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On the occurrence of Campanian rudist biostrome, Aruma Formation, Central Saudi Arabia

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The lower limestone Khanasir Member of the Aruma Formation in central Saudi Arabia is characterized by Campanian rudist biostrome at its uppermost part. The most abundant rudist fauna are *Eodictyoptychus arumaensis*, *Durania* sp. and *Biradiolites* sp. Succession is overlying continental siliciclastics of Wasia Formation and comprises shale at the base followed by slightly dolomitized, burrow, nodular limestone and caps with rudist biostrome. Abundant microfacies types are wackestones, packstones, grainstones and floatstones with green algae, benthic foraminifers. The succession in general, indicated shallowing upward sequence and rudist biostrome represents a shallow marine lagoonal environment.

[**Key words:** Rudist biostrome, Upper Cretaceous, Campanian, Aruma Formation, Saudi Arabia]**.**

Introduction

The epibenthic, sessile rudist bivalves of superfamily Hippuritacea (Late Jurassic–Maastrichtian) were dominant constituents of many Cretaceous Tethyan shallow marine communities[1, 2], and were among the important carbonate producers in calcareous depositional system[3-5].The term "rudist formation" has been designated for all rudist-bearing lithologies, irrespective of any other connotations[1, 6].

Campanian rudists are remarkably well and extensively exposed in Aruma Formation at Khashm Buwaibiyat (Lat. 25º 12´ 12´´, Long. 46º 49´ 27´´) in northeast Riyadh, central Saudi Arabia. Since the taxonomic study which identified new genus and species of canaliculated rudist bivalve, *Eodictyoptychus arumaensis*[7] from the topmost part (Campanian) of the Khanasir Member, there are no studies dealt with rudist formation in central Saudi Arabia. The more recent studies on the study area are the Campanian–Maastrichtian gastropods, stratigraphy and depositional environments of Aruma Formation[8, 9]. The present work aims to study stratigraphic setting and to document the depositional environment of the Upper Cretaceous rudist biostrome of the Khanasir Member, Aruma Formationin Central Saudi Arabia.

Materials and Methods

A composite section was measured and macrofossils (especially rudist materials) and rock samples were collected from the Khanasir Member in Khashm Bowaibiyat area (25° 12´ 12´´ N and 46° 49´ 27´´ E), Northeast Riyadh (Fig. 1). 55 Representative rock samples are chosen for thin sections. Rudist bivalves are photographed and stored in the Museum of the Geology and Geophysics Department, College of Science, King Saud University under numbers MGD-CSc-KSU-1:18.

Stratigraphic setting

The Aruma Formation was named for its occurrence in the Al 'Aramah plateau, a broad upland surface related to the easternmost of the Najd escarpments[10]. It crops out from Wadi ad Dawasir in southern Saudi Arabia beyond the Iraq-Saudi Arabia border, a distance of more than 1,600 km. At first, the formation was divided into four lithological units that were grouped into two members namely, the Atj and Lina members. Later, the formation was subdivided into three members, in ascending order: the Khanasir Member, the Hajajah Member and the Lina Member[7, 11, 12].

The Aruma carbonate and shale rocks are

underlain by various colored siliciclastic sediments of the Wasia Formation and overlain by gray crystalline *Lockhartia*-bearing dolomite of the Ummer Radhuma Formation. Present study concentrates on the upper most part of the lower Khanasir Limestone Member in Khashm Buwaibiyat area to the northeast of Riyadh. The age of the Khanasir Limestone Member could be as old as Santonian, as it contains *Meandropsina vidali* Schlumberger, which described from theSantonian of Spain[10]. However, the uppermost occurrence of *M. vidali* in Saudi Arabia overlaps the Campanian range of *Monolepidorbissanctae-pelagiae* Astre[10].

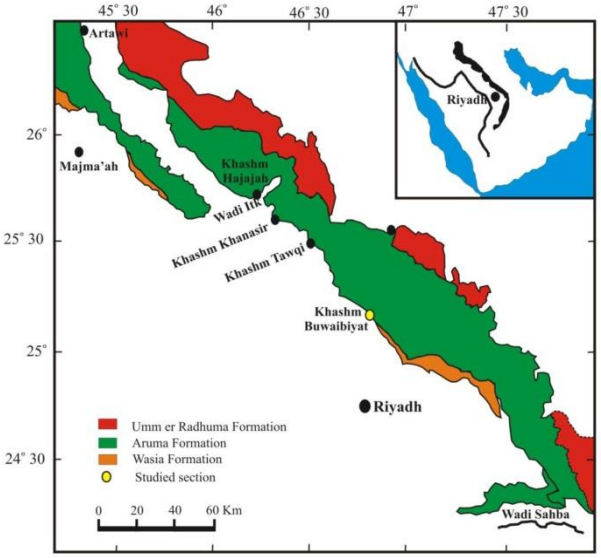

Fig. 1- Location map of the study area.

