www.czasopisma.pan.pl PAN www.journals.pan.pl

Acta Geologica Polonica, Vol. 71 (2021), No. 4, pp. 453–480
DOI: 10.24425/agp.2020.134560

Stratigraphy of the Albian–Cenomanian boundary interval in the Agadir Basin, Morocco: ammonites, microcrinoids, planktonic foraminifera

ANDREW SCOTT GALE[1,2], WILLIAM JAMES KENNEDY[3,4] and MARIA ROSE PETRIZZO[5]

[1, 2] *School of the Environment, Geography and Geological Sciences, University of Portsmouth, Burnaby Building, Burnaby Road, Portsmouth PO13QL UK and Earth Science Department, Natural History Museum, Cromwell Road, London SW75BD, UK. E-mail: andy.gale@port.ac.uk*
[3, 4] *Oxford University Museum of Natural History, Parks Road, Oxford, OX13PW and Department of Earth Sciences, South Parks Road, OX13AN UK. E-mail: jim.kennedy@oum.ox.ac.uk*
[5] *Dipartimento di Scienze della Terra 'A. Desio', Università degli Studi di Milano, via Mangiagalli 34, 1-20133 Milano, Italy. E-mail: mrose.petrizzo@unimi.it*

ABSTRACT:

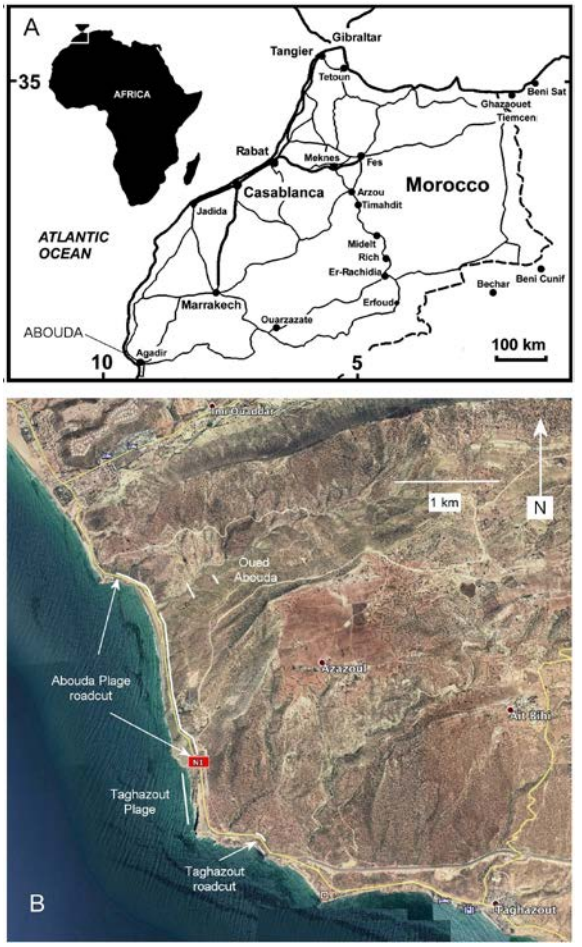
Gale, A.S., Kennedy, W.J. and Petrizzo, M.R. 2021. Stratigraphy of the Albian–Cenomanian boundary interval in the Agadir Basin, Morocco: ammonites, microcrinoids, planktonic foraminifera. *Acta Geologica Polonica*, **71** (4), 453–480. Warszawa.

The uppermost Albian and lowermost Cenomanian succession at Abouda Plage, north of Agadir, in the Agadir Basin, western Morocco, is described in detail, and ammonites, microcrinoids and planktonic foraminifera are recorded and illustrated. The lower part of the Aït Lamine Formation yields ammonites indicative of the *Pervinquieria* (*Subschloenbachia*) *rostrata* and *P.* (*S.*) *perinflata* ammonite zones, and the *Thalmanninella appenninica* planktonic foraminiferan Zone. The base of the Cenomanian is identified at 42.2 m above the base of the Aït Lamine Formation, based on the lowest occurrence of the planktonic foraminiferan *Thalmanninella globotruncanoides* Sigal, 1948. Lower Cenomanian ammonites of the *Graysonites adkinsi* Zone enter 3 m higher in the succession. Microcrinoid zones AlR11 and AlR12 are identified in the Upper Albian, and the base of the CeR1 Zone coincides with the lowest occurrence of Cenomanian ammonites. The ammonite and microcrinoid occurrences and detailed distributions are very similar to those found in north central Texas, which, in the Cenomanian, was 5,300 km to the west. The new records suggest that the *G. adkinsi* Zone is equivalent to the uppermost (Lower Cenomanian) part of the *Pleurohoplites briacensis* Zone of the Global Stratotype Section for the base of the Cenomanian stage. An hiatus, of global extent, immediately underlies the base of the *G. adkinsi* Zone and is represented in the Agadir Basin by an erosion surface containing bored and encrusted hiatus concretions.

Key words: Albian–Cenomanian boundary; Agadir; Planktonic foraminifera; Ammonites.

INTRODUCTION

The boundary between the Albian and Cenomanian stages was ratified in 2004, with the GSSP taken at the lowest occurrence of the planktonic foraminiferan *Thalmanninella globotruncanoides* Sigal, 1948 in the section at Mont Risou, Hautes-Alpes, southeastern France (Kennedy *et al*. 2004). It lies within the *Pleurohoplites briacensis* ammonite Zone, and ammonites of the *Mantelliceras mantelli* Zone appear 6 m higher in the succession. The occurrences of planktonic foraminiferans were detailed in Petrizzo *et al*. (2015), who demonstrated that a closely similar succession was present in the Blake



Text-fig. 1. A – Map to show position of the Abouda sections. B – Image of the coastal strip north of Taghazout, to show position of localities. The base of the Aït Lamine Formation in the Abouda Plage roadcut is close to the upper arrow.

Nose Plateau drilled by the Ocean Drilling Program (ODP) in the north-west Atlantic Ocean.

In North Africa, relatively few studies integrating ammonite and planktonic foraminiferal occurrences have investigated the Albian–Cenomanian boundary interval in any detail. In central Tunisia, at Kalaat Senan, Robaszynski *et al*. (1994, 2008) undertook an extensive study of ammonites and planktonic foraminifera across the boundary, and demonstrated that ammonites of the *Mantelliceras mantelli* Zone, *Neostlingoceras carcitanense* Subzone appeared slightly higher than *Thalmanninella globotruncanoides*, as in the case of the Global Stratotype Section.

In the Agadir Basin of western Morocco, a new road cut, widening the N1 arterial road north of Taghazout (Text-fig. 1) provides excellent exposures of the dolomites of the Kerchoula Formation and clays of the overlying Aït Lamine Formation. The succession was described by Essafraoui *et al.* (2015) who provided a detailed analysis of the sequence stratigraphy and planktonic foraminiferal dates for a number of samples. They concluded that the Albian–Cenomanian boundary lies at the contact between the Kerchoula and Aït Lamine formations, although they only found the basal Cenomanian marker, *Thalmanninella globotruncanoides*, approximately 80 m above the base of the Aït Lamine Formation. Their log of the road section shows a 22 m gap of non-exposure 46–68 m above the base of the Aït Lamine Formation.

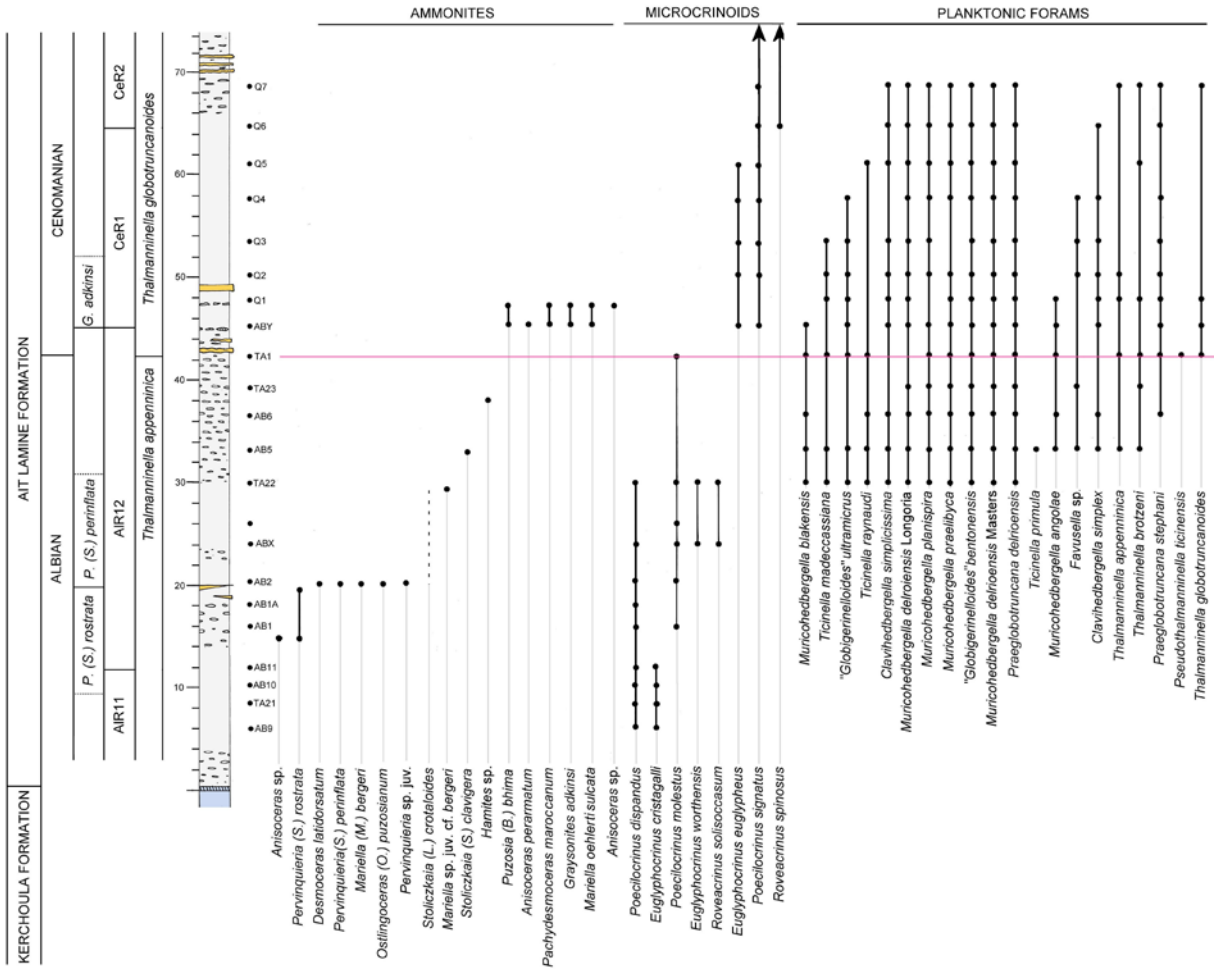
Gale (2020) provided a log of the road section, and discovered that the interval representing the gap beneath marker H of Essafraoui *et al*. (2015, their fig. 3) was well exposed in Oued Abouda, 500 m to the north of the road cut and yielded common Lower Cenomanian ammonites from a narrow interval, described in detail here. The lower part of the Aït Lamine Formation contains abundant microcrinoids of taxa which were previously known only from the Albian and Cenomanian of Texas; these provided a detailed correlation framework between the two regions (Gale 2020; Gale *et al*. 2021).

The present paper expands on the study of Gale (2020) by describing and illustrating the ammonite material, and also provides a detailed analysis of the distribution of planktonic foraminiferans through the Albian–Cenomanian boundary interval. This new data permits a detailed synthesis of the biostratigraphy of the Albian–Cenomanian boundary interval, incorporating ammonites, microcrinoids and planktonic foraminifera. The integration of the stratigraphical distribution of these groups permits a broader understanding of the boundary interval.

LOCATIONS AND STRATIGRAPHY

The studied section is located in the region adjacent to Abouda Plage, Taghazout, 20 km north of Agadir, Morocco. The locality comprises two parts: (1) the road cut on the east side of the N1 road, and (2) a valley, which extends north-east from the beach, called Oued Abouda (Gale 2020). The road cut includes a significant gap of 18 m, from 50 to 68 m (Text-fig. 2), not studied by Essafraoui *et al.* (2015), which is well exposed in the adjacent section of Oued Abouda, 500–700 m to the north of the coast road N1 (Text-fig. 1B).

In both the road cut and the valley, the dolomitic limestones of the Kerchoula Formation are terminated by a bored hardground, overlain by clays of the Aït



Text-fig. 2. Distribution of ammonites, roveacrinids and planktonic foraminifera in the Abouda sections. The thin red line marks the base of the Cenomanian as defined by the lowest occurrence of *Thalmanninella globotruncanoides* Sigal, 1948.

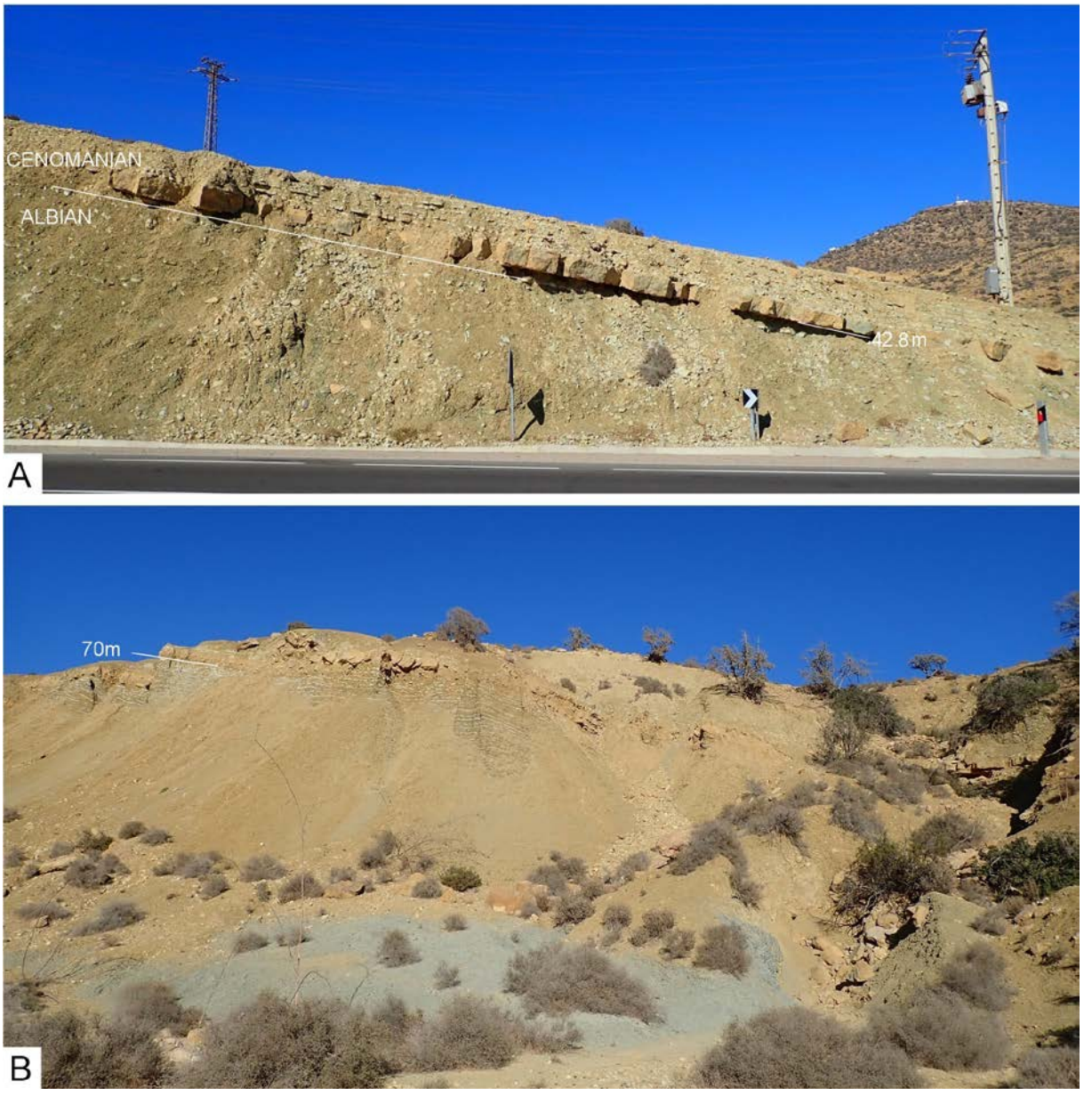
Lamine Formation, which contain numerous small, lensoid carbonate concretions at some levels. Key marker beds are thin but laterally persistent sandstones, some displaying hummocky cross-stratification (Text-fig. 2; 20 m, 43–44 m, 70–72 m). The lensoid sandstone at 20 m is not present in the road cut section. The group of sandstones at 43–44 m (Text-fig. 3A) includes a thin hardground and bored and encrusted hiatus concretions (Gale 2020, text-fig. 5; Text-fig. 4 herein). The group of thin sandstones outcropping east of Abouda Plage (70 m in Text-figs 2 and 3A; horizon H of Essafraoui *et al*. 2015) forms a scarp-capping unit on the south side of Oued Abouda (Text-fig. 2B).

The log provided here (Text-fig. 2) is a composite section from the road cut and the southerly 500 m (marked on Text-fig. 1B) of Oued Abouda, and shows the ammonite occurrences and selected microcrinoidal and foraminiferal data.

PLANKTONIC FORAMINIFERA

A total of 13 samples were analyzed for planktonic foraminifera (Text-fig. 2, Table 1). Rock samples were soaked in a 3% solution of hydrogen peroxide and washed under running water over a 38 µm sieve, and then dried on a hot plate. Foraminiferal preservation is generally moderate in all samples as specimens show minor to moderate test fragmentation and are overgrown with secondary calcite.

