

Fossilized-Brood Chambers in *Nummulites vascus* from Libya

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توثيق تواجد مستحاثات لحجرات حاضنة في نيوموليت فاسكوس لأحد مكاشف

الأوليغوسين المتأخر في شمال شرق ليبيا

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Abstract

Spherical calcite chamber-like objects of almost identical size have been found in a few tests of *Nummulites vascus*. These *Nummulites* constitute the dominant benthic foraminifera assembly among the reported foraminiferal assemblage of the Abraq Formation (Late Oligocene) at the Daryanah- Al Abyar Roadcut in Northeast Libya. These structures are identified as brood chambers or cysts formed during reproduction and retained within the mother test, where the embryos were hosted during life. The possibility of a diagenetic origin to these cysts is excluded due to the hollow-nature of these objects which supports a biotic origin rather than diagenesis. Similarly, a symbiotic relationship with microalga is also excluded due to the lack of any cellular microstructure. The existence of calcitic brood chambers in *Nummulites* is hitherto unknown. Importantly this sample appears to be the first example of a calcified brood pouch fossil or 'cyst' in *Nummulites* (23– 28 Ma) research.

Keywords: *Nummulites vascus*, Late Oligocene, Abraq formation, Northeast Libya.

الملخص

تم تسجيل تواجد أجسام تشبه حجرات جييرية كروية ممتلئة لبعضها تم العثور عليها في عدد قليل من أصداف نيوموليت فاسكوس، وهذه الأصداف تكون المنخرات القاعية السائدة من الحشد المنخري القاعي لتكوين الأبرق (العصر الأوليغوسيني المتأخر) في مقطع طريق دريانة - الأبيار بشمال شرق ليبيا. وتم اعتبار هذه التراكيب كحجرات جنينية أو أكياس تكونت أثناء عملية التكاثر وبقت بداخل الصدفة الأم حيث تقبع فيها الأجنة أثناء دورة الحياة، وبهذا تم استبعاد احتمالية أصل النشأة الترسيبية المتأخرة لهذه الأكياس كنتيجة لطبيعة تجاويف هذه الأشكال والتي تدعم الأصل الحيوي أكثر من كونها ترسيبية المنشأ. وبنفس الكيفية تم استبعاد العلاقة التكافلية للطحالب الدقيقة أيضا كنتيجة لغيات التراكيب الخلوية الدقيقة. إن وجود حجرات حاضنة جييرية في جنس النيوموليت غير معروفة حتى الآن، وتكمن أهمية هذه العينة أنها تمثل أول بحث لمستحاثات حقيبية حاضنة "كيس" في صدفة نيوموليت ترجع لـ 23 - 28 مليون سنة.

الكلمات الدلالية: نيوموليت فاسكوس، العصر الأوليغوسيني المتأخر، تكوين الأبرق، شمال شرق ليبيا.

1. Introduction

The outcrop from which the samples were collected from is located in the northeastern part of Libya, in an area known as Al Jabal Al Akhdar. This section is exposed on both sides of a road-cut located about 40km east of Benghazi city leading from the Daryanah (Tansolukh check point) to Al Abyar village (Figure 1). The road-cut exposes the following rock units the Algal Limestone of Al Bayda Formation, the Al Abraq Formation, the Al Faidiyah Formation and the Benghazi Formation with disconformity surfaces separating them from each other (Figure 2); and a more stratigraphy is noted by (Ewerfalli *et al.*, 2000; and El-Hawat and Abdulsamad, 2004). *Nummulites vascus* occurs in the lower part of the Upper Oligocene sequence in a bioclastic, marly limestone bed (Figure 3). Three *Nummulites* tests are documented in this study, quoted (NG1, NG2 and NG3) and are deposited at University of Benghazi, Faculty of Science, Department of Earth Sciences, Benghazi- Libya.