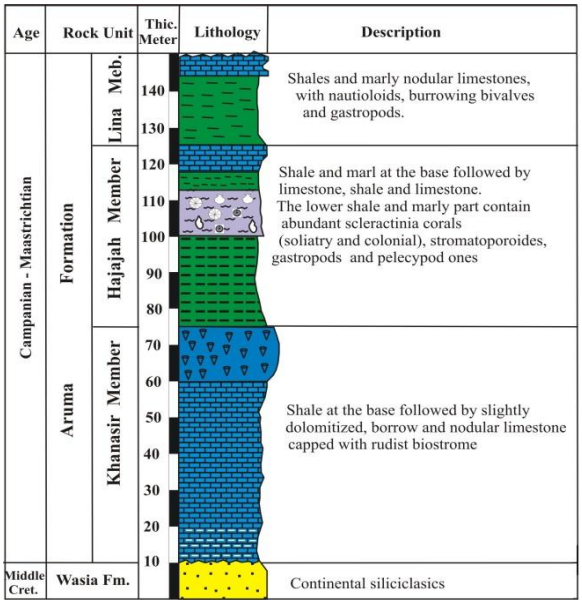

Fig. 2- Lithostratigraphic section of the Aruma Formation, KhashmBowaibiyat area, Northeast Riyadh[8].

The Khanasir Limestone member, in the study area is formed from 1.5 - 3 m unfossiliferous, varicolored sandy dolomite, with a few small pebbles disconformably overlies the Cenomanian siliciclastics of the Wasia Formation with a sharp contact (Figs. 2, 3). It followed upward with 16-20 fossiliferous clcarenitic, chalky, nodular limestone with few gastropod and bivalve molds and echinoids. The succession caps with 6-14.5 m fossiliferous molluscan calcarenitic limestone with abundant biostromal rudists, oysters, and large gastropods (Fig. 3).

Fig. 3- Field photographs of the Khanasir Member. A) The Khanasir Member overlies siliciclastics of the Wasia Formation. B) Close up view of the sharp contact between Wasia and Aruma formations. C) The succession of the Khanasir Member with rudist biostrome at the uppermost part. D) Close up view of the rudist biostrome.

Results and discussion

Biostrome description

The rudist biostrome forms the top most part (6-12 m) of the Khanasir Member (Fig. 3C, D). It is well developed at Khashm Hajajah, Khashm Khanasir and Khashm Buwaibiyat areas while it is found as remnants at Wadi Sahba and Majma'ah areas. In Khashm Buwaibiyat area, it is mostly consisting of *Eodictyoptychus arumaensis*, *Durania* sp. and *Biradiolites* sp. of apparently a single generation, embedded in growth position (autochthonous) without the free valve (Fig. 4). It has hundreds of meters in lateral extent, indicating rapid colonization and shows a packed texture (supported by the rudist shells). The packed texture corresponds to rudist rudstone, rudist bafflestone or rudist boundstone.

The hippurid biostrome is overlaying substrata of bioclastic wackestones to floatstones with abundant dacycladacean algae and larger foraminifers including *Omphalocyclus macroporous* (Lamarck) and few gastropod and bivalve molds and badly preserved echinoids. The identified species are of large, thick and cylindro-conical right valves with small attachment bases. The scattered individuals are lying on one side, while the aggregative ones are found in upright position.

