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# Trans-Tethyan correlation of the Lower–Middle Cenomanian boundary interval; southern England (Southerham, near Lewes, Sussex) and Douar el Khiana, northeastern Algeria

WILLIAM J. KENNEDY[1] and ANDREW S. GALE[2]

[1]*Oxford University Museum of Natural History, Parks Road, Oxford OX1 3PW, and Department of Earth Sciences, South Parks Road, Oxford OX1 3AN, United Kingdom. E-mail: jim.kennedy@oum.ox.ac.uk*
[2]*Department of Earth and Environmental Sciences, University of Portsmouth, Portsmouth PO1 3QL, United Kingdom. E-mail: andy.gale@port.ac.uk*

ABSTRACT:

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A 480 m section of marls with widely separated levels of nodular limestone in the Fahdene Formation north of Bou Khadra in Tebessa Province, northeastern Algeria, spans the Lower/Middle Cenomanian boundary. A total of 30 ammonite species are present, of which two: *Forbesiceras reversum* and *Calycoceras* (*Newboldiceras*) *algeriense* are new. The fauna allows recognition of the Northwest European upper Lower Cenomanian *Mantelliceras dixoni* Zone, the succeeding lower Middle Cenomanian *Cunningtoniceras inerme* Zone, the *Acanthoceras rhotomagense* Zone and its subzones of *Turrilites costatus* and *Turrilites acutus*. The sequence of index species occurs in the same order in both north-eastern Tunisia and the Southerham Grey Pit in Sussex (and indeed elsewhere in Northwest Europe), indicating these to be robust assemblage zones and subzones that can be recognised on both the north and south sides of the Tethys. Other occurrences of taxa that are common in both sections and regions are markedly different, and include the co-occurrence of *Cunningtoniceras inerme* (Pervinquière, 1907) with *Acanthoceras rhotomagense* (Brongniart, 1822) in the *costatus* Subzone in north-eastern Algeria and central Tunisia, the extension of *Acompsoceras renevieri* (Sharpe, 1857) into the lower Middle Cenomanian in north-eastern Tunisia, whilst the acme of *Turrilites scheuchzerianus* Bosc, 1801, is in the *dixoni* Zone in Northwest Europe, and in the *inerme* Zone in northeasten Algeria and adjacent parts of Central Tunisia. These differences are not a result of collection failure or non-preservation, but must rather reflect environmental controls on occurrence and abundance.

**Key words:** Trans-Tethyan correlation; Cenomanian; Ammonites; Algeria; England.

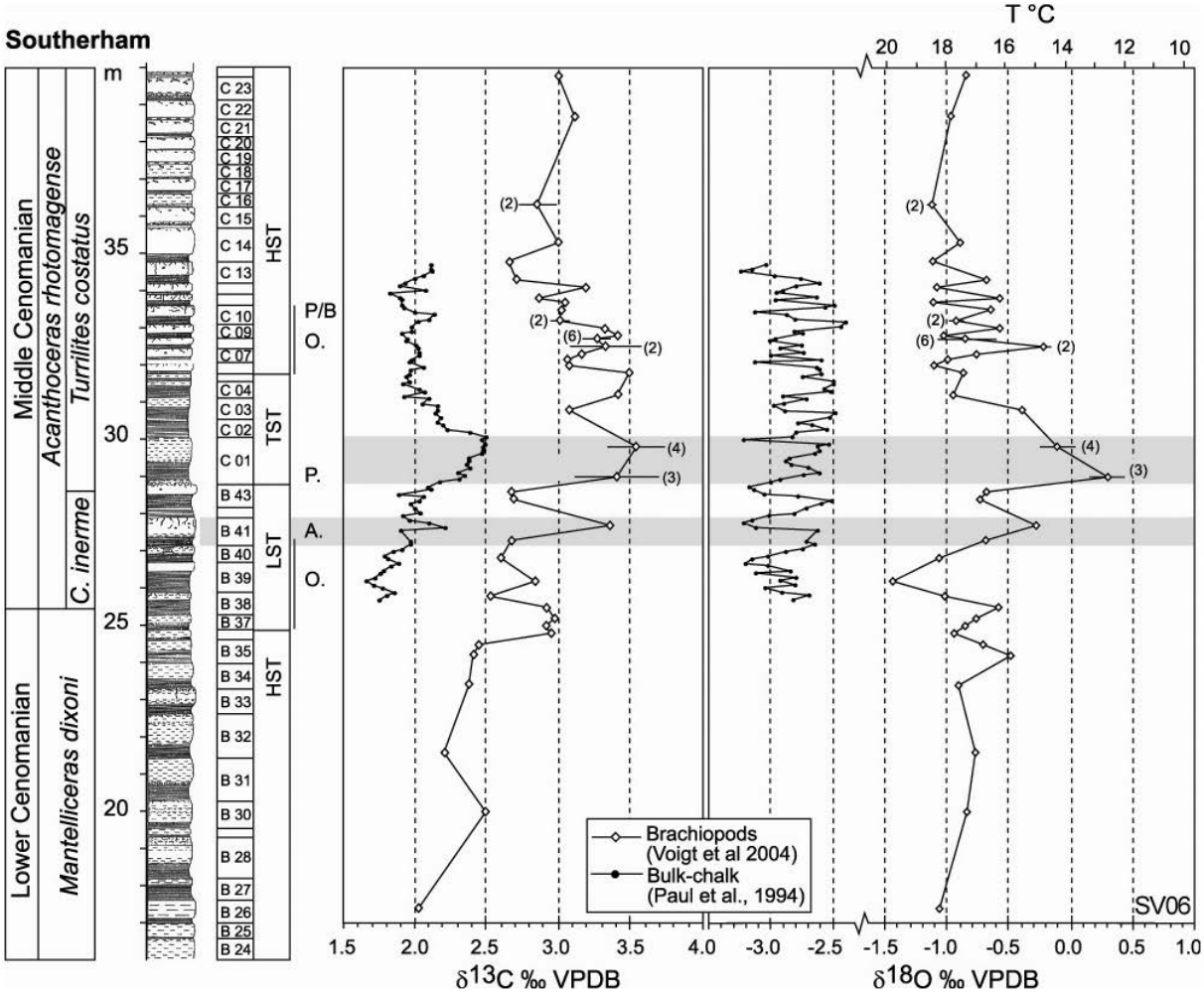
## INTRODUCTION

The boundary between the Lower and Middle Cenomanian substages is defined, in ammonite terms, at the first occurrence of the ammonite *Cunningtoniceras inerme* (Pervinquière, 1907) (and, in practice, other *Cunningtoniceras* species). It also corresponds to what has been termed the Mid-Cenomanian Event, the base of the *inerme* Zone corresponding to the lower of two positive $\delta^{13}C$ excursions (Text-fig. 1) that define the event (Paul *et al.* 1994; Gale 1995; Mitchell *et al.* 1996; Jarvis *et al.* 2001, 2006; Reboulet *et al.* 2013).

