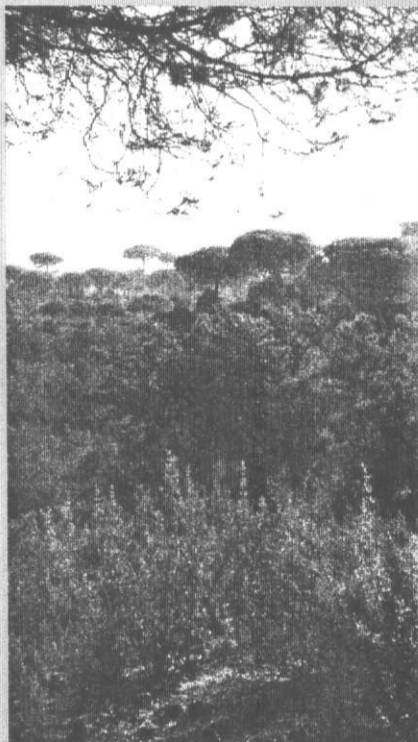




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SEVILLE (SPAIN)



Environmental Changes During the Holocene

Editors:

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Mid Holocene in Sant Julià de Boada (Baix Empordà, Girona): Stratigraphical Sequence and Paleoenvironmental Records of the Paludal Deposits

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Location and description of the sequence

The materials studied are found in the west slope of the Palafrugell corridor, a small Neogene fault trench located at the southern end of the plain of the Baix Empordà. They are located to the south of the village of Sant Julià de Boada, at between 23 m and 15 m above sea level. These are paludal deposits, related with a system of springs rich in calcium carbonate.

- Four sedimentary levels have been recognised, resting in discordance on top of the Paleogene sandstone. From top to bottom, they are as follows:

1) *A colluvial deposit constituted by clay and silts, grey and reddish, with abundant angular rocks scattered through it.* The depth varies between 1.5 m and 1 m. The contact with the deposit underneath is clearly discordant and locally erosive. The whole of this level contains fragments of Iberian pottery and shells of continental and marine molluscs, the later having being transported by human means for purposes of food.

2) *A carbonate crust.* The thickness varies between 2 cm and 10 cm. The contact with the upper level is discordant and erosive, while the lower level is net. There are frequent erosive furrows on the crust, which disappears entirely at the southern edge of the outcrop. In detail a structure of parallel layers can be observed which comes to form stratified mammillary structures. It contains large number of molluscs.

3) *Clay and blackish silt*. The thickness varies between 60 cm and 125 cm. Both the upper and lower contacts are net. The whole level has a high content of calcium carbonate. In the southern sector of the outcrop there are frequent discontinuous lentils of travertine pebbles, measuring a few centimetres, which present facies of incrustating stalks, often in a position typical of life. Molluscs are abundant throughout the level.

4) *Silts and fine carbonate sand of a yellowish colour, with 5% by volume of grains of quartz, feldspar, biotite and fragments of schist*. There are cylindrical concretions covering mouldings from algae stalks (Characeae), small calcareous nodules of secondary genesis and a large quantity of continental mollusc shells. The maximum thickness recorded is 110 cm. The spacing of levels 3 and 4 throughout the length of the outcrop seems to indicate an erosive discordance between them.

Paleoenvironmental interpretation

The characteristics of the sedimentation, together with a qualitative analysis of its malacological record (table 1), enables us to reconstruct the paleoenvironmental conditions of the four levels studied in broad terms.

Level 1. The malacofauna of the colluvial deposit on top of the sequence is represented by several species of terrestrial gastropods from open and dry areas. (*Cerneuella virgata*, *Cochlicella acuta*, *Eobania vermiculata*, *Pomatias elegans*, *Rumina decollata*, *Trochoidea elegans* and *Trochoidea trochoid.es*, as the most typical). The same fauna still live today at the immediate surroundings of the outcrop.

Level 2. The malacological content of the carbonate crust shows a terrestrial assemblage ranging from open and dry environments (*Cerneuella virgata*, *Pomatias elegans* and *Rumina decollata*) to humid areas (*Discus rotundatus*, *Monacha cartusiana* and *Oxyloma elegans*). It also includes an aquatic species (*Radix peregra*). From the sedimentological characteristics of the crust and its fauna content, it can be deduced that it was deposited in a submerged marshy environment surrounded by areas lacking arboreal cover.

