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Original article

Quantative analysis and paleoecology of Middle to Upper Eocene Ostracods from Jebel Jebil, central Tunisia

Analyse quantitative et paléoécologie des Ostracodes de l'Éocène moyen et supérieur de Jebel Jébil, Tunisie centrale

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Abstract

One hundred and seventy collected samples from Jebil section have been carefully studied for their ostracod content and referred to 41 species belonging to 20 genera. Their vertical distribution allowed to distinguish five successive associations of ostracod assemblages; two of which are correlated with the Early Lutetian, one with the Late Lutetian, another association with the Bartonian and the last one with the Priabonian. Community structure of the collected ostracod fauna has been studied; three indices have been calculated for each sample: Shannon (diversity), Margalef (richness) and Equitability indexes. In the lower and the middle part of the Formation, they indicate a stable environment supporting high diversity ostracod communities; whereas in the upper portion the environmental conditions were unstable characterized by low diversity. The results of a multivariate statistical method, using the cluster analysis and the Detrended Correspondence Analysis of the 41 ostracod species and the 170 samples, have led to conclude that the most effective environmental factor in the study area is the paleodepth and of less importance oxygenation and salinity. Thus, it allowed to distinguish four palaeoenvironmental intervals within the Cherahil Formation: the first one represented by taxa that are known from the shallower parts of the shelf; the second interval includes the majority of the encountered species of inner neritic shelf with normal salinity; the third one, corresponding to an outer neritic domain; and the last interval refers to a circalittoral environment, is comprised mainly of *Cytherella angulata* and of *Soudanella laciniosa triangulata*.

Keywords: Ostracods; Middle to Late Eocene; Central Tunisia; Community structure; Multivariate statistical analysis; Palaeoenvironmental intervals

Résumé

Cent soixante-dix échantillons prélevés de la section Jebil ont été soigneusement étudiés pour leur contenu en ostracodes ; la faune est composée de 41 espèces appartenant à 20 genres. La distribution verticale de ces espèces a permis de distinguer cinq associations successives d'ostracodes, dont deux sont corrélées avec le Lutétien inférieur, une avec le Lutétien supérieur, une autre avec le Bartonien et la dernière avec le Priabonien. La structure communautaire de la faune à ostracodes recueillie a été étudiée, trois indices ont été calculés pour chaque échantillon : indice de Shannon Waever (diversité), de Margalef (richesse) et d'Équitabilité. Dans la partie inférieure de la Formation, ils indiquent un environnement stable soutenant des communautés d'ostracodes à valeurs élevées de diversité ; tandis que dans la partie supérieure, les conditions environnementales ont été instables caractérisées par une faible diversité. Les résultats de l'analyse de cluster et de l'analyse détendancée de correspondances des 41 espèces d'ostracodes et des 170 échantillons ont permis de conclure que, dans la zone d'étude, le facteur environnemental déterminant est la paléo-profondeur et de moindre importance l'oxygénation et la salinité. Ainsi, cette étude a permis de distinguer quatre intervalles paléoenvironnementaux le long de la Formation Chérahil : le premier est souligné par des taxons connus dans les parties très peu profondes de la plateforme interne ; le

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second comprend la majorité des espèces rencontrées aux environnements à salinité normale de la plateforme interne ; le troisième correspond au domaine de plateforme externe et le dernier intervalle traduit un environnement circalittoral, composé principalement de *Cytherella angulata* et de *Soudanella laciniosa triangulata*.

Mots clés : Ostracodes ; Éocène moyen à supérieur ; Tunisie centrale ; Structure communautaire ; Analyse statistique multivariée ; Intervalles paléoenvironnementaux

1. Introduction

Several micropalaeontological (Oertli, 1976; Bismuth et al., 1978; Said-Benzarti, 1978; Bismuth, 1981; Mechmeche, 1981; Ben Ismail-Lattrache and Bobier, 1996; Ben Ismail-Lattrache, 2000; Trabelsi et al., 2015) and petroleum studies (Said-Benzarti and Kharbachi, 1995) have been realized on ostracods from Tunisia.