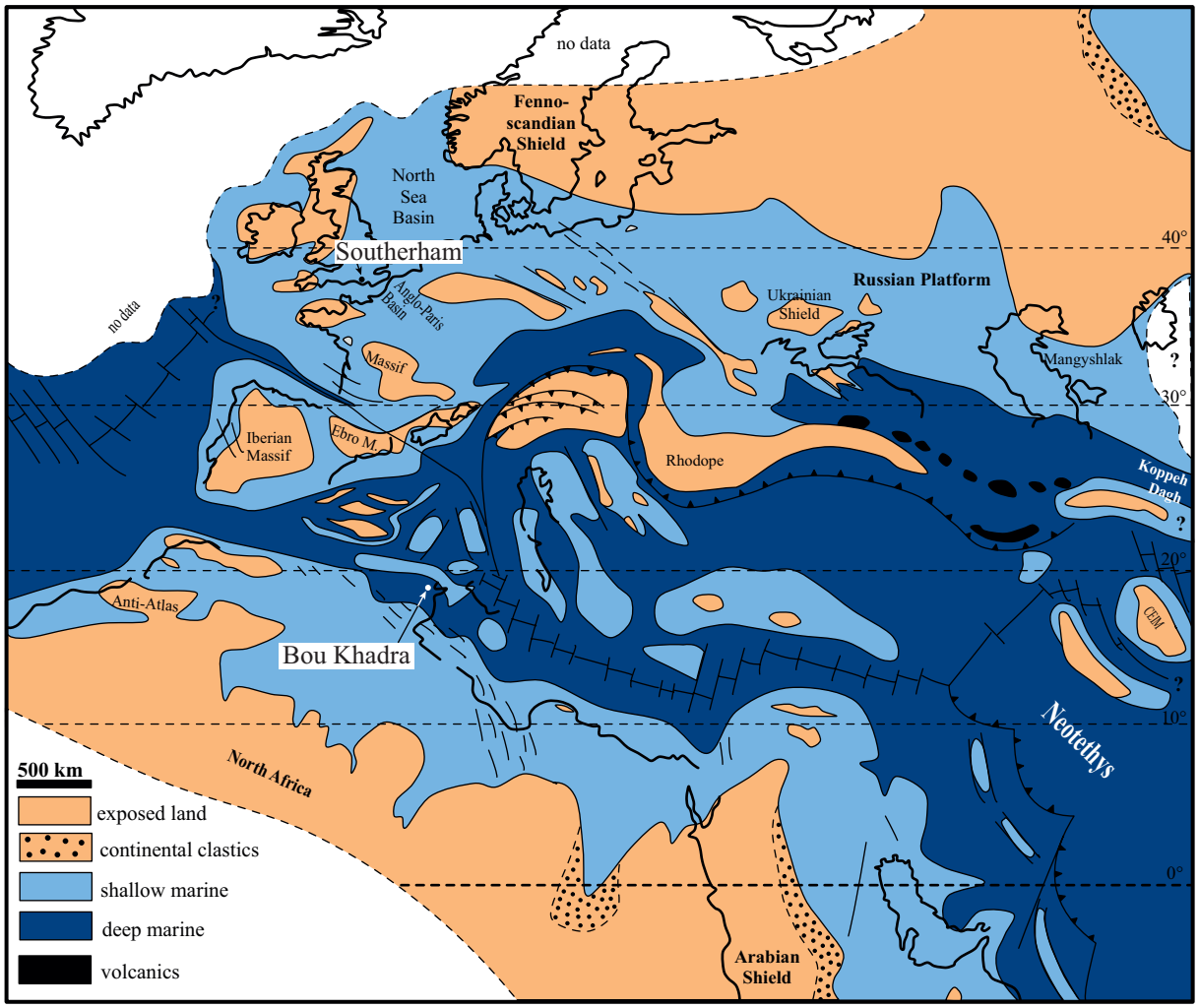
One of the most closely studied sections across this interval is in the Lower Chalk at the disused Southerham Grey Pit, near Lewes in Sussex, England. We review this section below, with special reference to the distribution of ammonites through the upper Lower and Lower Middle Cenomanian. To test the validity of these data, we compare the Southerham record with that a few kilometres north of the village of Bou Khadra, Tebessa Province, in northeastern Algeria, currently 1800 km to the south-south-east, and, during the Cenomanian, on the south side of the Tethys Ocean (Text-fig. 2).

## THE SUCCESSION NORTH OF BOU KHADRA

The section examined lies 4 km north of Bou Khadra (Text-fig. 3), on the side of Douar el Khiana at 8° 02′ E, 35° 48′N. It lies within the area covered by Dubourdieu's classic work *Étude Géologique de la Région de l'Ouenza (Confins Algéro-Tunisiens)* (1956); the source of the present material is discussed on p. 301 *et seq.* and his pl. 8 is a geological map of the area. Most of the fossil localities described by Dubourdieu are in the Lower Cenomanian, with limonitic nuclei, and genuinely diminutive species (Dubourdieu 1953; Sornay 1955). One of us (WJK) visited the area in the company of the late J.M. Hancock in April 1965. His log of the section is shown in Text-fig. 4. The sequence is of clays and marls with subsidiary nodular limestones, the latter richly fossiliferous. The whole succession has been subjected to intense small-scale folding; the section was measured in two deep wadis that cut through the outcrop, which at the time of our visit was largely free of vegetation. The nature of the topography and of the small scale folding meant that it was not everywhere possible to limit collecting to individual horizons, and in what follows some records are from mixed assemblages, as indicated by, for example, their reference to 'beds 3–7.'




Text-fig. 1. The Mid-Cenomanian stable isotope event plotted against the sequence in the Southerham Grey Pit near Lewes, Sussex

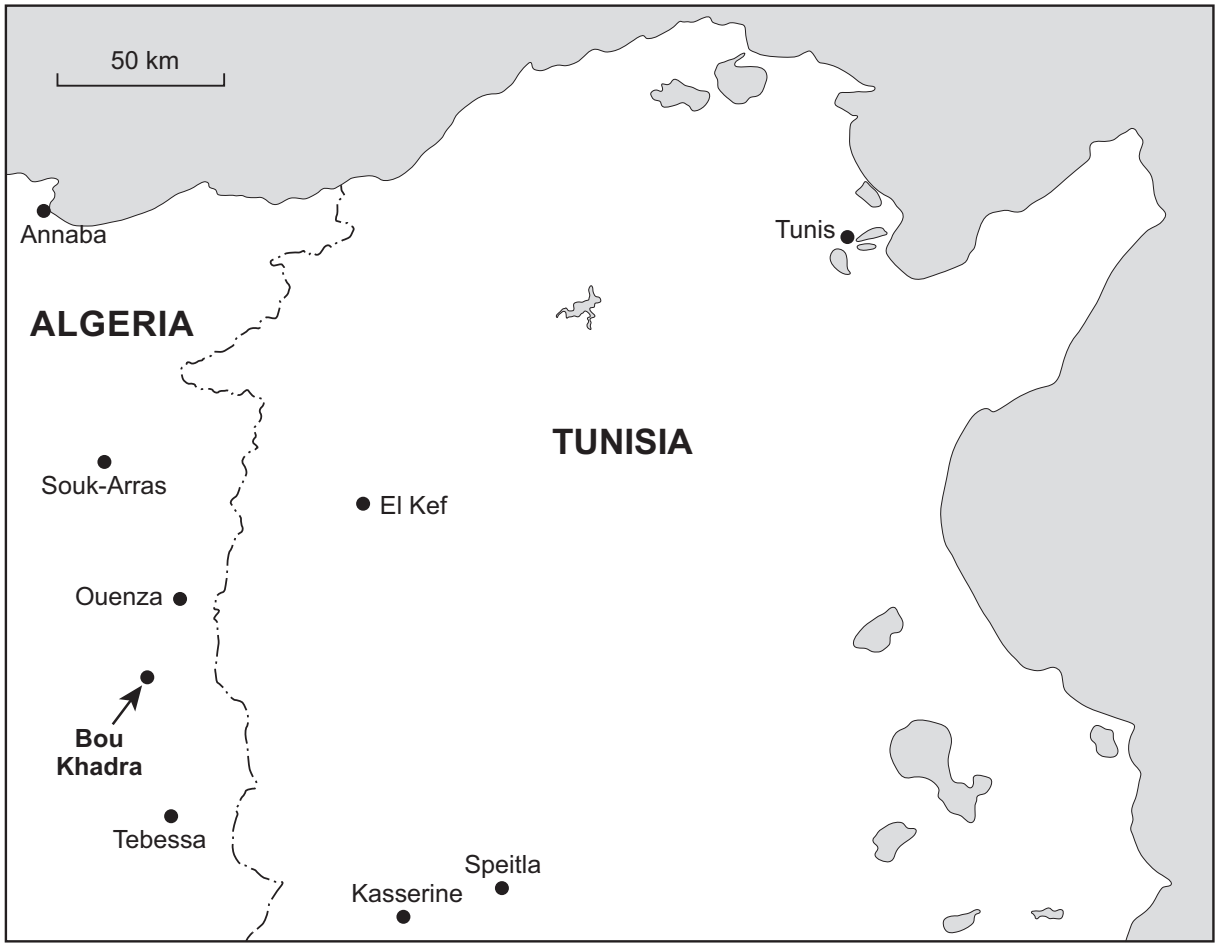



Text-fig. 2. The Cenomanian palaeogeography of the western Tethys (modified after Philip and Floquet 2000)

In addition to the ammonites, discussed in detail below, of which *Turrilites scheuchzerianus* Bosc, 1801, occurs in flood abundance at some levels, there is a diverse fauna, predominantly of other molluscan groups. The belemnite *Neohibolites* occurs in beds 3–7. Nautiloids are diverse; the commonest is *Cymatoceras calabrus* (Seguenza, 1881) (notably in beds 3–7); also present are species of *Cymatoceras*, *Pseudocenoceras*, *Eutrephoceras*, *Angulithes*, and *Deltocymatoceras*. Of gastropods, *Pterodontoceras dutrugeri* (Coquand, 1862) ranges through the sequence, and occurs in flood abundance in material derived from beds 3–7. Also present are *Nummocalcar* cf. *berthoni* (Pervinquière, 1912), *Dicroloma* aff. *carinella* (d'Orbigny, 1842), together with species of *Conotomaria* and *Gyrodes*. Bivalves include *Anisocardia papieri* Coquand, 1880, together with species of *Nucula*, *Leionucul*a, *Corbis*?, *Trigonarca*, *Pycnodonte*, *Lucina*, and *Durania*. Echinoids are represented by specimens of *Hemiaster* at several horizons. Small colonies of an ahermatypic coral occur in bed 22. Beds 3–7 yielded a well-preserved fish skull (OUM KX13480).

## THE SEQUENCE OF AMMONITE FAUNAS

The distribution of ammonites in the section at Dour el Khiana is discussed in terms of the zonal scheme developed in Western Europe, based on the studies by Kennedy (1969, 1970, 1971), Wright and Kennedy (1984), Amédro (1986), Gale (1989, 1995) , Gale and Friedrich (1995), Robaszynski *et al*. (1994, 1998), Amédro and Robaszynski (1999), Kaplan *et al.* (1998) and Wilmsen (2007), amongst others. The relevant part of the zonal/subzonal succession is shown in Text-fig. 5.




