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Brachiopods and rugose corals in an upper Serpukhovian (Mississippian) biostrome: preliminary results from the Djebel Arhlal (Béchar Basin, Algeria)

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ABSTRACT

The Djebel Arhlal is the southernmost outcrop of upper Serpukhovian strata in the Béchar Basin. Here the Djenien member of the Djenien Formation is three-folded and it contains a 10 m-thick coral biostrome in its middle unit formed by *Siphonodendron, Diphyphyllum* and *Lithostrotion*. Distances between in situ colonies are in the order of several decimetres and the space between them is filled with bioclastic limestone containing coral rubble. Few brachiopods and solitary corals are found as dwellers within the biostrome, but these groups are much more common in the strata below and above the coral biostrome. This is especially true for the brachiopods, which reach diversities of more than a dozen species in specific horizons. They mainly belong to the orders Productida, Spiriferida and Athyridida. Agitated open-marine platform interior or platform margin settings are the general facies encountered in the Djenien member at the Djebel Arhlal. The field data, including brachiopod coquinas and many fragmented brachiopods and corals, are confirmed by microfacies analysis. However, the coral biostrome records a quieter setting at the interface of middle and outer ramp settings, as seen in the co-existence of *in situ* coral growth, input of reworked material, deposition of carbonate mud, and sparitic textures. This autoparabiostrome at Djebel Arhlal is compared to other rather thick and of exceptional horizontal extension upper Serpukhovian biostromes (few kilometres).

Key words: Béchar Basin, Algeria, Serpukhovian, coral biostromes, brachiopods

Braquiópodos y corales rugosos en un biostroma del Serpukhoviense superior (Misisípico): resultados preliminares del yacimiento de Djebel Arhlal (Cuenca Béchar, Argelia)

RESUMEN

Djebel Arhlal es el afloramiento más meridional de los estratos serpukovienses en la cuenca Béchar. En esta zona el Miembro Djenien de la Formación Djenien ha sufrido tres etapas de plegamiento y contiene en su unidad media un biostroma de coral de 10 m de espesor y formado por Siphonodendron, Diphyphyllum *y* Lithostrotion. *Las distancias in situ entre las colonias son del orden de varias decenas de decímetros y el espacio entre ellas está relleno de caliza bioclástica que contiene restos de coral. Se han encontrado pocos braquiópodos y corales solitarios como residentes dentro del biostroma, aunque sí son abundantes en los estratos por debajo y por encima del mismo. Esto es especialmente cierto para los braquiópodos, los cuales llegan a alcanzar una diversidad de más doce especies en horizontes específicos; y pertenecen a los*

órdenes Productida, Spiriferida y Athyridida. Las facies generales que se encuentran en el Miembro Djenien en Djebel Arhlal son las que corresponden a ambientes energéticos de plataforma interior marina abierta o margen de plataforma. Los datos de campo incluyen conchas de braquiópodos y muchos fragmentos de braquiópodos y corales, tal y como se ha confirmado por análisis de microfacies. Sin embargo, el biostroma coralino registra un ambiente más tranquilo en la interfase entre ambientes de rampa media y externa, como se ha visto en la coexistencia del crecimiento del coral in situ, la entrada de material retrabajado, la deposición de lodo carbonático y las texturas espaleríticas. Este autoparabiostroma en Djebel Arhlal es comparable con otros biostromas del Serpukhoviense superior de bastante espesor y con una extensión horizontal excepcional (de unos pocos kilómetros).

Palabras clave: Cuenca Béchar, Argelia, Serpukhoviense, biostromas de coral, braquiópodos

VERSIÓN ABREVIADA EN CASTELLANO

Introducción

En la cuenca de Béchar (Fig. 1), los sedimentos del Carbonífero marino comportan varios episodios arrecifales, desde el Viseense inferior hasta el Bashkiriense. Aunque los arrecifes más importantes se han descrito del Vieseense superior, al sureste de la cuenca, se han mencionado otros episodios más modestos, a saber biostromas de coral, del Serpukhoviense superior, especialmente en el seno de la Formación calcareo-dolomítica de Djenien. La estratigrafía del Carbonífero marino ha sido establecida por diversos autores, fundamentalmente C. Pareyn y colaborares, durante los años 1950 a 1980, aunque sin ninguna descripción detallada de un nivel remarcable « en Lithostrotion *» hacia la culminación de la Formación de Djenien. El acceso a la localidad tipo de esta Formación, 9 km al S-E de la villa de Béchar es actualmente imposible. Otros buenos afloramientos que exponen esta unidad litoestratigráfica han sido señalados brevemente por diversos autores en Djebel Arhlal, principalmente P. Semenoff-Tian-Chansky. Es pues en este sector de Djebel Arhlal, de acceso relativamente fácil, donde las búsquedas de la Universidad de Orán han empredido el estudio sobre el terreno de la Formación Djenien, caracterizada por un biostroma de coral y su inserción en el seno de una sucesión de calizas ricas en macrofósiles, entre ellos los braquiópodos.*

Localización de las secciones

Djebel Arhlal, situado a 60 km al sur de Béchar (Fig. 1), es un anticlinal orientado NNE-SSO. Se trata del afloramiento más meridional de la cuenca de Béchar en la Formación de Djenien, que es infrayacente a la de Tagnana, e incluye en su miembro inferior el límite Serpukhoviense-Bashkiriense (Misisípico-Pensilvánico). La sección principal, en el flanco norte del anticlinal, se encuentra a 0.6 km al oesta de la carretera que une Béchar y Taghit, y un segundo perfil a 2 km hacia el oeste (Fig. 2). En este sector, los biostromas de coral están muy bien expuestos; pero el techo de la Formación de Djenien y el muro de la de Tagnana no afloran, pues están recubiertos de depósitos cuaternarios.

Estratigrafía

*La Formación de Djenien está bien datada como del Serpukhoviense superior gracias a los ammonites (*Delepinoceras*, Zona E 2b-c), conodontos (*Adetognathus unicornis*) y foraminífeross (*Neoarchaediscus postrugosus*, Zona C fa 8). Comprende braquiópodos contemporáneos ya reconocidos en el Sahara argelino, entre ellos los prodúctidos (por ejemplo,* Gigantoproductus flamandi*) y spiriferidos (*Anthracothyrina bressoni*). La Formación comporta dos miembros sucesivos : (a) el Miembro de Hid el Kef, calizas con gigantoprodúctidos, y (b) el Miembro de Djenien, calizas masivas y dolomías con silex. Este trabajo concierne al Miembro Djenien, con espesor de 52 a 66 m en el sector de estudio, donde se han distinguido tres unidades (Fig. 3, 4).*

*La unidad inferior, pre-biostroma. (Fig. 5), con un espesor de 14 m, está constituida por calcarenitas con crinoides, bioclasticas u oolíticas (Fig. 5 a, b), con algunos episodios margosos particularmente fosilíferos. Asimismo, se han reonocido faunas variadas de briozoos, lamelibranquios y crinoides en el seno de esta unidad. Los braquiópodos (Fig. 8, 9) están muy diversificados y comprenden prodúctidos de gran tamaño (*Gigantoproductus*, Datangia, Beleutella, Latiproductus *et* Striatifera*), a veces en lumaquelas y por tanto difícilmente identificables (Fig. 5c), o más reducido (*Productus, Echinoconchella, Fluctuaria *y* Buxtonia*). Están asociados a athyrididos (*Actinoconchus, Composita*) y espiriféridos esencialmente lisos y de talla pequeña*

*(*Reticularia, Martinothyris y Phricodothyris*). A techo de esta unidad, aparecen unos dos metros de facies nodulosas que continen corales solitarios y raramente coloniales : es el sustrato de la unidad siguiente (Fig. 5d, e, f).*

*La unidad media, biostroma de corales (Fig. 6, 10), con espesor de 10 metros y comenzando por un horizonte delgado de caliza bioclástica con faunas variadas, entre ellas corales solitarios y coloniales (Fig. 6 a, b). Le sigue un biostroma de corales coloniales (*Siphonodendron, Diphyphyllum et Lithostrotion*) en posición de vida (Fig. 6c). Los espacios (de 0.3 a 1.2 m de largo) entre las colonias se completan con calizas bioclásticas que contienen fragmentos de coral, algunos braquiópodos y lamelibranquios (Fig. 6d). Hacia el techo de esta unidad, en el seno de las calizas bioclásticas y oolíticas, los corales coloniales pasan a ser raros mientras que aparecen formas solitarias complejas con coralitos de más centímetros de diámetro (*Palaeosmilia y Aulophyllidae*) (Fig. 6 e), así como giganto-prodúctidos aislados (*Gigantoproductus flamandi*), (Fig. 6f).*

La unidad superior post-biostroma (Fig. 7) tiene un espesor de al menos 30 metros. Sobre la superficie ondulada del techo de la unidad precedente (Fig. 7a), un primer nivel de calizas margosas nodulosas (1.5 a 2 metros) está seguida de calizas con corales solitarios (Fig. 7b, c); y después por calizas bioclásticas, crinoidales, a veces dolomíticas y que contienen todavía algunos corales solitarios (Fig. 7d); los cuales se vuelven más raros conforme se asciende a lo largo de la serie, donde todavía se encuentran de manera excepcional los últimos corales coloniales de pequeño tamaño (Fig. 7 e). Las faunas asociadas están diversificadas: gasterópodos, ammonoideos. Los braquiópodos, bastante abundantes, particularmente en asociación con los corales, presentan algunas diferencias en relación con las asociaciones de la unidad inferior. Entre los productidos, las formas de gran talla se vuelven más raros: persistencia de algunos Datangia *y* Striatifera, *pero desaparición probable de los* Gigantoproductus *y* Latiproductus. *Otros productidos de talla media, comunes en el Viseense superior también están presentes:* Productus *sensu stricto y* Pugilis. *Entre los espiriféridos, las formas con ornamentación estriada, comunes en el Viseense superior pero aparentemente ausentes en la unidad pre-biostroma, si están presentes aquí:* Anthracothyrina *y* Brachythyris*. Algunas lumaquelas de pequeños braquiopodos están desarrollados e incluyen principalmente representantes del género* Composita (*Fig. 7f).*

Por último, hacia el techo de la unidad post-biostroma, en las calizas y dolomías con sílex (nódulos u horizontes litificados) no contienen más que faunas muy reducidas: troncos y placas de equinodermos y algunos braquiópodos indeterminables.

