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Original article

# Turonian and Coniacian Ostracods from the Gafsa Basin (central-southern Atlas of Tunisia) and the Gulf of Gabes (eastern coast of Tunisia): Biostratigraphic, paleoevironmental and paleobiogeographic implications

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**Abstract**

Three hundred thirty-nine samples were collected from the Turonian-Coniacian succession that crops out in the Gafsa Basin and drilled in the Gulf of Gabes; these samples come from four outcrops and four wells and they were examined for their ostracod content. Sixty-two species belonging to twenty-nine genera were identified. They are subdivided into two major groups: smooth - species dominated assemblages and ornamented - species dominated assemblages. In the present work, five research goals are pursued: 1) to document the ostracod biodiversity encountered in the studied outcrops and wells, 2) to establish their biostratigraphic distribution, 3) to suggest a zonation mainly based on ostracods and correlated directly with the equivalent planktic foraminiferal zones, 4) to attempt a paleoenvironmental reconstruction based on the application of paleoecological characteristics of the identified ostracod assemblages. Finally, paleobiogeographical relationships were carried out between the Tunisian ostracods and those recorded in different regions of the Tethyan realm.


*Keywords:* Turonian; Coniacian; Ostracods; Biozonation; Paleoecology; Paleobiogeography

## 1. Introduction

The Turonian-Coniacian sedimentary sequences of Tunisia have been studied under different angles, such as sedimentology, geochemistry, paleogeography and biostratigraphy. Glintzboeckel and Magné (1959), in their biostratigraphic study of the Jurassic and Cretaceous series of Tunisia and Algeria, showed that ostracods can give both paleogeographic and stratigraphical information, when their distribution is calibrated on characteristic microfauna. Thus, they were able to date the sedimentary sequences based, exclusively on their ostracod fauna by comparing them with those rich with planktic foraminifera and ostracods. Bismuth et al. (1981) defined, in Jebel Semmama, four major sedimentary sequences starting from the Upper Albian to the Coniacian. Simultaneously, they carried out a micropaleontological study based on abundant samples, permitting the identification of rich and diversified fauna comprised of algae, ostracods, planktic and benthic foraminifers. These authors also proposed for the first time in Tunisia, ostracod zonation for the Late Albian–Middle Turonian interval. Marie et al. (1984) carried out a geological synthesis of the Cretaceous of Tunisia; updating thus previous studies. They established a biostratigraphical chart based mainly on the planktic foraminiferan distribution and the paleogeographical and paleotectonic evolution of Tunisia during the Cretaceous. Dali-Ressot (1987) defined calcispheres biozones within the Late Cretaceous of Bireno and Boulahneche Jebels (central Tunisia), by comparing them with the foraminifer and ostracod biozones. Robaszynski et al. (1990), made an attempt to provide a sequence stratigraphic interpretation of the Turonian sedimentary distribution in Kalaat

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Senan area (Central Tunisia), by the use of macro and microfossils (ammonite and planktic foraminifer species). In their biostratigraphical study of the Middle and Upper Cretaceous outcrops of the northern range of the Chotts (South Tunisia), Abdallah et al. (1995) proposed biostratigraphical ranges for several fossil groups of ostracods, foraminifers, echinoids and ammonites. They also demonstrate the existence of a connection between the Jerid area and other sectors in the meridional Tethys, the Middle East, central and south Africa and western Europe.

The present paper yielded an additional faunal record, which has not been documented previously. The recorded ostracod fauna has been described and a zonation for the late Turonian and Coniacian was proposed for the first time in Tunisia besides those identified by Bismuth et al. (1981) for the Early and Middle Turonian. In this study, we tried to demonstrate that in the absence of fossil markers, ostracods are as useful as any other group of fossils like ammonites or planktic foraminifers, for the broader problems of stratigraphy and correlation.

