

New Early Cretaceous shrimp (Decapoda) from the Sidi Aïch Formation of the Northern Chotts Range, southern Tunisia: Taxonomy, biostratigraphy, and palaeoenvironmental implications



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ABSTRACT

The fossil dendrobranchiate shrimp *Macropenaeus* was originally described from the Upper Cretaceous (Cenomanian) limestones of Hadjoula, northwest Lebanon. A new species, *M. sidiachensis* sp. nov., was recovered from the Sidi Aïch Formation in the Northern Chotts Range, southern Tunisia. The Barremian occurrence of the genus in Tunisia suggests that *Macropenaeus* most likely originated in northern Africa and then migrated to Arabia in the Cenomanian. The association of the fossil shrimp with conchostracans, plant fragments, and fish indicates the interaction of freshwater and marine conditions that characterized the northern African margin as part of widespread coastal complex, paralic environments during the Barremian.

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1. Introduction

Since the 1950s, the main faunal and floral palaeontological discoveries in Tunisia have been from the Upper Jurassic to Upper Cretaceous sedimentary successions of the Tataouine Basin, southern Tunisia (Fig. 1A). The Tataouine Basin has yielded Early Cretaceous fish, turtles, crocodiles, and dinosaur remains (Pervinquière, 1912; Lapparent, 1951, 1960, 2000, 2002; Lapparent and Taquet, 1966; Tlig, 1987; Bouaziz et al., 1988; Benton et al., 2000; Srarfi et al., 2004; Srarfi, 2006; Anderson et al., 2007; Cuny et al., 2010; Contessi and Fanti, 2012a, b; Fanti et al., 2012, 2016a, b; Le Loeuff et al., 2012). The key evolutionary position of some of the fossils, including titanosauriforms, makes this area one of the most important Mesozoic fossil sites in northern Africa, rivalling the much better known Jehol Biota (China), Santana Formation (Brazil), Tlayúa Formation (Mexico), and Solnhofen Lithographic Limestone and Posidonia Shale (Germany).

Lower to middle Cretaceous shallow marine and nonmarine fossils document various habitats, the most common of which are continental aquatic vertebrates (crocodiles, fish (*Lepidotes*, *Ceratodus*), and turtles). Putative marine vertebrates, elasmobranchs (*Hybodus*), osteichthyes (*Onchopristsis*), and coelacanth (*Mawsonia*), are predecessors of forms inhabiting fresh water habitats in modern large equatorial or tropical rivers. Thus, both marine and nonmarine organisms appear to represent a “mixed” Aptian-Albian macro and microfossil vertebrate assemblage (Bouaziz et al., 1988; Ben Ismail, 1991; Benton et al., 2000; Ouaja et al., 2004; Anderson et al., 2007; Cuny et al., 2010; Le Loeuff et al., 2012; Contessi and Fanti, 2012a, b; Fanti et al., 2012, 2013).

The Chotts-Gafsa Basin in the Southern Chotts Range (Fig. 1B) lies north from the Tataouine Basin. There, Lower Cretaceous (Aptian) strata have yielded an angiosperm flora (Barale and Ouaja, 2001). A number of large excavations were made in the Lower Cretaceous strata from southern Tunisia (particularly in the Tataouine Basin), which produced a huge number of macro and microfossil remains, but no preserved fossil shrimp were found. The present paper provides palaeontological and biostratigraphical analyses of shrimp collected from a new fossil site in the Northern

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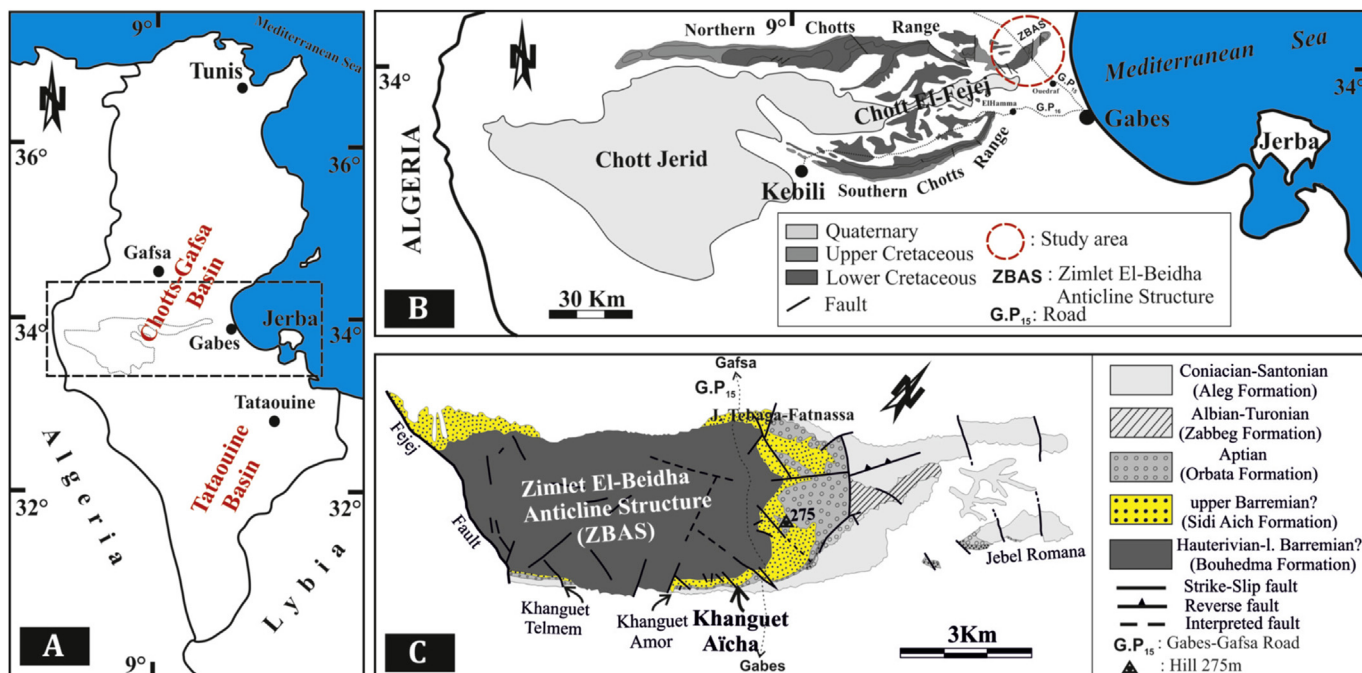