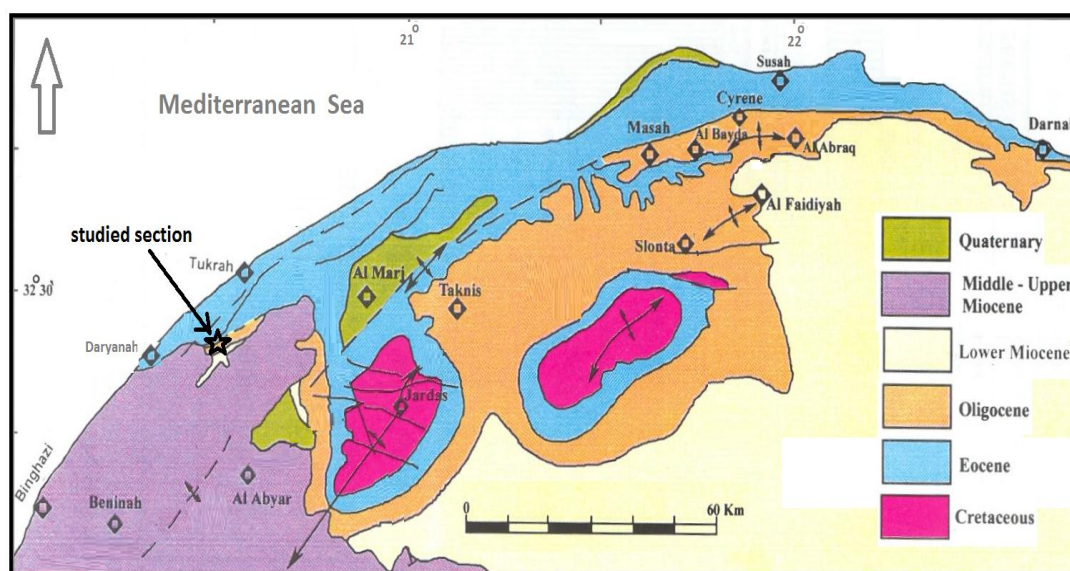


Figure 1. Location map of the studied section (modified after Elwerfalli *et al.*, 2000)

2. Foraminiferal Content

The section can be subdivided into three foraminiferal assemblages (I-III) from oldest to youngest:

2.1. Assemblage I (Bioclastic marly limestone bed)

Is dominated by nummulitids, including *Nummulites vascus* and *N. fichtelli* in addition to subsidiary *Brizalina* sp., *Nonion* sp. and undifferentiated textulariids (Figure 3).