Level 3. The layer of black carbonate pelites includes among the malacofauna terrestrial species from open and dry areas [*Cerneuella virgata*, *Eobania vermiculata*, *Pomatias elegans*, *Rumina decollata* and *Xerosecta cespitum*.] and from humid environments (*Monacha cartusiana*, *Vallonia pulchella* and *Vertigo* sp.), together with aquatic species (*Bithynia leachii*, *Galba truncatula* and *Radix peregra*). The compositional and fauna characteristics of the level indicate a swampy landscape, surrounded by areas with sparse woody cover, which received significant flows of waters rich in calcium carbonate.

Level 4. The malacofaunal assemblage contained in the silts and carbonate sand consists in land snails from humid areas (*Succinella oblonga* and *Vallonia pulchella*) and aquatic bivalves from still waters

(*Pisidium milium*). This carbonate level is derived from a submerged medium with an intense calcite precipitation and a small contribution of terrigen debris..

Isotopic and archeological dating

In a previous work (Mas *et al*, 1999), an age of 31,800 years BP was suggested for the black pelite level. However, two new radiocarbon dating place the formation of this level during the Holocene, *circa* 7,000 BP. This date is in good agreement with the second phase of travertine building in the southern regions of France and Spain, dated between 9,000 and 7,000 BP (Díaz del Olmo *et al*, 1997.).

The colluvial deposits which lie above the marshy materials are much younger, as can be understood from the Iberian archeological remains (IVth to Ist centuries BC) which are included as sedimentary grains, indicating a drastic reduction of the activity of springs in the area.

Conclusions

The paludal deposits of Sant Julià de Boada were generated in relation to the activity of springs rich in calcium carbonate, which took place in coincidence with the last stages of filling-in the Baix Empordà depression.

The sedimentary sequence consists of three marshy levels covered by a colluvium. The lowest level, composed of silts and fine carbonate sand, was formed in a submerged medium with an intense precipitation of calcite and a low proportion of terrigenous material. Over it lies, in discordance, a set of black carbonate clay and silts, which was deposited around 7,000 BC, in a still-water medium with an important contribution of fine detrital sediment. In the upper part of the pelite level lentils of travertine pebbles appear, the precipitation of which was induced by the high mineralisation of the springs. The bottom level is a crust of calcium carbonate accumulated in submerged conditions.

The malacological assemblage found enables the basic paleoenvironmental conditions of the deposits to be established. Thus, the species belonging to areas of still waters and humid places appear only in the marshy sediments. The presence of terrestrial fauna from open and dry spaces in this material reflects the environment of the surrounding area, away from the activity of the springs.

The malacofauna of the colluvial deposit which cover the marshy levels is typical of dry/open areas and identical to the modern fauna

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Mas, J.; Bach, J.; Linares, R.; Montaner, J.; Trilla, J. and Pallí, L. (1999). Aportación a la cronología del Cuaternario de la depresión del Baix Empordà (Girona). In L. Pallí and C. Roqué (ed.): *Avances en el estudio del Cuaternario español* 107-112. Girona.

Table 1. *Distribution of the malacofauna characteristic of aquatic, humid and dry environments in the stratigraphic levels of Sont Julià de Boada.*

Environments	Taxons	Levels			
		1	2	3	4
Still water or with very little current	Bithynia			•	
	Lymnaeidae		•	•	
	Pisidium				•
Damp areas, near the water	Discus		•		
	Monacha		•	•	
	Succinellidae		•		•
	Vallonia			•	•
	Vertigo			•	
Dry and open areas (unwooded).	Cerņuella	•	•	•	
	Cochlicella	•			
	Eobania	•		•	
	Pomatias	•	•	•	
	Rumina	•	•	•	
	Trochoidea	•			

MID HOLOCENE IN SANT JULIÀ DE BOADA (BAIX EMPORDÀ, GIRONA): STRATIGRAPHICAL SEQUENCE AND PALEOENVIRONMENTAL RECORDS OF THE PALUDAL DEPOSITS