Text-fig. 3. The location of the section north of Douar el Khiania, which lies north of Bou Khadra in Tebessa Province, northeastern Algeria

The distribution of key ammonites at selected levels is shown in Text-fig. 6. Key events are as follows.

Beds 1 and 2 yield a small assemblage that is clearly Lower Cenomanian, and referred to the upper Lower Cenomanian *Mantelliceras dixoni* Zone.

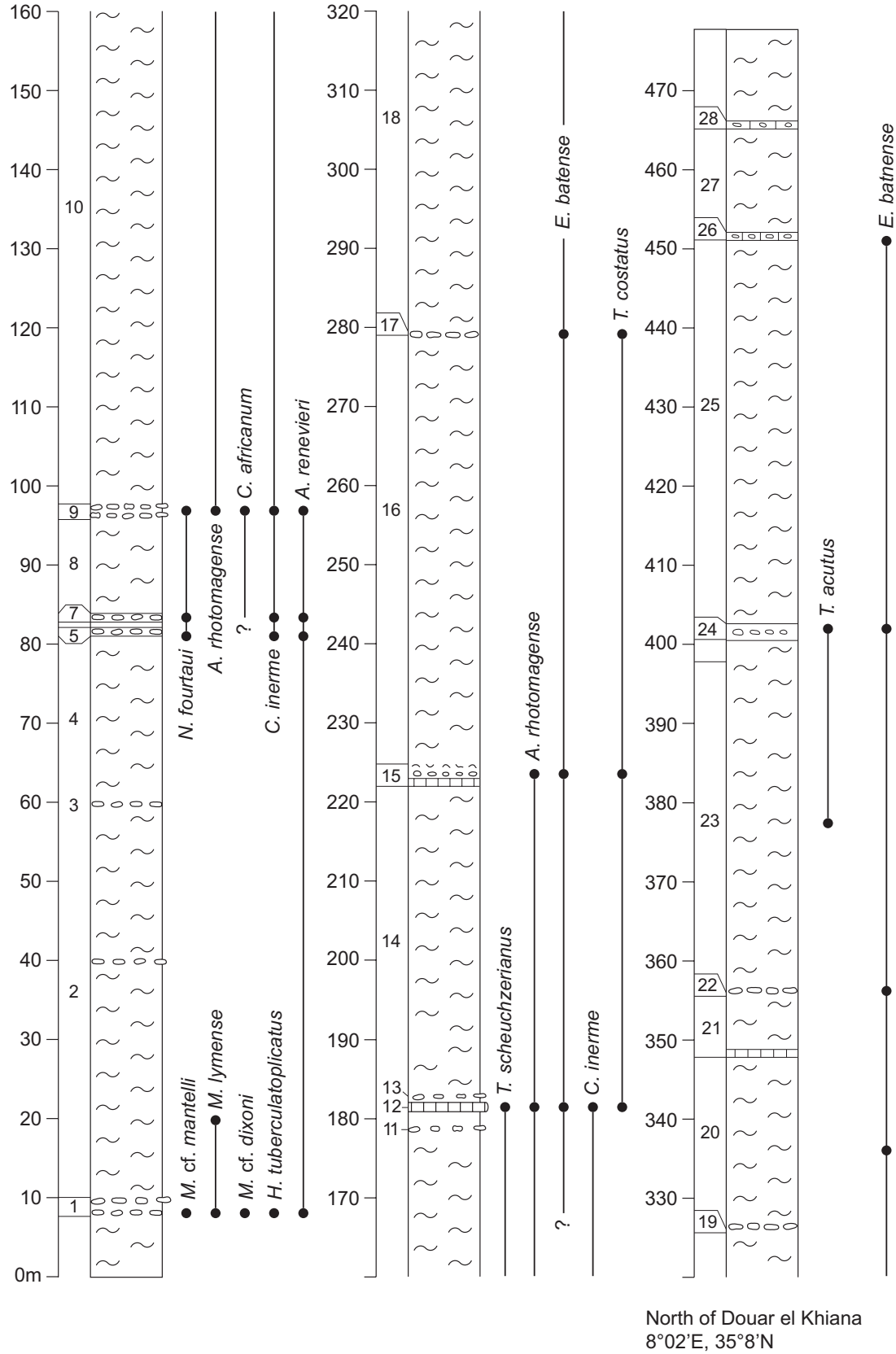
The first occurrence of *Cunningtoniceras inerme* (Pervinquière, 1907) in bed 5, indicating the base of the lower Middle Cenomanian *inerme* Zone.

The first occurrence of *Acanthoceras rhotomagense* (Brongniart, 1822) in bed 9 indicating the *rhotomagense* Zone, the base of which may lie below this, based on specimens referred to this species (OUM KX15365 and 15367–69) in the mixed assemblage collected from beds 3–7.

The co-occurrence of *A. rhotomagense* and *Turrilites costatus* Lamarck, 1801, in beds 12 and 15 confirm the presence of the lower, *costatus* Subzone of the *rhotomagense* Zone, as does the presence of the subzonal index in bed 17.

The first occurrence of *Turrilites acutus* Passy, 1832, in bed 22 indicates the base of the succeeding *acutus* Suzone of the *rhotomagense* Zone.

There is, however, a major apparent anomaly in the record: the presence of the typically upper Lower Cenomanian *Mantelliceras* cf. *dixoni* (OUM KX13612-13; Pl. 1, Figs 5, 6) and *Hypoturrrilites tubercuculatoplicatus* (Seguenza, 1882) (OUM KX13569; Pl. 17, Fig. 7) in bed 9, associated with a Middle Cenomanian *rhotomagense* Zone fauna. Absence of any other typically Lower Cenomanian ammonites amongst the many hundreds of fossils collected from the interval between the otherwise highest Lower Cenomanian ammonite (in bed 2) and bed 9 lead us to doubt the validity of the records. We suspect them to be a result of mixing on the outcrop at the time of collection, or subsequently, during curation, but cannot omit them from this account.




Text-fig. 4. The section in the Fahdene Formation north of Douar el Khiania

| SUBSTAGE | ZONE | SUBZONE |
|---|---|---|
| MIDDLE CENOMANIAN | *Acanthoceras jukesbrownei* | |
| | *Acanthoceras rhotomagense* | *Turrilites acutus* |
| | | *Turrilites costatus* |
| | *Cunningtoniceras inerme* | |
| LOWER CENOMANIAN | *Mantelliceras dixoni* | |
| | *Mantelliceras mantelli* | *Mantelliceras saxbii* |
| | | *Sharpeiceras schlueteri* |
| | | *Neostlingoceras carcitanense* |
| | *(Pleurohoplites briacensis)* (part) | |

Text-fig. 5. Lower and Middle Cenomanian ammonite Assemblage Zones and Subzones recognised in Northwest Europe

| | 1 | 2 | 3 | 5 | 7 | 3-7 | 9 | 10 | 12 | 15 | 17 | 20 | 22 | 23 | 24 | 26 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *N. fourtaui* | | | | * | * | * | * | | | * | | | | | | |
| *F. largilliertianum* | | | | | | * | | | | | | | | | | |
| *F. chevillei* | | | * | | * | * | * | | | | | | | | | |
| *F. obtectum* | | | | | | * | | | | * | * | | * | * | | |
| *F. subobtectum* | | | | * | | * | * | | | | | | | | | |
| *F. reversum* | | | | * | | * | | | | | | | | | | |
| *M.* cf. *mantelli* | * | | | | | | | | | | | | | | | |
| *M. lymense* | * | * | | | | | | | | | | | | | | |
| *M.* cf. *dixoni* | * | | | | | | ? | | | | | | | | | |
| *Sharpeiceras* sp. | * | | | | | | | | | | | | | | | |
| *A. renevieri* | * | | * | | * | * | * | | | | | | | | | |
| *C. inerme* | | | | * | * | * | * | | * | | | | | | | |
| *C. africanum* | | | * | * | * | * | * | | | | | | | | | |
| *A. rhotomagense* | | | | | | * | * | | * | * | | | | | | |
| *C.* (*G.*) *gentoni* | | | | | | | | | * | | | | | | | |
| *C.* (*N.*) *a. asiaticum* | | | | | | | | | | * | | | | | | |
| *C.* (*N.*) *tunisiense* | | | | | | | | ? | * | * | * | * | * | * | * | |
| *C.* (*N.*) *algeriense* | | | | | | | | | * | * | * | * | | | * | * |
| *E. batnense* | | | | | | | | ? | * | * | * | * | * | * | * | * |
| *L. elegans* | | | | | | | | | | * | | * | * | | ? | * |
| *A. plicatile* | | | | | | | | | * | | | | | | | |
| *H. tuberculatoplicatus* | * | | | | | | ? | | | | | | | | | |
| *T. wiestii* | | | * | | | * | | | | | | | | | | |
| *T. scheuchzerianus* | | | * | * | * | * | * | * | * | | | | | | | |
| *T. costatus* | | | | | | | | | * | * | | * | | | | |
| *T. acutus* | | | | | | | | | | | | | | * | * | |
| | 1 | 2 | 3 | 5 | 7 | 3-7 | 9 | 10 | 12 | 15 | 17 | 20 | 22 | 23 | 24 | 27 |