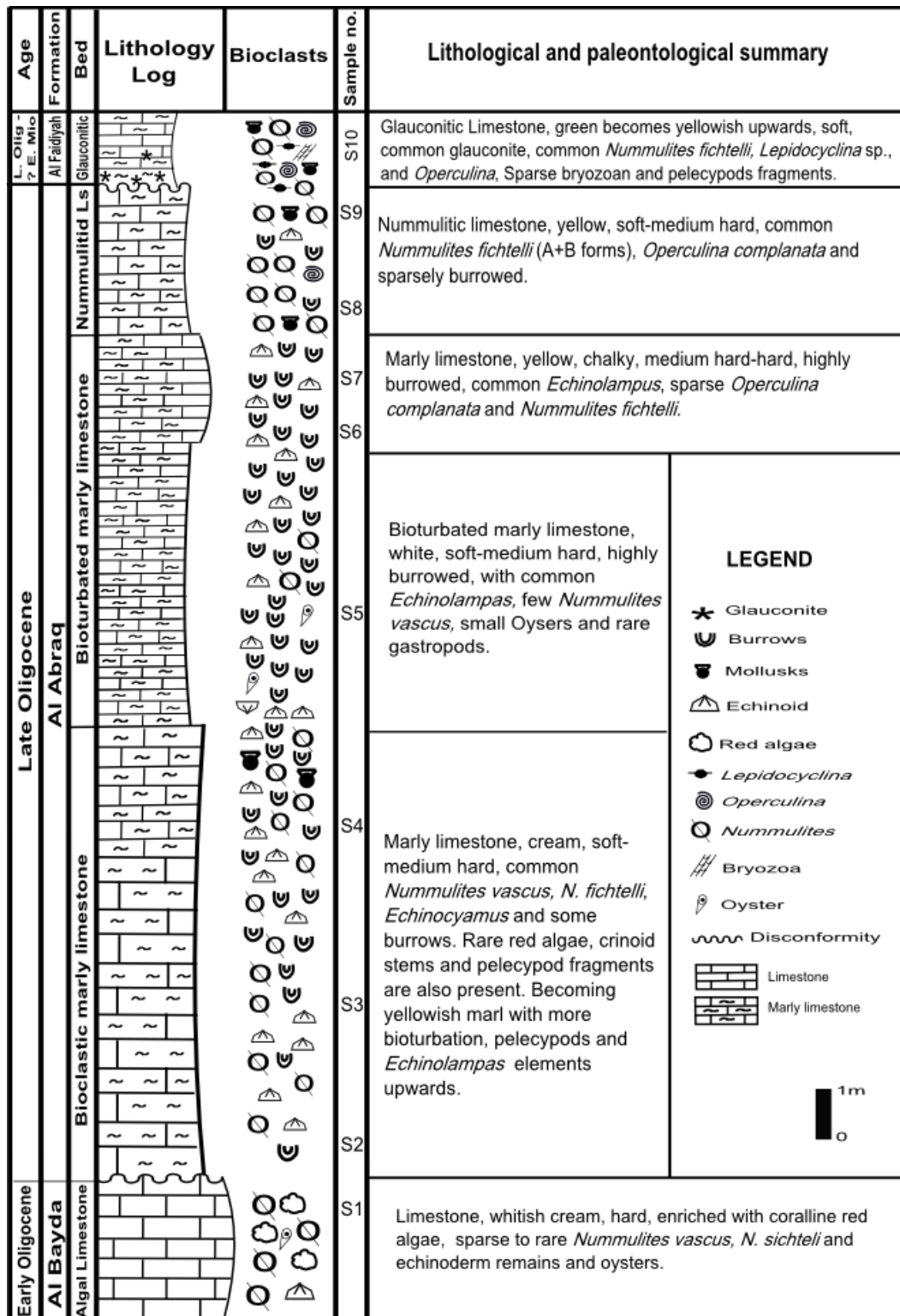


Figure 2. The Daryanah - Al Abyar roadcut section, showing the stratigraphical position of the Al Abraaq Formation.

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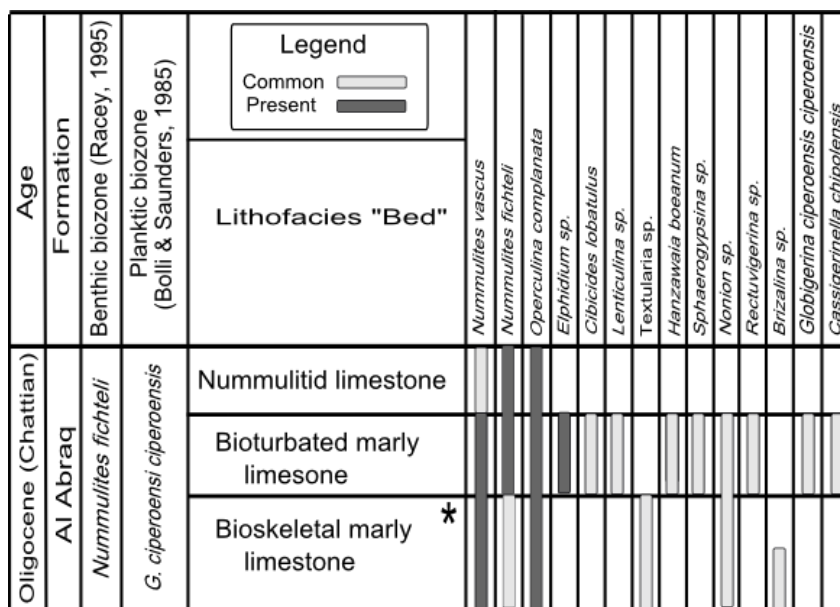


Figure 3. Distribution chart of the foraminifers in the studied locality.

(*indicates the horizon with in which the *Nummulites* with brood chambers are recorded)

2.2. Assemblage II (Bioturbated marly bed)

It is dominated by nummulitids, including *Nummulites vascus*, *N. fichtelli* and *Operculina complanata* in addition to few-common *Cibicides lobatulus*, *Nonion sp.*, *Lenticulina sp.*, *Hanzawaia boeanum*, *Sphaerogypsina sp.* and *Rectuvigerina sp.*. This assemblage relates to the *Globigerina ciperoensis ciperoensis* Zone of Bolli and Saunders (1985). Sparse planktic foraminifers including *Globigerina ciperoensis ciperoensis* and *Cassigerinella chipolensis* (Figure 3).

2.3. Assemblage III (Nummulitid bed)

Is dominated by nummulitids, including *Nummulites vascus*, *N. fichtelli* and *Operculina complanata* (Figure 3). The Dominance of the primary zonal marker *Nummulites fichtelli*, in association with *N. vascus* is strongly indicative of the Oligocene and is assigned to the *Nummulites fichtelli* Zone of Racey (1995). This zone is well known in the Al Jabal al akhdar area in Oligocene deposits including the Algal limestone of AL Bayda Formation and Al Abraq Formation. It is important to note that the *N. vascus* has been reported in Oman with a range from Late Eocene-Early Oligocene (Racey, 1995). However, the absence of *N. fabianii* and the presence of the planktic *Globigerina ciperoensis ciperoensis* and *Cassigerinella chipolensis* restrict the age of *N. vascus* at this section to Late Oligocene and the *Globigerina ciperoensis ciperoensis* Zone of Bolli and Saunders (1985).