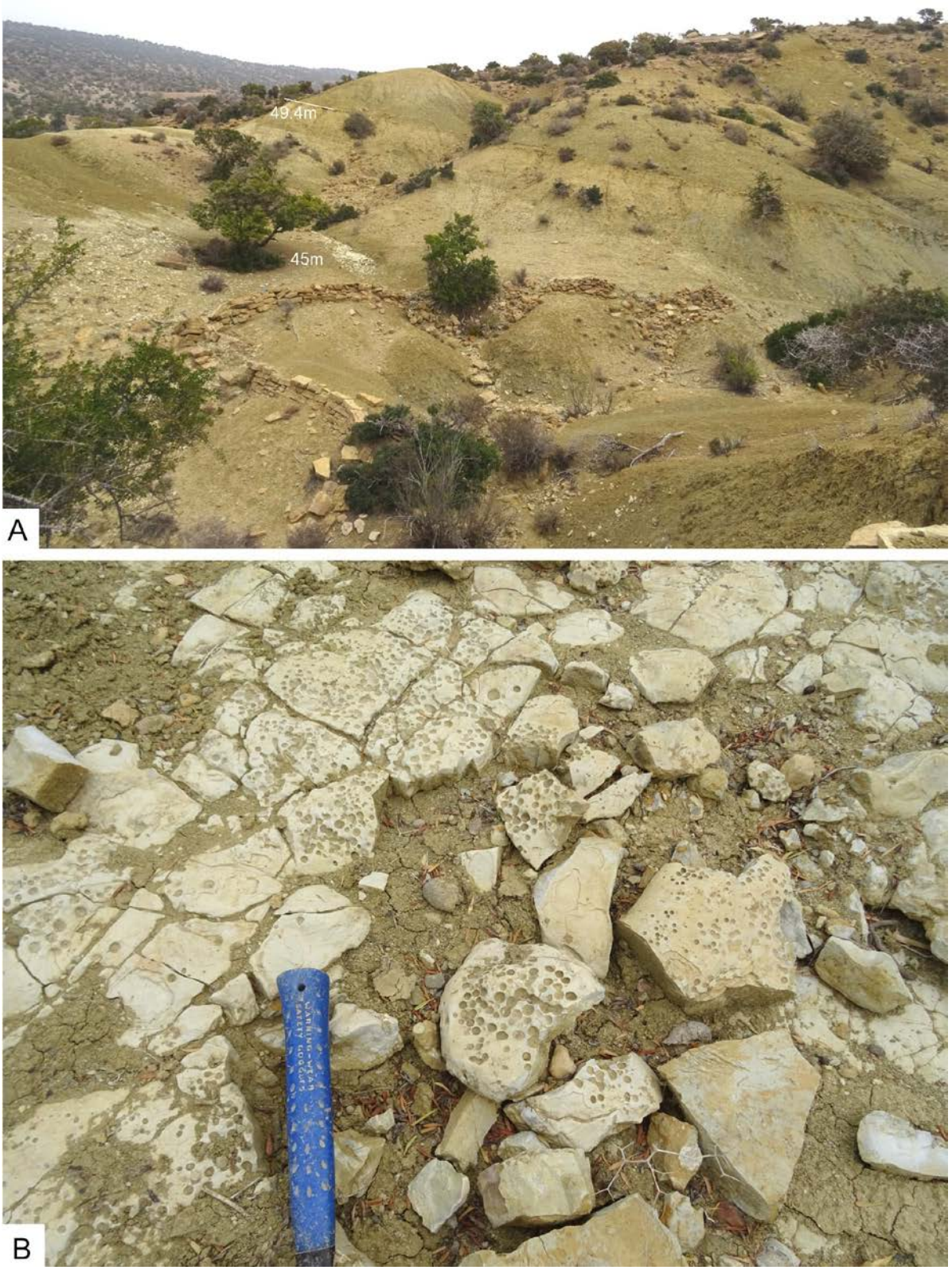
Taxonomic concepts for planktonic foraminiferal species identification follow their original descriptions and illustrations, Petrizzo and Huber (2006), Petrizzo *et al.* (2015), Falzoni and Petrizzo (2020) and the online taxonomic database for Mesozoic Planktonic Foraminifera "PF@mikrotax" available at http://www.mikrotax.org/pforams/index.html (see Huber *et al.* 2016). The planispiral genus



Text-fig. 3. A – The position of the Albian–Cenomanian boundary in the Abouda Plage roadcut on the N1, based on the lowest occurrence of *Thalmanninella globotruncanoides* Sigal, 1948 in sample TA1, at 42.2 m in Text-fig. 4. The sandstone bed is 0.5 m in thickness. B – Aït Lamine Formation in the Oued Abouda section, 500 m north of B. The triple sandstone bed at 70 m is horizon H of Essafraoui *et al*. (2015) and is 2 m in thickness.

Globigerinelloides Cushman, 1927, is placed in quotes in the text and figures because it is polyphyletic and currently under taxonomic revision (see discussion in Petrizzo *et al*. 2017). Biozonation is according to Robaszynski and Caron (1995).

The planktonic foraminiferal assemblages are characterized by the low abundance of large and single keeled taxa that only occur in a few samples, and by the common presence of unkeeled trochospiral species. The most important species are illustrated in Text-figs 5 and 6. *Thalmanninella globotruncanoides*, primary marker for the base of the Cenomanian Stage (Kennedy *et al*. 2004) first occurs in sample TA1 (Table 1; Text-fig. 2). *Thalmanninella brotzeni*



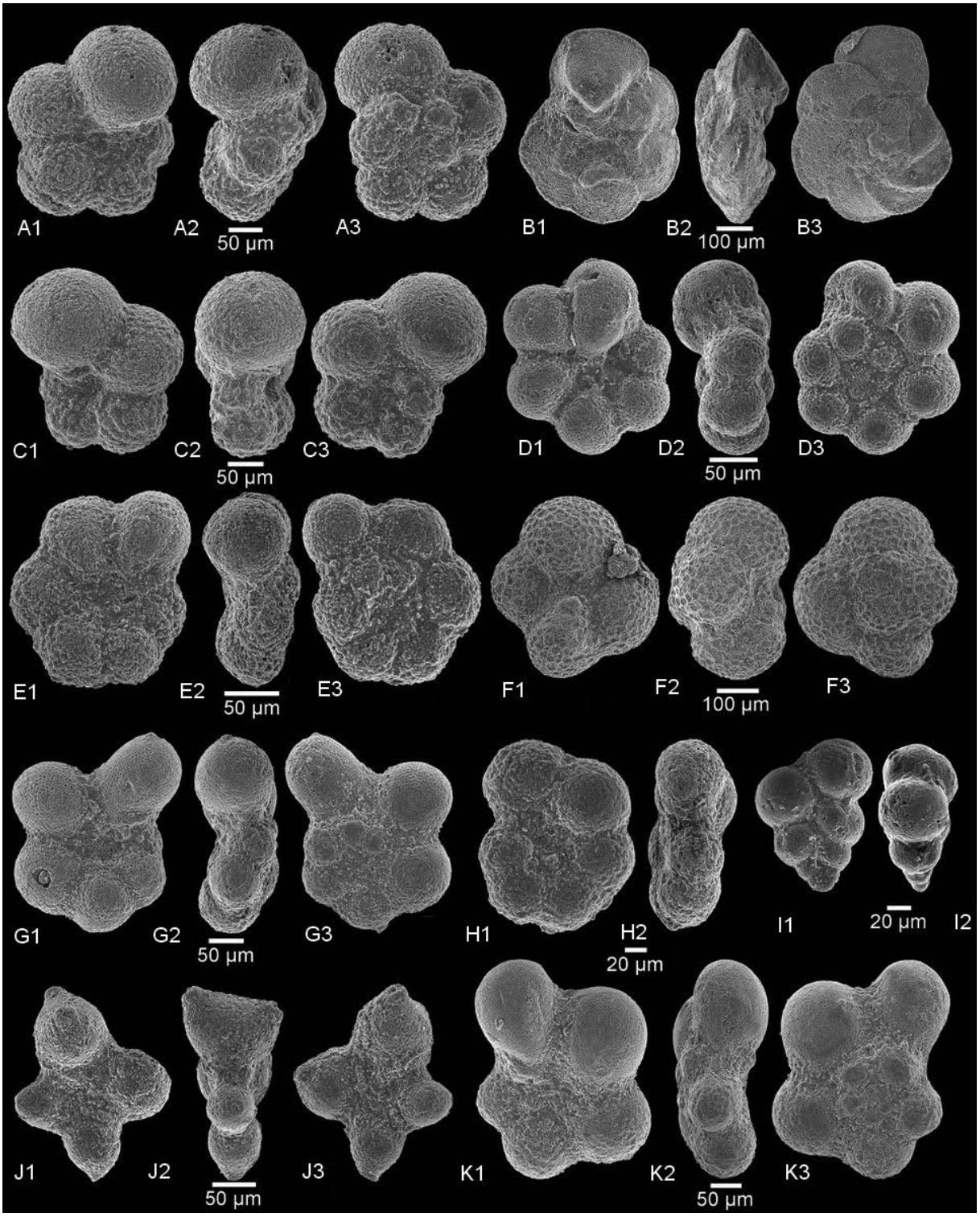
Text-fig. 4. A – The succession exposed in Oued Abouda, between 45 and 55 m (Text-fig. 2). Lower Cenomanian ammonites of the *Graysonites adkinsi* Zone occur between 45.2 and 47.2 m. B – enlargement of white patch adjacent to 45 m in A, to show hiatus concretions with bivalve borings (*Gastrochaenolites* isp.) immediately underlying the lowest occurrence of the *Graysonites adkinsi* Zone fauna.

Sample	Meters	*Guembelitria cenomana*	*Praeglobotruncana* cf. *delrioensis*	*Ticinella* cf. *moulladei*	*Muricohedbergella blakensis*	*Protoheterohelix* sp.	*Muricohedbergella astrepta*	*Ticinella madecassiana*	'*Globigerinelloides*' *ultramicrus*	*Ticinella raynaudi*	*Pseudoclavihedbergella simplicissima*	*Muricohedbergella delrioensis* sensu Longoria	*Muricohedbergella planispira*	*Muricohedbergella praelibyca*	'*Globigerinelloides*' *bentonensis*	*Muricohedbergella delrioensis* sensu Masters	*Praeglobotruncana delrioensis*	*Ticinella rischi*	*Ticinella primula*	*Muricohedbergella angolae*	*Favusella* sp.	*Microhedbergella praeplanispira*	*Pessagnoina simplex*	*Thalmanninella appenninica*	*Thalmanninella brotzeni*	*Guembelitria cretacea*	*Schackoina cenomana*	*Praeglobotruncana stephani*	*Ticinella* sp.	*Pseudothalmanninella ticinensis*	*Thalmanninella globotruncanoides*	*Ticinella* cf. *primula*	*Schackoina multispinata*	*Biticinella* sp.	*Schackoina bicornis*	*Muricohedbergella* cf. *praelibyca*	*Thalmanninella balernaensis*	*Bulimina* sp.	*Textularia* sp.	*Lenticulina* sp.	*Nodosaria* sp.	*Spiroplectammina* sp.	Ostracods	Fragments of bivalves	Fish teeth
Q7	68.7										×	×	×	×	×	×	×							×	×	×		×			×						×	×					×	×	
Q6	64.6										×	×	×	×	×	×	×						×			×		×								×		×					×	×	
Q5	61.2									×	×	×	×	×	×	×	×					×			×													×					×	×	
Q4	57.9								×			×	×	×	×	×	×				×		×			×		×										×					×	×	
Q3	53.5							×	×		×	×	×		×	×	×				×		×				×	×	×						×			×					×		
Q2	50.1						×	×	×		×	×	×	×	×	×	×				×		×	×			×	×					×	×				×					×		
Q1	47.8						×	×	×		×	×		×	×	×	×			×			×	×	×	×		×			×							×	×				×	×	×
ABY	45.3				×	×			×		×	×	×	×	×	×	×			×			×					×			×	×										×	×	×	
TA1	42.8				×	×		×	×	×			×	×	×	×	×			×				×	×	×		×		×	×							×		×	×		×	×	
TA23	39.3											×	×	×	×	×	×				×				×				×									×		×	×	×	×	×	
AB6	36.7				×					×	×	×	×	×	×	×	×			×			×			×	×	×										×	×	×			×	×	
AB5	33.4				×			×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×												×	×				×	×	
TA22	30	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×																					×					×		

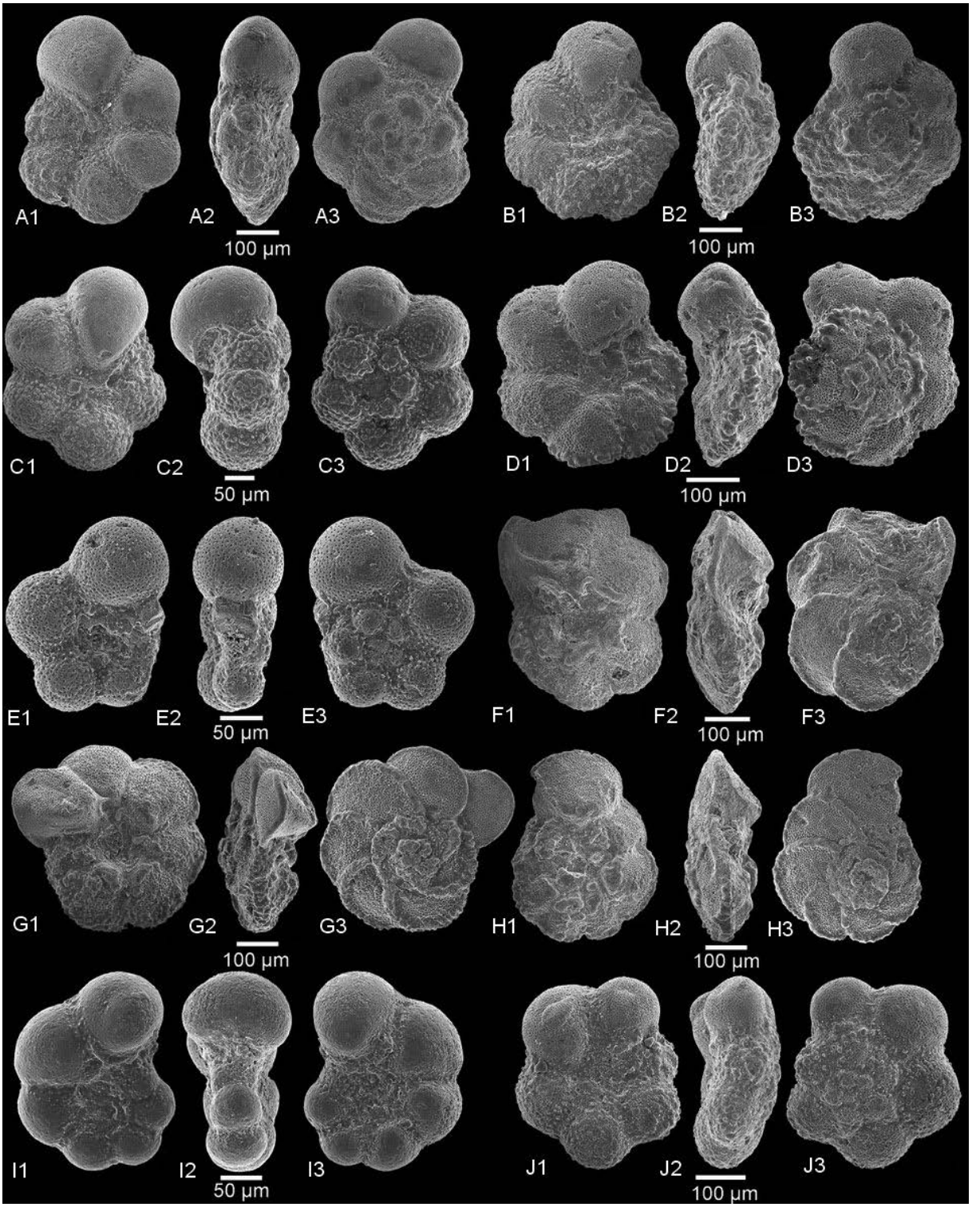
Table 1. Stratigraphic distribution of the planktonic foraminifera and of other components of the assemblages.

Sigal, 1948, is more abundant than *Thalmanninella globotruncanoides* whereas other single-keeled taxa such as *Pseudothalmanninella ticinesis* (Gandolfi, 1942), *Thalmanninella appenninica* (Renz, 1936) and *Thalmanninella balernaensis* (Gandolfi, 1957) are rare. The assemblages are characterized by the consistent and common occurrence of *Praeglobotruncana delrioensis* (Plummer, 1931), *Praeglobotruncana stephani* (Gandolfi, 1942), *Muricohedbergella planispira* (Tappan, 1940), '*Globigerinelloides*' *bentonensis* (Morrow, 1934), '*Globigerinelloides*' *ultramicrus* (Subbotina, 1949), *Pseudoclavihedbergella simplicissima* (Magné and Sigal, 1954) and *Muricohedbergella praelibyca* (Petrizzo and Huber, 2006). Species of *Ticinella* Reichel, 1950 are generally frequent in the lower part of the interval studied, but become rare in the upper part. Specimens corresponding to the neotypes of *Muricohedbergella delrioensis* (Carsey, 1926) designated by Longoria (1974) and Masters (1976) are both recognized in the assemblages (see discussion in Petrizzo and Huber 2006) and are frequent to common in all of the samples studied. In the large-sized fractions (> 250 μm) specimens assigned to *Favusella* sp. are frequent in some samples. The small-sized fractions (38–125 μm) are dominated by common *Protoheterohelix* sp., *Microhedbergella praeplanispira* Huber and Leckie, 2011, and *Guembelitria cenomana* (Keller, 1935). Benthic foraminifera *Textularia* sp., *Nodosaria* sp., *Spiroplectammina* sp. and *Lenticulina* sp. are frequent in the large sized-fractions. *Bulimina* sp. is abundant in the small-sized fractions. Ostracods and fragments of bivalves are frequent in all samples.