Text-fig. 6. Selected ammonite occurrences in the Fahdene Formation north of Douar el Khiania

## COMPARISONS WITH SEQUENCES IN CENTRAL TUNISIA

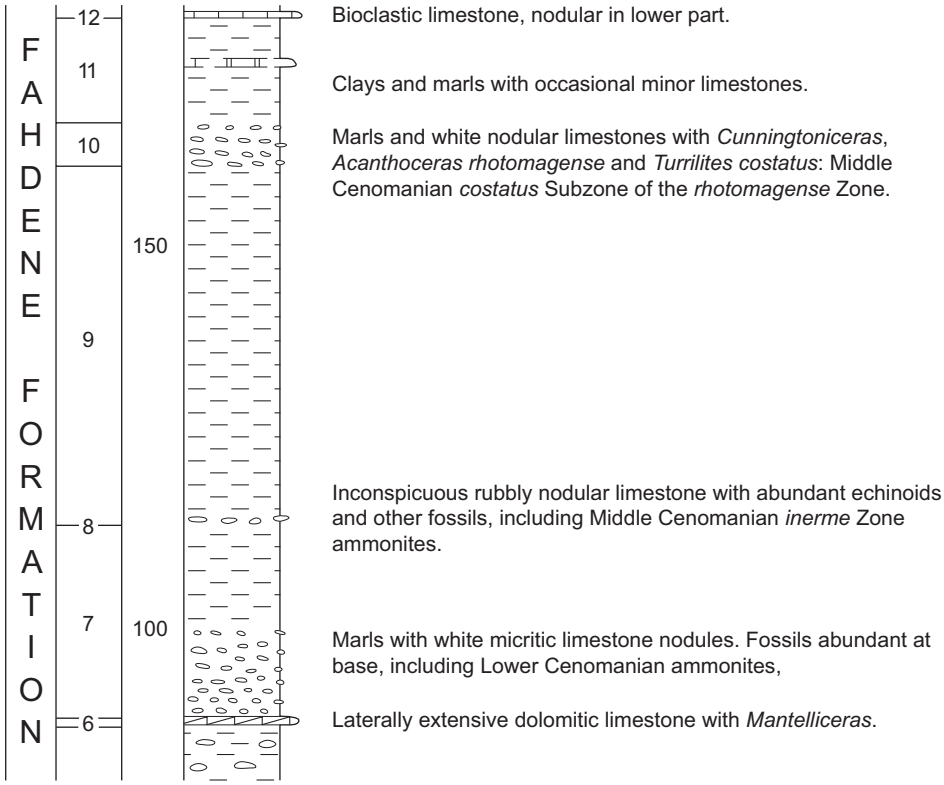
### Djebel Mrhila

The classic Cenomanian ammonite faunas from Djebel Mrhila, north-northeast of Speitla in Central Tunisia, 120 km ENE of the Douar el Khiania section (Text-fig. 3) were described by Pervinquière (1907), and recently revised by Kennedy and Gale (2015). Exposure is incomplete, but there is a good record in the lower Middle Cenomanian in the section south of Sif et Tella; Text-fig. 7 shows the critical part of the succession, and retains the original bed numbers of Kennedy and Gale (2015). The fauna of bed 8 is: *Neolobites fourtaui* Pervinquière, 1907, *Forbesiceras chevillei* (Pictet and Renevier, 1866), *Cunningtoniceras meridionale* (Stoliczka, 1864), *C. africanum* (Pervinquière, 1907), *C.* sp. juv., and *Turrilites scheuchzerianus*. Bed 9 yielded *Cunningtoniceras inerme*; Bed 10 yielded *Neolobites peroni*, *Forbesiceras flicki* Pervinquière, 1907, *Acompsoceras renevieri*, *Acanthoceras rhotomagense*, *Cunningtoniceras inerme*, *C. africanum*, *C.* sp., *Calycoceras* (*Gentoniceras*) cf. *gentoni* (Brongniart, 1822), *Calycoceras* (*Newboldiceras*) *asiaticum spinosum* (Kossmat, 1897), *C.* (*Newboldiceras*) sp., and *Turrilites costatus*. We place the base of the *inerme* Zone at the base of bed 8 (even thought the index species is absent from our collections), and correlate it with bed 5 of the Douar el Khiania section. Bed 10 is referred to the succeeding *costatus* Subzone of the *rhotomagense* Zone, and we correlate it with bed 7 of the Douar el Khiania section. Of particular significance is the co-occurrence of *Acanthoceras rhotomagense* and *Cunningtoniceras inerme* in both sections.

### Kalaat Senan

The Cenomanian succession at Kalaat Senan, 58 km south-west of El Kef (Text-fig. 3) was documented by Robaszynski *et al.* (1993, 1994, 2008). The Cenomanian sequence in the Fahdène Formation there is over 600 m thick. The following zonal sequence was recognised across the interval relevant to the present discussion:

Upper Cenomanian (part)
*Eucalycocera pentagonum* Zone
Middle Cenomanian
*Acanthoceras amphibolum* Zone
*Paraconlinoceras barcusi* Zone




Text-fig. 7. The Lower/Middle Cenomanian boundary sequence southof Sif et Tella in Djebel Mrhila, Central Tunisia

A*canthoceras* cf. r*hotomagense* Zone
*Cunningtoniceras inerme* Zone
Lower Cenomanian (part)
*Mantelliceras dixoni* Zone

Faunas as given by Robaszynski *et al*. are as follows*:*

***Mantelliceras dixoni*** **Interval Zone**: *Phylloceras* sp., *Metascaphites thomasi* (Pervinquière, 1907), *Forbesiceras* sp., *Mantelliceras* sp., *M. dixoni*, *Acompsoceras renevieri*, *Calycoceras* sp., *C*. (*Newboldiceras*) sp. and *Acompsoceras* (?) *suzannae* (Pervinquière, 1907).

***Cunningtoniceras inerme*** **Interval Zone**: *Forbesiceras* sp., *Acompsoceras* (?) *suzannae*, *Cunningtoniceras inerme*, *Calycoceras* sp., *C*. (*Newboldiceras*) sp., *Hamites* sp., *Turrilites costatus*, and *T. scheuchzerianus.*

***Acanthoceras*** **cf.** ***rhotomagense*** **Interval Zone**: *Puzosia* sp., *Forbesiceras* sp., *F. obtectum*, *Acanthoceras* sp., *A*. cf. *rhotomagense*, *Calycoceras* sp., *C*. (*Newboldiceras*) sp., *C*. (*N*.) *tunetanum*, *Hamites* sp., *Turrilites costatus*, and *Turrilites scheuchzerianus.*

***Paraconlinoceras*** **aff.** ***barcusi*** **Inteval Zone**: *Puzosia* sp., *Calycoceras* sp., *P.* aff. *barcusi*, *Calycoceras* sp., *C*. (*Newbodiceras*) sp., *C*. (*N*.) *asiaticum*, *C*. (*N*.) *tunetanum*, and *Turrilites acutus.*

***Acanthoceras amphibolum*** **Total Range Zone***: Forbesiceras* sp*., Forbesiceras obtectum, Acanthoceras* sp*., A. amphibolum, Calycoceras* sp*., C*. (*Gentoniceras*) sp., *C*. (*Newboldiceras*) sp., *C*. (*N*.) *asiaticum, C*. (*N*.) *tunetanum, C*. (*Proeucalycoceras*) sp., *Eucalycoceras* sp., *E. pentagonum, Lotzeites* sp., *Idiohamites* sp., and *Turrilites acutus.*

***Eucalycoceras pentagonum*** **Partial Range Zone**: *Puzosia* sp., *Forbesiceras* sp., *Metengonoceras* sp., *Neolobites vibrayeanus, Calycoceras* sp., *C*. (*Newboldiceras*) sp., *C*. (*Proeucalycoceras*) sp., *C*. (*P*.) *guerangeri, C*. (*Calycoceras*) sp., *Eucalycoceras* sp., *E. pentagonum, Thomelites* sp., *Euomphaloceras* cf. *euomphalum*.