3. Results and Discussion

Brood chambers with crowded embryos occur in chamberlets of living *Sorites orbiculus* are illustrated by (Kloos, 1984; and Reiss and Hottinger, 1984) from Gulf of Aqaba (Figure 4a-b). Whereas Hottinger (2006) illustrated few examples of last chamber filled with hatchlings in *Neorotalia sp.* from Spanish Pyrenees, Early Eocene. In addition, *Orbitolites sp.* exhibits the discrepancy between embryo size and brood chamberlet volumes in material from earliest Eocene, Farafrah Oasis, Egypt. The present study shows three specimens *Nummulites vascus* size 'brood chambers' for housing the offspring before hatching. Figure (4c) shows ten brood chambers of somewhat identical size; the shape variations being the result of preservation. The last chamber is free and collapsed. They are identical in size (radius 0.25 mm), elliptical in shape (with longest axis within the range of 0.30-40 mm). By comparison with recent examples seen in the illustrated chamberlets of the living *Sorites orbiculus* (Reiss and Hottinger, 1984) from Gulf of Aqaba (Figures 4a, b), it is clearly representative of brood chambers of the agamont generation. During the early examination of this phenomenon, the structures were considered to be of diagenetic origin but closer examination and consultation with colleagues via the ResearchGate website; including Dr. George Stanley University of Montana in Montana State-USA, Dr. Katalin Baldi from Eötvös Loránd University in Budapest-Hungary and Dr. André Klicpera from Leibniz Center for Tropical Marine Ecology in Bremen-Germany; who are much appreciated for their help in confirming the identification and the valuable discussions via the SEM Image herein.

In Conclusion, the Al Abraaq Formation (Late Oligocene) in the Tansolukh-Al Abyar section has been logged and samples analyzed; which exhibit a wealth of foraminifera from the lower "Bioclastic marly limestone" (Figures 2 and 3). A Late Oligocene age has been assigned to this marly rock sequence now correlated with the *Nummulites fichtelli* Zone of Racey, (1995) and the equivalent *Globigerina ciperoensis* Zone of Bolli and Saunders (1985). Hitherto no *Nummulites vascus* specimens with brood chambers have been documented from the Oligocene sediments of Libya. This phenomenon is also considered unique in fossil *Nummulites*, although previous comparative studies only focused on living foraminifers and some fossil foraminifera (Hottinger, 2006). The shelf faunal mixing of the planktic and shallow benthic nummulitids in the recorded section is most likely manifested by bottom current and/or the lateral transport of empty tests.

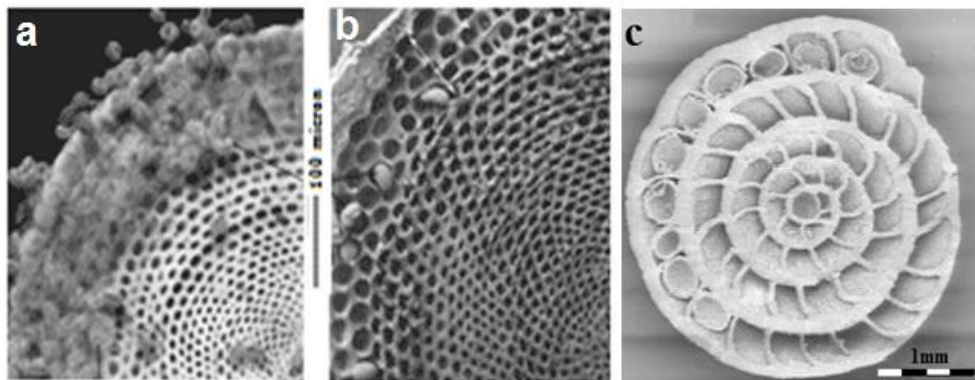


Figure 4. 'Parent' material with brood chambers in agamonts of *Sorites orbiculus* from the Gulf of Aqaba, Recent (Kloos, 1984) (a-b); and in gamont of *Nummulites vascus* from Al Jabal al Akhdar-Libya, Late Oligocene (c).

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