Repartición y diversidad de las faunas

Los braquiópodos (Fig. 8, 9) son los macrofósiles dominantes, excepto en el biostroma de la unidad media. Abajo, y por debajo del biostroma, los corales (Fig. 10) son localmente abundantes, pero frequentemente difíciles de extraer de las calizas. Las faunas accesorias son de ammonoideos, gasterópodos, lamelibranquios, briozoos y equinodermos. Foraminíferos, ostrácodos y algas calcareas también han sido reconocidos en sección.

Paleoambientes. Las facies son esencialmente calizas, bioclásticas y oolíticas, locamente con estratificaciones cruzadas, con macro-faunas frequentemente fragmentarias, de lumaquelas y braquiópodos. Indicando, para los cortes estudiados, ambientes de plataforma media abierta o de margen de plataforma, situada a veces bajo la acción de olas de tempestad. Algunos bancos calizos y las intercalaciones margosas en la unidad inferior revelan episodios de baja energía.

El biostroma de coral presenta una cierta estabilidad, con resistencia a las tempestades, de modo que muestra la coexistencia de colonias in situ con detritos de organismos. Está formado entre la interfase de la rampa media y la profunda. Se trata de un « autoparabiostroma » : término creado por S. Kershaw, designando un ambiente intermedio entre « autobiostroma » donde los organismos constructores están en el sitio, y el « parabiostroma », constituido por detritos de biostroma. En las secciones estudiadas en el flanco septemtrional de Djebel Arhlal, las colonias coralinas están relativamente espaciadas entre ellas, y su desarrollo parece limitado en duración. No se trata pues de otra barrera arrecifal en este sector.

Conclusión

El biostroma de coral colonial del Serpukhoviense superior localizado en el flanco norte de Djebel Arhlal es muy diferente de los espectaculares edificios arrecifales de edad viseense superior descritos en el sector oriental de la Cuenca de Béchar: biohermos de estructuras complejas de briozoos fenestelidos , espongiarios, algas y corales coloniales. La composición y la estructuración del biostroma de coral colonial descrinto en la Cuenca de Tindouf son muy diferentes de los obserbados en la Cuenca de Béchar. Estos son ejemplos de dos tipos de biostromas de corales coloniales que se formaron bajo diferentes contextos tecto-sedimentarios.

Diversos biostromas de corales han sido descritos en el Viseense de Europa occidental (Bélgica, Islas Británicas, España), y de Donetz, pero ninguno se ha identificado en el de Djebel Arhlal, sea por organismos constructores diferentes, más diversificados, sea por las diferencias de densidad de corales y de espesor del biostroma.

Otros biostromas brevemente mencionados en la literatura en las capas misisipienses de la Cuenca de Béchar, por ejemplo en Hassi Arhlal y Djebel Horreit, necesitan ser estudiados en profundidad para caracterizar mejor los bioconstructores coralinos de la cuenca y del Sahara argelino.

Introduction

Sedimentary rocks of Carboniferous age are known from several basins of the Sahara Platform (e.g. Conrad, 1985). The most complete and best-studied succession is that of the Béchar Basin. In this region, Carboniferous strata crop out along a ca. 120 km-long N-S transect (Fig. 1). The oldest Carboniferous rocks of Tournaisian age are found in the southern part of the basin in the region of Beni Abbès. The succession becomes progressively younger and the northern part of the basin attains a Bashkirian age, which is still found in the Djebels Antar and Horreit. Northwards, the basin is covered by Mesozoic strata.

Lemosquet and Pareyn (1985) proposed a lithostratigraphical division into three groups. The lower group, also called "Les Calcaires détritiques et périrécifaux de la Zousfana" (biodetrital and peri-reefal limestones of the Zousfana) consists of alternations of often fine-grained siliciclastic rocks and carbonates (mainly limestone). It is composed of 13 formations, which range from the Tournaisian to the Serpukhovian. Limestone with recurring intervals of siliciclastic intercalations dominates the middle group, also called "Les Calcaires du Djebel Béchar" (Limestone of the Djebel Béchar). This group comprises three formations dated as late Serpukhovian to Bashkirian. The upper group comprises almost exclusively siliciclastic rocks. The lower part of that group, the Kenadza Formation, is still fully marine, whereas the upper two formations were deposited in a continental setting. The age of this group is Moscovian for the marine deposits and Permo-Stephanian for the youngest continental deposits.

For the purpose of this study, the lower group is of special interest. Forerunners for the development of a carbonate platform are known in the lower Viséan. During late Visean and Serpukhovian times, this carbonate platform flourished and several reef episodes are known (Pareyn, 1961). The reefs dominated by calcimicrobes and sponges in the eastern part of the basin have been described in more detail (Bourque *et al.,* 1995, Madi *et al.,* 2000). Semenoff-Tian-Chansky (1974, 1985) reported the presence of rugose corals in those reefs, and localized coral build-ups and biostromes in the Djenien Formation (upper Serpukhovian) in other parts of the basin. He mentioned "countless colonies forming biostromes towards the top of the formation" and figured some samples from the "Arhlal" sector (Semenoff-Tian-Chansky 1985, p. 376, Pl. 14 fig. 4, 5). Detailed descriptions of these coral horizons are lacking, which results in the very limited knowledge of these structures and clearly hampers the development of palaeoenvironmental or palaeoecological interpretations. It might be even questionable if the term 'biostrome' refers to a bioconstructional activity or only denominates limestone somewhat richer in corals.

The Djenien Formation (Pareyn, 1961; Semenoff-Tian-Chansky, 1974) in its classical outcrop 7 km south-east of Béchar is currently not accessible. The 175 m-thick formation is there two-folded. An alternation of shale, sandstone, and limestone forms the older

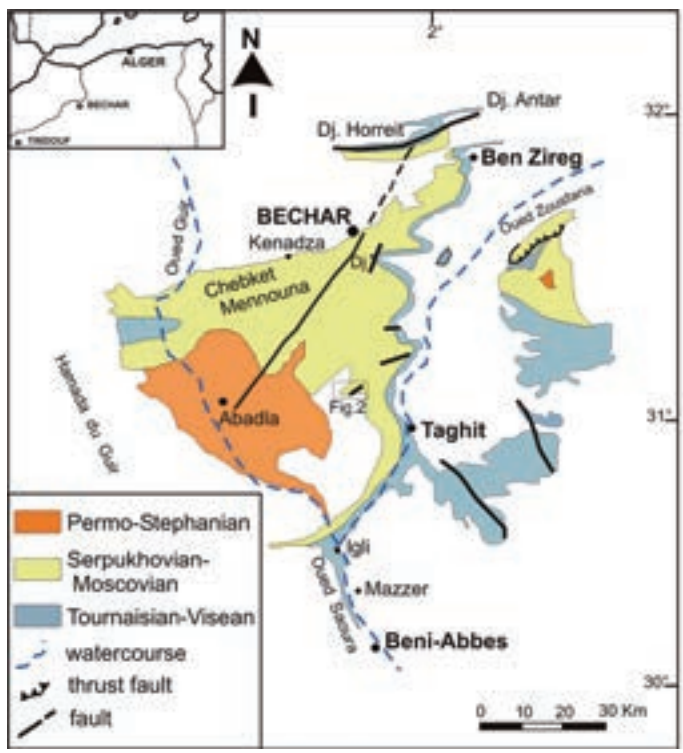

Figure 1. Simplified geological map for the Carboniferous strata of the Béchar Basin (modified from Fabre and Kazi-Tani, 2005). The inset indicates the position of Figure 2.