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LOCATION AND DESCRIPTION OF THE SEQUENCE

The materials studied are found in the west slope of the Palafrugell corridor, a small Neogene fault trench located at the southern end of the plain of the Baix Empordà. They are located to the south of the village of Sant Julià de Boada, at between 23 m and 15 m above sea level. These are paludal deposits, related with a system of springs rich in calcium carbonate. Four sedimentary levels have been recognised, resting in discordance on top of the Paleogene sandstone. From top to bottom, they are as follows:

1) A colluvial deposit constituted by clay and silts, grey and reddish, with abundant angular rocks scattered through it. The depth varies between 1.5 m and 1 m. The contact with the underneath is clearly discordant and locally erosive. The whole of this level contains fragments of Iberian pottery and shells of continental and marine molluscs, the latter having being transported by human means for purposes of food.

2) A carbonate crust. The thickness varies between 2 cm and 10 cm. The contact with the upper level is discordant and erosive, while the lower level is not. There are frequent erosive fingers or crevices which disappear abruptly at the southern edge of the outcrop. In detail a structure of parallel layers can be observed which come to form small millimetric structures. It contains large number of molluscs.

3) Clay and blackish silt. The thickness varies between 60 cm and 125 cm. Both the upper and lower contacts are not. The whole level has a high content of calcium carbonate. In the southern sector of the outcrop there are frequent discontinuous lenses of travertine pebbles, measuring a few centimetres, which present facets of incrustating stalks, often in a position typical of life. Molluscs are abundant throughout the level.

4) Silts and fine carbonate sand of a yellowish colour, with 5% by volume of grains of quartz, feldspar, biotite and fragments of schist. There are cylindrical concretions covering mouldings from algae stalks (Characeae), small calcareous nodules of secondary genesis and a large quantity of continental mollusc shells. The maximum thickness recorded is 110 cm. The spacing of levels 3 and 4 throughout the length of the outcrop seems to indicate an erosive discordance between them.

PALEOENVIRONMENTAL INTERPRETATION

The characteristics of the sedimentation, together with a qualitative analysis of its malacological record enables us to reconstruct the paleoenvironmental conditions of the four levels studied in broad terms.

Level 1. The malacofauna of the colluvial deposit on top of the sequence is represented by several species of terrestrial gastropods from open and dry areas, (*Cermeilla virgata*, *Cochlicella acuta*, *Eobania vermiculata*, *Pomatia elegans*, *Ranina decollata*, *Trichoides elegans* and *Trichoides peregrius*, as the most typical). The same fauna still live today at the immediate surroundings of the outcrop.

Level 2. The malacological content of the carbonate crust shows a terrestrial assemblage ranging from open and dry environments (*Cermeilla virgata*, *Pomatia elegans* and *Ranina decollata*) to humid areas (*Discus rotundatus*, *Monacha cartusiana* and *Oxyloma elegans*). It also includes an aquatic species (*Radix peregra*). From the sedimentological characteristics of the crust and its fauna content, it can be deduced that it was deposited in a submerged marshy environment surrounded by areas lacking arboreal cover.

Level 3. The layer of black carbonate pelites includes among the malacofauna terrestrial species from open and dry areas (*Cermeilla virgata*, *Eobania vermiculata*, *Pomatia elegans*, *Ranina decollata* and *Xerosecta cespium*) and from humid environments (*Monacha cartusiana*, *Valtonia pulchella* and *Vertigo* sp.), together with aquatic species (*Bithynia leachi*, *Galba truncatula* and *Radix peregra*). The compositional and fauna characteristics of the level indicate a swampy landscape, surrounded by areas with sparse woody cover, which received significant flows of waters rich in calcium carbonate.

Level 4. The malacofaunal assemblage contained in the silts and carbonate sand consists in land snails from humid areas (*Succinea oblonga* and *Valtonia pulchella*) and aquatic bivalves from still waters (*Pisidium milium*). This carbonate level is derived from a submerged medium with an intense calcite precipitation and a small contribution of terrigen debris.