The lowest occurrence of *T. globotruncanoides*, 42.2 m above the base of the Aït Lamine Formation, defines the base of the lower Cenomanian *Thalmanninella globotruncanoides* Zone and the upper limit of the underlying upper Albian *T. appenninica* Zone (Robaszynski and Caron 1995). The composition of the assemblages in the *T. appenninica*



Text-fig. 5. Planktonic foraminifera from Abouda sections, Agadir Basin, Morocco. **A** – *Muricohedbergella delrioensis* (Carsey, 1926) *sensu* Longoria, sample Q7. **B** – *Thalmanninella brotzeni* Sigal, 1948, sample Q5. **C** – *Muricohedbergella delrioensis* (Carsey, 1926) *sensu* Masters, sample Q7. **D** – *Ticinella raynaudi* Sigal, 1966, sample Q5. **E** – *Muricohedbergella planispira* (Tappan, 1940), sample Q4. **F** – *Favusella* sp., sample Q4. **G** – *Pessagnoina simplex* (Morrow, 1934), sample Q3. **H** – '*Globigerinelloides*' *ultramicrus* (Subbotina, 1949), sample Q4. **I** – *Protoheterohelix* sp., sample TA22. **J** – *Schackoina bicornis* Reichel, 1948, sample Q3. **K** – *Pseudoclavihedbergella simplicissima* (Magné and Sigal, 1954), sample Q3. 1 – umbilical view; 2 – side view; 3 – spiral view.



Text-fig. 6. Planktonic foraminifera from the Abouda sections, Agadir Basin, Morocco. **A** – *Praeglobotruncana delrioensis* (Plummer, 1931), sample Q2. **B**, **D** – *Praeglobotruncana stephani* (Gandolfi, 1942); B – sample Q1; D – sample ABY. **C** – *Muricohedbergella praelibyca* (Petrizzo and Huber, 2006), sample Q1. **E** – *Muricohedbergella angolae* (Caron, 1978), sample ABY. **F**, **H** – *Thalmanninella globotruncanoides* Sigal, 1948; F – sample ABY; H – sample TA1. **G** – *Pseudothalmanninella ticinensis* (Gandolfi, 1942), sample TA. **I** – '*Globigerinelloides*' *bentonensis* (Morrow, 1934), sample AB6. **J** – *Muricohedbergella blakensis* (Petrizzo and Huber, 2006), sample AB6. 1 – umbilical view; 2 – side view; 3 – spiral view.

Zone indicates the latest Albian based on the absence of *Planomalina buxtorfi* (Gandolfi, 1942), which is generally documented as disappearing slightly below the top of the zone (Robaszynski and Caron 1995; Coccioni and Premoli Silva 2015), and on the lowest occurrence of *Thalmanninella brotzeni* that appears in the topmost interval of the zone preceding the lowest occurrence of *T. globotruncanoides* (see review in Petrizzo *et al*. 2015). The stratigraphic record across the Albian–Cenomanian boundary is also documented by the disappearance of *Ticinella* spp. (Text-fig. 2, Table 1) in the lowermost Cenomanian, which is, however, likely to be diachronous as it is reported to fall either in the *T. appenninica* Zone (e.g., Leckie 1984; Caron 1985; Premoli Silva and Sliter 1995; Petrizzo and Huber 2006) or in the *T. globotruncanoides* Zone (Petrizzo and Gilardoni 2020). Also remarkable is the occurrence across the Albian–Cenomanian boundary interval of the genus *Favusella* Michael, 1973, which confirms deposition in shallow-water environments (e.g., Koutsoukos *et al*. 1989) as reported from stratigraphic sections located in different palaeogeographic areas (South Texas: Denne *et al*. 2014; Israel: Lipson-Benitah *et al.* 1997; Iran: Ghabeishavi *et al.* 2010; Japan: Kawabe *et al*. 2003).

MICROCRINOIDS

Microcrinoids are abundant in residues of the 0.5–1.0 mm fraction of the Aït Lamine Formation, and were described and illustrated by Gale (2020); only a summary of this work is provided here with details of stratigraphically important species (Text-fig. 2). The lowest samples, samples AB9–AB11) yield a fauna of the AlR11 zone, characterized by *Poecilocrinus dispandus* Peck, 1943 and *Euglyphocrinus cristagalli* Gale, 2020. The overlying interval (AB1–TA1) yields common *Poecilocrinus molestus* Peck, 1943, and infrequent examples of *Euglyphocrinus worthensis* Gale, 2020 and *Roveacrinus solisoccasum* Gale, 2020. Together, these taxa are characteristic of the microcrinoid zone AlR12 (Gale 2020; Gale *et al.* 2021). *Poecilocrinus signatus* (Peck, 1943) and *Euglyphocrinus euglypheus* (Peck, 1943; Text-fig. 7J), characteristic of the zone CeR 1, appear in sample ABY, and *E. euglypheus* continues up to sample Q5. *Roveacrinus spinosus* Peck, 1943 appears in sample Q6, and marks the base of the zone CeR 2. The microcrinoid distribution is very similar to that found in the Main Street Limestone and lower Grayson Formation of north central Texas (Gale 2020; Gale *et al.* 2021).

AMMONITES

The upper Upper Albian and Lower Cenomanian zonal schemes discussed below are set out in Table 2.

The 15–19.5 m level in the Aït Lamine Formation (Text-fig. 2) yielded several specimens of the Upper Albian zonal index *Pervinquieria* (*Subschloenbachia*) *rostrata* (J. Sowerby, 1817) and a single fragment of a specifically indeterminate *Anisoceras*. The index species was originally described from southern England (see Kennedy *et al*. 1998, 2005), but is of cosmopolitan distribution, with records from France, Spain, Germany, Hungary, Ukraine (Crimea), Turkmenistan, Iran, Texas, Angola, and Tamil Nadu in south India in addition to Morocco. The index of the succeeding *Pervinquieria* (*Subschloenbachia*) *perinflata* Zone appears only 50 cm higher, at the 20 m level, and what are interpreted as elements of the zonal fauna extend to the 33 m level: *Desmoceras* (*D.*) *latidorsatum* (Michelin, 1838), *Mariella* (*M.*) *bergeri* (Brongniart, 1822), *Ostlingoceras* (*O.*) *puzosianum* (d'Orbigny, 1842), and *Stoliczkaia* (*S.*) *clavigera* Neumayr, 1875. The last named of these occurs at the 33 m level, and is regarded as upper Upper Albian *perinflata* Zone on the basis of records at this level in north-eastern Algeria and central Tunisia (Kennedy 2020, p. 183, pl. 14, figs 10–15; pl. 17, fig. 26; text-figs 10e, 17c), although it extends into the Lower Cenomanian in Tamil Nadu, south India (Gale *et al*. 2019, p. 217, figs 10, 11, 13, 14). The *perinflata* Zone is widely recognized, the index species also known from southern England, France,

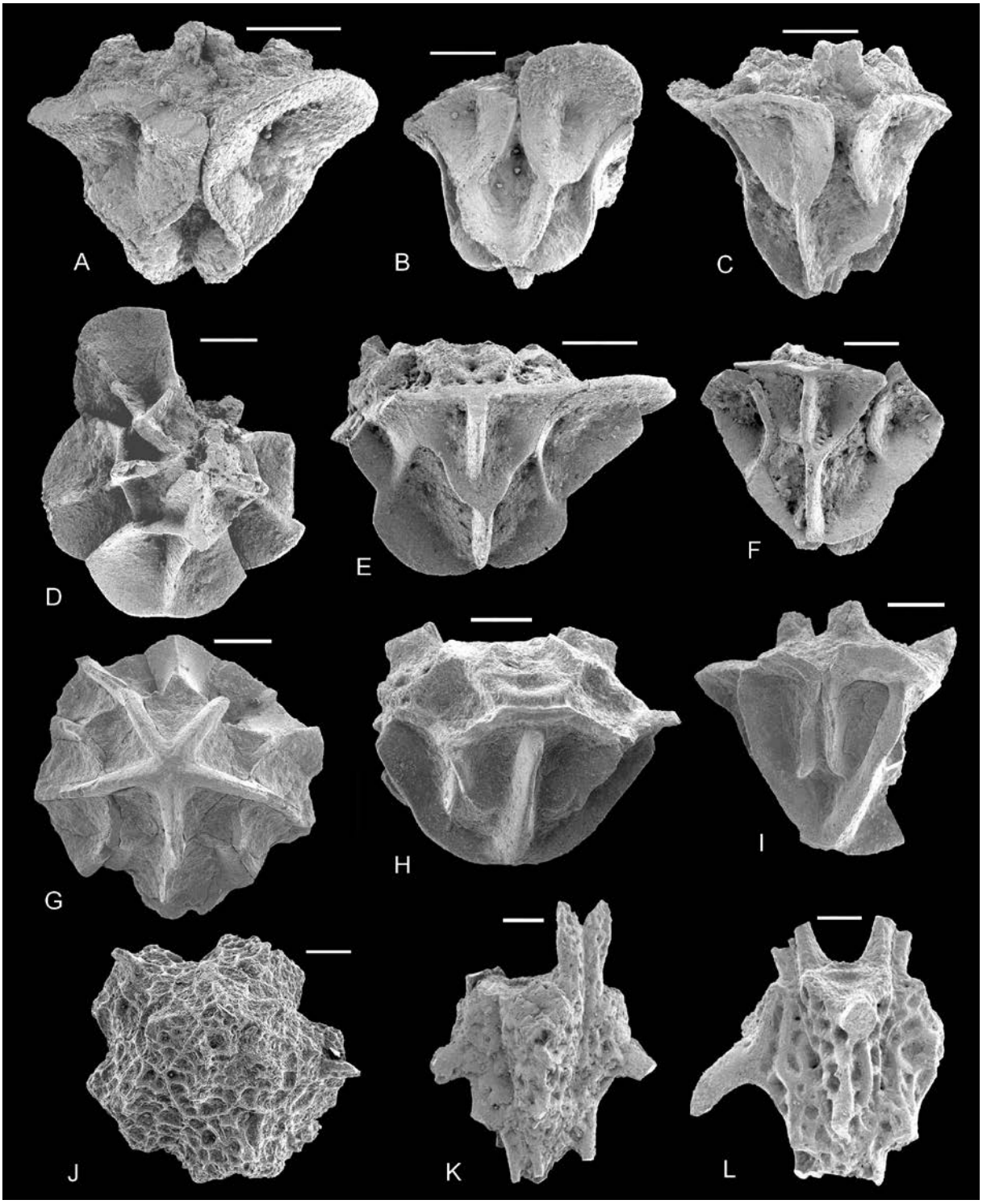
A

Substage	Zone
Lower Cenomanian (part)	*Mantelliceras mantelli* *Pleurohoplites briacensis* (part)
Upper Albian (part)	*Pleurohoplites briacensis* (part) *Pervinquieria* (*Subschloenbachia*) *perinflata* *Pervinquieria* (*Subschloenbachia*) *rostrata*

B

Substage	Zone
Lower Cenomanian (part)	*Budaiceras hyatti* *Graysonites wacoensis* *Graysonites adkinsi*
Upper Albian (part)	*Mariella* (*Wintonia*) *brazoensis* *Pervinquieria* (*Subschloenbachia*) *perinflata* *Pervinquieria* (*Subschloenbachia*) *rostrata*

Table 2. Upper Upper Albian and Lower Cenomanian ammonite zonal sequences discussed in the text. A – The standard zonation of Kennedy and Gale (2017). The *Mantelliceras mantelli* Zone is divided into successive subzones of *Neostlingoceras carcitanense*, *Sharpeicers schlueteri* and *Mantelliceras saxbii*. B – The sequence in north-east Texas, after Kennedy *et al*. (2015).



Text-fig. 7. Microcrinoids from the Abouda sections, Agadir Basin, Morocco. **A**–**C** – *Poecilocrinus dispandus* Peck, 1943. Lateral aspect of 3 cups, NHMUK PI EE 17561−17563; originals of Gale (2020, pl. 21, figs 4−6); sample TA21, Upper Albian. **D**–**F** – *Poecilocrinus molestus* Peck, 1943. Cups in aboral (D) and lateral (E, F) views, NHMUK PI EE 17567−17569; originals of Gale (2020, pl. 22, figs 4−6). D, F – sample ABX; E – sample TA22. **G**–**I** – *Poecilocrinus signatus* (Peck, 1943), NHMUK PI EE 17570, 17571; originals of Gale (2020, pl. 22, figs 10−12); sample Q2, Lower Cenomanian. **J** – *Euglyphocrinus euglypheus* (Peck, 1943), cup in aboral view, NHMUK PI EE 17431; original of Gale (2020, pl. 8, fig. 12); sample Q2, Lower Cenomanian. **K**, **L** – *Euglyphocrinus cristagalli* Gale, 2020, cups in lateral view, NHMUK PI EE 17389, 17391; originals of Gale (2020, pl. 14, figs 5, 13). K – sample AB9, L – sample AB10, Upper Albian. Scale bars: 0.5 mm for A−I and 0.2 mm for J−L.

Sardinia, Switzerland, Hungary, Romania, Ukraine (Crimea), Iran, Angola, KwaZulu-Natal in South Africa, Texas, and Tamil Nadu in south India. Above, there is an interval between the 33 m level and the 45.2 m level, where the first undoubted Lower Cenomanian ammonites appear, that cannot be dated in ammonite terms. The Lower Cenomanian ammonites that occur between the 45.2 and 47.4 m level include *Graysonites adkinsi* Young, 1958, a species adopted as index of the lowest undoubted Cenomanian ammonite zone recognized in Texas (see discussion in Kennedy *et al.* 2005). The associated fauna is *Puzosia* (*Bhimaites*) *bhima* (Stoliczka, 1865), *Pachydesmoceras marroccanum* Collignon, 1967, *Anisoceras perarmatum* Pictet and Campiche, 1861, and *Mariella* (*M.*) *oehlerti sulcata* Klinger and Kennedy, 1978. Of these, *Anisoceras perarmatum* has an Upper Albian, *perinflata* Zone acme (see for example Kennedy and Latil 2007), whereas *M.* (*M.*) *oehlerti sulcata*, previously known only from northernmost KwaZulu-Natal in South Africa, occurs there with typical Lower Cenomanian Mantelliceratinae. Recognition of the *Graysonites adkinsi* Zone only 3 m above the first occurrence of *Thalmanninella globotruncanoides*, which defines the base of the Cenomanian stage, in a section where lowest Cenomanian ammonites extend through at least 266 m suggests that the *adkinsi* Zone is equivalent to the upper, Cenomanian part of the *briacensis* Zone (Table 2) of the Global Stratotype Section. This suggestion is developed further below.

SYSTEMATIC PALAEONTOLOGY: AMMONITES (W.J. Kennedy)

Conventions:
GSI: Geological Survey of India, Kolkata.
MNHN: Muséum national d' Histoire Naturelle, Paris.
OUMNH: Oxford University Museum of Natural History.

The suture terminology is that of Korn *et al.* (2003): E = external lobe; A = adventive lobe; U = umbilical lobe; I = internal lobe.

Order Ammonoidea Zittel, 1884
Superfamily Desmoceratoidea Zittel, 1895
Family Desmoceratidae Zittel, 1895
Subfamily Puzosiinae Spath, 1922
Genus and Subgenus *Puzosia* Bayle, 1878

TYPE SPECIES: *Ammonites planulatus* J. de C. Sowerby, 1827 (p. 134, pl. 570, fig. 5), non Schlotheim, 1820 (p. 59) = *Ammonites mayorianus* d'Orbigny, 1841, p. 267, pl. 79, figs 1–3, by the subsequent designation of H. Douvillé (1879, p. 91).

Subgenus *Puzosia* (*Bhimaites*) Matsumoto, 1954

TYPE SPECIES: *Ammonites bhima* Stoliczka, 1865, p. 137, pl. 69, fig. 2, by the original designation of Matsumoto (1954, p. 113).

Puzosia (*Bhimaites*) *bhima* (Stoliczka, 1865)
(Text-fig. 8)

1865. *Ammonites bhima* Stoliczka, p. 137, pl. 69, figs 2, 3, ?non 1.
1898. *Puzosia bhima* Stol.; Kossmat, p. 184 (119).

Text-fig. 8. *Puzosia* (*Bhimaites*) *bhima* (Stoliczka, 1865). OUMNH KX.17294, from the Aït Lamine Formation, Oued Abouda, at the 47.2 m level, Lower Cenomanian, *Graysonites adkinsi* Zone. Scale bar 10 mm.

2011. *Puzosia* (*Bhimaites*) *bhima* (Stoliczka, 1865); Klein and Vašíček, pp. 94, 95 (with synonymy).
2014. *Bhimaites bhima* (Stoliczka, 1865); Kennedy and Klinger, p. 9, text-fig. 10.
2019. *Puzosia* (*Bhimaites*) *bhima* (Stoliczka, 1865); Kennedy in Gale *et al*., p. 203, pl. 10, figs 8, 9; pl. 12, figs 14, 15; text-fig. 16e.

TYPES: The lectotype, by the subsequent designation of Matsumoto (1988, p. 20) is the original of Stoliczka (1865, pl. 69, fig. 2), GSI. 272 in the collections of the Geological Survey of India, from the Upper Albian of Moraviatoor.

MATERIAL: OUMNH KX.17294, from the Aït Lamine Formation, Oued Abouda, at the 47.2 m level, Lower Cenomanian, *Graysonites adkinsi* Zone.

REMARKS: The specimen is a 60º sector of phragmocone and a 120º sector of adult body chamber with a maximum preserved diameter of 160 mm, and a maximum preserved whorl height of 78 mm. Coiling is moderately involute, the umbilicus comprising around 20–25% of the diameter, shallow, with a feebly convex outward-inclined umbilical wall and broadly rounded umbilical shoulder. The whorl section is compressed, with a whorl breadth to height ratio of 0.8 approximately on the undeformed sector of the phragmocone, the greatest breadth below mid-flank, the flanks feebly convex, converging to a convex venter. There are well-developed constrictions. They are feebly prorsiradiate, straight on the inner flank, flexing forwards and feebly convex on the outer flank, and crossing the venter in a linguoid peak. The adapertural side of the constrictions on the body chamber are flanked by a collar-rib strengthening markedly on the venter. They are widely separated, but it is not possible to determine their frequency because of poor preservation. The corroded suture is deeply and intricately incised. For discussion see Kennedy in Gale *et al*. (2019, p. 203).

OCCURRENCE: Upper Albian of northern KwaZulu-Natal, South Africa, Lower Cenomanian of Morocco, Middle Cenomanian of Tamil Nadu, south India.

