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GEOLOGY AND MICROMAMMALS OF THE SERRA-1 SITE (TABERNAS BASIN, BETIC CORDILLERA)

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RESUMEN

La Cuenca de Tabernas está situada en la zona interna de la Cordillera Bética, se da una cronología para los depósitos formados por abanicos aluviales y se plantea a través de datos paleontológicos y sedimentológicos un modelo paleoclimático para el Cuaternario en el sureste de España.

Palabras clave: *Micromamíferos, plesitoceno, abanicos aluviales, paleoclimatología.*

ABSTRACT

A chronology is given for the alluvial fan deposits in the Tabernas Basin (Internal Zone, Betic Cordillera). Palaeontological and sedimentological data are used to establish a palaeoclimatic model for the Quaternary in southeastern Spain.

Key words: *Micromammals, Pleistocene, alluvial fans, palaeoclimatology.*

Introduction

The Tabernas Basin is situated in the Internal Zone of the Betic Cordillera. It is an intramontane depression, bounded by the Sierra de Filabres to the north and the Sierra de Alhamilla to the south. It widens to the east and its margin opens into the Sorbas Basin, whereas to the west it narrows to form the Alpujarra Corridor. The geometry of the basin is comparable to that of an asymmetric trough lying East-West. The sedimentary filling of the basin consists of a succession of marine and continental sediments grouped in eight depositional sequences (Pascual Molina, 1991).

The Serra-1 site is located approximately 1 km east of Tabernas on the left bank of the Molinos rambla, near its confluence with the Galera rambla. This site is of great interest, as it provides the first dating for the continental filling of the Tabernas Basin.

The fauna collected at Serra-1 by washing of the sediment are: *Arvicola cf. sapidus* Miller, 1908; *Microtus brecciensis cf. cabrerae* Ruiz Bustos, 1988; *Pitymys* sp. and *Insectivora* sp.

The nomenclature used in this palaeontological study is that proposed by Ruiz Bustos (1988).

Stratigraphy of the site

During the Quaternary, a number of alluvial fans developed on the sierras bounding the Tabernas Basin, and eventually coalesced in the centre of the basin. These fans have been studied by Delgado Castilla (in press), who distinguished two Systems (I and II) separated by an erosive interval involving soil formation.

Alluvial fan System I (fig. 1) lies unconformably on both the filling materials of the basin and on the metamorphic materials of the substratum. The latter is characterised in the proximal zone by numerous, not very thick conglomerate layers with poor lateral extension, in which pebble imbrication and poorly marked horizontal stratification are sporadically observed. The layers have abundant matrix and the average diameter of pebbles is 30 cm, although they can measure up to 1 m. The best conserved part of the fans is the middle zone, which shows a predominance of the sandy fraction, with infrequent layers of conglomerates and lutites. In the distal zone the conglomerates are restricted to small lenses intercalated between sand and lutite beds. The characteristics of the materials described mainly correspond to chan-