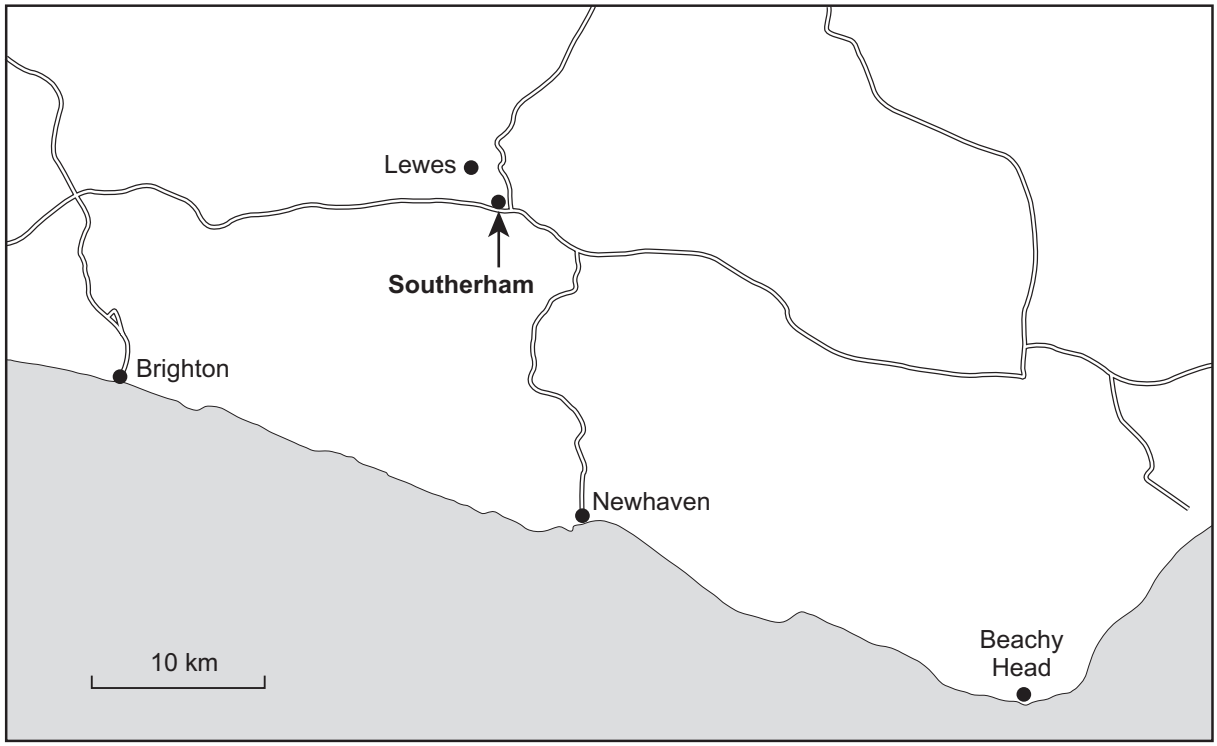
The base of the *dixoni* Zone is marked by the first and only occurrence of the index species in the section. *Turrilites costatus* is recorded from the top of the *dixoni* Zone, whereas it first occurs at the base of the *costatus* Subzone of the *rhotomagense* Zone (Text-fig. 5) elsewhere. This apparent anomaly appears to be based on misidentification. The juvenile *T. costatus* from the *dixoni* Interval Zone (Robaszynski *et al*. 1994, pl. 13, figs 5, 7) are juvenile *scheuchzerianus* in our view.

The base of the *inerme* Zone was defined by the first occurrence of the index species, as elsewhere. The presence of *T. costatus* in the *inerme* Zone is an apparent anomaly, perhaps explicable as above. The boundary between the *costatus* and *acutus* Subzones of the *Acanthoceas rhotomagense* as recognised in Northwest Europe falls within the *Acanthoceras* gr, *rhotomagense* Interval Zone, based on the last occurrence of *Turrilites costatus* and the first occurrence of *T. acutus*. The fauna of the *barcusi* Interval Zone is Middle Cenomanian in aspect, as is that of the lower part of the *amphibolum* Total Range Zone. The presence of *Eucalycoceras pentagonum* and *Lotzeites* at the top of the Zone suggests that this level is already Upper Cenomanian, as these are *guerangeri* Zone taxa.

## THE SUCCESSION AT SOUTHERHAM, NEAR LEWES, EAST SUSSEX

The Southerham Grey Pit provides a key succession across the Lower/Middle Cenomanian boundary. It lies to the south of the A27 road between Lewes and Eastbourne (Text-fig. 8; UK National Grid Reference TQ 426090). No longer a working quarry, it is now a protected Site of Special Scientific Interest. There is an extensive literature, the most recent accounts relevant to the present discussion are Gale (1989, 1995) and Paul *et al*. (1994). The significance of the section is that it is one of relatively few in Northwest Europe where there is a complete succession across the uppermost *Mantelliceras dixoni* Zone / *Cunningtoniceras inerme* Zone boundary. As Wilmsen (2007) has noted, sea level was falling during the late early Cenomanian, and there was a lowstand during early Middle Cenomanian times; as a result there is widespread erosion/non-deposition across this interval. Text-fig. 1 illustrates the isotopic event that characterises this interval, while Text-fig. 9 plots ammonite occurrences at Southerham. Key occurrences of taxa common to the Southerham and Douar el Khiana section are as follows:

- The last occurrence of *Mantelliceras mantelli* (J. Sowerby, 1814) in bed 28.
- The last occurrence of *Mantelliceras dixoni* in beds 32–33.
- The occurrence of *Hypoturrilites tuberculatoplicatus* in bed 32–33.
- The first occurrence of *Turrilites wiestii* in bed 39.
- The first occurrence of *Turrilites scheuchzerianus* in bed 39.
- The first occurrence of *Acompsoceras renevieri* in bed 41.




Text-fig. 8. The location of the Southerham Grey Pit

- The last occurrence of *Acompsoceras renevieri* in bed 63.
- The last occurrence of *Turrilites wiestii* in bed 63.
- The first occurrence of *Cunningtoniceras inerme* in bed 73.
- The last occurrence of *Cunningtoniceras inerme* in bed 79.
- The last occurrence of *Turrilites scheuchzerianus* in bed 83.
- The first occurrence of *Turrilites costatus* in bed 83.
- The first occurrence of *Acanthoceras rhotomagense* in bed 83
- The first occurrence of *Turrilites acutus* is not recorded at Southerham, but it appears in the correlative of bed 108 at Eastbourne.

## DISCUSSION

The following sequence of first/last occurrences is common to both the Southerham and Douar el Khiania sections:

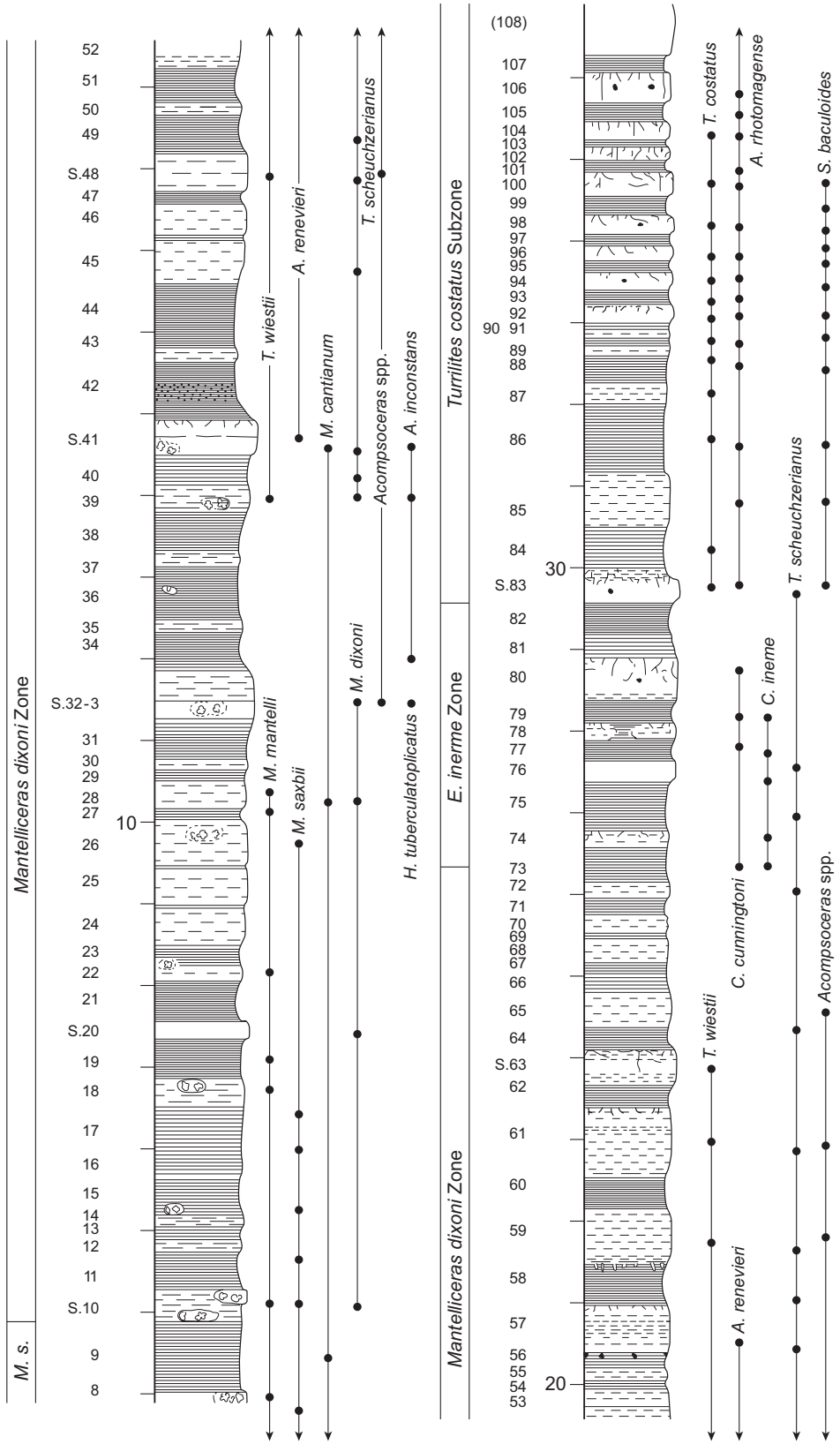
- The last occurrence of *Mantelliceras dixoni*
- The first occurrence of *Cunningtoniceras inerme*
- The first occurrence of *Acanthoceras rhotomagense*
- The inferred first occurrence of *Turrilites acutus*