Genus *Pachydesmoceras* Spath, 1922

TYPE SPECIES: *Ammonites denisonianus* Stoliczka, 1865, p. 133, pl. 65, fig. 4; pl. 66, figs 1, 2; pl. 66a, by the original designation of Spath (1922, p. 127).

Pachydesmoceras maroccanum Collignon, 1967
(Text-fig. 9)

1967. *Pachydesmoceras maroccanum* Collignon, p. 26, pl. 12, fig. 4.
2020. *Pachydesmoceras maroccanum* Collignon, 1967; Kennedy, p. 168, pl. 1, figs 4, 8.

TYPE: The holotype, by monotypy, is the original of Collignon (1967, pl. 12, fig. 4), from the Cenomanian of the Tarfaya Basin, Morocco.

MATERIAL: OUMNH KX.17301–3 from the Aït Lamine Formation, Oued Abouda, at the 45.4 m level, Lower Cenomanian, *Graysonites adkinsi* Zone.

REMARKS: The material consists of large phragmocone fragments with whorl heights of up to 88 mm, the whorl section compressed, with a whorl breadth to height ratio of 0.9, the maximum breadth just outside the umbilical shoulder. The flanks are convex, the outer flanks converging to a broadly rounded venter. Ornament is of crowded narrow primary ribs that are feebly concave on the inner flanks, straight and feebly prorsiradiate on the outer flanks, and passing near-straight across the venter. They are separated by weaker primary and both long and short intercalated ribs that are variable in number.

The Upper Albian *Pachydesmoceras hottingeri* Collignon, 1967 (Collignon 1967, p. 14, pl. 2, figs 1, 2) from the Tarfaya Basin, has sinuous ribs that branch on the ventrolateral shoulder.

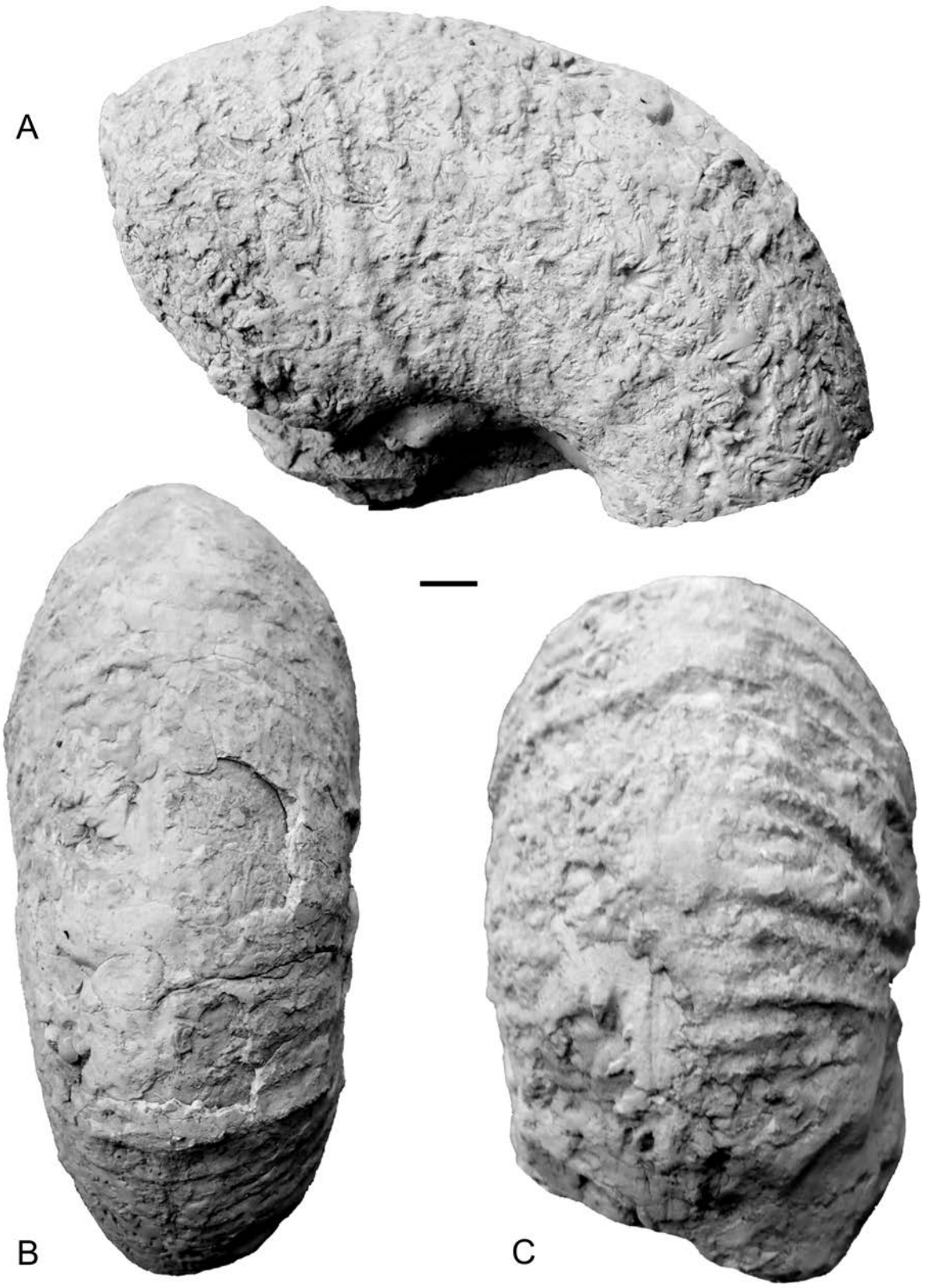
OCCURRENCE: Lower Cenomanian of Morocco, and Upper Cenomanian of Central Tunisia.

Subfamily Desmoceratinae Zittel, 1895
Genus and Subgenus *Desmoceras* Zittel, 1884

TYPE SPECIES: *Ammonites latidorsatus* Michelin, 1838, by the subsequent designation of Böhm (1895, p. 364).

Desmoceras (*Desmoceras*) *latidorsatum* (Michelin, 1838)
(Text-fig. 10)

1838. *Ammonites latidorsatus* Michelin, p. 101, pl. 12, fig. 9.
2011. *Desmoceras* (*Desmoceras*) *latidorsatum* (Michelin, 1838); Klein and Vašíček, pp. 141, 144 (with full synonymy).
2019. *Desmoceras* (*Desmoceras*) *latidorsatum* (Michelin,



Text-fig. 9. *Pachydesmoceras maroccanum* Collignon, 1967. A, B – OUMNH KX.17302; C – OUMNH KX.17303, both from the Aït Lamine Formation, Oued Abouda, at the 45.4 m level, Lower Cenomanian, *Graysonites adkinsi* Zone. Scale bar 10 mm.

Text-fig. 10. *Desmoceras* (*Desmoceras*) *latidorsatum* (Michelin, 1838); OUMNH KX.17289, from the Aït Lamine Formation, Oued Abouda, at the 20 m level, Upper Albian, *Pervinquieria* (*Subschloenbachia*) *perinflata* Zone. Scale bar 10 mm.

1838); Kennedy in Gale *et al*., p. 206, pl. 4, figs 19–25; pl. 11, figs 7–14.

2020. *Desmoceras* (*Desmoceras*) *latidorsatum* (Michelin, 1838); Kennedy, p. 168, pl. 7, figs 16–18; pl. 8, figs 14–19 (with additional synonymy).

TYPE: The neotype (Joly in Gauthier 2006, p. 97, pl. 3, fig. 1) is MNHN. F. B46095, *ex* d'Orbigny Collection 5773-B1, from the condensed Albian of Escragnolles, Var, France.

MATERIAL: OUMNH KX.17289, from the Aït Lamine Formation, Oued Abouda, at the 20 m level, Upper Albian, *Pervinquieria* (*Subschloenbachia*) *perinflata* Zone.

REMARKS: The specimen is a short fragment from the adapertural end of the phragmocone of an adult with a maximum preserved whorl height of 76 mm approximately, and a whorl breadth to height ratio of 1.14. The whorl section is compressed, with feebly convex converging flanks, broadly rounded ventrolateral shoulders and a convex venter. There is no ornament. The deeply incised sutures interfere; the saddles are bifid. The specimen differs in no significant respects from the large individuals from Tamil Nadu in south India (Stoliczka 1865, pl. 74, fig. 3; Kennedy and Klinger 2013b, text-fig. 5), although not preserving any constrictions.

OCCURRENCE: Middle Albian to Upper Cenomanian, southern England, southern France, Italy, northern Spain, southern Germany, Switzerland, Hungary, Romania, Serbia, Poland, Sardinia, Ukraine, Morocco, northern Algeria, Central Tunisia, Egypt, Nigeria, Angola, KwaZulu-Natal in South Africa, Mozambique, Madagascar, Tamil Nadu in south India, Pakistan, Japan New Zealand, Mexico and Venezuela.

Superfamily Acanthoceratoidea de Grossouvre, 1894
Family Brancoceratidae Spath, 1934
Subfamily Mortoniceratinae H. Douvillé, 1912
Genus *Pervinquieria* Böhm, 1910

TYPE SPECIES: *Ammonites inflatus* J. Sowerby, 1817, p. 170, pl. 178, by the original designation of Böhm (1910, p. 152).

Subgenus *Subschloenbachia* Spath, 1921
(=*Durnovarites* Spath, 1932, p. 380)

TYPE SPECIES: *Ammonites rostratus* J. Sowerby, 1817, p. 163, pl. 173, by the original designation of Spath (1921, p. 284).

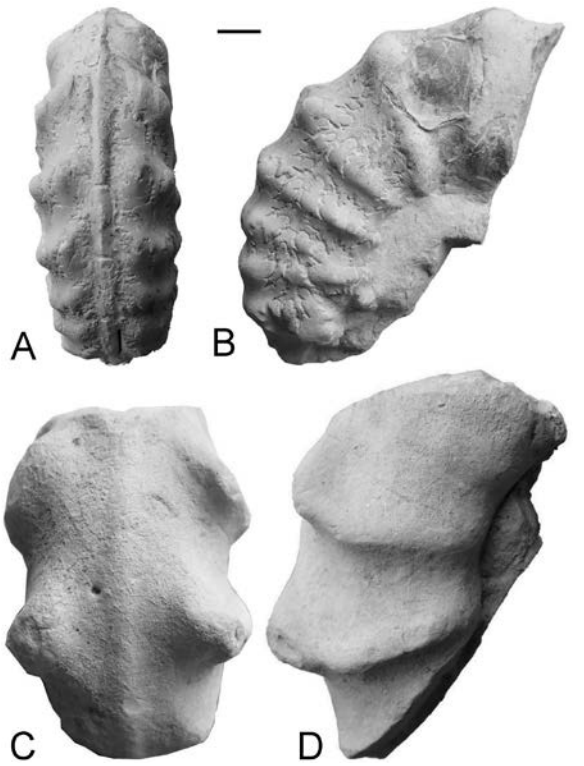
Pervinquieria (*Subschloenbachia*) *rostrata*
(J. Sowerby, 1817)
(Text-fig. 11A–D)

1817. *Ammonites rostratus* J. Sowerby, p. 163, pl. 173.
2018. *Mortoniceras* (*Mortoniceras*) *rostratum* (J. Sowerby, 1817); Klein, pp. 101, 122 (with additional synonymy).
2019. *Pervinquieria* (*Subschloenbachia*) *rostrata* (J. Sowerby, 1817); Kennedy in Gale *et al*., p. 214, pl. 13; pl. 14, figs 1, 2 (with additional synonymy).
2020. *Pervinquieria* (*Subschloenbachia*) *rostrata* (J. Sowerby, 1817); Kennedy in Gale and Kennedy, p. 65, pl. 18, figs 1–4; text-figs 44–46.

TYPE: The holotype, by monotypy, is OUMNH K.835, the original of *Ammonites rostratus* J. Sowerby, 1817, p. 163, pl. 173, from the Upper Greensand of Roke, 1.5 km NNE of Benson, Oxfordshire.

MATERIAL: OUMNH KX.17287 from the Aït Lamine Formation, Oued Abouda, at the 15 m level; OUMNH KX.17288, from the 19.5 m level, Upper Albian, *Pervinquieria* (*Subschloenbachia*) *rostrata* Zone.

REMARKS: OUMNH KX.17287 (Text-fig. 11A, B) is a 120º whorl sector from the adapertural end of an adult phragmocone and adapical end of the body chamber; the maximum preserved whorl height is 41.5 mm. The intercostal whorl section is compressed, the whorl breadth to height ratio 0.68, the greatest breadth below mid-flank, the feebly convex umbilical wall outward-inclined, the umbilical shoulder broadly rounded, the flanks subparallel, the ventrolateral shoulders broadly rounded, the venter feebly convex, with a strong siphonal keel. There are seven ribs on the fragment. All arise from well-developed umbilical bullae; most are single, but one bulla towards the adapical end of the fragment gives rise to a pair of ribs. The ribs are broad, straight and prorsiradiate, and bear a feeble outer lateral bulla, strong, conical inner ventrolateral tubercle and a smaller outer ventrolateral clavus, separated by a smooth zone from the siphonal keel. OUMNH KX.17288 (Text-fig. 11C, D) is a larger body chamber fragment with a maximum preserved intercostal whorl height of 42 mm. The ribs are strong and widely separated, with well-developed umbilical and outer lateral bullae, and a strong oblique ventrolateral bulla. The suture is moderately incised, with bifid lobes and saddles.



Text-fig. 11. *Pervinquieria* (*Subschloenbachia*) *rostrata* (J. Sowerby, 1817). A, B – OUMNH KX.17287 from the 15 m level; C, D – OUMNH KX.17288, from the 19.5 m level, Aït Lamine Formation, Oued Abouda, Upper Albian, *Pervinquieria* (*Subschloenbachia*) *rostrata* Zone. Scale bar 10 mm.

The fragments differ in no significant respects from comparable ontogenetic stages of the somewhat crushed holotype (Kennedy *et al.* 1998, text-figs 10–12) and better-preserved specimens assigned to the species from the Weno Limestone of north-east Texas (Kennedy *et al*. 1998, text-figs 13–18; Kennedy in Gale and Kennedy 2020, pl. 19, figs 1–4; text-figs 44–46).

OCCURRENCE: Upper Albian *Pervinquieria* (*Subschloenbachia*) *rostrata* Zone and correlatives, southern England, France, Germany, Spain, Switzerland, Hungary, Ukraine (Crimea), Morocco, Iran, Texas in the United States, Angola, and Tamil Nadu, south India.

Pervinquieria (*Subschloenbachia*) *perinflata* (Spath, 1922)
(Text-fig. 12A–D)

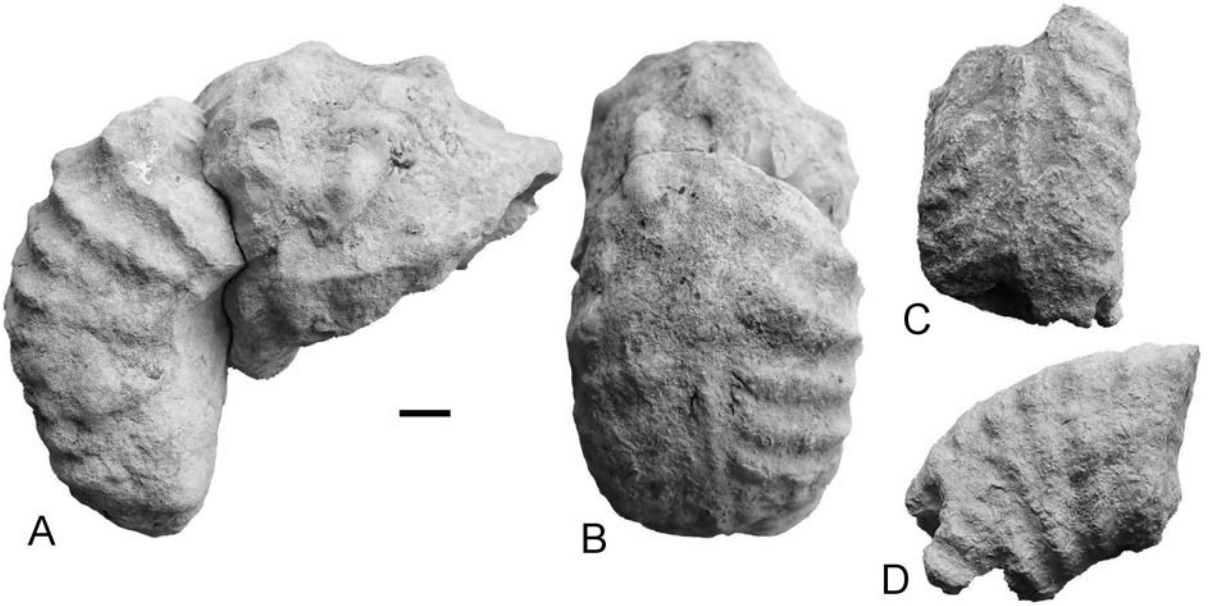
1860. *Ammonites inflatus* Pictet and Campiche (non J. Sowerby), p. 178, pl. 21, fig. 5; pl. 22, fig. 3.
1922. *Inflaticeras* (*Subschloenbachia*) *perinflata* Spath, p. 113.
2018. *Mortoniceras* (*Durnovarites*) *perinflatum* (Spath, 1921); Klein, pp. 137, 140 (with synonymy).
2018. *Mortoniceras* (*Durnovarites*) *subquadratum subquadratum* Spath, 1933; Klein, pp. 138, 144 (with synonymy).
2018. *Mortoniceras* (*Durnovarites*) *subquadratum crassicostatum* Spath, 1933; Klein, pp. 138, 143 (with synonymy).
2018. *Mortoniceras* (*Durnovarites*) *subquadratum tumidum* Spath, 1933; Klein, pp. 138, 145 (with synonymy).

TYPE: The holotype, by monotypy, is the original of Pictet and Campiche (1860, pl. 22, fig. 3), in the collections of the Muséum d' Histoire Naturelle, Geneva, and from the Upper Albian of La Vraconne, Saint Croix, Switzerland. It was refigured by Renz (1968, pl. 9, fig. 1) and Wiedmann and Dieni (1968, pl. 14, fig. 4).

