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Original article

Ostracods from the marginal coastal Lower Cretaceous (Aptian) of the Central Tunisian Atlas (North Africa): Paleoenvironment, biostratigraphy and paleobiogeography

Les ostracodes du Crétacé Inférieur (Aptien) margino-littoral de l'Atlas Central de Tunisie (Afrique du Nord) : paléoenvironnement, biostratigraphie et paléobiogéographie

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Abstract

This work provides the first detailed taxonomic study of ostracod species from the Lower Cretaceous (Aptian) marginal coastal deposits of the Central Tunisian Atlas, the Kebar Formation, as well as biostratigraphic, paleoecological and paleobiogeographic implications. The ostracod fauna provides new insights into the depositional environment and biostratigraphic framework of the Kebar Formation, and is represented mainly by freshwater and brackish-water species among them, *Perissocytheridea tunisiatlasica* nov. sp., is newly described. The environmental setting of this formation comprises marginal-littoral conditions in its lower part, thus not exclusively non-marine/continental as assumed previously. The ostracod associations from the studied locality, Jebel Ksaïra, indicate a minimum age of Early Aptian as recently attributed to the lower member of the Kebar Formation based on charophytes (presence of Late Barremian to Early Aptian *Globator maillardii* var. *biutricularis* Vicente and Martín-Closas, 2012), whereas an Early Albian age had been previously assigned to the Jebel Kebar site. The relative sea-level fall documented in the lower member of the Kebar formation at Jebel Ksaïra might correspond to the 3rd order cycle major eustatic sea-level fall event starting at the base of the Aptian. Paleobiogeographically, the non-marine ostracod fauna newly discovered in the Kebar Formation shows some affinities to contemporaneous faunas of southern and western Europe, e.g. that of the uppermost Weald Clay Group of southern England (*Cypridea fasciata* subzone of Horne, 1995), West Africa, and possibly to eastern South America (Brazil). Hence, the studied ostracods further support the hypothesis of supraregional faunal exchange by passive ostracod dispersal during the Early Cretaceous – between Europe and Northern Africa on the one hand, and eastern South America/western Africa and North Africa on the other hand. This leads to the hypothesis that the Peri-Tethyan islands could have worked as effective bridges for non-marine ostracods to become widely dispersed passively by "island-hopping" of larger animals and thus, ultimately, facilitated intercontinental faunal exchanges between South America and Europe – potentially even Asia – via North Africa during the Early Cretaceous.

Keywords: Brackish; Non-marine; Ostracods; Peri-Tethyan islands; Kebar Formation; Tunisia

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Résumé

Le présent travail fournit la première étude taxonomique détaillée des espèces d'ostracodes du Crétacé inférieur (Aptien) des dépôts margino-littoraux de la Formation Kebar de l'Atlas Central de Tunisie, ainsi que les implications biostratigraphiques, paléoécologiques et paléobiogéographiques. La faune d'ostracodes étudiée dans ce papier offre de nouvelles interprétations sur l'environnement sédimentaire et le cadre biostratigraphique de la Formation Kebar, comprenant essentiellement des espèces limniques à saumâtres, dont l'une, *Perissocytheridea tunisiatlasica* n. sp., est décrite pour la première fois. Ainsi, la Formation étudiée semble s'être alors déposée dans un environnement margino-littoral au niveau de son membre inférieur où on a récolté la faune d'ostracodes, et non pas exclusivement continental comme l'on supposait précédemment. Les associations d'ostracodes de la localité étudiée, Jebel Ksaïra, soutiennent un âge minimum Aptien inférieur pour le membre basal de la Formation Kebar, en accord avec les données fournies par les charophytes (présence d'espèces du Barrémien supérieur-Aptien inférieur), notamment l'espèce *Globator maillardii* var. *biutricularis* Vicente et Martín-Closas, 2012, alors qu'auparavant cette Formation Kebar dans sa localité type, le Jebel Kebar avait été attribuée à l'Albien inférieur. La baisse du niveau relatif de la mer documenté dans le membre inférieur de la Formation Kebar à Jebel Ksaïra a pu correspondre à l'événement majeur de chute du niveau de la mer du cycle eustatique de 3e ordre commençant à partir de la base de l'Aptien. D'un point de vue paléobiogéographique, la faune d'ostracodes limniques récemment découverte dans la Formation Kebar montre quelques affinités avec les faunes contemporaines du Sud et de l'Ouest de l'Europe, par exemple, celle du terme le plus supérieur du « Weald Clay groupe » du Sud de l'Angleterre (sous-zone à *Cypridea fasciata* de Horne, 1995), Afrique de l'Ouest, et, éventuellement, dans l'Est de l'Amérique du Sud (Brésil). Par conséquent, les ostracodes étudiés soutiennent davantage l'hypothèse d'échange faunistique suprarégional par voie de dispersion passive au cours du Crétacé inférieur, entre l'Europe et l'Afrique du Nord, d'une part, et de l'Est Amérique du Sud/Afrique de l'Ouest et Afrique du Nord, d'autre part. Ceci soutient bien l'hypothèse que les îles Péri-téthysiennes auraient fonctionné comme ponts efficaces qui facilitent largement la dispersion passive des ostracodes non marins par les animaux migrateurs « île en île », et entre autres faciliter les échanges fauniques intercontinentaux, entre l'Amérique du Sud et l'Europe – peut-être même en Asie – via l'Afrique du Nord, au cours du Crétacé.