Differences in first/last occurrence of the following taxa, relatively uncommon in one or both sections may be attributable to collection failure: *Hypoturrilites tuberculatoplicatus* (rare at both sections), *Turrrilites wiestii* (rare at both sections), *Turrilites costatus* (rare north of Douar el Khiania).

Occurrences of the following taxa that are relatively common in both sections may reflect real differences in ranges between the two sections and, indeed, between the north and south sides of the Tethys.

*Acompsoceras renevieri*. At Southerham, and generally on the north side of Tethys, the species has its acme in, and does not range above the *dixoni* Zone. In the Algerian and Tunisian sections it also has an acme in the *dixoni* Zone, but extends to the *costatus* Subzone of the *rhotomagense* Zone.

*Cunningtoniceras inerme* is restricted to its assemblage zone at Southerham and elsewhere in Western Europe. It extends into the *costatus* Subzone of the *rhotomagense* Zone in the Algerian and Tunisian sections. We note that the range of the genus *Cunningtoniceras* is discontinuous in both Northwest Europe and the Algerian and Tunisian sections, where it reappears in the lower Upper Cenomanian. *Cunningtoniceras arizonense* Kirkland and Cobban, 1986 occurs in the lower Upper Cenomanian at Eastbourne in Sussex (Gale *et*




Text-fig. 9. The succession, and selected ammonite occurrences across the Lower-Middle Cenomanian boundaryin the Southerham Grey Pit

*al*. 2005, p. 466, text-fig. 11), and an allied form is present in the Taigle area of Cantabria in northern Spain (the *Cunningtoniceras* ex. gr. *cookense*/*arizonense* of Wilmsen, 1997, pl. 27, fig. 7). *Cunningtoniceras tinrhertense* (Collignon, 1965) occurs at Djebel Mrhila in Central Tunisia (Kennedy and Gale 2015) and Tinrhert in the Algerian Sahara (Amédro *et al.* 1996).

*Turrilites scheuchzerianus* has its first occurrence and acme in the *dixoni* Zone in Northwest Europe (for example the *Turrilites scheuchzerianus* Bed of German authors: see discussion in Wilmsen 2007), and in the *inerme* Zone of the Algerian and Tunisian sections.

These differences cannot be attributed to breaks in the succession, a failure in preservation of originally aragonitic shells, or facies differences in our view, and must reflect some other, presumably environmental control or controls. There are other ammonite acme occurrences in the interval studied that are known in Northwest Europe but not the Algerian and Tunisian sections studied here, most notably the flood abundance of *Sciponoceras baculoides* (Mantell, 1822) in the *costatus* Subzone. In contrast, we conclude that the *Mantelliceras dixoni*, *Cunningtoniceras inerme* and *Acanthoceras rhotomagense* Assemblage zones, together with the *Turrilites costatus* and *acutus* Assemblge subzones of the latter are robust biostratigraphic units that can be applied on both the north and south sides of Tethys in the Old World.

## CONVENTIONS

The suture terminology is that of Korn *et al.* (2003): E = external lobe; A = adventive lobe (= lateral lobe, L, of Kullmann and Wiedmann 1970); U = umbilical lobe; I = internal lobe.

## REPOSITORIES OF SPECIMENS

BGS. GSM: British Geological Survey, Keyworth, Nottinghamshire.
BMNH: The Natural History Museum, London.
MNHP: Laboratoire de Paléontologie of the Muséum Nationale d'Histoire Naturelle, Paris.
OUM: Oxford University Museum of Natural History.

## SYSTEMATIC PALAEONTOLOGY (W.J. KENNEDY)

English representatives of the taxa listed from the Southerham sequence are fully described and illustrated in Wright and Kennedy (1984, 1987, 1990, 1995, 1996). Of taxa from the section north of Douar el Khiania, many are comprehensively discussed in recent literature, and are illustrated, but afforded minimal treatment below.

Order Ammonoidea Zittel, 1884
Suborder Phylloceratina Arkell, 1950
Superfamily Phylloceratoidea Zittel, 1884
Family Phylloceratidae Zittel. 1884
Subfamily Phylloceratinae Zittel, 1884
Genus *Phylloceras* Suess, 1866

TYPE SPECIES: *Ammonites heterophyllus* J. Sowerby, 1820, p. 119, pl. 226, by monotypy.

Subgenus *Hypophylloceras* Salfeld, 1924

TYPE SPECIES: *Phylloceras onoense* Stanton, 1895, p. 74, by monotypy.

*Phylloceras* (*Hypophylloceras*) *velledae velledae*
(Michelin, 1834)
(Pl. 1, Figs 1, 2)

1834. *Ammonites velledae* Michelin, pl. 35
2009 *Phylloceras* (*Hypophylloceras*) *velledae velledae* (Michelin, 1834); Klein *et al*., p. 27 (with full synonymy).

MATERIAL: OUM KX15185, from beds 3–7.

REMARKS: The specimen is a phragmocone 69 mm in maximum preserved diameter, with very feebly convex flanks, broadly rounded ventrolateral shoulders, and a feebly convex venter. The whorl breadth to height ratio is 0.66 appproximately. Characteristic ornament of delicate riblets is preserved in places on ventrolateral shoulders and venter. The specimen is refered to *velledae* on the basis of coiling and whorl proportions.

OCCURRENCE: Upper Aptian to Lower Cenomanian. The geographic distribution extends from France to the Balearic Islands, Ukraine (Crimea), KwaZulu-Natal South Africa, Mozambique, and Madagascar.

Suborder Lytoceratina Hyatt, 1889
Superfamily Tetragonitoidea Hyatt, 1900
Family Tetragonitidae Hyatt, 1900
Subfamily Tetragonitinae Hyatt, 1900
Genus *Tetragonites* Kossmat, 1895

TYPE SPECIES: *Ammonites timotheanus* Pictet, 1847, p. 295, pl. 2, fig. 6; pl. 3, figs 1, 2, by the original designation of Kossmat 1895, p. 131 (35).

*Tetragonites* cf. *subtimotheanus* Wiedmann, 1962

1895. *Lytoceras* (*Tetragonites*) *Timotheanum* Mayor sp.; Kossmat, p. 133, (37), pl. 17 (3), figs 11, 13.
1962. *Tetragonites subtimotheanus* Wiedmann, p. 131.
2009. *Tetragonites subtimotheanus maclearni* Wiedmann,1962; Klein *et al*., p. 244 (with full synonymy).
2009. *Tetragonites subtimotheanus subtimotheanus* Wiedmann, 1962; Klein *et al*., p. 244 (with full synonymy).

TYPE: The holotype, by the original designation of Wiedmann 1962, p. 131, is the original of Kossmat 1895, p. 133, (37), pl. 17 (3), figs 11, 13, from the Upper Albian or Lower Cenomanian of South India.

MATERIAL: OUM KX13449, from beds 3–7.

REMARKS: The specimen is an incomplete phragmocone with a maximum preserved diameter of 60 mm approximately. The coiling is relatively involute, the umbilicus small, deep, with a feebly convex, outward-inclined umbilical wall and broadly rounded umbilical shoulder. The whorl section is as wide as high, with feebly convex, subparallel inner to middle flanks, convergent outer flanks, broadly rounded ventrolateral shoulders, and a broad, very feebly convex venter. The surface of the internal mould is smooth, but for widely separated constrictions, prorsiradiate and straight to very feebly concave on the inner to middle flank, sweeping back and convex on the outermost flank and ventrolateral shoulder, and crossing the venter in a shallow concavity, where a well- developed adapical collar rib is preserved adjacent to one of the constrictions. The suture is very corroded.

The specimen is clearly a *Tetragonites* on the basis of the whorl proportions, coiling, form and course of the constrictions, which resembles those of *Tetragonites subtimotheanus*, with which it is compared.

OCCURRENCE: The species ranges from Upper Albian to lower Upper Cenomanian, with records from South India, KwaZulu-Natal in South Africa, Madagascar, southern England, south-eastern France, Spain, Hungary, British Columbia and Alaska.