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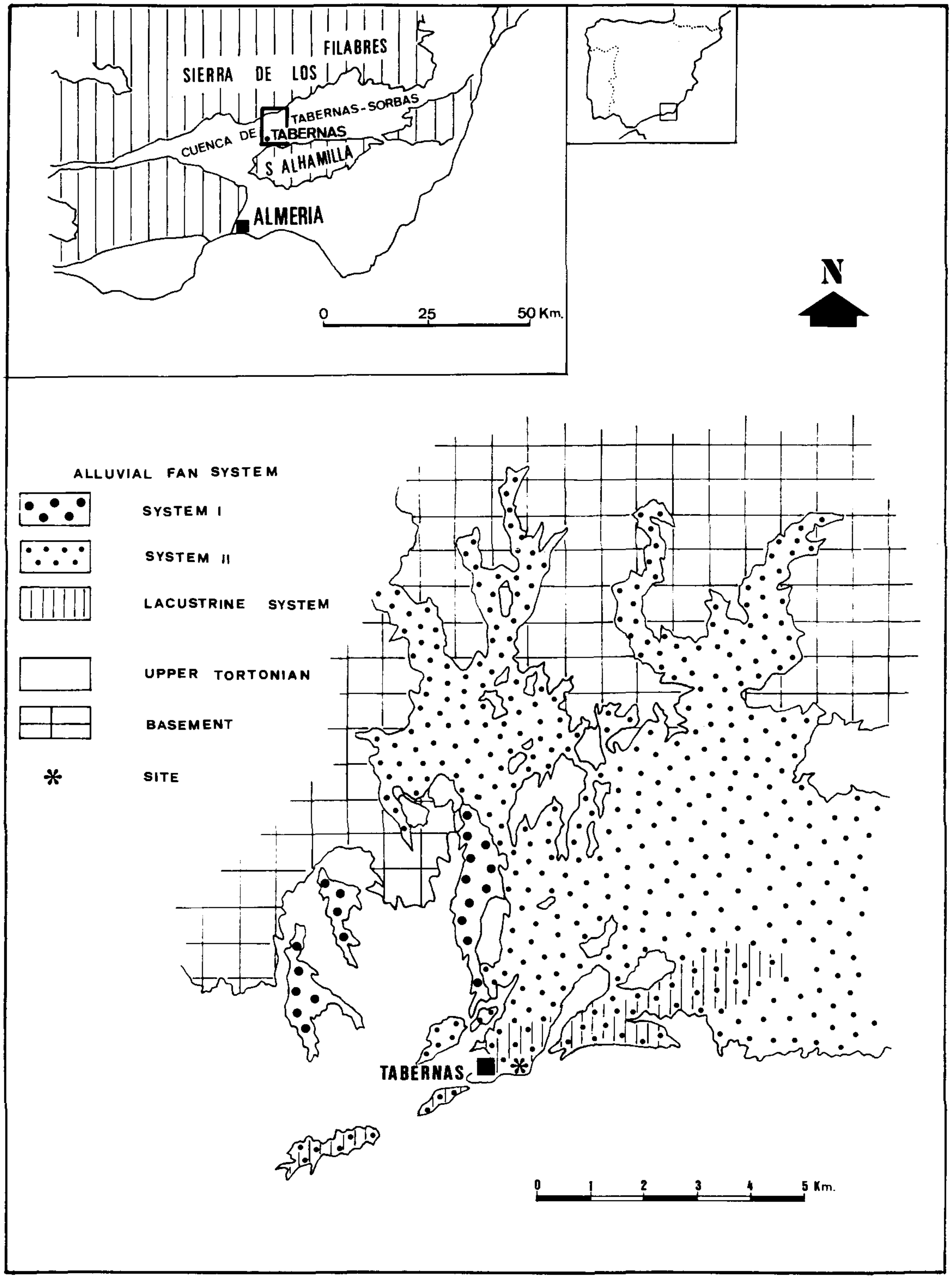

Fig. 1.—Geological and geographic location of the Serra-1 site.

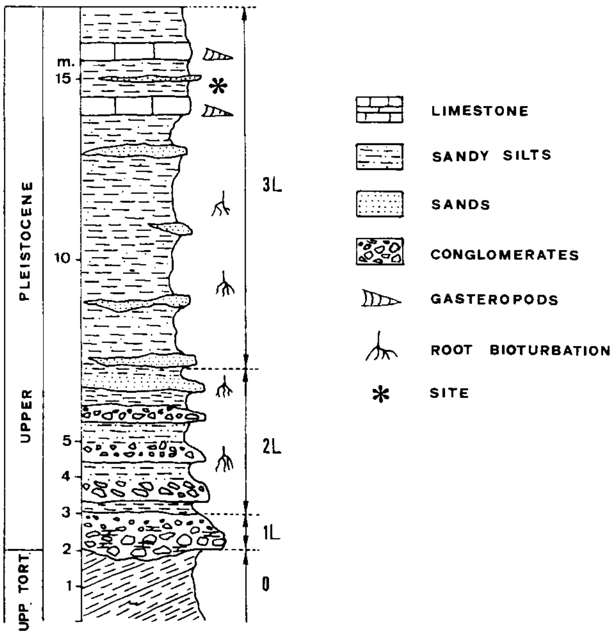

Fig. 2.—Local stratigraphic section of Serra-1.

nel deposits alternating with overbank-flood deposits, where braided-type activity is responsible for these facies.

System II (fig. 1) is better represented in the basin, both by reason of its greater thickness and because it is more recent and less eroded. In proximal areas this System contains sands with intercalated lenses of microconglomerates with an erosive base. Where the apex of these fans is conserved, a succession of conglomerates with small sandy intercalations is observed. Lutites predominate in the middle zone, occasionally containing large conglomerate lenses. Lacustrine facies developed in distal areas, giving rise to the formation of the Serra-1 site (fig. 1). These facies lie unconformably on the Upper Tortonian materials constituting the nucleus of the Serrata del Pueblo anticline, whose relief acted as a dyke, retaining the water and thus bringing about the formation of the lacustrine deposits.

