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Foraminifera from the Lower-Middle Jurassic of the Lusitanian Basin (Portugal) – biostratigraphic and palaeocological significance

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ABSTRACT

The detailed study of benthic foraminifera of four reference sections from the Lower-Middle Jurassic of the Lusitanian Basin has allowed the recognition of the biozonal scale based on foraminifera, established in the North Hemisphere (Dorbignyi Biozone). The analysis of abundances of the recorded taxa points out palaeoecological preferences, at the species level, among apparently homogeneous assemblages corresponding to different depositional environments in the basin. Determination of richness and dominance indexes supports the recognition of two palaeoecological different intervals along the Lower-Middle Jurassic transition, ranging from unstable to more stable conditions for the development of benthic foraminiferal communities. This kind of detailed studies, based on this microfossil group, seems to be a good proxy for age determination, North Atlantic correlations and palaeoenvironmental interpretations.

KEYWORDS: Foraminifers, Lower-Middle Jurassic boundary, Lusitanian Basin, Portugal.

1. Introduction

In this work a detailed study of benthic foraminifera of four reference sections from the Lower-Middle Jurassic transition of the Lusitanian Basin (Central Portugal) is presented. Data refer to Murtinheira (Canales *et al*., 2000; Canales & Henriques, 2008; Henriques *et al*., 2008), S. Gião (Magno, 2010) and Maria Pares (Guterres, 2010) sections, which are located in the Northern Lusitanian Basin; and to Zambujal de Alcaria (Figueiredo, 2009; Figueiredo *et al.*, 2010) section, located in the Central Lusitanian Basin (FIG.1).

The four sections represent different facies of the *sag* interval which follows the Late Triassic rifting episode of the basin (Henriques *et al.*, 2008), corresponding to distal external marine ramp (Murtinheira; Cape Mondego), transitional zones of the platform (S.Gião and Maria Pares), and proximal internal marine ramp (Zambujal de Alcaria; Maciço Calcário Estremenho), clearly differentiated in Bajocian-Calovian times through the litholofacies record (Azerêdo *et al.*, 2003), now reinforced through the foraminiferal record.

2. Composition of the foraminiferal assemblages

A total of 73 samples have been collected from the Upper Toarcian (Mactra and Aalensis Subzones; Aalensis Biozone), Lower Aalenian (Opalinum and Comptum

Subzones; Opalinum Biozones) and Middle Aalenian (Bradfordensis Subzone; Bradfordensis Biozone) marly limestones, based on a previous biostratigraphic framework, well calibrated through the rich and diversified ammonite record (Henriques, 1992, 1995, 2000). More than 31,700 specimens of benthic foraminifera have been obtained (5,291 from Zambujal de Alcaria; 15,273 from Maria Pares; 8,764 from S. Gião; 2,375 from Murtinheira), which have allowed the study of the assemblages´ composition and the analysis of its evolution throughout this time interval.

The studied assemblages are abundant and diverse. Specimens are well preserved and no significant taphonomic processes seem to have affected the recorded assemblages, which are composed by typical taxa of the Boreal Realm. Most of the assemblages are dominated by Lagenina Suborder, Vaginulinidae Family and *Lenticulina* Genus. However, differences in the spatial distribution of the species have been recognized, reflecting paleoenvironmental preferences.