MATERIAL: OUMNH KX.17290, from the Aït Lamine Formation, Oued Abouda, at the 20 m level; OUMNH KX.17293, collected loose at the same level, Upper Albian, *perinflata* Zone.

REMARKS: OUMNH KX.17293 (Text-fig. 12C, D) is a 60º phragmocone fragment with a maximum preserved whorl height of 28 mm, the whorl section is slightly depressed, with a feebly convex, outward-inclined umbilical wall and broadly rounded umbilical shoulder. The flanks are flattened and subparallel, the ventrolateral shoulders broadly rounded, the venter flattened, with a strong siphonal keel. Four well-developed umbilical bullae give rise to single ribs or pairs of straight prorsiradiate ribs with lateral bullae, a conical inner ventrolateral tubercle from which a well-developed rib sweeps forwards to a poorly preserved outer ventrolateral tubercle, beyond which the rib declines and effaces before reaching the siphonal keel. This fragment corresponds to the adapical sector of the outer whorl of the topotype of *perinflata* figured by Renz (1968, pl. 9, fig. 2).

OUMNH KX.17290 (Text-fig. 12A, B) is a much larger, battered phragmocone with a maximum preserved diameter of 115 mm. Ribs arise in pairs from umbilical bullae at the adapical end of the fragment, but most ribs are single, with well-developed umbilical bullae, weaker lateral bullae, strong conical inner ventrolateral and clavate outer ventrolateral tubercles. The ornament is coarser than in the holotype (Renz 1968, pl. 9, fig. 1), matching that of the robustly ornamented topotypes figured by Renz (1968, pl. 8, fig. 1), and corresponding to the robustly ornamented individuals from the Bakony Mountains of Hungary figured by Scholz (1979, pl. 28).



Text-fig. 12. *Pervinquieria* (*Subschloenbachia*) *perinflata* (Spath, 1922). A, B – OUMNH KX.17290, from the 20 m level; C, D – OUMNH KX.17293, collected loose at the same level, Aït Lamine Formation, Oued Abouda, Upper Albian, *Pervinquieria* (*Subschloenbachia*) *perinflata* Zone. Scale bar 10 mm.

OCCURRENCE: Upper Upper (but not uppermost) Albian, *Pervinquieria* (*Subschloenbachia*) *perinflata* Zone with a geographic range from southern England to south-eastern France, Sardinia, Switzerland, Hungary, Romania, Ukraine (Crimea), the lesser Caucasus, Morocco, Iran, Angola, KwaZulu-Natal in South Africa, Texas in the United States, and Tamil Nadu in south India.

Family Lyelliceratidae Spath, 1921
Subfamily Stoliczkaiinae Breistroffer, 1953
Genus and subgenus *Stoliczkaia* Neumayr, 1875

TYPE SPECIES: *Ammonites dispar* d'Orbigny, 1841, p. 142, pl. 45, figs 1, 2, by the subsequent designation of Diener (1925, p. 179).

Stoliczkaia (*Stoliczkaia*) *clavigera* Neumayr, 1875
(Text-fig. 13F, G)

1864. *Ammonites dispar* Stoliczka, p. 85 (*pars*), pl. 45, fig. 1 only.
1875. *Stoliczkaia clavigera* Neumayr, p. 933.
2018. *Stoliczkaiella* (*Stoliczkaiella*) *clavigera* Neumayr, 1875); Klein, pp. 222, 223 (with synonymy).
2019. *Stoliczkaia* (*Stoliczkaia*) *clavigera* (Neumayr, 1875); Kennedy in Gale *et al*., p. 217, pl. 17, figs 10–14 (with synonymy).
2020. *Stoliczkaia* (*Stoliczkaia*) *clavigera* (Neumayr, 1875); Kennedy, p. 183, pl. 14, figs 10–15; pl. 17, fig. 26; text-figs 10E, 17C.

TYPE: The holotype, by monotypy, is the original of Stoliczka (1864, pl. 45, fig. 1 only), GSI. 191, from the Utatur Group of Moraviatoor. A cast of this specimen was figured by Delanoy and Latil (1988, pl. 5, fig. 1).

MATERIAL: OUMNH KX.17297 from the Aït Lamine Formation, Oued Abouda, at the 33 m level, Upper Albian, *perinflata* Zone.

REMARKS: The specimen is a 120º sector of phragmocone with a maximum preserved whorl height of 24 mm, the whorl breadth to height ratio of 0.7, the greatest breadth below mid-flank. The flanks are very feebly convex, subparallel, the outer flanks converging to broadly rounded ventrolateral shoulders, the broad venter feebly convex. Primary ribs arise at the umbilical seam, and some strengthen into very feeble umbilical bullae. The ribs are near-straight and feebly prorsiradiate on the flanks, bifurcating both low and high on the flanks, whilst additional ribs intercalate, then passing straight across the venter without developing ventral tubercles. The specimen compares well with material from south India and Central Tunisia assigned to the species (Kennedy in Gale *et al.* 2019, pl. 17, fig. 12; Kennedy 2020, pl. 14, figs 10–15).

OCCURRENCE: Upper Upper Albian *Pervinquieria* (*Subschloenbachia*) *rostrata* Zone to lower Lower Cenomanian *Mantelliceras mantelli* Zone, with records from southern England, southeast France, northern Spain, Switzerland, Hungary, Romania, Turkmenistan, Morocco, north-eastern Algeria, Central Tunisia, Japan, Texas, Cuba, Tamil Nadu in south India, and northern KwaZulu-Natal in South Africa.

Subgenus *Lamnayella* Wright and Kennedy, 1978

TYPE SPECIES: *Stoliczkaia* (*Lamnayella*) *juigneti* Wright and Kennedy, 1978, p. 398, pl. 37, figs 1–10; pl. 38, figs 1–12, by the original designation of Wright and Kennedy (1978, p. 394).

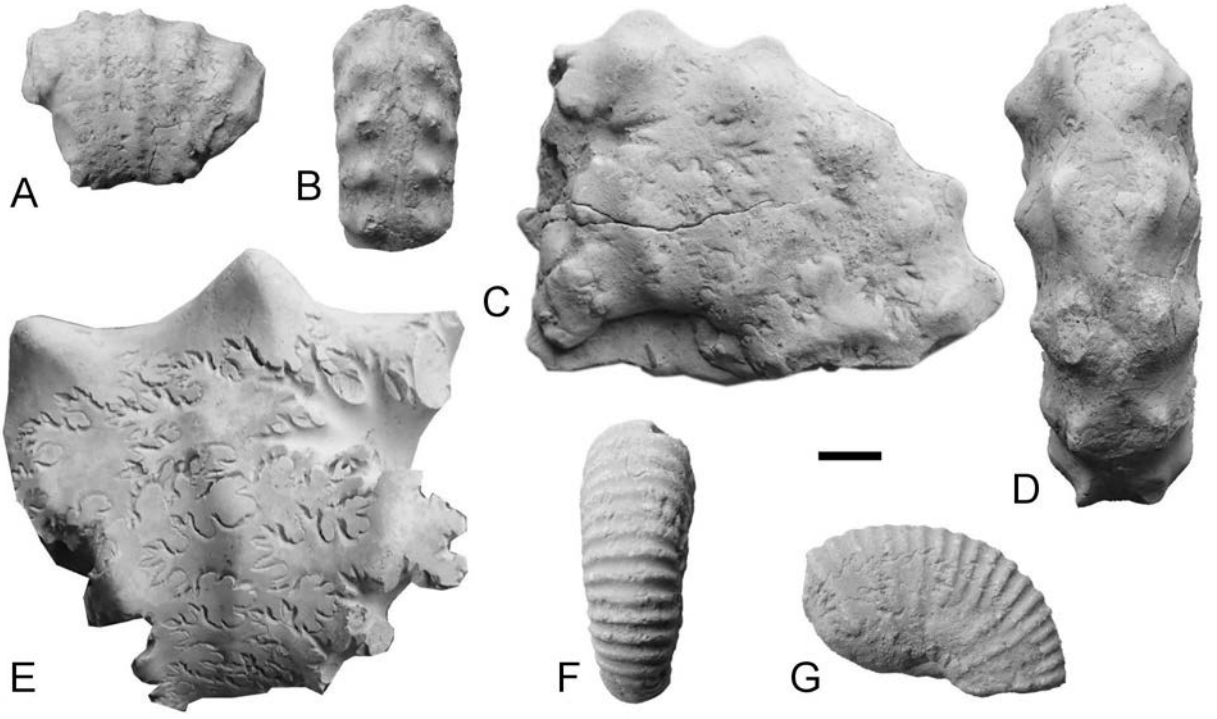
Stoliczkaia (*Lamnayella*) sp.

MATERIAL: OUMNH KX.17295, from the Aït Lamine Formation, Oued Abouda, at the 20–30 m level, Upper Albian, *Pervinquieria* (*Subschloenbachia*) *perinflata* Zone.

DESCRIPTION: The specimen is a worn 60º sector of phragmocone with an estimated maximum preserved whorl height of 27 mm approximately. The whorl section is compressed, with very feebly convex flanks, broadly rounded ventrolateral shoulders, and a feebly convex venter. The worn ornament consists of very coarse ribs that arise either singly or in pairs from the umbilical shoulder, strengthen across the flanks and are very coarse and transverse on the venter.

Poor as the fragment is, but given the age, it is clearly a *Stoliczkaia* (*Lamnayella*), agreeing well with the Upper Albian *Stoliczkaia* (*Lamnayella*) *crotaloides* (Stoliczka, 1864) (see revision in Kennedy and Klinger 2013a, p. 7, text-figs 7q, r; 8d, e; 14a–c, g–j; 15 f, g; Kennedy in Gale *et al*. 2019, p. 218, pl. 17, figs 1–7, 15; text-fig. 15b; with full synonymy).

OCCURRENCE: *Stoliczkaia* (*Lamnayella*) ranges from the Upper Albian *Pervinquieria* (*Subschloenbachia*) *perinflata* Zone to the Lower Cenomanian *Neostlingoceras carcitanense* Subzone of the *Mantelliceras mantelli* Zone, with records from southern



Text-fig. 13. **A**–**E**, *Graysonites adkinsi* Young, 1958. A, B – OUMNH KX.17317, from the 45.4 m level; C, D – OUMNH KX.17319, from the 45.4 m level; E – OUMNH KX.17313, from the 47.2 m level, all from Aït Lamine Formation, Oued Abouda, Lower Cenomanian, *Graysonites adkinsi* Zone. **F**, **G** – *Stoliczkaia* (*Stoliczkaia*) *clavigera* (Neumayr, 1875). OUMNH KX.17297, from the Aït Lamine Formation, Oued Abouda, at the 33 m level, Upper Albian, *Pervinquieria* (*Subschloenbachia*) *perinflata* Zone. Scale bar 10 mm.

England, France, Switzerland (?), Romania, Turkmenistan, Israel, KwaZulu-Natal in South Africa, Tanzania (?), Japan, Texas and northern Mexico.

Family Acanthoceratidae de Grossouvre, 1894
Subfamily Mantelliceratinae Hyatt, 1903
Genus *Mantelliceras* Hyatt, 1903

TYPE SPECIES: *Ammonites mantelli* J. Sowerby, 1814, p. 199, by the original designation of Hyatt (1903, p. 113) (ICZN Specific Name No. 1634).

Mantelliceras cf. *lymense* (Spath, 1926)

compare:
1926. *Eucalycoceras lymense* Spath, pp. 427, 431.
1984. *Mantelliceras lymense* (Spath, 1926); Wright and Kennedy, p. 102, pl. 10, fig. 9; pl. 22, figs 1–6; pl. 23, figs 1–3; pl. 31, figs 1, 2; pl. 36, fig. 4; text-figs 19; 24a, b; 26d; 28f–j (with synonymy).
2020. *Mantelliceras lymense* (Spath, 1926); Kennedy, p. 200, text-fig. 18c, d (with additional synonymy).

TYPE: The lectotype, by the subsequent designation of Wright and Kennedy (1984, p. 102), is the original of Pervinquière (1907, pl. 16, fig. 16), refigured by Wright and Kennedy (1984, text-fig. 24a, b), and Kennedy (2020, text-fig. 18c, d), from south of Bargou, Tunisia, an unregistered specimen in the collections of the École des Mines, Paris, currently housed in the collections of the Université de Lyon 1-Villeurbanne.

MATERIAL: OUMNH KX.17321, from the 311 m level of the Aït Lamine Formation, Oued Abouda, Lower Cenomanian.

REMARKS: The specimen is a poorly preserved 90º sector, in part phragmocone, with a maximum preserved whorl height of 32 mm approximately. The whorl section is slightly depressed, with the greatest breadth below mid-flank, the flanks feebly convex, the ventrolateral shoulders broadly rounded, the broad venter very feebly convex. Coarse primary ribs arise at the umbilical seam, strengthen across the umbilical wall and shoulder and develop into umbilical bullae. These give rise to strong straight recti-

radiate ribs that link to well-developed ventrolateral clavi, linked across the venter by a strong transverse rib. Intercalated ribs arise below mid-flank and strengthen to match the primaries on the ventrolateral shoulders and venter.

The pattern of ribbing and tuberculation of this fragment are exactly those of *Mantelliceras lymense*, and find a close match in specimens from southern England of the same size (see Wright and Kennedy1984, pl. 22, fig. 5; pl. 31, figs 1, 2 and discussion therein).

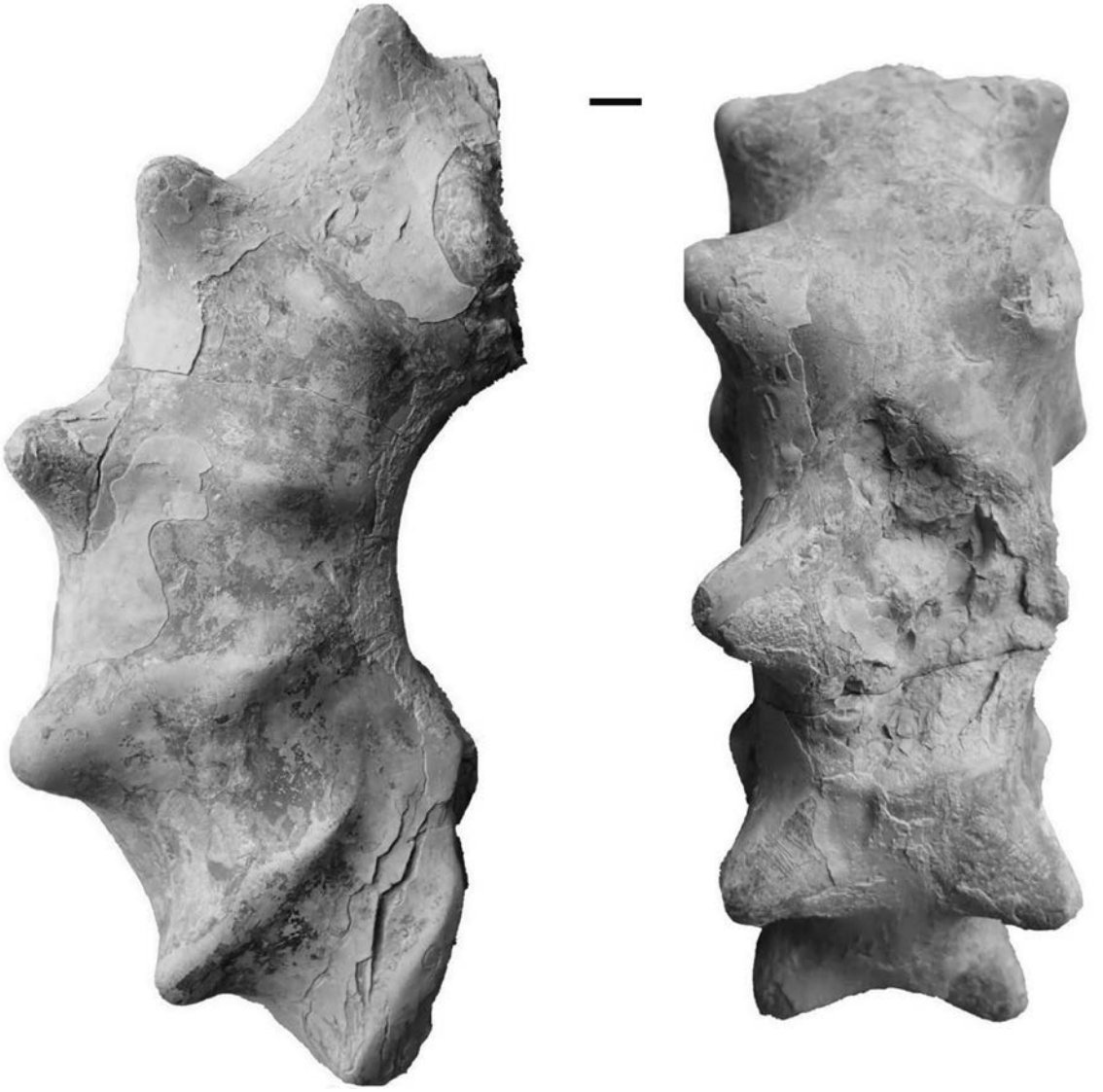
OCCURRENCE: Lower Cenomanian, southern England, Northern Ireland, France from the Boulonnais south to Bouches-du-Rhône, Morocco, northeastern Algeria, Central Tunisia, Madagascar, Tamil Nadu in south India, and possibly Germany and Iran.

Genus *Graysonites* Young, 1958

TYPE SPECIES: *Graysonites lozoi* Young, 1958, p. 172, pl. 27, figs 1–11, text-fig 1b–d, f, by original designation = *Mantelliceras wacoense* Böse, 1928, p. 215, pl. 5, figs 9–25, pl. 6, figs 1–4.

Graysonites adkinsi Young, 1958
(Text-figs 13A–E, 14)

1958. *Graysonites adkinsi* Young, p. 176, pl. 29, figs 1, 7; text-figs 2a, e, f; 3a, e.



Text-fig. 14. *Graysonites adkinsi* Young, 1958. OUMNH KX.17318, from the 47.2 m level, Aït Lamine Formation, Oued Abouda, Lower Cenomanian, *Graysonites adkinsi* Zone. Scale bar 10 mm.