The stratigraphic sequence of the section of the Serra-1 site beings with a layer of conglomerates (fig. 2, 1L) changing to sand near the top. Thickness is 1 m and the pebbles are metamorphic in origin (graphitic schists and quartz). The conglomerates have a channelled base and irregular, discontinuous carbonate caliches are observed, acting as cement. A 4m thick bed follows (fig. 2, 2L), made up of alternating conglomerates and layers of grey silts becoming thicker towards the top. The conglomerates have a slightly erosive base and the pebbles are 2 to 4 cm in diameter with a petrological composition similar to those of the previous layer. Throughout their thickness, they grey silts present abundant roots in life position and pyritised leaves. The last layer (fig. 2, 3L), is 10 m thick, made up of grey clayey silts with small, sporadic layers of sand. In the uppermost third of this layer there are two carbonatic layers 50 cm thick, between which the bed containing micromammals is found. The latter presents a high concentration of gastropods and small layers of peat.

In general, the sequence of the Serra-1 site shows a decrease from bottom to top of coarse detrital supply and turbulent water. The progressive loss of energy in the depositional environment concludes with an overflow stage, creating a reductive environment with abundant organic material. This overflowing environment was sporadically affected by the supply of carbonate-rich water, which, when forming pools, caused calcareous deposits containing numerous gastropod shells.

Systematic palaeontology

ORDER RODENTIA Bowdich, 1821.
FAMILY ARVICOLIDAE Gray, 1821.
GENUS ARVICOLA La Cépede, 1799.
Arvicola cf. sapidus Miller, 1908.

The material collected consists of: S-1, M/1 left (fig. 3A); S-2, M/2 left (fig. 3B) and S-3, M/3 right (fig. 3C). Dimensions in table I.

The morphology of the crown of M/1 is a basic triplet, common to all the Arvicolidae and made up of three closed triangles (T1, T2 and T3) and the anteroconid complex formed by a single space delimiting vertices 3e, 4e, 4i and 5i.

The values of the Enamel Units (EU) (defined in Ruiz Bustos, 1988) in specimen S-1 give the Enamel Units Graph (EUG) in fig. 4. This is characteristic of the *Arvicola* genus, as the values of EU I and VII are lower than those of the five other EU and, of these, the values of EU II and VI are lower than those of EU III, IV and V. By ordering these values from higher to lower we obtain the EU sequence: III, V, IV, VI, II, I, VII. The large size of the teeth studied and the thicker enamel on the proximal side of the triangles are progressive features and can be observed in the present species *Arvicola sapidus*.

GENUS MICROTUS, Schrank, 1798.
Microtus brecciensis cf. cabrerae Ruiz Bustos, 1988.

The material collected consists of: S-4, M/1 left (fig. 3D crown, 3E root) and S-5, M/1 right (fig. 3F). Dimensions in table 1.

Together with the basic triplet, the specimens present an anteroconid complex formed by two spaces: one delimited by vertices 4i and 3e and which is divided, forming two closed triangles (T4 and T5), and another delimited by vertices 4e, 5i and 6i.

The following progressive features are present:

Specimen S-4: highly individualised 4e vertex with subsquare contour and considerable asymmetry in the fold size between outer and inner sides of the tooth. This must be inferred from the root face of the tooth, as the specimen is young and therefore not very worn.

Specimen S-5: The high value of EU VII, as shown by EUG (Enamel Units Graph) fig. 4, is closer to the present *Microtus brecciensis cabrerae* than *Microtus brecciensis brecciensis* from the Cullar de Baza I site (Ruiz Bustos, 1988: graphs 12 and 13); undersquare morphology of vertex 4e and clear asymmetry, as shown by EU II, III and IV with similar values, higher than those of EU V and VI.

These features in specimens S-4 and S-5 indicate that this was an evolved animal, related to the present species *Microtus brecciensis cabrerae* Ruiz Bustos, 1988.

GENUS PITYMYS Mc. Murtrie, 1831.
Pitymys sp.

The material collected consists of: S-6, M/1 left (fig. 3G) and S-7, M/1 left (fig. 3H). Dimensions in table I.

M/1 has a symmetrical anteroconid complex. The space delimited by vertices 4i and 3e is single.

Specimen S-6 belongs to Morphological Unit 11, Group 11A, as defined in Ruiz Bustos (1988). Its EUG is represented in fig. 4, which shows the specific characteristic of *Pitymys* to be the low value of EU II in comparison to EU III, and the high value of EU VII, similar to that of EU I. In addition to the six folds of the anterocone complex in UM-11, specimen S-7 also presents vertex 7i, which implies the existence of an area of initial mitosis (m-7i), and therefore should be included in Morphological Unit 35. The existence of vertex 7i indicates that its morphology is close to the most evolved morphotypes of present species.