Figura 1. *Mapa geológico simplificado del Carbonífero de la Cuenca de Béchar (modificado de Fabre y Kazi-Tani, 2005). El recuadro indica la localización de la Figura 2.*

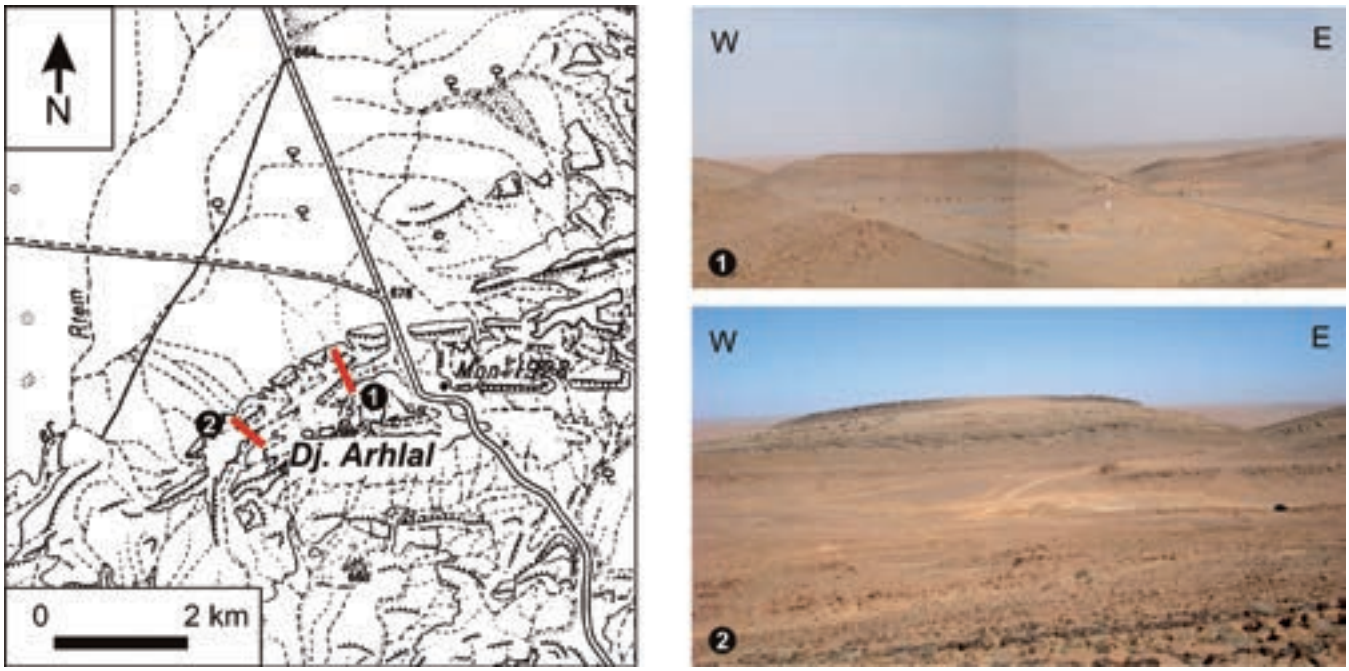

Figure 2. Left: Localisation of the studied sections on the topographic map Menouarar (1:100,000) and field photographs of the studied section at Djebel Arhlal. Main section (1) 31°5'10.41"N, 2°13'48.91"W, to 31°4'52.60"N, 2°13'38.50"W, additional section (2) 31°4'46.65"N, 2°14'34.31"W to 31°4'37.73"N, 2°14'20.82"W. Right: Photographs for the general overview of the studied sections. Note that the Béchar-Taghit road is clearly visible in the top right photo.

Figura 2. *Localización de las secciones estudiadas sobre el mapa topográfico Menouarar (1:100.000). Sección principal (1) 31°5'10.41"N, 2°13'48.91"W, à 31°4'52.60"N, 2°13'38.50"W. Sección secundaria (2) : 31°4'46.65"N, 2°14'34.31"W to 31°4'37.73"N, 2°14'20.82"W. Derecha: fotografías de Djebel Arhlal correspondiente a las dos secciones. Destaca la carretera Béchar-Taghit que se observa en la parte superior derecha de la fotografía.*

Hid el Kef member, which is topped by the massive peri-reefal limestone, sometimes dolomitized or containing chert, of the Djenien member. The top of the Djenien Formation is characterized by a remarkable karst surface, from which "Neptunian dykes" reach up to 30 m down into the Djenien member (Lemosquet and Pareyn, 1985). The Serpukhovian-Bashkirian boundary is recorded in the lower member of the following Tagnana Formation (Weyant, 1982).

In this paper the most southern coral biostrome of late Serpukhovian age in the western part of the Béchar Basin is described and analyzed. It is the aim of this paper to study the spatio-temporal distribution of the benthic macrofauna in and around the biostrome *sensu stricto*. A special focus will be on the two dominant groups, the brachiopods and the rugose corals. In descending order of abundance these two groups are associated to echinoderms, gastropods and bryozoans.

Setting

The Djebel Arhlal is situated about 30 km NNW of the town of Taghit and about 55 km south of Djenien; it is crossed by the RN 110 Béchar–Taghit road (Fig. 2). Dominant morphological elements are roughly W-E orientated ridges and crests, which are typical for the northern prolongation of the Taghit Plateau. The Djebel Arhlal comprises the most southern exposures of the upper Serpukhovian strata in the Béchar Basin. They are found on the northern and southern limbs of a large anticline, which correspond to the above-mentioned crests and ridges. Although easily accessible, the region has only rarely been studied. Lithostratigraphical and biostratigraphical data are found in Pareyn *et al.* (1971), Legrand-Blain (1985), Sebbar (1986), Sebbar and Lys (1989) and Atif (2012). Pareyn *et al.* (1971) indicated that the Djebel Arhlal region is one of the key regions for studying the important lithological changes found in the latest Serpukhovian in the Béchar Basin. They reported the presence of incised valleys with depths of up to 100m, attaining the carbonates of Djenien Formation: in a section (n° 21) located near Hassi Arhlal, about 2 km NNE of the eastern extremity of the northern limb of Djebel Arhlal. The palaeovalleys are filled with mainly detrital rocks of the Tagnana Formation.

The Djenien Formation, which contains a well-exposed coral biostrome in its upper part, has been studied in two roughly NNW-SSE orientated sections on the northern limb of the anticline at Djebel Arhlal (Fig. 2). The main section is located about 0.6 km west of the road Béchar-Taghit (Figs. 2, 3). A second section has been studied laterally to the main section about 2 km west of the road. In these sections, Quaternary deposits cover the top of Djenien Formation and the Djenien–Tagnana boundary.

The Djenien Formation is a stratigraphically important marker horizon for the upper Serpukhovian in the Béchar Basin. Biostratigraphical data are available for different groups. Using ammonoids Manger *et al.* (1985) attributed the formation to the *Delepinoceras* Zone (E 2b-c). Conodonts indicate the *Adetognathus unicornis* Zone (Weyant, 1982), foraminifers the base of the *Neoarchaediscus postrugosus* Zone (Cfa 8) (Sebbar, 2006). Semenoff-Tian-Chansky (1985) placed the Djenien Formation on the top of the local coral zone 3a. Brachiopods, especially gigantoproductides (*Gigantoproductus flamandi*) and spiriferides (*Anthracothyrina bressoni*) are characteristic for the late Serpukhovian of the Sahara Platform (Legrand-Blain, 1986, 1987; Atif and Legrand-Blain, 2011).

Studied outcrops

In the main section the Djenien Formation is 128 m-thick. Greenish shale, with intercalated crinoidal limestone beds containing fragments of ammonoids, bryozoans and solitary rugose corals make up the lower part of the 62 m-thick Hid El Kef Member. A cliff of crinoidal limestone, partly oolithic and bioclastic,