## 2. Geological and stratigraphic setting

The study area covers the Gafsa Basin and the Gulf of Gabes, which contain interesting geological sections along the Turonian–Coniacian interval, characterized by carbonate, marl and evaporitic deposits evolving from proximal marine to more distal, eastwards. The first area is limited by the stable Saharan platform, in the south and the central Tunisia uplift, in the north. This region corresponds to E-W trending anticlines (Berda, Chemsi, Orbata and Belkhir Jebels), with NE vergence at their eastern ending. It is bordered by two dextral strike-slip faults: Gafsa (directed N120) and Meich (directed N120-130) corridors and some second order faults with N60 and N90 trending (Zouaghi et al., 2005); (2) the second region is located on the eastern coast of Tunisia. In this region, various tectonic events were recorded. They are characterized by (1) intense subsidence during the Triassic, the Jurassic and some restricted intervals in the Cretaceous, (2) a very active halokinesis of Triassic evaporates took place resulting in the development of diapiric extrusions, (2) extensional faults of NW-SE direction are created, leading to the formation of horsts and grabens and (3) a volcanic activity during different Cretaceous episodes (Fig. 1).

Detailed study of the Turonian - Coniacian series of the eastern part of the Gafsa Basin is based on the realization of four outcrop sections, in Berda, Chemsi, Orbata and Belkhir. These sections allow to study the Annaba, Bireno, Lower Aleg and Douleb Members of the Aleg formation (Figs. 2–9). The latter overlies the Gattar dolomites (Uppermost Cenomanian) or the Bahloul horizon (Late Cenomanian- Early Turonian) and underlies the Abiod Formation (Campanian-Maastrichtian). The depositional environment is mostly controlled by the global sea level fluctuation and the regional tectonic movements. The Aleg formation is comprised of shales, marls, carbonates or evaporites.

## 3. Material and methods

Only the Turonian-Coniacian deposits were measured, described and sampled in order to determine their faunal content, particularly ostracods. These are, correlated with their counterparts situated in the Gulf of Gabes and sampled in the P1, P2, P3 and P4 wells.

A total of 339 samples were collected from marly levels. They were disintegrated with hydrogen peroxide ($H_2O_2$), washed through sieves with meshes of 250, 180 and 63 micrometers and dried at 60° C overnight. The selected specimens were identified using a binocular microscope and then imaged using a scanning electron microscope. The most useful publications for the identification of ostracods are those of Vivière (1985) and Bellion et al. (1973). Their classification is that adopted in the paper by Horne et al. (2002). The descriptive terms used, are mainly those of Bate (1972), Mohamed Taha Al Bashir (1986) and Majoran (1989).

## 4. Lithostratigraphy

The Aleg Formation, of Turonian - Early Campanian age, is well-known in Tunisia both from outcrops and boreholes (Ben Ferjani et al., 1990). It is subdivided into five members recognized from base to top: Annaba, Bireno, Lower Aleg marls, Douleb and Upper Aleg marls members. This subdivision corresponds to the alternation of argillaceous members of a relatively deep marine environment (Annaba, Lower Aleg marls and Upper Aleg Marls) and carbonate members of a shallow marine environment (Bireno and Douleb Members). Only the Upper Aleg member was not studied here.

### 4.1. Annaba Member

This member is represented by marly deposits, sometimes interbedded with fine carbonate levels and contains a faunal association composed of ostracods, benthic and planktic foraminifers (Figs. 2–9).

This member is attributed to the Early Turonian thanks to the presence of the zonal species of *Whiteinella archaeocretacea* zone (*Whiteinella archaeocretacea* Pessagno, *Whiteinella paradubia* Sigal, *Whiteinella baltica* Douglas and Rankin, *Whiteinella aprica* (Loeblich and Tappan), *Whiteinella brittonensi* (Loeblich and Tappan), *Hedbergella delrioensis* (Carsey), *Hedbergella planispira* (Tappan) and *Heterohelix moremani* (Cushman). In the absence of planktic foraminiferan markers, the occurrence of the ostracod species *Cythereis mahjoubi* Donze & Saint-Marc, recognized by Bismuth et al. (1981) in the Early Turonian of Jebel Semmama (central–northern Tunisia), permits to date the Annaba Member as Early Turonian.

### 4.2. Bireno Member

This member is mainly composed of an intercalation of limestone, dolomite, marls and gypsum or anhydrites in some places. Carbonates are often bioclastic and bioturbated, sometimes stromatolitic. The macrofaunal content consists of rudists (Hypuritidae and Radiolitidae) associated with other bivalves, algae, echinoderms, bryozoans and gastropods; the microfauna includes ostracods, pithonels, benthic and planktic foraminifers (especially in the Gulf of Gabes). Non biogenic allochems are

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