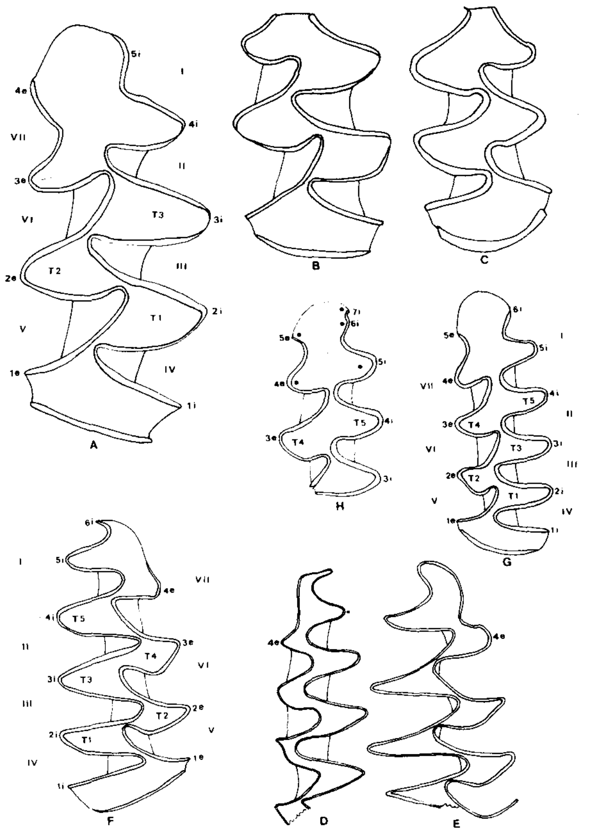

Fig. 3.—A) S-1, M/1 left; B) S-2, M/2 left; C) S-3, M/3 right; D) view of crown, and E) view of root of S-4, M/1 left; F) S-5, M/1 right; G) S-6, M/1 left and H) S-7, M/1 left.

The absence of M/3 in the material collected from the site prevents specific attribution.

Dating

The Günz, Mindel, Riss and Würm glaciations have chronological and climatic significance that makes them useful reference points on a European sca-

Table 1.—**Sizes of teeth collected at the Serra-1 site. 1. *Arvicola cf. sapidus:* S-1 (M/1); S-2 (M/2) and S-3 (M/3). *Microtus brecciensis cf. cabrerae:* S-5 (M/1). *Pitymys sp.:* S-6 (M/1). Length and width in mm, EU I to VII are percentages.**

Specimens	Leng	Wid	I	II	III	IV	V	VI	VII
S-1	3,95	1,57	9,523	15,353	18,473	15,681	16,912	15,435	8,620
S-2	2,43	1,38							
S-3	2,43	1,25							
S-5	2,86	1,19	17,624	14,514	14,420	13,760	12,252	12,629	13,289
S-6	2,67	0,87	18,015	12,271	14,621	14,099	11,879	11,749	17,362

le. However, correction factors must be introduced to distinguish the information on the basis of latitude, as glaciations periods were shorter in southern areas of Europe than in the Alps and interglacials were longer at lower latitudes. These factors were studied in Ruiz Bustos (1991a) and Ruiz Bustos & Martín Algarra (1991b), where the term Mediterranean was added to Alpine names. Thus the Günz-Mindel interglacial coincides with the Mediterranean Günz-Mindel, but the latter lasted slightly longer than the Günz-Mindel in the Alps. On the contrary, as glacial conditions were shorter in southern areas, the Mediterranean Riss refers to that time of the Riss when the effects of its climatic conditions were appreciable in southern areas.

The sedimentological and faunal data in south-eastern Iberia indicate the existence of three main stages of interglacial climatic conditions in the Quaternary. These stages are progressively shorter and are separated by brief erosive intervals (Ruiz Bustos, in press).

The oldest Quaternary stage in the Betic Cordilleras is characterised by small-sized species of the *Arvicola* genus such as *Arvicola deucalion* and *Arvicola ruffoi* and the *Euphaiomys* genus. It can therefore be equated with the Lower Pleistocene and its climatic characteristics represent the Mediterranean Günz-Mindel. After a brief erosive period, the next stage is characterised by the appearance in the region of *Allocricetus bursae* and its association with the mid-sized *Arvicola mosbachensis* species. This fauna dates this stage as Middle Pleistocene and the climatic characteristics are those of the Mediterranean Mindel-Riss. The interval separating the first and second stages is equivalent to the Mediterranean Mindel. The third stage is characterised by the presence of evolved species of the *Arvicola* genus, such as *Arvicola cantiana, Arvicola terrestris* and *Arvicola sapidus,* associated with evolved species of the *Pitymys* and *Microtus* genera. Equivalence can therefore be established with the Upper Pleistocene. This is the shortest of the stages and its climatic characteristics correspond to the Mediterranean Riss-Würm interglacial. The fauna of the Serra-1 site correspond to this stage.