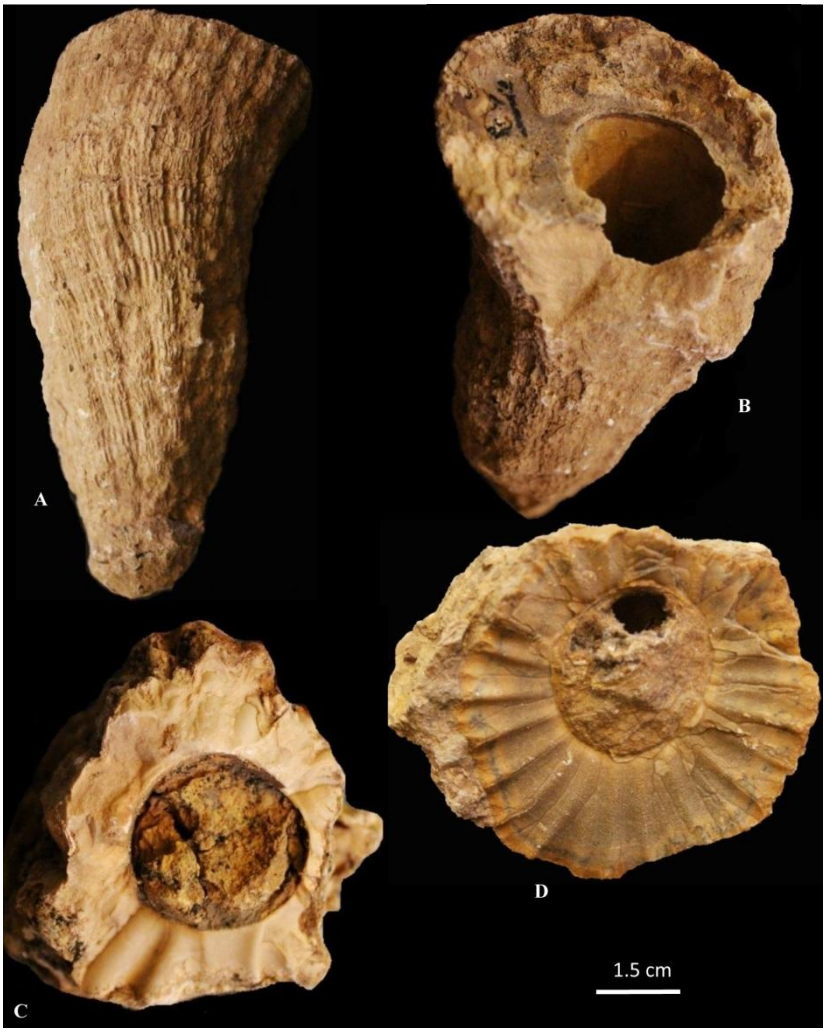

Fig. 4- Examples of the identified rudist fauna. A) External view of *Durania* sp. B) Internal view of a hollow valve of *Durania* sp. C) Internal view of a *Durania* sp. valve filled with lime mud D) Internal view of a *Biradiolites* sp. valve filled with lime mud.

Depositional environment

The type and rate of ambient sedimentation were of particular importance for the development of rudist formations, due to the sessile, epifaunal, suspension feeding life habit of rudist bivalves[1]. Rudists reefoid lithosomes[5]. Elevators required a certain amount of background sedimentation to stabilize the vertically growing shells[4, 15] and did not form bound, wave-resistant frameworks which significantly altered.

From a sequence stratigraphy point of view, rudist biostrome can be encountered in the neritic sector of each system tract of a depositional sequence. The transgressive systems tract is

dominated by siliciclastics, and typically contains rudist thickets and biostromes that were deposited in lagoons with carbonates or siliciclastics deposition. In areas protected from siliciclastics input, in the highstand, small carbonate shelves developed that included only the inner shelf to lagoonal sector. The inner shelf environment was characterized by coral-rudist mounds and hippuritid biostromes and was separated from an open lagoonal environment by a distinctive shore zone with bioclastic sand bodies[6].

The succession of the Khanasir Member with its sharp contact with the Wasia Formation (Fig. 3A) and comprises of arenites or marls overlain by bioclastic wackestones which, in turn, are overlain by rudist biostrome indicated a single upward shoaling cycle. Thin sections of the limestones of this member gave algal wakestone, foraminiferal algal wakestone and algal packstone (Fig. 5) with abundant dasycladacean algae (*Salpingoporella arumaensis*, *Dissocladella D. intercedens* and *Griphoporella* sp.). All bioclastic fragments are recrystallized. These algal floras with the associated macrofossils mostly indicated a shallow marine lagoonal depositional environment[16]. The occurrence of rudist-dasyclad biofacies and benthic foraminifera clearly supports the interpretation of deposition in a shallow marine environment that was well within the depth limits of the photic zone[17].

