Protohistoric VI-V Century b. C., Isoetes, in La Mata de Campanario, Badajoz, Extremadura, Spain.

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Abstract

During the archaeological excavations at the 6th-5th century B.C. manorial mansion in La Mata, Campanario, Badajoz province (Spain), the presence of *Isoetes* was revealed in the original mud used for making the adobe bricks for the building. Specifically, the adobe bricks were found to contain megaspores of *Isoetes histrix* and *Isoetes velatum*. These two species of quillworts are not to be found nowadays in the area from which the original material was taken. Therefore it can be concluded that, if cultural activities must have been of considerable importance in the disappearance of certain humid zones from which the original mud was extracted, it cannot be ruled out that more humid environmental conditions prevailed in that period as has been made evident in former studies on paleoenvironments.

Resumen

Durante la prospección arqueológica llevada a cabo en el edificio señorial del siglo VI-V a. C. en La Mata, Campanario, provincia de Badajoz, España, se puso en evidencia la presencia de *Isoetes* en los barros originales que fueron utilizados para la fabricación de los adobes del edificio. Específicamente se encontraron en los adobes megasporas de *Isoetes histrix* e *Isoetes velatum*. Actualmente no existen, en el sector de donde procede la materia prima original, helechos juncales por lo que podemos concluir que si bien las prácticas culturales han podido tener una gran importancia en la desaparición de ciertas zonas húmedas de donde fueron extraídos originalmente los barros, no hay que excluir unas condiciones ambientales de mayor humedad en aquel período como se ha puesto por otra parte también en evidencia en los estudios precedentes de paleoambiente.

Kewwords: archeological excavations, 6^{th}-5^{th} century B.C., Lycophyta, *Isoetes*, megaspores, Spain.

Introduction

During the 6th and 5th centuries B.C. in the SW of the Iberian Peninsula– and particularly in the territory of the present day Extremadura province (Fig.1) –appeared a new model of occupation of the territory (Rodríguez Díaz, 2004; Rodríguez Díaz and Ortiz Romero 2004; Rodriguez Diaz et al. 2004) with a distribution of land property that involves the presence of wealthy landowners. As one more expression of their social status in the rural environment, these gentlemen built fortified manorial mansions from which they were going to administer their property (Fig 2).

These settlements are characterized by an architectural style marked with eastern Mediterranean influences (Rodríguez Díaz, 2004; Rodríguez Díaz and Ortiz Romero

2004) in that they make use of surrounding rock materials as building and ornamental materials (Ponce de León Iglesias, 2004; Rodríguez Díaz and Ortiz Romero 2004), at reduced transport costs; thus, the foundations and base of the walls, the exterior as well as some interior walls, are made of rock blocks from the geological formations of the hercynian substratum underlying the more or less immediate surroundings: granites, hornfels, quartzs, graywackes, quartzites and slates; these blocks are surmounted by an elevation in adobes or compacted earth. The adobe blocks, of standardised sizes, will be the most typical building material of this architecture and no less than 500 cubic meters of slime and sands were employed for the construction of the La Mata de Campanario manorial mansion (Ponce de León Iglesias et al. 2004)

The geological survey of the area and the granulometric and mineralogical analyses have allowed us to identify the places which provided the mud used as material for the adobe blocks and the mortar for the joints. From three adobe blocks and three joints, randomly sampled in the building, the different granulometrical fractions were isolated. The 250 μm and 315 μm bracket revealed, in all six samples, an important quantity of megaspores of *Isoetes* which were whole and very well preserved; very exceptionally some fragment was found, which shows the absence of displacement after sedimentation in the slime and sand, in which they are included, on the floor of shallow depressions. These palynomorphs are the object of this study.

In the floor of the depressions where the mud is likely to have been extracted, we have carried out a sampling of the present-day soils in two representative points, which have not revealed the existence of *Isoetes*; neither have we observed the presence of quillworts in any of the broad, shallow vales of the immediate surroundings of La Mata and in particular in the floor of the vales that have been the extraction site for the raw material.

Isoetes L. (Lycophyta) is a Pteridophyta heterosporate with cosmopolitan distribution. It grows in the temperate regions of all the continents, from the level of the sea up to an altitude of up to 4200 m, more frequently about 2000 m (Tryon & Tryon, 1982). Some species are terrestrial whereas others are found in aquatic, amphibious or marshy biotopes and live totally or partially immersed. They feature an erect 2- (or 3)-lobed rhizome; the roots are found at in the lower part of the rhizome and are dichotomously branched.

The microphylls are linear, graminiform, erect, curved, uninervial, with four aeriferous longitudinal channels with transversal septa and spirally filotaxis. The sporangia– one per microphyll – are septate, they are immersed at the base and adaxial to the sporophylls. The microsporangium and megasporangium produce microspores and megaspores respectively. The megaspores are trilete and the microspores are monolete.

Seven species grow in Spain: *I. durieui* Bory, *I. echinospora* Durieu, *I. histrix* Bory, *I. lacustris* L., *I. longissima* Bory, *I. setacea* Lam. y *I. velata* A.Braun (Prada, 1983) The spores of these species were studied in the works of Prada and Saenz de Rivas (1978) and Prada (1983, 1986) where the authors analyze the microspores and megaspores by Scanning Electron Microscope (SEM) and Light Microscopy (LM).