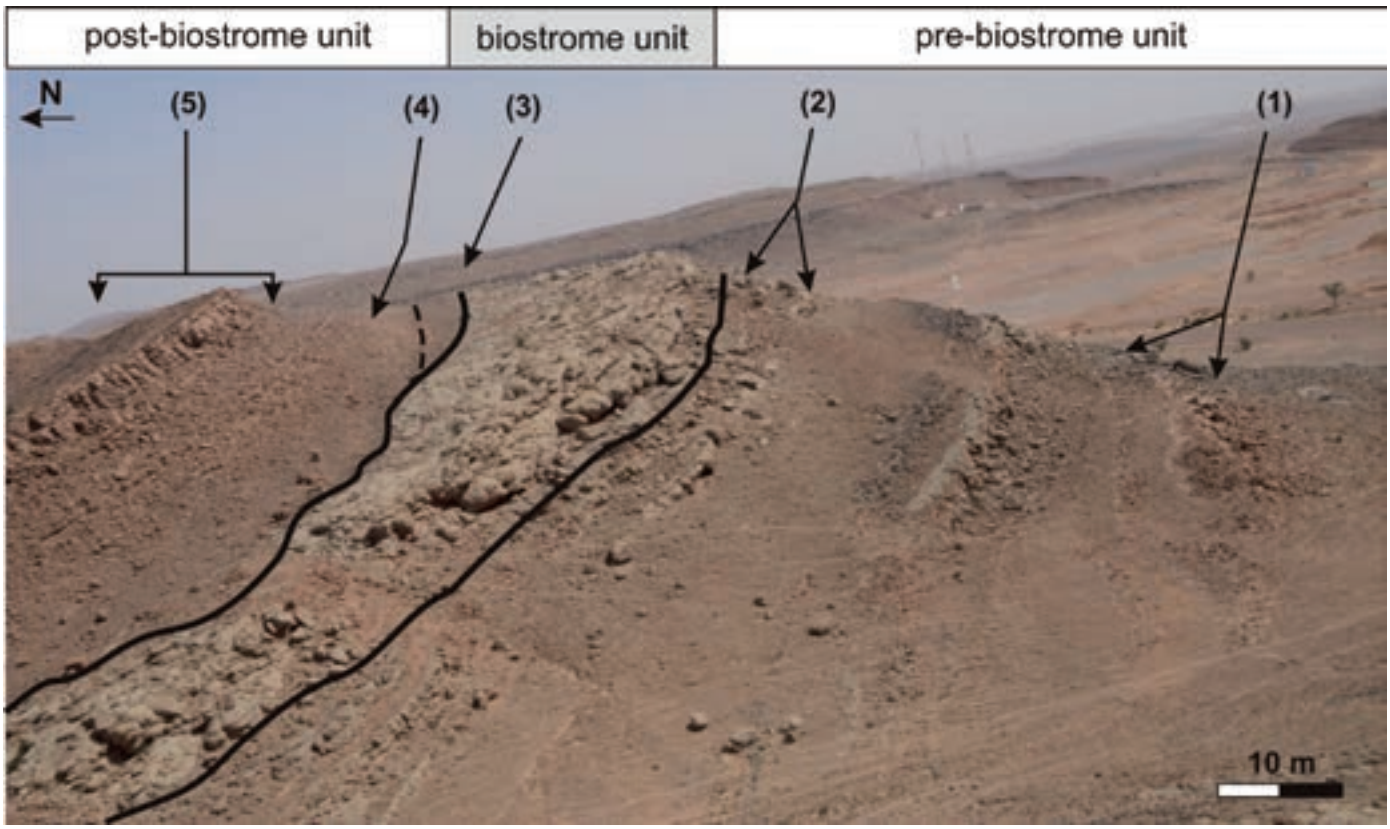

Figure 3. Overview on the main studied section at Djebel Arhlal clearly showing the undulating upper surface of the biostrome. Lower unit: (1) oolithic limestone with gigantoproductids; (2) nodular to pseudo-nodular limestone. Middle unit: (3) horizon with solitary rugose corals and gigantoproductids at the top of the unit: Upper unit: (4) brecciated level with solitary corals, (5) cherty limestone. Dotted line indicates marly lenses on top of the biostrome.

Figura 3. *Vista general de la sección principal estudiada en Djebel Arhlal mostrando claramente la superficie ondulante del biostroma. Unidad inferior: (1) calizas oolíticas con gigantoproductidos; (2) calizas nodulosas a seudo-nodulosas. Unidad media: (3) horizontes con corales rugosos solitarios y gigantoproductidos al techo de la unidad. Unidad superior: (4) nivel brechificado con corales solitarios, (5) calizas con sílex. La línea punteada indica lentes margosas a techo del biostroma.*

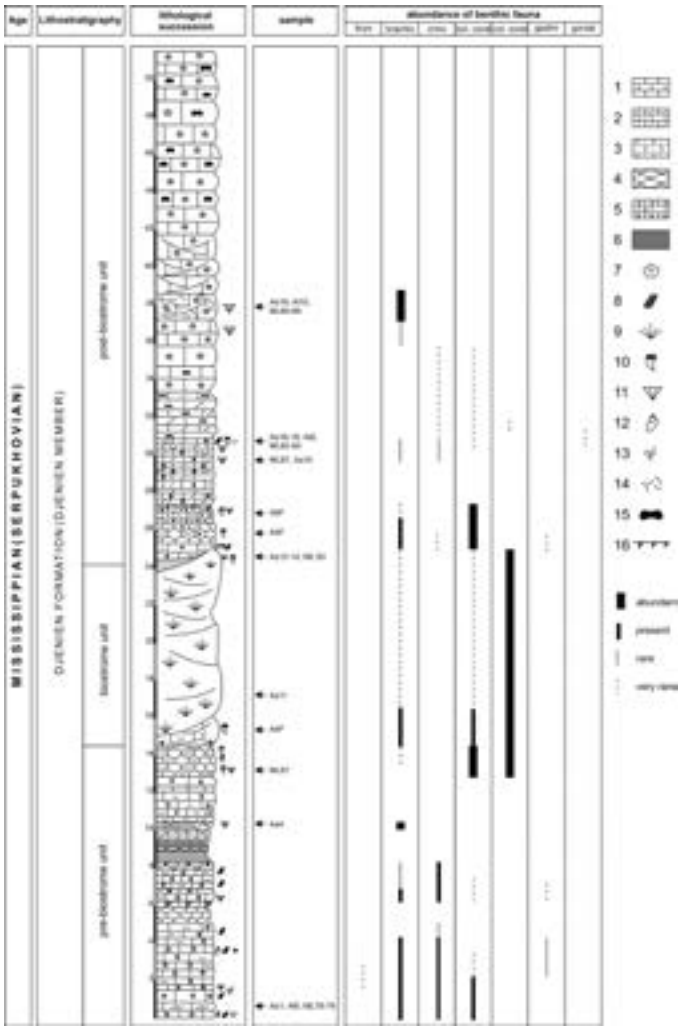

Figure 4. Detailed log of the main section with the main stratigraphical, lithological and palaeontological characteristics. (1) limestone, (2) dolomitic limestone, (3) oolithic limestone, (4) pseudonodular limestone, (5) coral-dominated limestone, (6) marls, (7) isolated echinoderm plate, (8) echinoderm: steam element(s), (9) colonial rugose coral, (10) solitary rugose coral, (11 brachiopod, (12) gastropod, (13) bryozoan, (14) coquina, (15) chert (bedded or isolated nodule), (16) bioturbation. bryo= bryozoans, brachio = brachiopods, crino = crinoids, sol. coral = solitary rugose corals, col. coral = colonial rugose corals, gastro = gastropods, goniat = ammonoids

Figura 4. *Perfil detallado de la sección principal: caracteres estratigráficos, litológicos y paleontológicos. (1) caliza, (2) caliza dolomítica, (3) caliza oolítica, (4) caliza seudo-nodulosa, (5) caliza de coral, (6) marga, (7) placa de equinodermo, (8)* vástago *de eqinodermo, (9) tetracoral colonial, (10) tetracoral solitario, (11) braquiópodo, (12) gasterópodo, (12) briozoario, (14) lumaquela, (15) sílex, (16) bioturbación. Bryo = briozoos, brachio =braquiópodos, crino = crinoides, sol. coral = tétracorales solitarios, col. coral = tetracorales coloniales, gastro = gasterópodos, goniat = ammonoideos.*

with gigantoproductid brachiopods, and few solitary corals and ammonoids forms the upper part of the Hid El Kef Member.

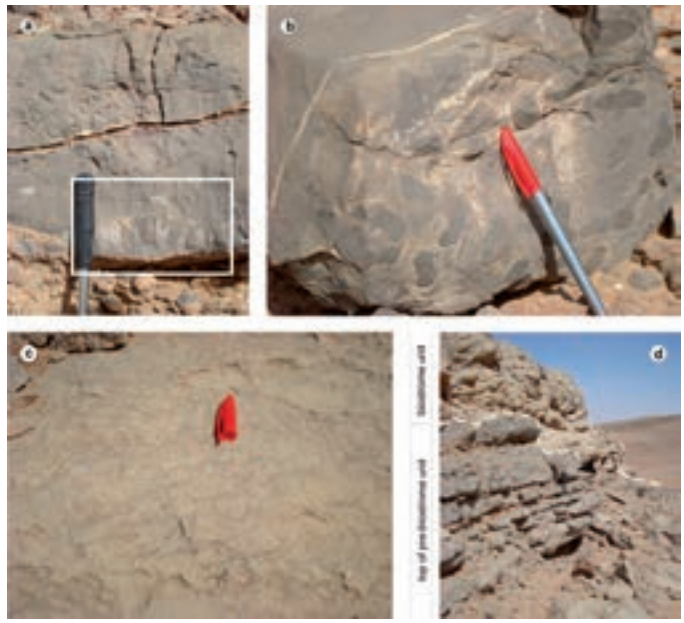

Figure 5. Overview on the facies of the pre-biostrome unit. a. Bioturbation in oolithic crinoidal limestone (6m above base of the section). b. Close-up view of a. c. Coquina of Gigantoproductids (level As4, 10m above base of the section). d. Boundary (dotted line) between the pseudo-nodular limestone rich in corals and brachiopods of the pre-biostrome unit and the internally bedded coral autoparabiostrome (15 m above base of the section).

Figura 5*. Aspectos sobre las facies de la unidad pre-biostroma. a. Bioturbaciones en una caliza oolítica crinoidal (6 m sobre la base de la sección). b. Vista ampliada de a. c. Lumaquela de gigantoproductidos (nivel As4, 10 metros por encima de la base de la sección). d. Límite (línea punteada) entre la caliza seudo-nodular ricas en corales y braquiópodos de la unidad pre-biostroma y el autoparabiostroma coralino con estratificación interna (15 m por encima de la base de la sección).*

The following Djenien member is 52 m to 66 m-thick according to different sections and can be divided into three units (Fig. 3, 4; Atif, 2012).