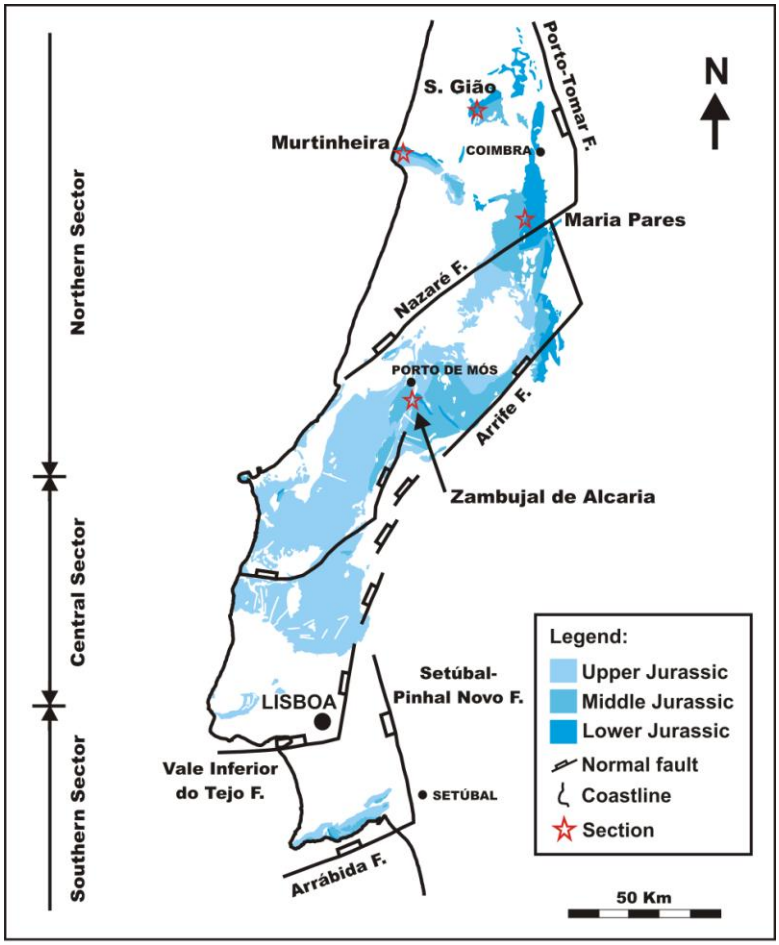

FIG.1 – Location of the Murtinheira, S. Gião and Maria Pares sections (North Lusitanian Basin) and Zambujal de Alcaria (Central Lusitanian Basin).

3. Biostratigraphical and palaeoecological implications

The recognition of *Astacolus dorbignyi* (Roemer) as index species for the studied stratigraphic interval, in the four studied sections, allows accurate correlations with other North European basins.

Taxonomical composition of the recorded assemblages is apparently homogenous due to the presence of the almost the same species in the four studied sections. However, the analysis of the abundances of the taxa, in each section, points out that the distribution of some species is spatially differentiated, allowing the recognition of three types of assemblages (FIG.2):

- Assemblages developed in distal facies of shelfal basin environment, where *Ammobaculites fontinensis* (Terquem), *Spirillina numismalis* Terquem & Berthelin, *Spirillina orbicula* Terquem & Berthelin, *Prodentalina pseudocommunis* (Franke), *Planularia protracta* (Bornemann) and *Eoguttulina liassica* (Strickland) show the highest values of abundances of the four sections (Murtinheira);
- Assemblages developed in transitional facies from internal to distal facies of shelfal basin environment (S. Gião, Maria Pares), being the most abundant and diverse of the four sections. Here, the Miliolina Suborder representatives and the species *Falsopalmula jurensis* (Franke), *Nodosaria liassica* Barnard, *Nodosaria pseudoregularis* Canales, *Pseudonodosaria vulgata* (Bornemann), *Lenticulina helios* (Terquem), *Citharina colliezi* (Terquem) and *Planularia cordiformis* (Terquem) show the highest abundance values.
- Assemblages developed in internal facies of shelfal environment, where *Ammobaculites coprolithiformis* (Schwager), *Ammobaculites vetustus* (Terquem & Berthelin), *Nodosaria pulchra* (Franke) and *Lenticulina toarcense* (Payard) show the higher abundance values of the four sections (Zambujal de Alcaria).