2005. *Graysonites adkinsi* Young, 1958; Kennedy in Kennedy *et al*., p. 402, text-figs 21e–g; 23i–l; 33g; 39–41; 42a–e (with full synonymy).

TYPE: The holotype, by original designation, is no. 272 in the collections of the Texas Memorial Museum, the original of Young (1958, p. 176, pl. 9, figs 1, 7), described as being from the top of the Main Street Limestone east of highway 81, at the top of the south bluff of the Lampas River, south of Belton, Bell County, Texas.

MATERIAL: OUMNH KX.17314, 17317 and 17319 from the 45.4 m level; OUMNH KX.17313, 17315, 17316 and 17318, from the 47.2 m level of the Aït Lamine Formation, Oued Abouda, Lower Cenomanian, *Graysonites adkinsi* Zone.

REMARKS: OUMNH KX.17317 (Text-fig. 13A, B) is the smallest specimen seen, with a maximum preserved costal whorl height of 23.5 mm. At this stage, widely separated primary ribs arise at the umbilical seam and strengthen into small umbilicolateral bullae. They are straight and prorsiradiate on the flanks, linking to small conical/bullate inner ventrolateral tubercles, linked to an outer ventrolateral clavus, the clavi linked across the venter by a low, broad rib. The primary ribs are separated by single intercalated ribs that arise below mid-flank and strengthen to match the primary ribs on outer flanks, ventrolateral shoulders and venter. OUMNH KX.17319 (Text-fig. 13C, D) is a larger fragment with a maximum preserved costal whorl height of 41 mm approximately and a costal whorl breadth to height ratio of 0.6 approximately. There are three strong, coarse primary ribs on the fragment, with coarse umbilical bullae, conical inner and clavate outer ventrolateral tubercles, separated by single intercalated ribs with comparable outer flank and ventral development. The fragment differs in no significant respects from the adapical part of the outer whorl of the holotype (Young 1958, pl. 29, figs 1, 7; Kennedy *et al*. 2005, fig. 39). Fragments (OUMNH KX.17314, 17316) link these individuals to OUMNH KX.17318 (Text-fig. 14), a 120º body chamber fragment with a maximum preserved whorl height of 72 mm. There are five very distant, coarse primary ribs on the fragment, with massive umbilicolateral bullae and ventrolateral horns into which the inner ventrolateral tubercles have been assimilated. This specimen corresponds to the adult fragment from Coahuila, Mexico, described as *Acanthoceras cunningtoni* Young, 1958 var. of Böse (1928, pl. 3, figs 1–3, refigured in Kennedy *et al*. 2005, text-fig. 21 e–g) and the specimens of *Graysonites fountaini* Young, 1958, a synonym of *G. adkinsi*, figured by Young (1958, pl. 29, figs 3, 5, 6).

OCCURRENCE: Lower Lower Cenomanian, *Graysonites adkinsi* Zone and correlatives, Texas, northern Mexico, the Betic Cordillera in Spain, Morocco, and Hokkaido, Japan.

Suborder Ancyloceratina Wiedmann, 1966
Superfamily Turrilitoidea Gill, 1871
Family Anisoceratidae Hyatt, 1900
Genus *Anisoceras* Pictet, 1854

TYPE SPECIES: *Hamites saussureanus* Pictet in Pictet and Roux, 1847, p. 118, pl. 13, figs. 1–4, by the original designation of Pictet (1854, p. 705).

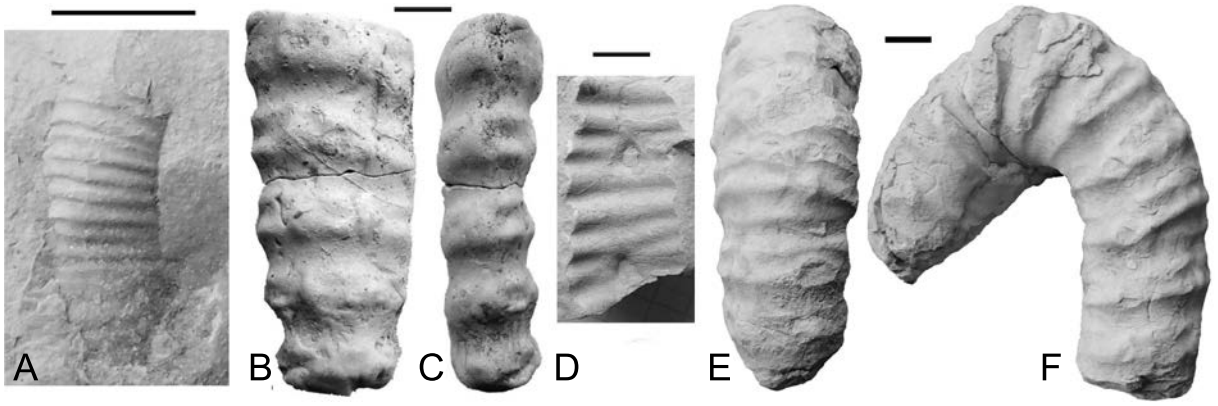
Anisoceras perarmatum Pictet and Campiche, 1861
(Text-fig. 15B, C, E, F)

1861. *Anisoceras perarmatum* Pictet and Campiche, p. 65 (*pars*), pl. 49, figs 1–5, non fig. 6.
2015. *Anisoceras perarmatum perarmatum* Pictet and Campiche, 1861; Klein, pp. 26, 37 (with full synonymy).
2015. *Anisoceras perarmatum perarmatum dorsocostatum* Chiriac, 1981; Klein, pp. 26, 36 (with full synonymy).
2015. *Anisoceras perarmatum renzi* Kotetishvili, 1977; Klein, pp. 26, 39 (with full synonymy).
2015. *Anisoceras perarmatum simplex* Renz, 1968; Klein, pp. 26, 39 (with full synonymy).
2017. *Anisoceras perarmatum* Pictet and Campiche, 1861; Tajika *et al*., p. 40, text-fig. 10g.
2019. *Anisoceras perarmatum* Pictet and Campiche, 1861; Kennedy in Gale *et al*., p. 276, pl. 50, figs 2–4, 7; pl. 51, figs 9–12.

TYPE: The lectotype, by the subsequent designation of Renz (1968, p. 74) is the original of Pictet and Campiche (1861, pl. 49, fig. 1), no. 21280 in the collections of the Musée Géologique, Lausanne. It was refigured by Renz (1968, pl. 13, fig. 5; text-figs 27a, 28g), and is from the upper Upper Albian south of La Vraconne, Vaud, Switzerland.

MATERIAL: OUMNH KX.17299 and 17300, from the Aït Lamine Formation, Oued Abouda, at the 45.4 m level, Lower Cenomanian *Graysonites adkinsi* Zone.

REMARKS: OUMNH KX.17299 (Text-fig. 15B, C) is a laterally crushed fragment 64 mm long, with a



Text-fig. 15. **A** – *Hamites* sp. OUMNH KX.17298, from the 38 m level. **B**, **C**, **E**, **F** – *Anisoceras perarmatum* Pictet and Campiche, 1861. B, C – OUMNH KX.17299; E, F – OUMNH KX.17300, both from the 45.4 m level, Lower Cenomanian *Graysonites adkinsi* Zone. **D** – *Anisoceras* sp. OUMNH KX.17286 from the 15 m level, Upper Albian, *Pervinquieria* (*Subschloenbachia*) *rostrata* Zone. All specimens are from the Aït Lamine Formation, Oued Abouda. Scale bar 10 mm.

maximum preserved whorl height of 29 mm, made up of a single chamber filling and the adapical part of the body. Preservation is poor, but there are four pairs of coarse ribs on the flanks, linked by an inner lateral bulla and ventral clavus, the clavi linked across the venter by a pair of coarse ribs. Poor as this specimen is, the ornament is exactly that of the lectotype. OUMNH KX.17300 (Text-fig. 15E, F) is crushed specimen comprising the adapertural part of the penultimate shaft, curved sector, and the adapical part of the final shaft. The dorsum bears delicate transverse ribs, some of which strengthen markedly into coarse, widely separated ribs that link to a coarse conical/bullate inner lateral tubercle, from which a pair of coarse transverse ribs or a single rib link to a coarse conical/clavate outer ventrolateral tubercle. These tubercles are linked across the venter by a single rib or a pair of ribs. There are occasional nontuberculate ribs on the flanks and venter between the tuberculate groups. The ornament of this specimen finds a match in topotypes of *A. perarmatum* (Renz 1968, pl. 14, figs 2, 3).

OCCURRENCE: Upper Upper Albian, and now confirmed as occurring in the Lower Cenomanian. The geographic distribution extends from Switzerland to southern England, France, Sardinia, Spain, Germany, Hungary, Romania, Ukraine, Georgia, North Africa, Nigeria, KwaZulu-Natal in South Africa, Mozambique, Tamil Nadu in south India, and Texas.

Family Hamitidae Gill, 1871
Genus *Hamites* Parkinson, 1811

TYPE SPECIES: *Hamites attenuatus* J. Sowerby, 1814, p. 137, pl. 61, figs 4, 5, by the subsequent designation of Diener (1925, p. 65).

Hamites sp.
(Text-fig. 15A)

MATERIAL: OUMNH KX.17298, from the 38 m level of the Aït Lamine Formation, Oued Abouda, Upper Albian.

REMARKS: An 18 mm long internal mould of the flank of a *Hamites* has a maximum preserved whorl height of just over 6 mm. Ornament consists of fine, crowded prorsiradiate ribs, the rib index six. It is specifically indeterminate.

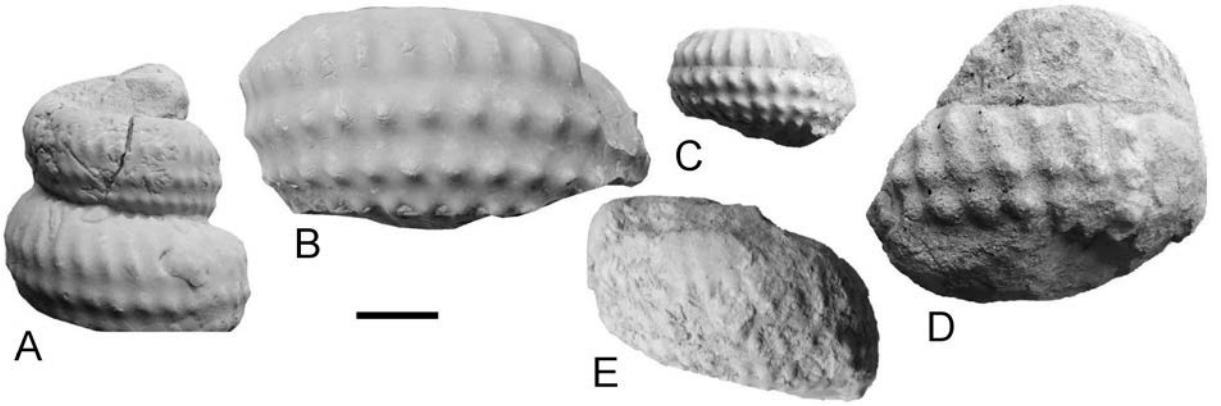
OCCURRENCE: As for material.

Family Turrilitidae Gill, 1871
Genus and Subgenus *Ostlingoceras* Hyatt, 1900

TYPE SPECIES: *Turrilites puzosianus* d'Orbigny, 1842, p. 587, pl. 143, figs 1, 2, by the original designation of Hyatt (1903, p. 587).

Ostlingoceras (*Ostlingoceras*) *puzosianum*
(d'Orbigny, 1842)
(Text-fig. 16E)

1842. *Turrilites puzosianus* d'Orbigny, p. 587, pl. 143, figs 1, 2.



Text-fig. 16. **A**–**C** – *Mariella* (*Mariella*) *oehlerti sulcata* Klinger and Kennedy, 1978. A – OUMNH KX.17311; B – OUMNH KX.17309; C – OUMNH KX.17312, all from the 45.4–47 m level, Lower Cenomanian, *Graysonites adkinsi* Zone. **D** – *Mariella* (*Mariella*) *bergeri* (Brongiart, 1822), OUMNH KX.17291, from the 20 m level, Upper Albian, *Pervinquieria* (*Subschloenbachia*) *perinflata* Zone. **E** – *Ostlingoceras* (*Ostlingoceras*) *puzosianum* (d'Orbigny, 1842), OUMNH KX.17292, from the 20 m level, Upper Albian, *Pervinquieria* (*Subschloenbachia*) *perinflata* Zone. All specimens are from the Aït Lamine Formation, Oued Abouda. Scale bar 10 mm.

2015. *Ostlingoceras* (*Ostlingoceras*) *puzosianum* (d'Orbigny, 1842); Klein, pp. 192, 194 (with full synonymy).
2020. *Ostlingoceras* (*Ostlingoceras*) *puzosianum* (d'Orbigny, 1842); Kennedy, p. 232, pl. 35, figs 13, 14, 16, 17.

TYPES: These have not been traced (Kennedy and Latil 2007, p. 473); they were from Reposoir (Haute-Alpes), France.

MATERIAL: OUMNH KX.17292, from the Aït Lamine Formation, Oued Abouda, at the 20 m level, Upper Albian, *Pervinquieria* (*Subschloenbachia*) *perinflata* Zone.

REMARKS: A single whorl is part phragmocone, part body chamber, 17.5 mm high at the adapical end of the fragment. The upper whorl face is feebly concave, the junction between upper and outer whorl faces narrowly rounded and crenulated to accommodate the lowest row of tubercles of the preceding whorl, the outer whorl face flattened, the junction of outer and lower faces broadly rounded, the lower whorl face feebly convex. Delicate prorsiradiate ribs extend from the top of the outer whorl face to a little below the middle of the whorl face, where they link to small rounded tubercles. A narrow sunken zone separates this row from a second, slightly smaller transversely elongated row separated by a narrow sunken zone from a third row, again adaperturally displaced, at the junction of outer and lower whorl face. They give rise to delicate ribs that extend across the lower whorl face.

Although poorly preserved, the fragment differs in no significant respect from better-preserved specimens, such as those described by Atabekian (1985, 1987) and Kennedy (2020). See Kennedy and Latil (2007, p. 473) for further discussion.

OCCURRENCE: Upper Upper Albian, southern England, France, Spain, Sardinia, Switzerland, Hungary, Poland, Romania, North Caucasus, Ukraine (Crimea), Georgia, Iran, Turkmenistan, Morocco, north-eastern Algeria, Central Tunisia and Madagascar.

Genus and subgenus *Mariella* (*Mariella*) Nowak, 1916

TYPE SPECIES: *Turrilites bergeri* Brongniart, 1822, p. 395, pl. 7, fig. 3, by the original designation of Nowak (1916, p. 10).

Mariella (*Mariella*) *bergeri* (Brongniart, 1822)
(Text-fig. 16D)

1822. *Turrilites bergeri* Brongniart, p. 395, pl. 7, fig. 3.
2015. *Mariella* (*Mariella*) *bergeri bergeri* (Brongniart, 1822); Klein, pp. 131, 133 (with synonymy).
2020. *Mariella* (*Mariella*) *bergeri* (Brongniart, 1822); Kennedy, p. 237, pl. 36, figs 19, 21, 23.

TYPE: The holotype, by monotypy, is the original of Brongniart (1822, pl. 7, fig. 3), from the Montagne de Fiz, Savoie, France; it has not been traced.

MATERIAL: OUMNH KX.17291, from the 20 m

level; OUMNH KX.17296, from the 29 m level of the Aït Lamine Formation, Oued Abouda, Upper Albian, *Pervinquieria* (*Subschloenbachia*) *perinflata* Zone.

REMARKS: OUMNH KX.17296 is a tiny whorl fragment with a maximum preserved whorl height of 5 mm approximately. Crowded prorsiradiate ribs arise at the junction of upper and outer whorl faces and link to well-developed elongated prorsiradiate tubercles sited above mid-flank, then weaken, producing a spiral depression before strengthening into an adapertualy displaced row of subequal tubercles, separated by a spiral depression from a third row of subequal tubercles, again adapically displaced. A fourth row of tubercles is partially preserved. OUMNH KX.17291 (Text-fig. 16D) comprises just over a whorl with a maximum preserved whorl height of 20 mm approximately, with four rows of tubercles, as in the previous specimen. It compares well with specimens assigned to a variable *Mariella* (*Mariella*) *bergeri* by Atabekian (1985, 1987, pl. 2, figs 4, 5; pl. 3, figs 1–11; pl. 4, figs 1–7).

OCCURRENCE: Upper Upper Albian, southern England, France, Switzerland, Germany, Spain, Sardinia, Hungary, Iran, Morocco, north-eastern Algeria, Central Tunisia, KwaZulu-Natal in South Africa, Tamil Nadu in south India, Venezuela and California.

Mariella (*Mariella*) *oehlerti sulcata* Klinger and Kennedy, 1978
(Text-figs 16A–C, 17)

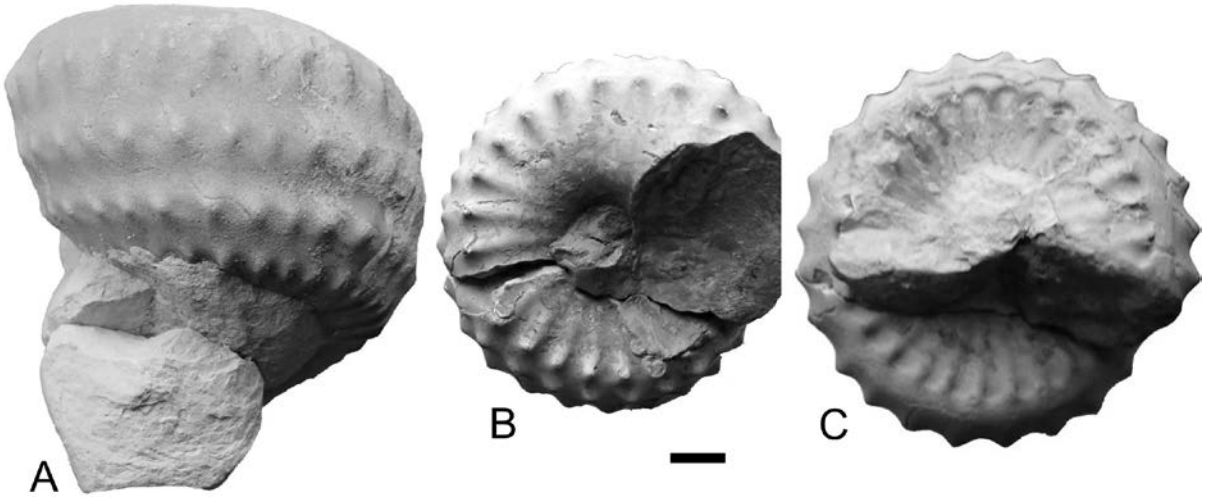
1978. *Mariella* (*Mariella*) *oehlerti sulcata* Klinger and Kennedy, p. 33, pl. 3, fig. D; pl. 8, fig. D; text-fig. 3D, E, H.