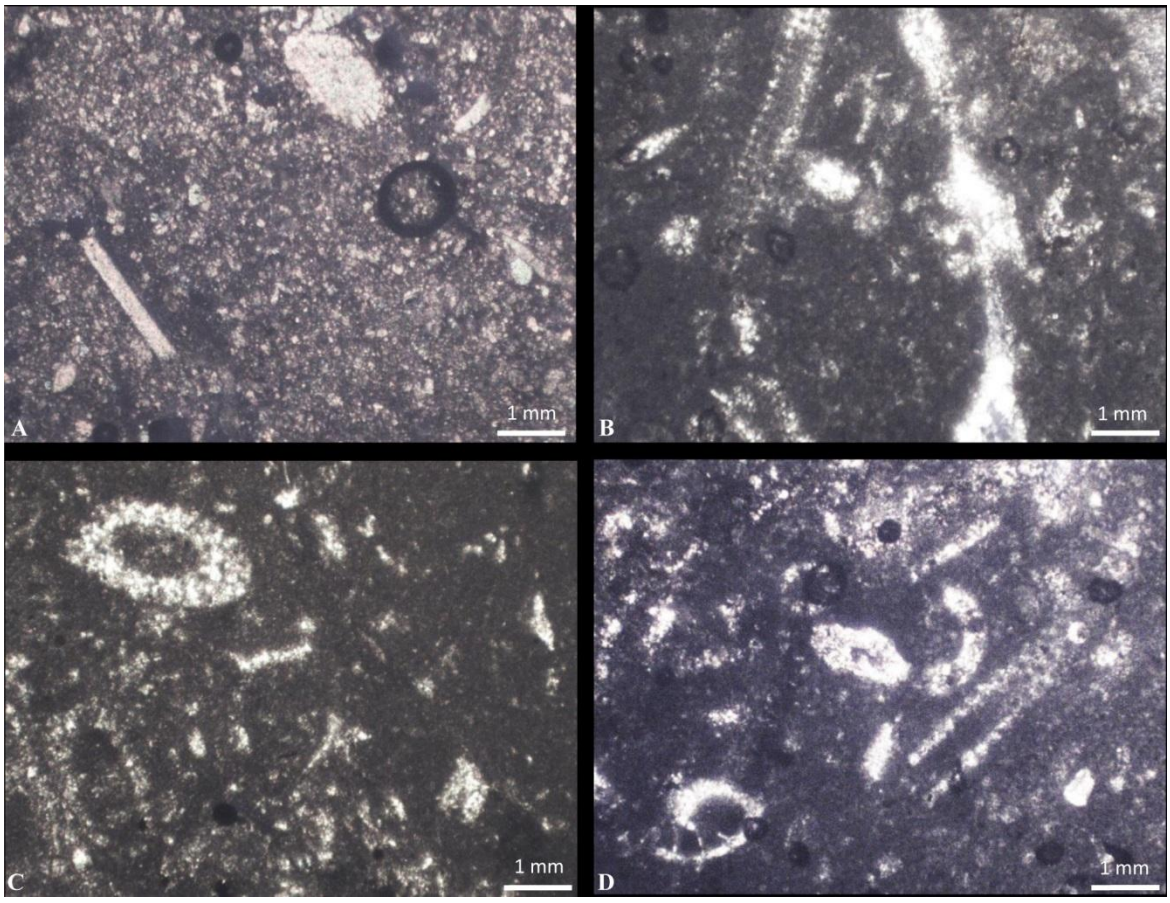

Fig. 5-Thin sections photographs of the Khanasir Member (crossed nicols). A) Echinoidal, dolomitized grainstone with echinoid fragments and fine dolomite rhombs. B) Algal wackestone with fragment of *Salpingoporella* sp. C) Algal wackestone with transverse section of *Dissocladella D. intercedens* Bakalova. All bioclastic fragments are recrystallized. D) Foraminiferal algal wacke/packstone with algal fragments and benthic foraminifera. All fragments are recrystallized.

Conclusions

A rudist biostrome, 0.75-1.5 m thick and several hundred meters lateral extension, characterized by abundant *Eodictyoptychus arumaensis*, *Durania* sp. and *Biradiolites* sp. was recorded at uppermost part of Khanasir Member, Aruma Formation in central Saudi Arabia. The studied rudist fauna have elevator ecological morphotype and encountered in the neritic sector of the system tract of depositional sequence or in the highstand, small carbonate shelves developed that included only the inner shelf to lagoonal sector. According to stratigraphic, faunal content, especially rudist biostrome at the uppermost part and microfacies analysis, the Khanasir Member indicated shallowing upward sequence.

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