The lower unit (pre-biostrome unit) is 14 m-thick and composed of thin- to medium-bedded limestone and few intercalated marly horizons (Fig. 5). The limestone is crinoidal, oolithic or bioclastic, and especially in the upper part of the unit it becomes pseudo-nodular. Bioclastic and oolithic grainstone, which contain peloids, dominate the lower part of the unit. Locally marly bioturbated levels occur (Fig. 5a, b), and nodular or brecciated facies. Ostracods, foraminifers, bryozoans, echinoderms, gastropods, bivalves and brachiopods (productides - especially gigantoproductides -, athyrides, spiriferides, spiriferinides), and some calcareous algae have been found in this unit. Several horizons contain brachiopod coquinas (Fig. 5c).

Nodular facies have developed in the last 2 metres of the unit. This nodular to pseudo-nodular limestone

is grey to dark and comprises numerous solitary and colonial corals. The preservation of the corals on the bed surfaces is poor (Fig. 5d). This package of nodular facies is the substratum of the biostrome in the following unit.

The middle unit (biostrome unit) is 10 m thick. It starts with a 0.4–0.8 m thick horizon of bioclastic limestone rich in bivalves, brachiopods and solitary rugose corals. Colonial rugose corals are sparse at the base, but their abundance steadily increases throughout the horizon (Fig. 6 a, b, c). This is topped by a coral biostrome composed of colonies of *Siphonodendron, Diphyphyllum* and *Lithostrotion*. These colonies are in growth positions and reach sizes of several decimetres in diameter and height. The distances between colonies vary between 30 cm to 120 cm. Growth forms are very variable and vary from unidirectional upward growth to more concentric growth patterns. Some bivalves and brachiopods can be found next to the colonies. This facies dominated by *in situ* colonies is the constructive backbone of the biostrome. In between the *in situ* facies, patches of bioclastic facies containing large and small colony fragments (Fig. 6d) exist indicating periodic and partial reworking of the biostrome.

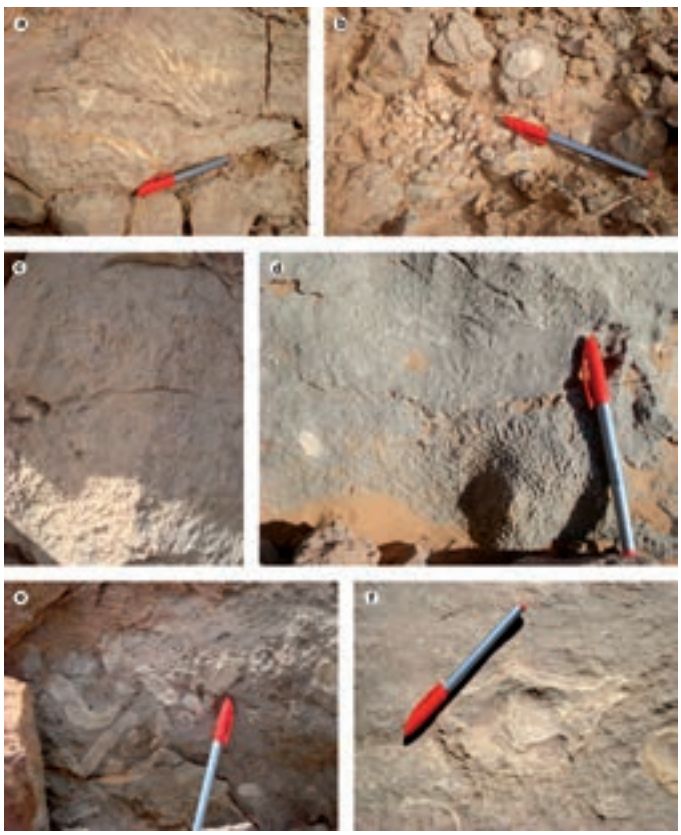

Figure 6. a-b. Overview on the facies of the biostrome unit. Small fasciculate corals (Siphonodendron?) from the base of the biostrome. (A4F, 15 m above base of the section), c. Large fasciculate colonial coral in the middle part of the biostrome (As11; 18 m above base of the section). d. Colonial coral surrounded by coarse bioclastic sediments (22 m above base of the section). e.-f. Uppermost beds of the biostrome (As 12-13-14, 25 m above base of the section). e. Large solitary corals f. shell of Gigantoproductus.
Figura 6. *a-b. Aspectos de las facies de la unidad biostroma. Pequeños corales fasciculados (*Siphonodendron *?) en la base de biostroma (A4F, 15 m por encima de la base de la sección. c. Coral colonial fasciculado de gran tamaño en la parte media del biostroma (As11 ; 18 m por encima de la base de la sección). d. Coral colonial rodeado de sedimentos bioclásticos gruesos (22 m por encima de la base de la sección). e.f. Al techo del biostroma (As 12, 13, 14, 25 m por encima de la base de la sección). e. grandes corales solitarios, f. concha de* Gigantoproductus.

Towards the top of the unit (last 1.5 to 2 m) the colonial coral abundance decreases drastically. The facies is essentially bioclastic and oolithic. It contains gigantoproductides (*Gigantoproductus flamandi*) and aulophyllids (e.g. *Dibunophyllum* and *Clisiophyllum)* become dominant among solitary rugose corals (Fig. 6e, f).

The upper surface of the middle unit undulates. The base of the upper unit (post-biostrome unit), where the thickness varies between 1.6 and 2 m, is composed of marls and argillaceous nodular limestones; both lithologies are often lenticular (Fig. 3, 7a, b). These rocks already belong to the upper unit (post-biostrome unit). Above this basal horizon follow more than 25 m of brecciated (Fig. 7b, c), crinoidal and dolomitic limestone. Large solitary corals are relatively abundant in the lower part of the unit, but become progressively rare up-section. Colonial corals are only rarely found in a single horizon (Fig. 7e) just below the onset of bioclastic facies (Fig. 7d). Associated fauna contains gastropods, ammonoids, and brachiopods. Spiriferides, productides, and athyridides dominate the latter. A remarkable horizon is the *Composita* coquina (Fig. 7f). Chert-bearing limestone characterizes the upper part of the unit. Cherts occur as larger nodules or bedded chert horizons. The macrofauna in this cherty facies is restricted to widespread fragments of echinoderms (steams and isolated plates), and diverse brachiopods.

Faunal distribution and diversity

Brachiopods are the dominant macro-organisms in the studied sections, although rugose corals dominate in specific horizons. Accessory fauna comprises ammonoids, gastropods, bivalves and bryozoans. Thin section analyses reveal the presence of different carbonate microorganisms (foraminifers, ostracods

and calcareous algae), as well as a diversified spectrum of fragments of larger organisms. Especially the fragments of echinoderms are widespread (steams and isolated plates). Overall, diversity in the lower and upper units is higher than that in the middle unit. This trend correlates well with the facies variability observed in these units.

The lower unit comprises a very diverse brachiopod fauna (Fig. 8). In total there are at least 19 genera. An even larger diversity may be hidden in several brachiopod coquinas, since the preservation of this material did not allow a precise identification. Productides, which are represented by *Krotovia, Semicostella, Productus, Buxtonia, Echinoconchus, Echinoconchella, Fluctuaria, Gigantoproductus, Beleutella, Datangia, Latiproductus, Striatifera,*

Figure 7. Overview on the facies of the top of the biostrome unit and the post-biostrome unit. a. Upper irregular surface of the biostrome (white dashed line) (25 m above base of the section). b.-c. Breccia at the base of the post-biostrome unit containing numerous solitary corals (A6F, 25 m above base of the section). d. Bioclastic limestone containing crinoids (cr), brachiopods (br) and solitary corals (ps), some metres above the biostrome (As16, 31 m above the base of the section). e. Uppermost small fasciculate colonial coral above the biostrome (As16-18, 31 m above the base of the section). f. Coquina of Composita in the chert-bearing limestone characteristic for the middle and upper part of the unit (As19, 31 m above the base of the section).