Order Ammonoidea Zittel, 1884
Suborder Ammonitina Hyatt, 1889
Superfamily Desmoceratoidea Zittel, 1895
Family Desmoceratidae Zittel, 1895
Subfamily Puzosiinae Spath, 1922
Genus and Subgenus *Parapuzosia* Nowak, 1913

TYPE SPECIES: *Sonneratia daubreei* de Grossouvre, 1894, p. 154, pl. 28, by the subsequent designation of Spath 1922, p. 127.

Subgenus *Austiniceras* Spath, 1922

TYPE SPECIES: *Ammonites austeni* Sharpe, 1855, p. 28, pl. 12, fig. 1, by the original designation of Spath 1922, p. 127.

*Parapuzosia* (*Austiniceras*) cf. *austeni* (Sharpe, 1855)

Compare:
1855. *Ammonites Austeni* Sharpe, p. 28, pl. 12, fig. 1, *non* 2 (= *Puzosia* (*Anapuzosia*) *dibleyi* (Spath, 1922)).
1984. *Parapuzosia* (*Austiniceras*) *austeni* (Sharpe, 1855); Wright and Kennedy, p. 60, pl. 5, figs 3, 6; text-fig. 5 (with full synonymy).
1998. *Parapuzosia* (*Austiniceras*) *austeni* (Sharpe, 1855); Kaplan *et al*., p. 78, pl. 1, figs 4, 7, 9; pl. 2, fig. 4 (with additional synonymy).

TYPES: The lectotype, designated by Spath (1922, p. 127) is BMNH C3382 from the Lower Chalk of Guildford, Surrey; it is the original of Sharpe, 1855, pl. 12, figs 1a, b, and was refigured by Wright and Kennedy 1984, text-fig. 5. Paralectotypes have not been traced.

MATERIAL: OUM KX15182–4, from beds 3–7; 13638, from beds 11–13.

DESCRIPTION AND DISCUSSION: The material consists of phragmocone fragments with whorl heights of 40 to 84 mm. The whorl section is compressed, the whorl breadth to height ratio ranging from 0.6 in the smallest specimen to 0. 76 in the largest. The umbilicus is shallow, with a low, feebly convex wall and quite narrowly rounded umbilical shoulder. The flanks are feebly convergent, convex, with broadly rounded ventrolateral shoulders and a relatively narrow, very feebly convex venter. Surfaces of the internal moulds are corroded, but the smaller specimens show traces of narrow, prorsiradiate, even ribs on the outer flanks that sweep forwards and cross the venter in a broad, shallow convexity. The largest fragment (OUM KX13683) shows, in addition, a single narrow constriction. Although poor, the present material

clearly belongs to the Puzosiinae, and such of the ornament as is preserved is compatible with comparison to *P.* (*A.*) *austeni*, for example the specimen from Wunsdorf, Germany, figured by Kaplan *et al.* (1998, pl. 4).

OCCURRENCE: *Parpuzosia* (*Austiniceras*) *austeni* first occurs in the lower Lower Cenomanian, and ranges to the Middle Turonian *Collignoniceras woollgari* Zone. There are records from Germany, England, France, the Czech Republic, Crimea, and possibly, northeastern Algeria.

Superfamily Hoplitoidea H. Douvillé 1890
Family Engonoceratidae Hyatt, 1900
Genus *Neolobites* Fischer, 1882

TYPE SPECIES: *Ammonites vibrayeanus* d'Orbigny, 1841, p. 322, pl. 96, figs 1–3, by monotypy.

*Neolobites fourtaui* Pervinquière, 1907
(Pl. 1, Figs 3, 4, 7–11, 14)

1907. *Neolobites Fourtaui* Pervinquière, p. 209, pl. 8, fig. 2–6, text-figs 78, 79.
2005. *Neolobites fourtaui* Pervinquière, 1907; Wiese and Schulz, p. 940, fig. 8, figs d, e, f, g (?), i, j, k.
2015. *Neolobites fourtaui* Pervinquière, 1907; Kennedy in Kennedy and Gale, p. 253, pl. 2, figs 1–9; text-figs 9, 10b–d (with full synonymy).

TYPES: The species is based on "huit à dix fragments, plus ou moins importantes" from east of Bou Hanèche, Kef Si Abd El Kebir in Djebel Mrhila, and Oued Hachichina on the Bir Rekeb sheet (Pervinquière 1907, p. 211). Five fragments were figured by Pervinquière. They have not been traced.

MATERIAL: OUM KX 14971–77, 14979, from bed 5; 15186–94, 15197–98, 15213–19, 15220 (collective of five specimens), 15221 (collective of six specimens), 15222 (collective of eight specimens), 15223, from beds 3–7; 15083–84, 15087–89, from bed 7;13614–69, from bed 9; 13513–14, from beds 3–9; 13690–91, from beds 11–13; 13920–23, from bed 15.

REMARKS: The present material agrees well with Pervinquière's syntypes, and material from Djebel Mrhila. Phragmocone fragments have four large, blunt umbilical bullae per half whorl that give rise to two or three feeble broad ribs, while additional ribs intercalate, all ribs strengthening on the outermost flank, and linking to well-developed ventral clavi, 14 per half whorl in OUM KX13617 (Pl. 1, Figs 3, 4). Body chamber fragments have whorl heights of up to 48 mm (Pl. 1, Figs 11, 14). The ribs strengthen markedly, and the primaries develop a blunt mid-lateral bulla. See Wise and Schulz (2005) and Kennedy and Gale (2015) for further discussion.

OCCURRENCE: Where well-dated, the species is lower Middle Cenomanian, *inerme* and *rhotomagense* Zones. The geographic distribution extends from southeastern France to northeastern Algeria, Djebel Mrhila in central Tunisia, Tébaga de Médenine in southern Tunisia, and Egypt.

Superfamily Acanthoceratoidea De Grossouvre, 1894

Family Forbesiceratidae Wright, 1952
Genus *Forbesiceras* Kossmat, 1897

TYPE SPECIES: *Ammonites largilliertianus* D'Orbigny, 1841, p. 320, pl. 95, by the subsequent designation of Diener 1925, p. 180.

REMARKS: Fragments of *Forbesiceras*, mostly worn smooth and specifically indeterminate, range from bed 3 to bed 23 of the section. At least five species are present, as described below.

*Forbesiceras largilliertianum* (d'Orbigny, 1841)
(Pl. 1, Figs 9, 10)

1841. *Ammonites largilliertianus* d'Orbigny, p. 320, pl. 95 (*pars*).
1984. *Forbesiceras largilliertianum* (d'Orbigny, 1841); Wright and Kennedy, p. 89, pl. 11, figs 2–6; pl. 12, figs 1–3, 9; pl. 16, fig. 2; text-figs 12a–l; 13 a–z'; 14a–h (with full synonymy).
2006. *Forbesiceras largilliertianum* (d'Orbigny, 1841); Kennedy *et al*. in Gauthier, p. 116, pl. 54, figs 1–3.
2008. *Forbesiceras largilliertianum* (d'Orbigny, 1841); Kennedy and Klinger, p. 120, pl. 1, figs 2–5; text-fig. 2a, f (*pars*), d, e (with additional synonymy).

MATERIAL: OUM KX15169–70, from beds 3–7

REMARKS: Fragments of phragmocone have whorl heights of up to 50 mm. The characteristic fine prorsiradiate concave ribs on the outer flanks link to tiny ventral clavi. These are linked in turn across the venter by a delicate transverse rib. There is a feeble mid-

ventral ridge. See Wright and Kennedy (1984) and Kennedy and Klinger (2008) for discussion.

OCCURRENCE: *F. largilliertianum* extends throughout the Lower and Middle Cenomanian. The geographic range extends from Southern England, to France, Switzerland, northern Spain, Germany, Iran, central Asia, Algeria, Tunisia, KwaZulu-Natal in South Africa, Madagascar, south India, and Japan.

*Forbesiceras obtectum* (Sharpe, 1853)
(Pl. 2, Figs 12–13; Pl. 3, Figs 1–5, 9–10; Pl. 4, figs 1–4)

1853. *Forbesiceras obtectum* Sharpe, 1853, p. 20, pl. 7, fig. 4.
1984. *Forbesiceras obtectum* (Sharpe, 1853); Wright and Kennedy, p. 94, pl. 12, fig. 4; pl. 14, figs 1, 2; pl. 15, fig. 4; text-figs 16g–j, 18 (with full synonymy).

MATERIAL: OUM KX15175, from beds 3–7; 13692, from beds 11–13; 13872, 13874–75, 13881, from bed 15; 13951–52, from bed 17; 14027–29, from bed 22; 14055, from bed 23; 1655, from bed 28.