Mots clés : Laguno-lacustre ; Ostracodes ; Îles Péri-téthysiennes ; Formation Kebar ; Tunisie

1. Introduction

Early Cretaceous sedimentary successions of North Africa show evidence of many minor cycles of transgression and regression as the southern margin of the Tethys Ocean moved north and south. This is an important time paleogeographically, as the North Atlantic Ocean continued to open, as the South Atlantic Ocean began to open, and as land connections between Africa and Europe, perhaps across the Iberian Peninsula, waxed and waned (Andreu et al., 2003). During the so-called "Purbeck-Wealden interval" (latest Tithonian to Barremian/earliest Aptian), the approximate interval named after the English "Purbeck" and "Wealden" (now the Purbeck Group and Wealden Supergroup respectively), non-marine strata in respective facies are worldwide registered, which also applies to the Peri-Tethyan islands. Coinciding with relative sea-level lowstands and the enhanced availability and diversification of non-marine habitats (e.g. freshwater swamps) during this time interval (Martín-Closas, 2003), the non-marine ostracods of the Superfamily Cypridoidea underwent an 'explosive' radiation, the main part of which has been attributed to the now-extinct Family Cyprideidae Martin, 1940 (the genus *Cypridea* and its close relatives) and reached their maximum dispersion and diversity (Whatley, 1992; Sames and Horne, 2012). Since the 1940s, many hundred species of this family have been described and biozonations have been proposed mainly based on species of *Cypridea*, notably in northwestern Central and western Europe (England, Germany, France and Spain; see Sames, 2011a; Sames and Horne, 2012 and references therein) as well as eastern Brazil and western Africa (see Poropat and Colin, 2012b). Indeed, despite all this progress, the respective ostracods remain poorly known and understood in northern Africa. So far, insufficient data from North Africa makes it difficult to establish correctly and clearly intercontinental biogeographic correlations between the northern and southern margins of the Tethys.

The discovery of moderately rich non-marine ostracod associations of Lower Aptian age in the Kebar Formation of the Tunisian Atlas facilitates an improved biostratigraphic contraint of this series and demonstrates the utility of non-marine ostracods as tool for improved supraregional biostratigraphy and regional chronostratigraphy. Moreover, the studied ostracod fauna allows new interpretations not only for the depositional environment of the Kebar Formation, but also for the paleogeographic extension of this particular succession through the Central Tunisian Atlas. In the global paleobiogeographic context, the results shown here represent the first study of Aptian non-marine ostracods from the Tunisian Atlas. Therefore, this paper emphasizes the hypothesis of the Atlas domain being a bridging area for ostracod dispersal across the islands between the southern and northern margins of the Tethys.

2. Geographical and geological setting

During Aptian–Albian time, Central Tunisia was one of the largest islands in the southern margin of the Tethys Archipelago (M'Rabet, 1979), bearing rich non-marine deposits with charophytes, called "Kebar Formation" (Trabelsi et al., 2010). This formation, in its type locality of Jebel Kebar (Fig. 1), had previously been assigned to the lower Albian on the basis of charophyte and ostracode assemblages (Trabelsi et al., 2010, 2011). The same assemblages were found in the upper part of the