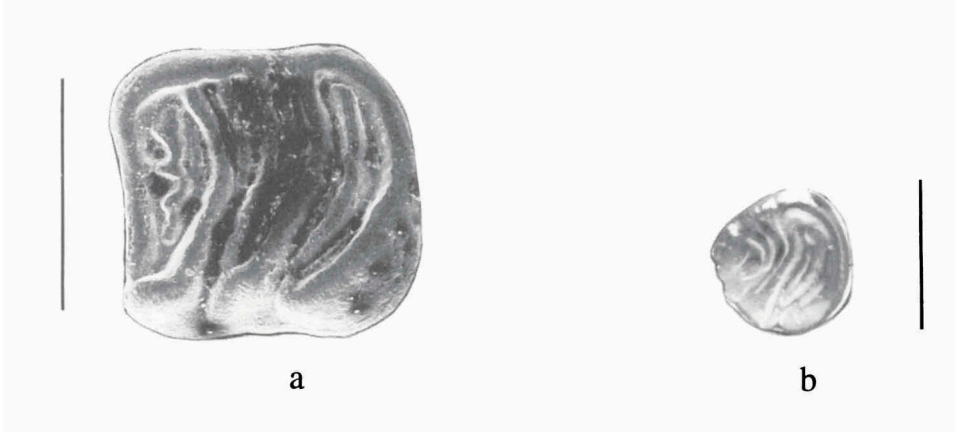

Fig. 4. *Ramys* cf. *perezi* Alvarez-Sierra, 1986; a: M_2, ALC-212-03; b: P_4, ALC-212-02 (scale = 1 mm).

centroloph. The posterior centroloph — of medium length — reaches the center of the crown. An anterior extra ridge is observed between the protoloph and the anterior centroloph. A small extra ridge is present on each side of the metaloph, and lingually fused to it. The posteroloph is connected to the protocone.

Remarks — The genus *Ramys* was created by García Moreno & López Martínez (1986) to include some populations of a medium-sized Dryomyinae with complicated dental pattern, previously included in the genera *Peridyromys* and *Vasseuromys*. As shown by Agustí (1981) and García Moreno & López Martínez (op. cit.), the species included in *Ramys* — *R. multicrestatus* (de Bruijn, 1966), R. perezi Alvarez-Sierra, 1986 — are clearly related with some advanced populations of the genus *Miodyromys: M. hamadryas* (Forsyth Mayor, 1899), *M. aegercii* Baudelot, 1972.

The few specimens of *Ramys* cf. *perezi* from Alcubierre-212 agree in size and morphology with the sample from the type-locality Ampudia-9 in the Duero Basin (Alvarez Sierra & García Moreno, 1986): size larger than *R. multicrestatus*, absence of endoloph in the upper molars, extra ridge between centrolophid and mesolophid in the M2, anterolophid labially isolated and mesolophid lingually connected to the posterolophid. The only differences are found in the P_4, which in Alcubierre-212 is more reduced. On the other hand, this character approaches the Ebro material to *R. multicrestatus*. However, we do not think this difference to justify its assignment to the latter species, since the P_4 length and width values lie within the observed variability of *R. perezi*.

Family Sciuridae Gray, 1821
Genus *Spermophilinus* de Bruijn & Mein, 1968

Spermophilinus bredai (von Meyer, 1848)

Material and measurements —1 $M^{1,2}$, 1.50 × 1.96 mm.

Description — This tooth has a triangular shape, similar to that observed in other specimens of this species. The mesostyle is absent, and there is a well-developed parastyle.

Biostratigraphy and relationships to other localities

Dating of the Neogene sequences in the westernmost sectors of the eastern and central Ebro Basin is based on the palaeomastological assemblages found in the Cinca Valley, Llanos de Cardiel, Lanaja, and Sierra Alcubierre (Agustí et al., 1985, 1988-1990; Azanza et al., 1988; Cuenca, 1991; Cuenca et al., 1989, 1992, in press). To date several Early Miocene fossil mammal assemblages have been characterised in the lowermost sequences of the genetic unit N-1. None of the localities found in the N-2 and N-3 genetic units in the Sierra Alcubierre have yielded a faunal assemblage characteristic enough to determine their age.

The known fossil mammal localities in the Neogene sequences of the Sierra Alcubierre are located in its northern part: Casero 1, Puig Ladrón (Cuenca, 1991) and Santa Quiteria (Cuenca et al., 1992). Casero 1 and Sta. Quiteria are included in the genetic unit N-1, while Puig Ladrón is placed in the N-2 unit, close to its base. Cuenca et al., (1992, in press) established that due to the scarceness or limited significance of the identified taxa, a Middle to Late Miocene age has to be assigned provisionally to these localities.

The chronological attribution of the genetic units established in the central Ebro Basin sectors has been based on the correlation with the Neogene sequences that crop out in the southern marginal basin zones. Genetic units defined in the Sierra Alcubierre (Figs. 1-2) have been correlated with those defined near the Iberian Margin of the Ebro Basin (Pérez et al., 1988), where the fossil mammal localities have permitted to date the genetic units N-1 (Late Agenian-Middle Aragonian), N-2 (Middle-Late Aragonian) and N-3 (Late Aragonian-Vallesian).

The most significant mammal localities in the genetic unit N-3 sections along the Iberian Range margin are:

1) Moyuela (Pérez, 1989), attributed to the Late Aragonian (intrabiozone G, probably equivalent to the biozone MN7).

2) El Buste, Late Aragonian in age (MN7-8; Azanza, 1986).

3) La Ciesma 2b, 3 and 4, first attributed to the Aragonian-Vallesian boundary (Azanza, 1986; Azanza et al., 1988) and later more precisely to the Vallesian (Cuenca et al., in press).

These localities are in the lower and middle part of the genetic unit N-3 sequences and permit one to date this unit as Late Aragonian-Vallesian in the above mentioned area. This dating has been applied to the Sierra Alcubierre too.

The new locality of San Caprasio allows us to detail somewhat more the age of the upper parts of the preserved record of the genetic unit N-3 in the area. In the Iberian Peninsula, the two species of the genus *Ramys* have mainly a Vallesian distribution. The type species, *R. multicrestatus*, has been recorded from the Early Vallesian of the Calatayud-Daroca Basin (*Cricetulodon* Zone, Pedregueras 2C; de Bruijn, 1966) and from the Late Vallesian of the Duero Basin (*Progonomys hispanicus* Zone Torremormojón-1, López Martínez et al., 1986). On the other hand, *R. perezi* has been found in the Early Vallesian of the Duero Basin (*Cricetulodon* Zone), although its range can be extended to the *Megacricetodon ibericus* Zone which partially includes the Late Aragonian. The assemblage of *Ramys* cf. *perezi* and *Megacricetodon* sp. in Alcubierre-212 strongly suggests that this locality belongs to the latest part of the Aragonian (MN-8) or to the Early Vallesian (MN9).

On the other hand the presence of *Ramys* in the Ebro Basin stresses the affinities of the Neogene faunas in the Ebro Basin with those recorded in the Central Iberian palaeobiogeographic province (Agustí, 1990), rather than with those of the Ibero-Levantine province (e.g. Vallès-Penedès Basin).

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