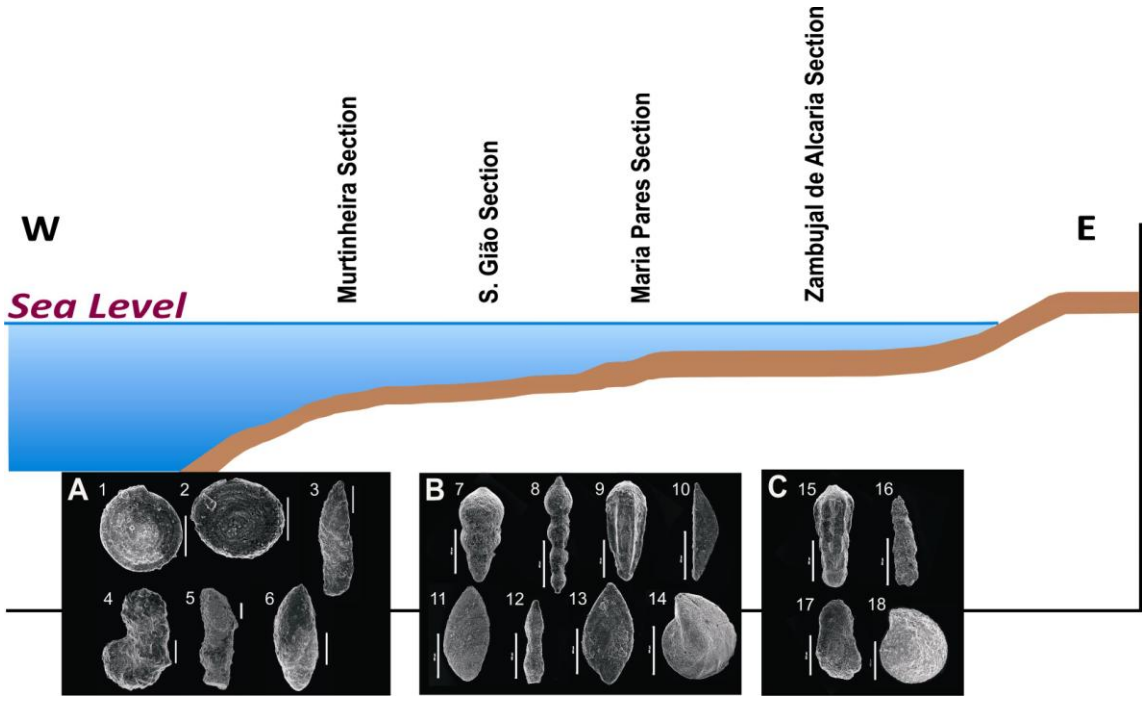

FIG.2 – Spatial distribution of some foraminiferal species in the Lusitanian Basin for the Lower-Middle Jurassic transition. A) Selected species showing a significant high abundance in distal facies of shelfal basin environment (Murtinheira section): 1. *Spirillina numismalis*

Terquem & Berthelin; 2. *Spirillina orbicula* Terquem & Berthelin; 3. *Planularia protracta* (Bornemann); 4. *Ammobaculites fontinensis* (Terquem); 5. *Prodentalina pseudocommunis* (Franke); 6. *Eoguttulina liassica* (Strickland). B) Selected species showing a significant high abundance in transitional facies from internal to distal facies of shelfal basin environment (São Gião and Maria Pares sections): 7. *Pseudonodosaria vulgata* (Bornemann); 8. *Nodosaria pseudoregularis* Canales; 9. *Nodosaria liassica* Barnard; 10. *Citharina colliezi* (Terquem); 11. *Planularia cordiformis* (Terquem); 12. Specimen of the Miliolina Suborder; 13. *Falsopalmula jurensis* (Franke); 14. *Lenticulina helios* (Terquem). C) Selected species showing a significant high abundance in internal facies of shelfal environment (Zambujal de Alcaria section): 15. *Nodosaria pulchra* (Franke); 16. *Ammobaculites vetustus* (Terquem & Berthelin); 17. *Ammobaculites coprolithiformis* (Schwager); 18. *Lenticulina toarcense* Payard..

Richness indexes (Fischer´s α and Margalef) and diversity indexes (Simpson, Berger-Parker, Shannon-Wiener and Equitability) have been calculated for each studied sample. Analysis of the resulting data, as well as comparison of data of the four sections, allows distinguishing two intervals along the Lower-Middle Jurassic transition. First interval ranges from the Mactra Subzone (Aalensis Biozone, Upper Toarcian) to the lower part of the Comptum Subzone (Opalinum Biozone, Lower Aalenian). There, the indexes show regular values, indicating unstable environmental conditions. Second interval ranges from the lower part of the Comptum Subzone (Opalinum Biozone, Lower Aalenian) to the lower part of the Bradfordensis Subzone (Bradfordensis Biozone, Middle Aalenian). Along this interval, indexes values are higher than in the previous interval, and homogeneous, reflecting more stable and favourable environmental conditions for the development of foraminiferal assemblages.

The biostratigraphic and palaeoecological data resulting from this approach can represent a proxy to determinate both age and depositional environments assigned to core samples analysis from the Lower-Middle Jurassic boundary of the Lusitanian Basin.

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