Figura 7. *Aspectos de las facies del techo de la unidad biostroma y de la unidad post-biostroma. a. Superficie superior irregular del biostroma: línea blanca discontinua (25 m por encima de la base de la serie). b.-c. Brecha en la base de la unidad post-biostroma, conteniendo numerosos corales solitarios (A6F, 25 m por encima de la base de la sección). d. Caliza bioclástica con crinoides (cr), braquiópodos (Br) y corales solitarios (Ps), algunos metros por encima del biostroma (As16, 31 m por encima de la base de la sección). e. Última pequeña colonia coralina por encima del biostroma (As16, 31 m por encima de la base de la sección). f. Lumaquela de* Composita *en las calizas con sílex e. Última pequeña colonia debajo del biostroma (As16 18, 31 m debajo del muro del corte). f. Lumaquela de* Composita *en las calizas con silex característicos de los niveles medios y superiores de la unidad (As19, 31 m por encima de la base la sección).*

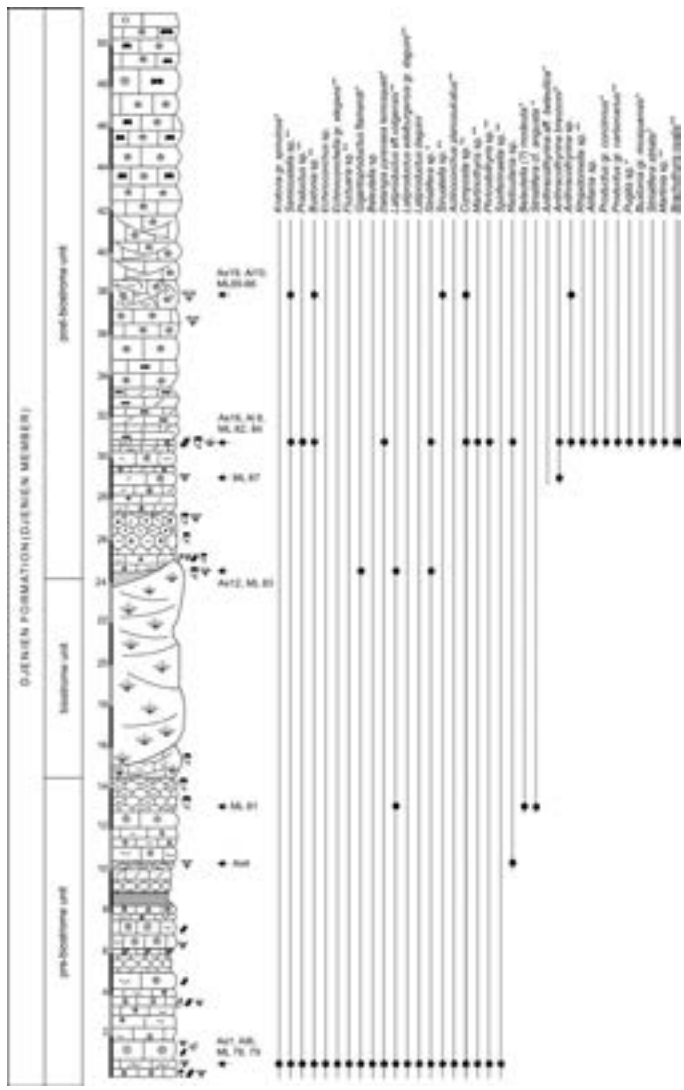

Figure 8. Brachiopod distribution in the Djenien Formation, Djenien member, at Djebel Arhlal, northern limb. *data from Legrand-Blain (1985), ** data from Atif (2012).

Figura 8. *Distribución de braquiópodos en la Formación de Djenien, Miembro de Djebel, en el flanco norte de Djebel Arhlal: * datos de Legrand-Blain (1985), ** datos de Atif (2012).*

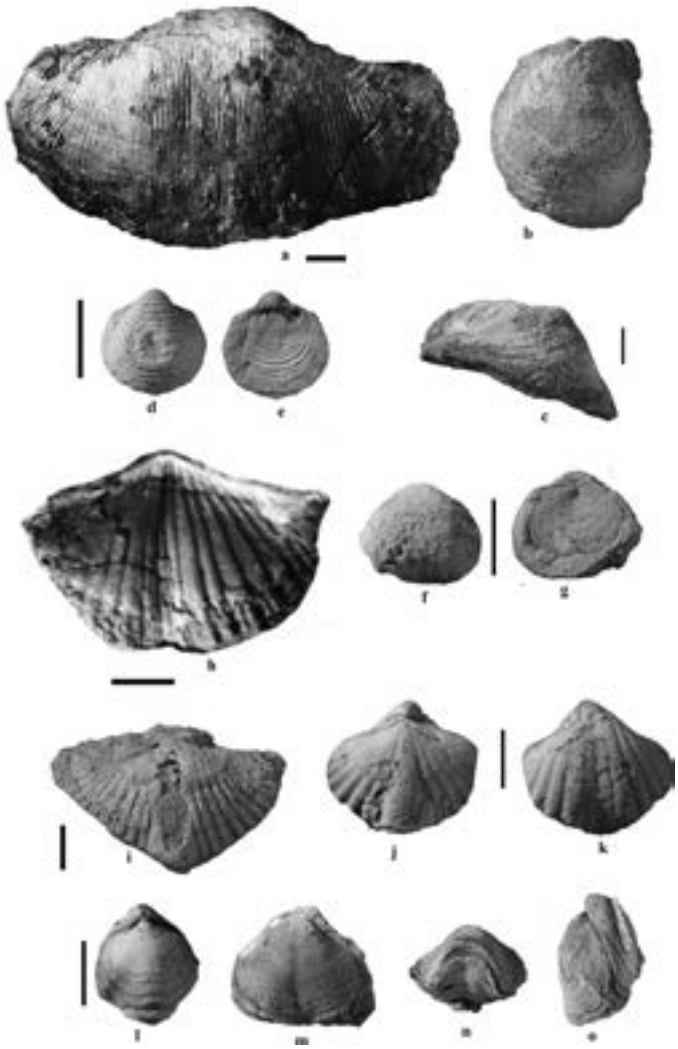

Figure 9. Brachiopods from the Djenien Formation, Djenien member, at Djebel Arhlal, northern limb. Scale bar = 1 cm. a-e : pre-biostrome unit. a. Latiproductus daguini Legrand-Blain, 1981. ML 79 a 2, figured in Legrand-Blain (1981), pl.4, Fig. 1. b-c. Striatifera sp. Al 6 c1, in : b, ventral ; c lateral views. d-e. Echinoconchella gr. elegans (M'Coy, 1844). Al 6 e1, d, ventral ; e, dorsal views. f-o: post-biostrome unit. f-g. Productus gr. carbonarius de Koninck, 1842. Al 8 j1, in : f, ventral; g, dorsal views. h. Anthracothyrina bressoni Legrand-Blain, 1986. ML 82 g 4, figured Legrand-Blain (1986) pl.4, Fig. 13. i. Anthracothyrina sp. Al 8 a2. j-k. Brachythyris ovalis (Phillips, 1836). Al 8 b1, in: j, dorsal ; k, ventral views. l-o. Composita sp. Al 10, in: l, dorsal ; m, ventral ; n, frontal ; o, lateral views.

***Figura 9**. Braquiópodos de la Formación Djenien, Miembro de Djenien. Djebl Arhlal, flanco norte. Barra de escala = 1 cm. a-e: unidad pre-biostroma. a.* Latiproductus daguini *Legrand-Blain, 1981. ML 79 a2, figura por Legrand-Blain (1981), pl.4 fig. 1. b-c.* Striatifera sp. *Al 6 c1 ; vistas : b, ventral ; c, lateral. d-e.* Echinoconchella gr. elegans (*M'Coy, 1844). Al 6 e1 ; vistas : d, ventral ; e, dorsal. –f-o: Unidad post-biostroma. f-g.* Productus gr. carbonarius *de Koninck, 1842. Al 8 j1 ; vistas : f, ventral; g, dorsal. h.* Anthracothyrina bressoni *Legrand-Blain, 1986. ML 82 g 4, figura por Legrand-Blain (1986, pl.4, fig. 13). i.* Anthracothyrina sp. *Al 8 a2. j-k.* Brachythyris ovalis *(Phillips, 1836). Al 8 b1 ; vistas : j, dorsal ; k, ventral. l-o.* Composita *sp. Al 10 ; vistas: l, dorsal ; m, ventral ; n, frontal ; o, lateral.*

and *Sinuatella*, largely dominate the assemblages. Athyridides (*Actinoconchus* and *Composita*) and spiriferides (*Martinothyris, Phricodothyhris, Reticularia*) and spiriferinides (*Spiriferinaella*) are less common.

Rugose corals are rare in the lower unit. The basal horizon contains *Aulophyllum fungites*, and the nodular facies some indeterminated dissepimented solitary rugose corals.

Brachiopods in the middle unit (Fig. 8) are found as fragments in the bioclastic facies between the coral colonies or better preserved in the association with large solitary rugose corals in the top of the unit. Compared to the lower unit the diversity is low and restricted to large-sized productides (*Gigantoproductus, Latiproductus,* and *Striatifera*).

The highest coral diversity is found in the middle unit (Fig. 10). A dozen species of medium- to large-sized solitary and colonial rugose corals can be identified. Diversity is highest below and above the biostrome, thus in the firm ground and capping bed facies. The sampling of the colonial corals in the massive limestones of this unit has been particularly difficult, and thus the diversity of these forms is most likely underestimated. In the capping bed facies, some clusters of solitary rugose corals may represent fragments of colonial forms like (*Corwenia* or colonial forms resembling '*Koninckophyllum'*). However, the current sampling does not allow a clear determination and so far these forms are treated as solitary corals.

In the upper unit the abundance and diversity of brachiopods (Fig. 8) increases towards the top of the unit. Spiriferides become locally abundant. The overall diversity is more than 10 genera belonging to the orthides (*Rhipidomella*), productides (*Semicostella, Productus, Buxtonia, Datangia, Striatifera, Alitaria,* and *Pugilis*), and spiriferides (*Anthracothyrina* and *Brachythyris*).