However, rare are the studies that attempted a paleoecological analysis of Eocene ostracod assemblages from Tunisia. As to other countries from North and West Africa, there exist several studies related to the paleoecology and paleogeography of Eocene ostracods (Elewa et al., 1999; Elewa, 2002; Elewa, 2004; Elewa, 2005; Shahin, 2005; Elewa, 2007; Shahin, 2008; Amami-Hamdi and Ben Ismail-Lattrache, 2013; Amami-Hamdi et al., 2014). In Libya, El Waer (1992) used the ostracod morphology and carapace nature of Eocene ostracods for paleoenvironmental reconstructions. In West Africa, Sarr (1995 and 1999) studied the migration of ostracods during the Middle Eocene and their relation with the paleoenvironmental evolution of the western senegalian deposits; the same author (2012) illustrated a link between changes in ostracod faunas and the paleogeographic evolution of the Senegalese basin. Elewa et al. (2001) focused his study on the reconstruction and interpretation of the paleoenvironmental conditions that prevailed during the deposition of the Middle Eocene succession of Northern Somalia by means of ostracod assemblages. In Egypt, Elewa (2004) realized a paleoecological study of the Eocene series in the region of Cairo, based on the quantitative analysis of ostracod assemblages.

Mixed methods integrating quantitative and qualitative data collection and analysis were explored in recent studies (Gliozzi and Grossi, 2004; Mazzini, 2004, 2005; Elewa, 2004, 2005; Guasti, 2005; Van Itterbeeck, 2007, Gliozzi and Grossi, 2008; Grossi and Gennari, 2008; Sarr, 2012; Amami-Hamdi and Ben Ismail-Lattrache, 2013 and Amami-Hamdi et al., 2014). They were applied to Middle and Upper Eocene deposits, which are rich in pelagic microfauna.

We have sampled and studied in detail the Middle and Upper Eocene succession of the Jebil outcrop in order to obtain a detailed report of its ostracod assemblages.

2. Stratigraphy

The Jebil section is located in central Tunisia, near the Khit El-Oued village (18° 10′ N and 3° 71′ E); the area is covered by the geological map of Haffouz (1:50,000 scale) (Fig. 1).

The Middle and Upper Eocene marine deposits are 200 m thick and well exposed in Jebel Jebil. They present intercalations of bioclastic limestone (oyster rich) and marls rich in foraminifers and ostracods. These deposits correspond to the Cherahil Formation (Comte and Dufaure, 1973), which is subdivided into three units, which are as follows from base to top: the Lower Cherahil, the Siouf and the Upper Cherahil Members (Fig. 2).

2.1. Lower Cherahil Member

This member can be divided into three main units:

- the lower unit (J1–J48) is 46 m thick and comprised of laminated green clays with crystallized calcite interbedded with thin argillaceous limestones and a lumachellic limestone bed;
- the middle unit (J48–J88) is 40 m thick and comprised of yellowish sandy clays, sometimes gypsiferous and slightly phosphatic with ferruginous concretions and flint nodules. These levels are interbedded with centimetric dolomite beds rich in nummulites;
- the upper unit (J88–J122) is 35 m thick and composed of laminated gray-green clays intercalated with fossiliferous argillaceous limestones containing ferruginous concretions.

2.2. Siouf Member

It is 5 m thick and composed of lumachellic gray sandy limestones. This level is rich in large benthic foraminifera: *Nummulites gizehensis*, *Discocyclina roberti*, *Discocyclina sella*, *Operculina* sp. and *Alveolina* sp.

2.3. Upper Cherahil Member

This member can be divided into two units:

- the lower unit (J129–J149) is 20 m thick and represented by green laminated claystones, rich in iron oxides and gypsum, and intercalated with centimetric dolomite beds;
- the upper unit (J149–J184) is 35 m thick, comprised of fine greenish sandy clays and interbedded with metric lumachellic limestones, rich in *Ostrea lamellosa*. These limestones are represented by biomicritic grainstone texture with bryozoans, bivalves and algae.

3. Materials and methods

Many authors have analyzed different aspects of the Jebil section. Ben Ismail-Lattrache (2000) has been the first to study the planktic and benthic foraminifera, as well as the

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