2015. *Cenomariella oehlerti sulcata* (Klinger and Kennedy, 1978); Klein, pp. 153, 155.

TYPE: The holotype is no. A259 in the collections of the Geological Survey of South Africa, Pretoria, the original of Klinger and Kennedy (1978, pl. 3, fig. D) from the lower Lower Cenomanian of the Skoenberg, locality 61 of Kennedy and Klinger (1975, p. 289, text-fig. 6) in northern KwaZulu-Natal, South Africa.

MATERIAL: OUMNH KX.17307–12, from the Aït Lamine Formation, Oued Abouda, at the 45.4 to 47.4 m level, Lower Cenomanian, *Graysonites adkinsi* Zone.

REMARKS: Whorl heights range from 13 to 35 mm. The upper whorl face is feebly concave, with grooves to accommodate the radial ribs on the base of the preceding whorl. The junction between upper and lower whorl faces is crenulated to accommodate the fourth and lowest row of tubercles of the preceding whorl. The outer whorl face is convex between the rows of tubercles, the junction between outer and lower whorl faces broadly rounded, the lower whorl face feebly convex. OUMNH KX.17311 (Text-fig. 16A), one of the smaller specimens, has a maximum preserved whorl height of 17 mm. Over 30 ribs per whorl arise at the top of the outer whorl face. They are feebly prorsiradiate, strengthen progressively, and link to well-developed tubercles above the mid-point of the whorl face. They then efface, producing a shallow smooth sulcus before strengthening into a second row of transversely elongated tubercles. A second smooth sulcus separates the second and third row of tubercles, the latter displaced adaperturally, and



Text-fig. 17. *Mariella* (*Mariella*) *oehlerti sulcata* Klinger and Kennedy, 1978. OUMNH KX.17310, from the 45.4–47.4 m level, Aït Lamine Formation, Oued Abouda, Lower Cenomanian, *Graysonites adkinsi* Zone. Scale bar 10 mm.

elongated spirally. A third smooth sulcus separates the third and fourth rows of tubercles, the latter conical, sited at the junction of outer and lower whorl faces, and giving rise to straight radial ribs that extend across the lower whorl face. OUMNH KX.17307 is just over a whorl of body chamber, with a maximum preserved whorl height of 35 mm, and 25 ribs/tubercles per whorl, the three smooth sulci between successive rows of tubercles becoming progressively narrower. OUMNH KX.17310 (Text-fig. 17), with a maximum preserved whorl height of 43 mm, is interpreted as coming from close to the adult aperture, the ribs irregular, weakening and effacing.

Mariella (*Mariella*) *oehlerti sulcata* differs from the nominate subspecies in developing a distinct spiral groove between the second and third rows of tubercles.

OCCURRENCE: Lower Lower Cenomanian of KwaZulu-Natal in South Africa and Morocco.

INTEGRATED STRATIGRAPHY AND CORRELATION

The results presented here allow us to revise the conclusions of Essafraoui *et al*. (2015) that the Aït Lamine Formation in the Abouda section is entirely Cenomanian in age. Rather, we demonstrate that the lowest 42.2 m of the formation in the Oued Abouda section are of late Albian age, and include the uppermost Albian ammonite zones of *Pervinquieria* (*Subschloenbachia*) *rostrata*, *P.* (*S.*) *perinflata* and, by inference, the lower, Albian part of the *Pleurohoplites briacensis* Zone that spans the Albian–Cenomanian boundary, beneath the Lower Cenomanian zone of *Graysonites adkinsi*. The exact age of the underlying Kerchoula Formation remains unknown. The presence of the ammonite *Mantelliceras* cf. *lymense*, 311 m above the base of the Aït Lamine Formation, indicates that the Lower Cenomanian is very expanded at Abouda (Gale 2020).

The GSSP for the base of the Cenomanian Stage was taken in the expanded hemipelagic succession at Mont Risou, Hautes-Alpes, south-eastern France (Gale *et al*. 1996; Kennedy *et al*. 2004; Petrizzo *et al*. 2015), and is marked by the lowest occurrence of the planktonic foraminiferan *Thalmanninella globotruncanoides*. Rare ammonites of the *Pleurohoplites briacensis* Zone occur in the lowermost 4 m of the Cenomanian above the boundary, and the GSSP lies 6 m below the first occurrence of ammonites of the *Neostlingoceras carcitanense* Subzone of the *Mantelliceras mantelli* Zone, which at Risou include *M. mantelli* (Sowerby, 1814), *Neostlingoceras oberlini* (Dubourdieu, 1953), *Algerites ellipticus* (Mantell, 1822), *Sciponoceras roto* (Cieśliński, 1959) and *Hyphoplites curvatus* (Mantell, 1822) (Gale *et al*. 1996; Kennedy *et al*. 2004). The base of the Cenomanian lies 96 m above the highest occurrence of ammonites of the *Pervinquieria* (*Subschloenbachia*) *perinflata* Zone at Risou.

The new records from the Abouda succession provide definitive evidence of the age of the *Graysonites adkinsi* Zone, because here the zonal index appears 3 m above the lowest occurrence of *Thalmanninella globotruncanoides*. This suggests the *Graysonites adkinsi* Zone may be equivalent to the upper, Cenomanian part of the *Pleurohoplites briacensis* Zone in the Global Stratotype Section. This suggestion finds support in the Texas succession (Table 2), where the *Graysonites adkinsi* Zone is succeeded by a *Graysonites wacoense* Zone (see discussion in Kennedy *et al*. 2005, p. 353 *et seq*. and Kennedy and Gale 2017, p. 529 *et seq*.): the index species is known from the lowest, *Neostlingoceras carcitanense* Subzone of the *Mantelliceras mantelli* Zone in Dorset, England (Kennedy 2015, p. 404, text-fig. 157g, h). The ammonite succession of the north central Texas region, where *P.* (*S.*) *rostrata* and *P.* (*S.*) *perinflata* occur within the Main Street Limestone, and are succeeded by a *Mariella* (*Wintonia*) *brazoensis* partial range Zone (*P.* (*S.*) *perinflata* overlaps with the index species), with *G. adkinsi* appearing at the base of the overlying Grayson Formation (Kennedy *et al*. 2005; Gale *et al*. 2021) is thus closely comparable to that seen in the Agadir Basin. The Texas *Mariella* (*Wintonia*) *brazoensis* Zone corresponds to part or all of the interval between 33 and 42.5 m in the Oued Abouda section that lacks ammonites, and the lower, Albian part of the *Pleurohoplites briacensis* Zone in the Global Stratotype Section.

The correlation with the north Texas region and Agadir is independently supported by the microcrinoid succession in the uppermost Albian and lowermost Cenomanian (Gale 2020; Gale *et al*. 2021). The comparative ranges of species in the Albian AlR11 and AlR12 zones are identical around Fort Worth, Texas, and Agadir, and the first occurrence of the CeR1 fauna is precisely coincident with that of *Graysonites adkinsi* in both regions, which were then 5,300 km apart.

The base of the Cenomanian is marked in many regions of the world by a hiatus, commonly represented by a hardground or minor erosional surface (Gale *et al*. 2019); Albian ammonites are present beneath the surface, and Cenomanian taxa above. This can be demonstrated, for example, in Tamil Nadu, south India (Gale *et al*. 2019), central Tunisia (Robaszynski *et al*. 1994), the Anglo-Paris Basin of England and

France (Robaszynski *et al.* 1998), Mangyschlak, Kazakhstan (Gale *et al.* 1999), and Texas, USA (Gale and Kennedy 2020; Gale *et al.* 2021). The new data from Agadir shows that the hiatus there is actually in the lowermost Cenomanian, 1.4 m above the lowest occurrence of *Thalmanninella globotruncanoides*. It is represented in the Oued Abouda section by bored and encrusted hiatus concretions (Gale 2020, text-fig. 5; herein Text-fig. 4B), immediately above which ammonites of the *Graysonites adkinsi* Zone appear.

Acknowledgements

We thank Eliza Howlett, Head of Earth Collections at the Oxford University Museum of Natural History for technical support. ASG would like to thank Meg Jacobs, David and Alison Ward for field assistance, and Christine Hughes for help with SEM imaging. The fieldwork was supported by Brading Geoscience Ltd. MRP acknowledge funds from the Università degli Studi di Milano (Piano di Sostegno alla Ricerca 2018−2019). We are most grateful to the referees for their invaluable comments, and to Anna Żylińska for her editorial work.

REFERENCES

Atabekian, A.A. 1985. Turrilitids of the late Albian and Cenomanian of the southern part of the USSR. *Transactions of the Academy of Sciences of the USSR*, **14**, 1−112. [In Russian]

Atabekian, A.A. 1987. Turrilitidae de l'Albien supérieur et du Cénomanien du sud de l'URSS. Transl. J. Pietresson de Saint Aubin, 86 pp. Association Géologique Auboise; Troyes.

Bayle, É. 1878. Fossiles principaux des terrains. Explication de la Carte Géologique de France, 4, (1), (Atlas), 158 pls. Service de la Carte Géologique detailée; Paris.

Böhm, J. 1895. Review of A. de Grossouvre: Recherches sur la craie supérieure. 2nd part. *Neues Jahrbuch für Mineralogie, Geologie und Paläontologie*, **1895**, 360–366.

Böhm, J. 1910. Review of 'Études de Paléontologie Tunisienne' by L. Pervinquiére. *Neues Jahrbuch für Mineralogie, Geologie und Paläontologie*, **1910**, 149–155.

Böse, E. 1928. Cretaceous ammonites from Texas and northern Mexico. *University of Texas Bulletin*, **2748**, 143–357. [misdated 1927]

Breistroffer, M. 1953. Commentaires taxonomiques. In : Breistroffer, M. and Villoutreys, O. de (Eds), Les ammonites albiennes de Peille (Alpes-Maritimes). *Travaux du Laboratoire de Géologie de l'Université Grenoble*, **30**, (for 1952), 69–74.

Brongniart, A. 1822. Sur quelques terrains de Craie hors du Bassin de Paris, pp. 80–101. In: Cuvier, G. and Brongniart, A., Description géologique des environs de Paris. 3rd edn., 428 pp. Dufour et D'Ocagne; Paris.

Caron, M. 1978. Cretaceous planktonic foraminifera from DSDP Leg 40, southeastern Atlantic Ocean. *Initial Reports of the Deep Sea Drilling Project*, **40**, 651−678.

Caron, M. 1985. Cretaceous planktonic foraminifera. In: Bolli, H.M., Saunders, J.B. and Perch-Nielsen, K. (Eds), Plankton Stratigraphy, volume 1, 17–86. Cambridge University Press; Cambridge.

Carsey, D.O. 1926. Foraminifera of the Cretaceous of Central Texas. *University of Texas Bulletin*, **2612**, 1–56.

Cieśliński, S. 1959. The Albian and Cenomanian of the northern periphery of the Święty Krzyż Mountains. *Prace Instytutu Geologicznego*, **28**, 1−95. [In Polish]

Coccioni, R. and Premoli Silva, I. 2015. Revised upper Albian–Maastrichtian planktonic foraminiferal biostratigraphy and magnetostratigraphy of the classical Tethyan Gubbio section (Italy). *Newsletters on Stratigraphy*, **48**, 47–90.

Collignon, M. 1967. Les céphalopodes crétacés du bassin côtier de Tarfaya. *Notes et Mémoires Service des Mines et de la Carte Géologique du Maroc*, **175**, 7–148 (1966 imprint).

Cushman, J.A. 1927. An outline of a reclassification of the foraminifera. *Contributions from the Cushman Laboratory for Foraminiferal Research,* **3**, 1−105.

Delanoy, G. and Latil, J.-L. 1988. Découverte d'un nouveau gisment Albien dans les environs de Drap (Alpes-Maritimes, France) et description d'une riche ammonitofaune d'age Albien terminal. *Géobios*, **21**, 749–771.

Denne, R.A., Hinote, R.E., Breyer, J.A., Kosanke, T.H., Lees, J.A., Engelhardt-Moore, N., Spaw, J.M. and Tur, N. 2014. The Cenomanian–Turonian Eagle Ford Group of South Texas: Insights on timing and paleoceanographic conditions from geochemistry and micropaleontologic analyses. *Palaeogeography*, *Palaeoclimatology*, *Palaeoecology*, **413**, 2−28.

Diener, C. 1925. Ammonoidea neocretacea. *Fossilium Catalogus* (1: Animalia), **29**, 1–244.

Douvillé, H. 1879. Note accompagnant le présentation de l'Atlas de t. iv de l'explication de la carte géologique de France de E. Bayle and R. Zeiller. *Bulletin de la Société Géologique de France*, **7**, 91–92.

Douvillé, H. 1912. Evolution et classification des Pulchelliides. *Bulletin de la Société Géologique de France*, (4), **11**, 285–320.

Dubourdieu, G. 1953. Ammonites nouvelles des Monts du Mellègue. *Bulletin du Service de la Carte Géologique de l'Algerie, 1e série, Paléontologie*, **16**, 76 pp.

Essafroui, B., Ferry, S., Groshény, D., Icame, N., El Aouli, H., Masrour, M., Bulot, L.G., Géraud, Y. and Aoutem, M. 2015. Sequence stratigraphic architecture of marine to fluvial deposits across a passive margin (Cenomanian, Atlantic margin, Morocco, Agadir transect). *Carnets de Géologie*, **15** (12), 137–172.

Falzoni, F. and Petrizzo, M.R. 2020. Patterns of planktonic foraminiferal extinctions and eclipses during Oceanic Anoxic Event 2 at Eastbourne (SE England) and other mid-low latitude locations. *Cretaceous Research*, **116**, 104593.

Gale, A.S. 2020. Roveacrinidae (Crinoidea, Articulata) from the Cenomanian and Turonian of North Africa (Agadir Basin and Anti-Atlas, Morocco and central Tunisia). *Acta Geologica Polonica*, **70**, 273−310.

Gale, A.S., Hancock, J.M. and Kennedy, W.J. 1999. Biostratigraphical and sequence correlation of the Cenomanian successions of Mangyshlak (Kazakhstan), Crimea (Ukraine) and southern England. *Bulletin de l'Institut Royal des Sci-*

ences Naturelles de Belgique. *Sciences de la terre*, **69**-supp. A, 67–86.

Gale, A.S. and Kennedy, W.J. 2020. Upper Albian ammonites from north-east Texas. *Révue de Paléobiologie*, **39**, 1–139.

Gale, A.S., Kennedy, W.J., Burnett, J.A., and Caron, M. 1996. The Late Albian to Early Cenomanian succession at Mont Risou near Rosans (Drome, SE France): an integrated study (ammonites, inoceramids, nannofossils, planktonic foraminifera and carbon isotopes). *Cretaceous Research*, **17**, 515–606.

Gale, A.S., Kennedy, W.J. and Walaszczyk, I. 2019. Upper Albian, Cenomanian and Lower Turonian stratigraphy, ammonite and inoceramid bivalve faunas from the Cauvery Basin, Tamil Nadu, South India. *Acta Palaeontologica Polonica*, **69**, 161–338.

Gale, A.S., Rashall, J.M., Kennedy, W.J. and Holterhoff, F.K. 2021. The microcrinoid taxonomy, biostratigraphy and correlation of the upper Fredricksburg and lower Washita groups (Cretaceous, middle Albian to lower Cenomanian) of northern Texas and southern Oklahoma, USA. *Acta Geologica Polonica*. DOI: 10.24425/agp.2020.132256

Gandolfi, R. 1942. Ricerche micropaleontologiche e stratigrafiche sulla Scaglia e sui Flysh cretacici dei dintorni di Balerna. *Rivista Italiana di Paleontologia*, *Memorie*, **4**, 1–118.

Gandolfi, R. 1957. Notes on some species of *Globotruncana*. *Contributions from the Cushman Laboratory for Foraminiferal Research*, **8**, 59–65.

Gauthier, H. 2006. Révision Critique de la Paléontologie Française d'Alcide d'Orbigny, 6, Céphalopodes Crétacés, 1–292 + 1–662. Backhuys; Leiden.

Ghabeishavi, A., Vaziri-Moghaddam, H., Taheri, A. and Taati, F. 2010. Microfacies and depositional environment of the Cenomanian of the Bangestan anticline, SW Iran. *Journal of Asian Earth Sciences*, **37**, 275–285.

Gill, T. 1871. Arrangement of the Families of Mollusks. *Smithsonian Miscellaneous Collections*, **227**, xvi + 49 pp.

Grossouvre, A. de 1894. Recherches sur la craie supérieure, 2, Paléontologie. Les ammonites de la craie supérieure. Mémoires du Service de la Carte Géologique détaillée de la France, 264 pp. Imprimerie Nationale; Paris. [misdated 1893]

Huber, B.T. and Leckie, R.M. 2011. Planktic foraminiferal species turnover across deep-sea Aptian/Albian boundary sections. *Journal of Foraminiferal Research*, **41**, 53–95.

Huber, B.T., Petrizzo, M.R., Young, J., Falzoni, F., Gilardoni, S., Bown, P.R. and Wade, B.S. 2016. A new online taxonomic database for planktonic foraminifera. *Micropaleontology*, **62**, 429–438.