References to the presence or development of tetralete megaspores are scarce. Their development is probably related to the position of the spore in the tetrad during development. Gupta (1998) described tetralete megaspores in Bryophyta such as *Riccia* y *Marchantia*. They were also described in certain species of Pteridophyta such as *Pteris cretica* (Sladkov 1957, 1971). While Gamerro (1977) described a tetralete megaspore of the Upper Cretaceous of Chubut, Argentina, which, on account of its morphologic characteristics, was assigned to the Isoetales.

More recently, Hickey et al. (2003) described tetralete megaspores in the *I. savatieri* Franchet, species that grows in Tierra del Fuego, Argentina.

Material and Methods

For the identification of the spores, Prada (1983, 1986) was consulted. For the SEM analyses, the spores were not treated chemically. The samples were placed on double-side adhesive tape on bronze stubs, coated with gold-palladium and then examined under a SEM JSM6301F microscope at the "Centre de microscopie électronique à balayage et microanalyse (Cmeba)", Université de Rennes 1.

The terms used to describe the ornamentation of the megaspores are referred to Tryon and Lugardon (1991). To describe the form of the tetralete spores Kremp's terminology (Kremp, 1965) was used.

Results

Descriptions

Isoetes histrix Bory (fig. 4)

The megaspores are trilete, and 410 (458) 500 μm in equatorial diameter. Their shape is spheroidal in polar view. The proximal and distal faces are hemispherical in equatorial view. The 220 (245) 286 μm-long laesurae join in the equatorial "zone". This area– also named collar, edge or cingulum– is 22.5 μm wide and it is perpendicular to the laesurae.

The ornamentation on both sides is pustulate (Tryon and Lugardon, 1991) (fig. 4, A, B, C) and consists of projections that are radially symmetrical with the rounded apex. The "zone" features the same type of ornamentation as the rest of the spore. The laesurae have no ornamentation.

Some spores featured lightly pronounced sculptural elements that fuse and form short ridges arranged in various directions (fig. 4, A, B).

Isoetes velatum A.Br. sub sp. *velata* (fig. 5, D, E, F, G).

The megaspores are trilete, 400 (438) 540 μm in equatorial diameter. Their shape is subtriangular in polar view. The proximal face is convex and the distal one is hemispheric in equatorial view. The laesurae are 240 μm long. Each laesura is fused to the equatorial zone, which is 30 μm wide.

The ornamentation consists of verrucae distributed over the whole surface of the spore. Some of the verrucae are fused and form short elements, irregular in outline and similar to ridges. The equatorial zone and the laesurae feature the same ornamentation as the rest of the spore.

Tretalete megaspores, 353x368 μm in equatorial diameter, were observed. Their shape is tetragonal in polar view. The proximal face is convex and the distal one is hemispheric in equatorial view. The laesurae are 197 μm long and 36-to-39 μm wide. Each laesura is fused to the equatorial zone which is 32 μm wide.

The ornamentation is verrucate in both faces. Some of the verrucae are fused in major sculpturals units in the shape of ridges. The equatorial area and the laesurae feature the same ornamentation as the rest of the spore.

Conclusions

The presence of *Isoetes* in the adobe blocks and their absence in the present-day valley floor deposits we have studied may essentially result from a modification of agricultural practices in the sector that interests us– particularly in the valley floors whose drainage may consequently have been altered; nevertheless, in spite of the presence of (most notably) *Isoetes velatum* A. Braum, which requires more humid conditions still than *Isoetes hystrix* Bory, and whose distribution is less frequent in Extremadura, it could also result from a decrease in environmental moisture conditions, as was also made clear incidentally through the analysis of pollen, seeds and carbons, sampled in the building of La Mata (Grau Almero et al., 2004). Or, naturally, from a conjunction of both phenomena.

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Captions

Fig. 1.-Situation map of La Mata de Campanario, Badajoz province, Extremadura, Spain

Fig. 2 - Reconstruction of the manorial mansion of La Mata de Campanario. The front side of the manorial mansion is twenty meters long. From *Rodríguez Díaz, A. & P. Ortiz Romero, 2004 a*, p. 303 fig. D.

Fig. 3 - View of one of the collapsed interior walls; can be observed the different colour of the material used in the adobes and in the mortar for the joints. At the back can be distinguished the interior wall face with a plaster of kaolinite (white colour). From *Ponce de León Iglesias, 2004*, p. 321, fig. H.

Fig. 4 - Megaspores of *Isoetes histrix* as seen with SEM. A. Proximal view. The sculpture of the silica cover is pustulate. The laesurae are high. B. Equatorial view. The whole surface is pustulate. The zone marks the equator. C. Spores in equatorial (top, left corner) and proximal (top, right corner) views. The zone has the same sculpture as the rest of the spore. Scale bar: 100 μm.

Fig. 5 - Megaspores of *Isoetes velatum* as seen with SEM. D. Proximal view. The verrucae are distributed over the whole surface, and they are also present on the

laesurae. E. Equatorial view. The zone marks the equator and has the same sculpture as the rest of the spore. F. Megaspores in equatorial view. G. Distal view (left) and proximal view (right). Scale bar: 100 μm.

Fig. 6- Tetralete megaspores of *I. velatum*. H. Proximal view. The sculpture in each facet is composed by verrucae. I. Equatorial view. The distal pole is at the top. The equatorial one has the same sculpture as the rest of the spore. J. Proximal view. The verrucae are distributed over the whole surface. The laesurae are high. K.