The upper unit contains mainly solitary rugose corals. Unidentified fasciculate colonial corals (probably *Siphonodendron* or *Diphyphyllum* sp.) occur very rarely. Coral occurrences are restricted to the lower part of this unit, they vanish away where chert facies settles.

Palaeoenvironmental considerations

Widespread oolithic and bioclastic facies, brachiopod coquinas, often fragmented macrofauna, channelized and/or cross-stratified beds, the presence of calcareous algae, and the absence of carbonate mud in many of the carbonates clearly indicate conditions typical for open-marine platform interior or platform margin environments with significant sediment

remobilisation due to wave and storm activities. The presence of marls in the lower unit indicates occasional times of low energy outer-platform conditions. So far the source of the cherts is unidentified, but surrounding sediments are still dominated by grainstone and packstone texture. The numerous facies changes in the studied section, these environments have rarely been stable for a long time.

A high proportion of *in situ* assemblages can be assumed only in the case of the coral biostrome. This biostrome displays a coral framework, which had some resistance to higher energy levels, as seen in the coexistence of colonies in place and storm-related debris, but not on a very large scale. According to the mixture of the *in situ* and reworked material is an internally thick-bedded coral autoparabiostrome (classification after Kershaw, 1994). There are no evidences that on a smaller scale, coral patch-reefs formed within the biostromal unit. The distances between individual coral colonies are too far to assume any localized important framework building in this unit. There is also no correlation between the wavy upper surface of the biostrome and the presence of *in situ* colonies. Although the autoparabiostrome is

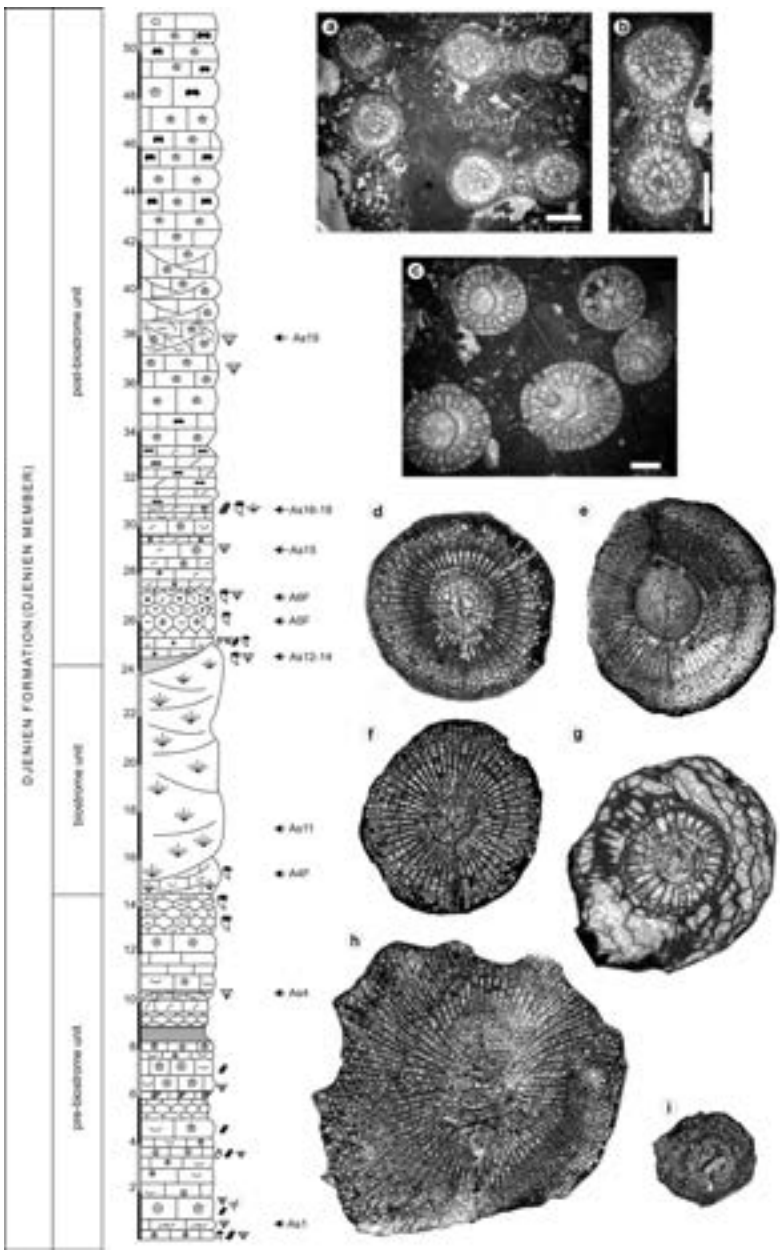

Figure 10. Rugose corals from the Djenien Formation, Djenien member, at Djebel Arhlal, northern limb. Positions of sampled coral occurrences are indicated along the log. a. Siphonodendron cf. dutroi Armstrong, 1972 from horizon As 13. The species was figured by Semenoff-Tian-Chansky (1985, pl. 14, Fig. 5) from contemporaneous strata from nearby Hassi Arhlal: 8 km to the E-NE of the main section at Djebel Arhlal. The specimens found in the studied biostrome may belong to Siphonodendron tindoufense Rodriguez *et al.,* 2013, but further studies are needed to decide if the Bechar specimens can be ranged in that species. b. close-up of a. c. Diphyphyllum cf. furcatum Hill, 1840 from horizon As 14. Note that Semenoff-Tian-Chansky (1985, pl. 14, Fig. 4) figured Diphyphyllum cf. lateseptatum (McCoy, 1849) from the Djebel Arhlal. Scale bars for a-c = 2 mm. d. Dibunophyllum bipartitum (McCoy, 1849), horizon A5F, e. Aulophyllum fungites (Fleming, 1828), horizon As1. f. Clisiophyllum? sp., horizon As15. g. Axoclisia sp., horizon A4F. h. Palaeosmilia sp., horizon As11. i. Koninckophyllum sp., horizon A5F. d.-i: x1,5

Figura 10. *Tetracorales de la Formación de Djenien, Miembro de Djenien, a Djbel Arhlal, flanco norte. Las posiciones de los horizontes que condicionan los corales están indicados al lado del perfil estratigráfico. a.* Siphonodendron cf. dutroi *Armstrong, 1972 del horizonte As 13. La misma especie fue descrita por Semenoff-Tian-Chansky (1985, pl. 14, Fig. 5) en estratos de la misma edad en Hassi Arhlal : 8 km al E-NE de la sección principal de Djebel Arhlal. Los especímenes encontrados en el biostroma estudiado pueden ser de* Siphonodendron tindoufense *Rodriguez et al., 2013, pero serán necesarios estudios en profundidad para saber si esta especie existía en la Cuenca de Béchar. b. ampliación de a. c.* Diphyphyllum *cf.* furcatum *Hill, 1940 en el horizonte AS 14. Es necesario destacar que Semenoff-Tian-Chansky (1985, pl. 14, Fig. 4)* Diphyphyllum *cf.* lateseptatum *(McCoy, 1849) de Djebel Arhlal. Barra de escala para a-c = 2 mm. d.* Dibunophyllum bipartitum, *(McCoy, 1849) horizonte A5F, e.* Aulophyllum fungites *(Fleming, 1828), horizonte As1. f.* Clisiophyllum ? *sp., horizonte As15. g.* Axoclisia *sp., horizonte A4F. h.* Palaeosmilia sp., *horizonte As11. i.* Koninckophyllum *sp., horizon A5F. d.-i: x1,5.*

an important element of middle part of the Djenien platform, but it does not represent anything like a stable large sized reefal barrier along a platform margin. Moreover, carbonate mud can be abundant in the coral biostrome as seen in the sediment preserved in-between the corallites of some fasciculate colonies (Fig. 10a, b, c). Thus lower-energy conditions existed during biostrome formation, which might be found towards the platform interior or in outer platform settings. The co-existence of *in situ* coral growth and input of reworked material advocates for a biostrome formation in a transitional position between high-energy and low-energy platform settings. If the geometry of the Djenien platform is the same as in older strata in the Béchar Basin (Madi *et al.,* 1996, 2000), the biostrome formed at the interface between inner and outer ramp settings.

Additional palaeoenvironmental information can be obtained from the brachiopods. The marly bed ML 79 (lower unit) contains *Latiproductus daguini*, and numerous small-sized productides, spiriferides, athyrides, which are quite finely preserved (Fig. 9.a, e) Legrand-Blain 1980, p. 12). They indicate an episode of very low energy. In oolithic-bioclastic limestone, the situation is different, because the productides predominate with numerous representatives of the genera *Productus*, *Buxtonia*, *Echinoconchus,* and *Echinoconchella*. A part from *Echinoconchus*, they are characterized by their concavo-convex shell and their anchorage in the substrate by spines is interpreted as adaptations to higher hydrodynamic conditions (Legrand-Blain, 1985, Alexander, 1986) also seen by substrate fixation with a pedicle as in *Composita*. It is important to observe if these forms are abraded or fragmented, and if their micro-ornamentation is still well-preserved. This is not the case for several levels rich in gigantoproductides (*Latiproductus, Datangia,* and *Striatifera*). The latter often form the several centimetre-thick coquinas beds. However, the presence of this group commonly known in calm conditions (Legrand-Blain, 1985; 1987) in these coquinas may indicate the preservation of thanatocenoses, and the rapid accumulation of these beds during storm events.