Fig. 1. A. Map of Tunisia showing the position of Tataouine and Chotts-Gafsa Basins. The dashed-line box shows the study area. B. Geological map showing the Chotts Basin within northern and southern Chotts Ranges. The dashed-line circle indicates the study area which is located at the eastern end part of the northern Chotts Range, Southern Tunisia. C. Geological map (Abdeljaouad, 1983; Louhaïchi and Tlig, 1993; Gharbi et al., 2013) showing the main lithostratigraphic formations cropping out in the ZBAS and particularly the location of the Sidi Aïch Formation at the Khanguet Aïcha locality.

Chotts Range yielding well preserved fossil fish, clam shrimp, shrimp, plants, and other organisms recently discovered in Lower Cretaceous siliciclastic sediments (Fig. 1B). This diverse fauna will permit reconstitution and understanding of the Early Cretaceous paralic sedimentary sequence in the Early Cretaceous system. Interpretation of this sequence has sparked a longstanding debate (Abdeljaouad and Zargouni, 1981; Abbès and Zargouni, 1986; M'Rabet, 1987; Abbès and Tlig, 1991; Gallala et al., 2009; Ouaja et al., 2011; Aloui et al., 2012; Gharbi et al., 2013). These faunal investigations are aimed at better understanding and reconstructing the Early Cretaceous ecosystems of the Chotts-Gafsa Basin (Fig. 1A) and the taphonomic fate of their organisms.

2. Geological setting

2.1. Stratigraphy and age

Lying within the Chotts-Gafsa Basin, the Zimlet El-Beidha Anticline Structure (ZBAS) (Fig. 1C) constitutes the easternmost part of the Northern Chotts Range (Fig. 1B). The geological age of the ZBAS ranges from Cretaceous to Quaternary. The Cretaceous rocks in the ZBAS (Fig. 1C) have been studied by numerous authors (Abdeljaouad and Zargouni, 1981; Abbès and Zargouni, 1986; Ben Youssef and Peybernes, 1986; M'Rabet, 1987; Abbès and Tlig, 1991; Louhaïchi and Tlig, 1993; Chaabani and Razgallah, 2006; Lazzez and Ben Youssef, 2008; Lazzez et al., 2008; Ouaja et al., 2011; Aloui et al., 2012; Gharbi et al., 2013; Boukhalfa et al., 2015; Li et al., 2017). The Cretaceous stratigraphic chart (Fig. 2A), a product of previous work in the Chotts B Lower Cretaceous deposits, documents three Lower Cretaceous formations, the Bouhedma, Sidi Aïch, and Orbata formations in ascending order (Fig. 2B and C).

The Bouhedma Formation (Burolet, 1956) is a 600 m succession considered Hauterivian–Barremian in age based on ostracod assemblages (Damotte et al., 1987; Damotte, 1990; Chakhma et al., 1990).

Burolet (1956) named the Sidi Aïch Formation for a 120 m thick sequence at Jebel Sidi Aïch in the central Atlas Mountains of Tunisia. It consists of medium- to coarse-grained sandstone interbedded with siltstone layers that are exposed throughout the Chotts-Gafsa Basin. The Sidi Aïch Formation has been assigned a late Barremian age in the study area based on presence of the conchostracan, *Cratostracus? tunisiaensis* Boukhalfa, Li, Ben Ali, and Soussi, 2015, described from the Northern Chotts Range at the Zimlet El-Beidha Anticline Structure. The age of *C.? tunisiaensis* was based on it being congeneric with forms in China (Boukhalfa et al., 2015).

The Orbata Formation was named by Burolet (1956). Stratigraphic work (Bismuth et al., 1981; Ben Youssef et al., 1985; Ben Youssef and Peybernes, 1986; Abdallah, 1987; M'Rabet, 1987; Chaabani et al., 1992; Chaabani and Razgallah, 2006), on the 260 m thick carbonate sequence has resulted in subdivision of the formation into five lithological units (Chaabani and Razgallah, 2006). The formation is characterized by Aptian benthic foraminiferal faunal associations (Chaabani and Razgallah, 2006). In the Chotts region, the Orbata Formation has undergone a marked reduction in thickness, where it consists of 20 m of fossiliferous massive dolomite and marl interbedded with thin dolostone layers. The fauna consists of orbitolinid and miliolid foraminifera, bivalves including rudists, gastropods, and echinoderms (Chaabani and Razgallah, 2006). The ages based upon this fauna are late Barremian–Gargasian (Ben Youssef and Peybernes, 1986) and Aptian (Bedoulian–Gargasian) (M'Rabet, 1987; Abdallah et al., 1995; Chaabani and Razgallah, 2006; Lazzez et al., 2008; Hfaïedh et al., 2013).

2.2. Fossil-bearing strata

The strata of the Khanguet Aïcha exposure (Fig. 3A) permit detailed bed by bed logging of the Sidi Aïch Formation sequence (Fig. 3B), which consists of 120 m of sandstone arrayed in thick, fining upward sequences. Each sequence is dominated by fine-

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