The faunas from the Cueva del Agua and Las Yedras sites represent two reference points for the chronology of the Upper Pleistocene in the Betic Cordillera. Comparison of the Serra-1 and Cueva del Agua faunas reveals similarity, although the latter is less evolved, as individualisation of vertex 4e is in no case as clear in the *Microtus brecciencis* population and vertex 7i is not found in *Pitymys.*

The lower asymmetry of the *Microtus* from Serra-1 indicates that the fauna from this site is slightly more

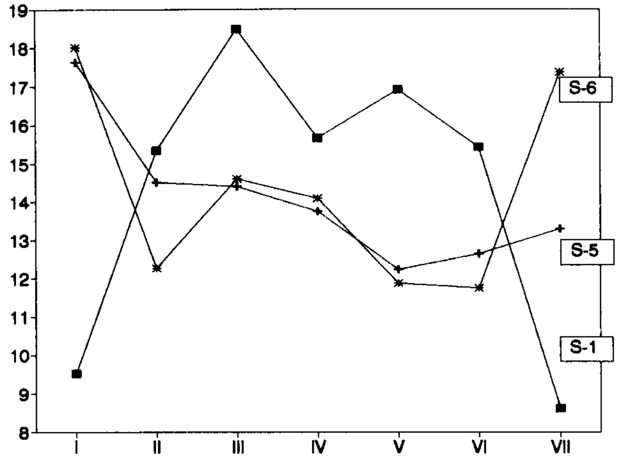

Fig. 4.—EU (Enamel Unit) graph. S-1, *Arvicola cf. sapidus* Miller, 1908; S-5, *Microtus brecciensis cf. cabrerae* Ruiz Bustos, 1988; S-6, *Pitymys* sp.

ancient than that from Las Yedras, which marks the beginning of the Mediterranean Würm. The morphology of vertex 4e observed in specimen S-5 from Serra-1 is not present in the Las Yedras population, having been totally substituted by more progressive morphologies showing a larger, more individualised 4e vertex. *Microtus* and *Pitymys* are smaller in Serra-1 than in Las Yedras.

According to the chronological scheme proposed by Ruiz Bustos and Martín Algarra (1991b), the Serra-1 site would have developed during the interglacial conditions of the Mediterranean Riss-Würm, with an absolute age of around 150000 ± 50000 years.

Conclusions

The geological study of the alluvial fans in the Tabernas Basin and the data provided by the fauna from the Serra-1 site indicate the existence of two stages with sufficient humidity conditions for development of Systems I and II. These are separated by a phase of morphogenetic stability with caliches and red soil formation. The more modern stage, in which the alluvial fans of System II were formed, corresponds to the Mediterranean Riss-Würm according to the fauna from the Serra-1 lacustrine site.

Observations on a regional scale in south-eastern Iberia reveal Middle Pleistocene lacustrine sites Cullar de Baza I and Solana, whose faunas respectively date the beginning and end of the interglacial conditions of the Mediterranean Mindel-Riss. The younger faunal set next observed is that of the Cueva del Agua, with species such as *Clethrionomys glareolus,* typical of deciduous forests, indicating Mediterranean Riss-Würm conditions. Between the Mediterranean Mindel-Riss (Cullar de Baza I and Solana) and Mediterranean Riss-Würm (Cueva del Agua) there is a phase of predominantly erosive phenomena. Here there are no fauna and any deposits are local, consisting of conglomerates such as those found at the top of the Solana site. The most probable age for this phase is Mediterranean Riss, as the bottom is later than the Solana site and the top is previous to the entrenchment of the present hydrographic network, which occurred in the Upper Pleistocene.

On the basis of the parallelism that can be established between the data from South-east Iberia and those obtained from the Tabernas Basin, and also the age of the Serra-1 site, a working hypothesis can be proposed. This consists of the identification of the most ancient stage in which water circulated on the surface, thus giving rise to System I, with occasional periods of Mediterranean Mindel-Riss, and the erosive stage separating Systems I and II, presenting Mediterranean Riss conditions in the region.

This hypothesis is open to modification, as new data are required to confirm these suggestions. It is, nonetheless, useful as a starting point in the search for a model to explain the Quaternary in South-east Iberia.

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