In the middle unit, brachiopods occur mainly as larger bioclasts. Their proliferation seems to be hampered in this facies of a tropical shallow-water platform and rugose corals outnumber them. Brachiopods only re-occur at the top of the unit with the arrival of some siliciclastic input, which enables either the recolonization or a short transport of shells such as *Gigantoproductus flamandi*.

The upper unit again shows diversified assemblages, in various environments. In the ML 82 coquina, many brachiopods (diverse productides and spiriferides such as *Anthracothyrina)* are only known as isolated ventral valves, with abraded microornament. Bed ML 84 is a coquina made of *Striatifera* incomplete shells and fragments, associated with some crinoid elements, in a bedded packstone. Their environment is interpreted as temporary storm events. Other coquinas are found in less disturbed environments: *Productus* and *Reticularia* in bioclastic and crinoidal limestones, *Anthracothyrina, Brachythyris* and *Martinia* in some interbeds in the lower part of the unit.

Comparisons

Semenoff-Tian-Chansky (1985) mentioned numerous biostromes in the upper part of the Djenien Formation without providing any detailed descriptions of these structures. However, since the coral fauna he mentioned from these biostromes show similarities with the fauna found in the studied sections, it is very likely that other biostromes in the Djenien Formation were formed in similar environments and showed the same compositional structure. This assumption also seems to be supported by very similar facies described from various sections in the Djenien Formation of the Béchar Basin (e.g. Pareyn, 1961), although these descriptions are often not very detailed.

Pareyn (1961) and Lemosquet and Pareyn (1982) described very different reef structures in the Carboniferous succession of the Béchar Basin. However, they neglected the biostromes and focused on biohermal structures, which occur in different formations in different parts of the basin. This is not surprising since these structures are very spectacular as demonstrated in the biohermal belt of the eastern Béchar Basin. Bourque *et al.* (1995), Madi *et al.* (1996, 2000) and Bourque (2007) provided more detailed analysis of these bioherms. Corals occur at best as dwellers in most parts of the bioherms, which are dominated by sponges, bryozoans, and microbial mud. However corals can be concentrated on top of these bioherms and either locally contribute to the formation of the bioherms or more often form capping beds in using the elevated morphology and hard substrate of the bioherms. It is interesting to note that very similar structures have been described from the upper Visean succession of the nearby Tafilalt Basin in eastern Morocco (Wendt *et al.,* 2001) and several hundred kilometres further north in the eastern Moroccan Meseta (Aretz and Herbig, 2008).

On the other hand, the older literature (see above) contains hints for coral biostromes in different

stratigraphic horizons of the Visean to Bashkirian succession of the Béchar Basin, but none of these biostromes has been studied in detail. Data on the abundance of colonial corals, their diversity, the distances between individual colonies, the proportion of *in situ* and reworked material and the sediment between the corals are generally unknown, thus making any attempt of detailed comparison with the studied sections impossible. It can only be assumed that other coral autoparabiostromes exist in the basin, but some of those 'biostromes' could also be limestone richer in corals without and bioconstructional activity.

Insufficient descriptions of coral biostromes are common to many Carboniferous successions. Coral biostrome contemporaneous with the coral autoparabiostrome at the Djebel Arhlal have been described from the Donets Basin (Ogar, 2012). Striking difference is that corals contributed to the formation of those biostromes, but they are only among other bioconstructors like chaetetid sponges. Another difference is the size of the Algerian biostrome. It is several times thicker and its known lateral extension of 2 km is not comparable to the biostromes in the Donets Basin.

Rodriguez *et al.* (2013) described a 4.5 m thick coral biostrome from the top of the Djebel Ouarkziz Formation at the northern limb of the Tindouf Basin and dated it as early Bashkirian. This biostrome contains similarly to the biostrome at the Djebel Arhlal colonial colonies *in situ* colonies and as fragments. Whereas in the Tindouf Basin the biostrome these two types of preservation are clearly separated, with a concentration of fragments in the basal part and *in situ* colonies towards the top, the Djebel Arhlal biostrome shows no clear separation and intermixing of these types. Rodriguez *et al.* (2013) also showed lower distances between colonies. The frequent intergrowth of gigantoproductid brachiopods, rugose corals and chaetetid sponges observed in the Tindouf Basin has not been observed at the Djebel Arhlal. Chaetetid sponges are completely absent, and brachiopods very rare in the biostrome. Thus both biostromes seem to represent different types of coral biostromes of different palaeoenvironmental settings, which is also in the different facies in the under- and overlying strata. Rodriguez *et al.* (2013) note that their coral biostrome can be traced over 300 km through the Tindouf Basin and even point to analogous beds in the Reggane, Ahnet and Taoudenni basins. A biostrome covering several hundred thousand square kilometres of the Sahara Platform seems to be rather unlikely. Instead, the formation of larger and smaller biostromes in different local and regional tectono-sedimentary settings of the Sahara Platform should be envisaged for the Serpukhovian.

In Western Europe a series of coral biostromes have been described from the Visean successions of Belgium, British Isles, France and Spain *(*Aretz, 2001, 2002; Aretz and Herbig 2003; Aretz and Chevalier 2007; Aretz and Nudds 2007; Aretz *et al.*, 2010; Somerville *et al.*, 2007, 2009). All these biostromes share characteristics with Arhlal biostromes, e.g. the middle Visean biostromes in Belgian (Aretz, 2002, Aretz and Chevalier, 2007) or the biostrome at Little Asby Scar (Aretz and Nudds, 2007) are laterally traceable on a kilometre scale, but they are much thinner than the Algerian biostrome. Thus, none of the European biostromes is identical to the Djebel Arhlal biostrome. Either their composition is different, since other bioconstructors are involved (British Isles: Aretz and Nudds, 2007, Somerville *et al.* 2007), or they are much thinner (middle and upper Visean Belgium; Aretz, 2001, 2002, Aretz and Chevalier, 2007) or thicker and internally more complex (Somerville *et al.*, 2009, Aretz *et al.*, 2010). Additionally in all these examples the abundance of coral colonies is higher and the distances between them shorter than in Algeria. Thus the Algerian autoparabiostrome seems to be a more loosely spaced construction, which results in the questions if (a) this might be related to a specific palaeoenvironment and if (b) the biostrome represents an attempt to form a distinctive construction or does it represent a more or less closely spaced settlement of corals (coral meadow in the sense of Aretz 2010)?

Currently none of these questions can be sufficiently answered, and it requires further detailed studies, not only of the Arhlal region, but also of other parts of the Béchar Basin.

Conclusions

The Djenien Member (upper Serpukhovian) is well-exposed at the Djebel Arhlal. Oolithic and bioclastic limestone, sometimes cross-stratified largely dominate and indicate depositional settings in agitated open-marine platform interior or platform margin settings. The coral biostrome itself formed at the interface of middle and outer ramp settings, as seen in the co-existence of *in situ* coral growth, deposition of carbonate mud, the input of reworked material and sparitic textures. A diversified macrofauna is found in the entire member, although towards its top the abundances are decreasing. Remarkable are some brachiopod coquinas and two horizons, in which more than a dozen brachiopod species are known (respectively 1 m and 31 m above the section base).

Another remarkable element of the succession is a 10 m-thick horizon rich in colonial corals. It is dominated by colonies of *Siphonodendron*, *Diphyphyllum* and *Lithostrotion* which are either in place or found as coral rubble between several decimetres spaced *in situ* colonies. This biostrome did not form a large stable reefal barrier, since the corals are too loosely spaced to provide the necessary structural stability for a large-scaled resistant structure.

However, the horizon classified as a coral autoparabiostrome allows the separation of the Djenien member at the Djebel Arhlal into three units; in ascending order the pre-biostrome unit, the biostrome unit and the post-biostrome unit.

Factors that enable the formation of the biostrome are rather hard to decipher. Small-scale sea level fluctuations combined with changes in the current regime may be possible factors, but the absence of detailed data on facies variations for the Djenien Formation hampers the interpretation.

This autoparabiostrome at Djebel Arhlal is compared to other rather thick and of exceptional horizontal extension upper Serpukhovian biostromes (few kilometres). The coral biostrome in the upper Ouarkziz Formation of the Tindouf Basin represents a different type of coral biostrome, which most probably formed in a different regional tectono-sedimentary setting. The Arhlal biostrome shares some characteristics with Visean coral biostromes in Western Europe and North Africa, but a more detailed comparison shows that the Arhlal biostrome is rather unique in this spectrum of Visean-Serpukhovian coral biostromes. However, it may be less unique, since coral-rich horizons have been reported in the Djenien member of other sections in the Béchar Basin, and potentially similar biostromes could be found. Nevertheless, these speculations can only be verified with more detailed facies and coral data from these sections. It should also be noted that the coral autoparabiostrome is a type of bioconstruction, which has so far not been described from the Béchar Basin, where especially Visean bioherms in the SE part of the basin have been intensively studied.

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