Hyatt, A. 1900. Cephalopoda. In: Zittel, K.A. Von (Ed.), Textbook of Palaeontology, 502–604, transl. Eastman, C.R. Macmillan; London and New York.

Hyatt, A. 1903. Pseudoceratites of the Cretaceous. *United States Geological Survey Monograph*, **44**, 351 pp.

Kawabe, F., Takashima, R., Wani, R., Nishi, H., and Moriya, K. 2003. Upper Albian to Lower Cenomanian biostratigraphy in the Oyubari area, Hokkaido, Japan: toward a Cretaceous biochronology for the North Pacific. *Acta Geologica Polonica*, **53**, 81–91.

Keller, B.M. 1935. Microfauna of the Upper Cretaceous in the Dnieper–Donets valley and some other adjoining regions. *Byulletin Moskovskogo Obshchestva Ispytateley Prirody Otdel Geologicheskiy*, **13**, 522–558. [In Russian]

Kennedy, W.J. 2015. The Ammonoidea of the Lower Chalk, part 6. Monograph of the Palaeontographical Society, 404–459. Palaeontographical Society; London.

Kennedy, W.J. 2020. Upper Albian, Cenomanian and Upper Turonian ammonite faunas from the Fahdène Formation of central Tunisia and correlatives in northern Algeria. *Acta Geologica Polonica*, **70**, 147–272.

Kennedy, W.J., Cobban, W.A., Gale, A.S., Hancock, J.M. and Landman, N.H. 1998. Ammonites from the Weno Limestone (Albian) in northeast Texas. *American Museum Novitates*, **3236**, 46 pp.

Kennedy, W.J., Cobban, W.A., Hancock, J.M. and Gale, A.S. 2005. Upper Albian and Lower Cenomanian ammonites from the Main Street Limestone, Grayson Marl and Del Rio Clay in northeast Texas. *Cretaceous Research*, **26**, 349–428.

Kennedy, W.J and Gale, A.S. 2017. Trans-Tethyan correlation of the Lower–Middle Cenomanian boundary interval; southern England (Southerham near Lewes, Sussex) and Douar el Khiana, northeastern Algeria. *Acta Geologica Polonica*, **67**, 75–108.

Kennedy, W.J., Gale, A.S., Lees, J.A. and Caron, M. 2004. The Global Boundary Stratotype Section and Point (GSSP) for the base of the Cenomanian Stage. *Episodes*, **27**, 21–32.

Kennedy, W.J. and Klinger, H.C. 1975. Cretaceous faunas from Zululand and Natal, South Africa. Introduction, Stratigraphy. *Bulletin of the British Museum* (*Natural History*), *Geology*, **25**, 263–315.

Kennedy, W.J. and Klinger, H.C. 2013a. Cretaceous faunas from Zululand and Natal, South Africa. The ammonite Subfamily Stoliczkaiinae Breistroffer, 1953. *African Natural History*, **9**, 1–38.

Kennedy, W.J. and Klinger, H.C. 2013b. Cretaceous faunas from Zululand and Natal, South Africa. The ammonite Subfamily Desmoceratinae Zittel, 1895. *African Natural History*, **9**, 39–54.

Kennedy, W.J. and Klinger, H.C. 2014. Cretaceous faunas from Zululand and Natal, South Africa. *Valdedorsella*, *Pseudohaploceras*, *Puzosia*, *Bhimaites*, *Pachydesmoceras*, *Parapuzosia* (*Austiniceras*), and *P.* (*Parapuzosia*) of the ammonite subfamily Puzosiinae Spath, 1922. *African Natural History*, **10**, 1–46.

Kennedy, W.J. and Latil, J.-L. 2007. The Upper Albian ammonite succession in the Montlaux section, Hautes-Alpes, France. *Acta Geologica Polonica*, **57**, 453–478.

Klein, J. 2015. Lower Cretaceous Ammonites VIII Turrilitoidea–Anisoceratidae, Hamitidae, Turrilitidae, including representatives of the Upper Cretaceous species. *Fossilium Catalogus* (I: Animalia), **154** (*pars*), 265 pp.

Klein, J. 2018. Lower Cretaceous Ammonites XI Acanthoceratoidea: Leymeriellidae, Brancoceratidae, Lyelliceratidae, Flickiidae, Forbesiceratidae, including Upper Cretaceous representatives. *Fossilium Catalogus* (I: Animalia), **158**, 333 pp.

Klein, J. and Vašiček, Z. 2011. Lower Cretaceous Ammonites V

Desmoceratoidea. *Fossilium Catalogus* 1; Animalia, **148**, 311 pp.

Klinger, H.C. and Kennedy, W.J. 1978. Turrilitidae (Cretaceous Ammonoidea) from South Arica, with a discussion of the evolution and limits of the family. *Journal of Molluscan Studies*, **44**, 1–48.

Korn, D., Ebbighausen, V., Bockwinkel, J. and Klug, C. 2003. The A-mode ontogeny in prolecanitid ammonites. *Palaeontology*, **46**, 1123–1132.

Kossmat, F. 1895–1898. Untersuchungen über die Südindische Kreideformation. *Beiträge zur Paläontologie Österreich – Ungarns und des Orients*, **9** (1895), 97–203 (1–107); **11** (1897), 1–46 (108–153); **11**(1898), 89–152 (154–217).

Koutsoukos, E.A.M., Leary, P.N. and Hart, M.B. 1989. *Favusella* Michael (1972): evidence of ecophenotypic adaptation of a planktonic foraminifera to shallow-water carbonate environments during the mid-Cretaceous. *Journal of Foraminiferal Research*, **19**, 324–336.

Leckie, R.M. 1984. Mid-Cretaceous planktonic foraminiferal biostratigraphy off central Morocco, Deep Sea Drilling Project Leg 79, Sites 545 and 547. *Initial Reports of the Deep Sea Drilling Project*, **79**, 579–620.

Lipson-Benitah, S., Almogi-Labin, A. and Sass, E. 1997. Cenomanian biostratigraphy and palaeoenvironments in the northwest Carmel region, northern Israel. *Cretaceous Research*, **18**, 469–491.

Longoria, J.F. 1974. Stratigraphic, morphologic and taxonomic studies of Aptian planktonic foraminifera. *Revista Española de Micropaleontologia, v. Numero Extraordinario*, 5–107.

Magné, J. and Sigal, J. 1954. Description des espèces nouvelles; 1 – Foraminifères. Résultats géologiques et micropaléontologiques du sondage d'El Krachem (Hauts Plateaux algérois). *Bulletin de la Société Géologique de France*, **6**, 480−489.

Mantell, G.A. 1822. The fossils of the South Downs; or illustrations of the geology of Sussex, xvi+327 pp. Lupton Relfe; London.

Masters, B.A. 1976. Planktic foraminifera from the Upper Cretaceous Selma Group, Alabama. *Journal of Paleontology*, **50**, 318–330.

Matsumoto, T. (Ed.) 1954. The Cretaceous System in the Japanese Islands, 324 pp. Japan Society for the Promotion of Science; Tokyo.

Matsumoto, T. 1988. A monograph of the Puzosiidae (Ammonoidea) from the Cretaceous of Hokkaido. *Palaeontological Society of Japan Special Papers*, **30**, 1–179.

Michael, F.Y. 1973. Planktonic foraminifera from the Comanchean Series (Cretaceous) of Texas. *Journal of Foraminiferal Research*, **2**, 200−220.

Michelin, H. 1838. Note sur une argile dépendant du Gault, observée au Gaty, commune de Gérodot, départment de l'Aube. *Mémoires de la Société Géologique de France*, **1**, 3 (1), 97–103.

Morrow, A.L. 1934. Foraminifera and Ostracoda from the Upper Cretaceous of Kansas. *Journal of Paleontology*, **8**, 186−205.

Neumayr, M. 1875. Die Ammoniten der Kreide und die systematik der Ammonitiden. *Zeitschrift der Deutschen Geologischen Gesellschaft*, **27**, 854–942.

Nowak, J. 1916. Über die bifiden Loben der oberkretazischen Ammoniten und ihre Bedeutung für die Systematik. *Bulletin International de l'Académie des Sciences de Cracovie. Classe des Sciences Mathématiques et Naturelles*, Série B: Sciences Naturelles, **1915**, 1–13.

Orbigny, A. d' 1840–1842. Paléontologie française: Terrains crétacés. 1. Céphalopodes, 1–120 (1840); 121–430 (1841); 431–662 (1842). Masson; Paris.

Parkinson, J. 1811. Organic remains of a former world, 3, 479 pp. J. Robson; London.

Peck, R.E. 1943. Lower Cretaceous crinoids from Texas. *Journal of Paleontology*, **17**, 451–475.

Pervinquière, L. 1907. Études de paléontologie tunisienne. 1. Céphalopodes des terrains secondaires Carte Géologique de la Tunisie, v + 438 pp. De Rudeval; Paris.

Petrizzo, M.R., Berrocoso, Á.J., Falzoni, F., Huber, B.T. and Macleod, K.G. 2017. The Coniacian–Santonian sedimentary record in southern Tanzania (Ruvuma Basin, East Africa): Planktonic foraminiferal evolutionary, geochemical and palaeoceanographic patterns. *Sedimentology*, **64**, 252–285.

Petrizzo, M.R., Caron, M. and Premoli Silva, I. 2015. Remarks on the identification of the Albian/Cenomanian boundary and taxonomic clarification of the planktonic foraminiferal index species *globotruncanoides*, *brotzeni* and *tehamaensis*. *Geological Magazine*, **152**, 521–536.

Petrizzo, M.R. and Gilardoni, S.E. 2020. Planktonic foraminiferal biostratigraphy of late Albian−Cenomanian pelagic sequences from the Umbria−Marche Basin (central Italy) and the Mazagan Plateau (northeast Atlantic Ocean). *Rivista Italiana di Paleontologia e Stratigrafia*, **126**, 865−904.

Petrizzo, M.R. and Huber, B.T. 2006. Biostratigraphy and taxonomy of Late Albian planktonic foraminifera from ODP Leg 171B (western north Atlantic Ocean). *Journal of Foraminiferal Research*, **36**, 166–190.

Pictet, F.J. 1854. Cephalopodes. In: Traité de Paléontologie, 2nd edition, 583–716. J.-B. Baillière; Paris.

Pictet, F.J. and Campiche, G. 1858–1864. Description des fossiles du terrain crétacé des environs de Saint-Croix part 2 (1). Description des fossiles. Matériaux pour la Paléontologie Suisse (2) part 1, 1–380; part 2, 752 pp. Kressmann; Geneva.

Pictet, F.J. and Roux, W. 1847–1854. Description des mollusques fossiles qui se trouvent dans les Grès Verts des environs de Genève. *Mémoires de la Société de Physique et d'Histoire Naturelle de Genève*, **11**, 257–412 (also published independently with the same title; described as Première Livraison, Céphalopodes, 1–136. Fick; Geneva).

Plummer, H.J. 1931. Some Cretaceous foraminifera in Texas. *University of Texas Bulletin*, **101**, 109–203.

Reichel, M. 1948. Les Hantkéninidés de la Scaglia et des Couches rouges (Crétacé supérieur). *Eclogae Geologicae Helvetiae*, **40**, 391−408.

Reichel, M. 1950. Observations sur les *Globotruncana* du gisement de la Breggia (Tessin). *Eclogae Geologicae Helvetiae*, **42**, 596−617.

Renz, O. 1936. Stratigraphische und mikropaläontologische Untersuchung der Scaglia (Obere Kreide−Tertiär) im zentralen Apennin. *Eclogae Geologicae Helvetiae*, **29**, 1−149.

Renz, O. 1968. Die Ammonoidea im Stratotyp des Vraconnien bei Sainte-Croix (Kanton Waadt). *Schweizerische Paläontologische Abhandlungen*, **87**, 1–99.

Robaszynski, F., Amédro, F., González-Donoso, J.-M. and Linares, D. 2008. The Albian (Vraconnian)–Cenomanian boundary at the western Tethyan margins (Central Tunisia and southeastern France). *Bulletin de la Société Géologique de France*, **179**, 245–256.

Robaszynski, F. and Caron, M. 1995. Foraminiféres planctoniques du Crétacé: commentaire de la zonation Europe-Méditerranée. *Bulletin de la Société Géologique de France*, **166**, 681–692.

Robaszynski, F., Caron, M., Amédro, F., Dupuis, C., Hardenbol, J., Gonzales Donoso, J.M., Linares, D. and Gartner, S. 1994. Le Cénomanien de la région de Kalaat Senan (Tunisie Centrale): Litho-biostratigraphie et interprétation séquentielle. *Revue de Paléobiologie*, **12**, 351–505.

Robaszynski, F., Gale, A.S., Juignet, P., Amédro, F. and Hardenbol, J. 1998. Sequence stratigraphy in the Upper Cretaceous of the Anglo-Paris Basin, exemplified by the Cenomanian Stage. In: Hardenbol, J., Thierry, J., Farley, M.B., Jaquin, Th., De Graciansky, P.-C. and Vail, P.R. Mesozoic and Cenozoic Sequence Stratigraphy of European Mesozoic Basins. SEPM Special Publication No. 60, pp. 363–386. SEPM; Tulsa.

Schlotheim, E.F. von 1820. Die Petrefaktenkunde auf ihrem jetzigen Standpunkte durch die Beschreibung seiner Sammlung..., lxii + 437 pp. Becker; Gotha.

Scholz, G. 1979. Die Ammoniten des Vracon (Oberalb, *dispar* Zone) des Bakony-Gebirges (Westungarn) und eine revision der wichtigsten Vracon-arten der Westmediterranen faunenprovinz. *Palaeontographica A*, **165**, 1–136.

Sigal, J. 1948. Notes sur les genres de foraminifères *Rotalipora* Brotzen 1942 et *Thalmanninella*, famille des *Globorotaliidae. Revue de l'Institut français du pétrole et Annales des combustibles liquides*, **3** (4), 95–103.

Sigal, J. 1966. Contribution à une monografie des *Rosalines*. 1. Le genre *Ticinella* Reichel, souche des *Rotalipores*. *Eclogae Geologicae Helvetiae*, **59**, 185–217.

Sowerby, J. 1812–1822. The Mineral Conchology of Great Britain. **1**, pls 1–9 (1812), pls 10–44 (1813), pls 45–78 (1814), pls 79–102 (1815); **2**, pls 103–14 (1815), pls 115–50 (1816), pls 151–86 (1817), pls 187–203 (1818); **3**, pls 204–21 (1818), pls 222–53 (1819), pls 254–71 (1820), pls 272–306 (1821); **4**, pls 307–18 (1821), pls 319–83 (1822). The Author; London.

Sowerby, J. de C. 1823–1846. The Mineral Conchology of Great Britain (continued), **4**, pls 384–407 (1823); **5**, pls 408–443 (1823), pls 444–485 (1824), pls 486–603 (1825); **6**, pls 504–544 (1826), pls 545–580 (1827), pls 581–597 (1828), pls 598–609 (1829); **7**, pls 610–618 (1840), pls 619–623 (1841), pls 624–628 (1843), pls 629–643 (1844), pls 644–648 (1846). The Author; London,

Spath, L.F. 1921. On Cretaceous Cephalopoda from Zululand. *Annals of the South African Museum*, **12**, 217–321.

Spath, L.F. 1922. On the Senonian ammonite fauna of Pondoland. *Transactions of the Royal Society of South Africa*, **10**, 113–147.

Spath, L.F. 1926. On the zones of the Cenomanian and the uppermost Albian. *Proceedings of the Geologists' Association*, **37**, 420–432.

Spath, L.F. 1932. A Monograph of the Ammonoidea of the Gault. Monograph of the Palaeontographical Society, Part 9, 379–410. Palaeontographical Society; London.

Spath, L.F. 1934. A Monograph of the Ammonoidea of the Gault. Monograph of the Palaeontographical Society, Part 11, 443–496. Palaeontographical Society; London.

Stoliczka, F. 1863–1866. The fossil cephalopoda of the Cretaceous rocks of Southern India. Ammonitidae with revision of the Nautilidae etc. *Memoirs of the Geological Survey of India*. *Palaeontologica Indica*, **3** (1): 41–56 (1863); (2–5), 57–106 (1864); (6–9), 107–154 (1865); (10–13), 155–216 (1866).

Subbotina, N.N. 1949. Microfauna of the Cretaceous of the southern slope of the Caucasus. *VNIGRI, Microfauna of the oilfields of the USSR*, **34**, 5–36. [In Russian]

Tajika, A., Kürsteiner, P., Pictet, A., Lehmann, J., Tschanz, K., Jattitot, R. and Klug, C. 2017. Cephalopod associations and paleoecology of the Cretaceous (Barremian–Cenomanian) succession of the Alpstwein, northeastern Switzerland. *Cretaceous Research*, **70**, 15–54.

Tappan, H. 1940. Foraminifera from the Grayson Formation of northern Texas. *Journal of Paleontology*, **14**, 93–126.

Wiedmann, J. 1966. Stammesgeschichte und system der posttriadischen ammonoideen; ein überblick. *Neues Jahrbuch für Geologie und Paläontologie Abhandlungen*, **125**, 49–79; **127**, 13–81.

Wiedmann, J. and Dieni, I. 1968. Die Kreide Sardiniens und ihre Cephalopoden. *Palaeontographia Italica*, **64**, 1–171.

Wright, C.W. and Kennedy, W.J. 1978. The Ammonite *Stoliczkaia* from the Cenomanian of England and northern France. *Palaeontology*, **21**, 393–409.

Wright, C.W. and Kennedy, W.J. 1984. The Ammonoidea of the Lower Chalk. Monograph of the Palaeontographical Society, Part 1, 1–126. Palaeontographical Society; London.

Young, K. 1958. *Graysonites*, a Cretaceous ammonite in Texas. *Journal of Paleontology*, **32**, 171–182.

Zittel, K.A. Von. 1884. Handbuch der Palaeontology. 1, Abt. 2; Lief 3, Cephalopoda, 329–522. R. Oldenbourg; Munich and Leipzig.

Zittel, K.A. Von. 1895. Grundzüge der Palaeontologie (Palaeozoologie), vii + 972 pp. R. Oldenbourg; Munich and Leipzig.

Manuscript submitted: 19th August 2020
Revised version accepted: 7th December 2020