REMARKS: Phragmocone fragments of what are interpreted as coarsely ribbed variants (OUM KX13873: Pl. 4, Figs 3, 4; 13875: Pl. 3, Figs 9, 10; 13952: Pl. 3, Figs 1–3 ) have whorl heights of up to 68 mm. Feebly concave prorsirdiate ribs on the inner flank link to, or intercalate between small mid-lateral bullae. The ribs flex back at mid-flank, and are convex and strongly rursiradiate on the outer flanks, sweeping back to intersect the line of the venter at a low angle, where they link to tiny ventral clavi. There is a marked mid-ventral ridge. The ventral clavi are linked across the venter by delicate transverse ribs, which strengthen into an incipient to feeble transversely elongated tubercle on the mid-ventral ridge. Variants of this type correspond to the example from Sarthe in France figured by Kennedy and Juignet (1984, text-fig. 29). Feebly ornamented variants (OUM KX13872; Pl. 4, Figs 1, 2, 14055; Pl. 3, Figs 4, 5) have barely detectable ribs, only visible under low angle illumination,and lack mid-lateral tubercles, as with the individual from Rouen, Seine-Maritime, France, one of the several specimens used by d'Orbigny in his restoration of his *Ammonites largilliertianus* (the specimen is illustrated photographically by Kennedy *et al.* in Gauthier 2006, pl. 55, figs 1a–c and Klinger and Kennedy 2008, text-fig. 2b, c). Pervinquière's specimen from Djebel Mrhila (1907, pl. 5, fig. 11) is intermediate between the two variants.

OCCURRENCE: Upper Lower Cenomanian to lower Upper Cenomanian. The geographic distribution extends from southern England to France, Turkmenistan, Algeria, Tunisia, Lebanon, Nigeria and Madagascar.

*Forbesiceras chevillei* (Pictet and Renevier, 1866)
(Pl. 3, Figs 1–8)

1866. *Ammonites chevillei* Pictet and Renevier, p. 102, pl. 4, fig. 2.
1984. *Forbesiceras chevillei* (Pictet and Renevier, 1866); Wright and Kennedy, p. 93, pl. 13, fig. 2; pl. 15, figs 1, 2; text-fig. 17 (with full synonymy).
2008. *Forbesiceras chevillei* (Pictet and Renevier, 1866); Kennedy and Klinger, p. 124, pl. 1, figs 1, 6–12; pl. 2, figs 8, 12, 13; text-fig. 6 (with additional synonymy).
2015. *Forbesiceras chevillei* (Pictet and Renevier, 1866); Kennedy in Kennedy and Gale, p. 262, pl. 5, figs 1, 2, 6; text-fig. 13c.

MATERIAL: OUM KX15179, 15195 (collective of eight specimens), 15196 (collective of 5 specimens), from beds 3–7; 15092–95, from bed 7; 13623, from bed 9, 13775, from bed 12.

REMARKS: See Wright and Kennedy (1984) and Kennedy and Klinger (2008).The present material consists of phragmocone fragments with whorl heights of up to 42 mm. The inner flanks are near-smooth, in some fragments; in others there are delicate prorsiradiate ribs. There are widely separated mid-lateral bullae that give rise to pairs of broad, flat-topped, feebly concave prorsiradiate ribs, while additional ribs intercalate, all ribs linking to well-developed ventral clavi. In the best-preserved individuals the clavi are seen to be linked across the venter by a broad swelling that bears a pair of delicate ribs linking the clavi. Additional delicate ribs intercalate between.

OCCURRENCE: *Forbesiceras chevillei* ranges from Lower to lower Middle Cenomanian. The geographic distribution extends from southern England to France, Germany, Switzerland, northern Spain, Turkmenistan, northeastern Algeria, Central Tunisia, Nigeria, KwaZulu-Natal in South Africa, Madagascar, and, possibly, Texas.

*Forbesiceras subobtectum* (Stoliczka, 1864)
(Pl. 2, Fig. 11; Pl. 4, Fig. 5)

1864. *Ammonites subobtectus* Stoliczka, p. 96, pl. 49, fig. 2.
1964. *Forbesiceras subobtectum* Stol.; Collignon, p. 62, pl. 335, fig. 1501.

1984. *Forbesiceras* cf. *subobtectum* (Stoliczka, 1864); Wright and Kennedy, p. 95, pl. 12, fig. 5; text-fig. 11h, i (with additional synonymy).
2008. *Forbesiceras* cf. *subobtectum* (Stoliczka, 1864); Kennedy and Klinger, p. 125, pl. 2, figs 1–7.

MATERIAL: OUM KX14980, from bed 5; 15180, from beds 3–7; 15090, from bed 7; 13620, from bed 9.

REMARKS: OUM KX 13822 (Pl. 2, Fig. 11) is a 90° sector of phragmocone with a maximum preserved whorl height of 70 mm. There are five narrow distant straight prorsiradiate ribs on the inner half of the flanks, each of which links to a well-developed tear-shaped mid-lateral bulla. A smooth zone separates the bullae from twice as many convex, strongly rursiradiate outer flank ribs that expand across the flanks and terminate in well-developed ventral clavi. The venter of the specimen is worn. OUM KX14980 (Pl. 4, Fig. 5) is an adult 180 mm in diameter, the last few septa approximated, retaining a 180° sector of body chamber. The flank ornament of the phragmocone is as in the previous specimen. The venter is well-preserved, with a strong siphonal ridge. There are crowded delicate convex ribs that link the clavi across the venter, and intercalate between. The ribs coarsen and broaden on the flank of the adapical half of the body chamber, the lateral bullae effacing, while the delicate transverse ventral ribbing is lost. On the adapical 90° sector of the body chamber ornament is lost, and the venter rounds.

The phragmocone ornament of these specimens differ in no significant respects from that of the holotype and the poorly preserved example from Madagascar figured by Collignon (1964, pl. 335).

OCCURRENCE: Known with certainty only from South India, Madagascar, and, now, northeastern Algeria, where it is firmly dated as lower Middle Cenomanian. There are also doubtful records from southern England and northern KwaZulu-Natal in South Africa.

*Forbesiceras reversum* sp. nov.
(Pl. 3, Figs 6–8; Pl. 5, Figs 1, 2)

TYPES: The holotype is OUM KX14978 (Pl. 3, Figs 6–8) from bed 5; paratype OUM KX15171 (Pl. 5, Figs 1, 2) is from beds 3–7.

DIAGNOSIS: A species of *Forbesiceras* in which the ribs are convex and strongly rursiradiate on the inner half of the flank and straight and feebly prorsiradiate on the outer half, linking to tiny ventrolateral clavi. Venter with feeble siphonal ridge. Ventrolateral clavi linked across venter by single straight transverse ribs with a slightly larger transversely elongated siphonal tubercle.

REMARKS: There is little to add to the diagnosis. The holotype (Pl. 3, Figs 6–8) is a wholly septate internal mould with an estimated maximum preserved whorl height of 56 mm. The outer flank ribbing is fine on the adapical half of the fragment, but thereafter coarsens progressively. The wholly septate paratype (Pl. 5, Figs 1, 2) has, in contrast, fine, evenly developed outer flank ribbing throughout.

*Forbesiceras reversum* sp. nov. differs from all other described *Forbesiceras* species in having convex rursiradiate ribs on the inner flank and straight prorsiradiate ribs on the outer flank, the opposite arrangement to that seen in *Forbesiceras obtectum, F. subobtectum*, and *F. bicarinatum* Szász, 1976 (p. 170, pl. 1; pl. 2; pl. 3, figs 1,2; text-figs 1, 2; see revision in Wright and Kennedy 1984, p. 96, pl. 14, figs 3–6; pl. 15, fig. 3; pl. 16, figs 1, 3, 4).

OCCURRENCE: As for types.

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* sp. juv., cf. *mantelli* (J. Sowerby, 1814)
(Pl. 5, Figs 5, 6)

Compare:
1814. *Ammonites mantelli* J. Sowerby, p. 119, pl. 55, lower figure only.
1984. *Mantelliceras mantelli* (J. Sowerby, 1814); Wright and Kennedy, p. 99, pl. 16, fig. 5; pl. 17, figs 1, 3; pl. 18, figs 1–3; pl. 19, figs 1–6; pl. 21, figs 1, 2, 4; pl. 24, fig. 3; pl. 36, fig. 1; text-figs 20a–d, 26a, c, e, 28a–e (with full synonymy).
1998. *Mantelliceras mantelli* (J. Sowerby, 1814); Kaplan *et al*., p. 115, pl. 11, figs 1, 2; pl. 17, figs 12, 13; pl. 19, figs 1–9; pl. 22, figs 3, 4; pl. 23, fig. 8; pl. 24, figs 4–6; pl. 25, figs 1–5 (with additional synonymy).
2014. *Mantelliceras mantelli* (J. Sowerby, 1814); Kennedy *et al*., p. 634, pl. 2, figs 1–7; pl. 3, figs 1–5 (with additional synonymy).

2015. *Mantelliceras mantelli* (J. Sowerby, 1814); Kennedy *et al*., p. 2, text-figs 1a–g; 2c–h, k, l; 3d–k, n, o.
2015. *Mantelliceras mantelli* (J. Sowerby, 1814); Kennedy in Kennedy and Gale, p. 264, pl. 7, fig. 3; pl. 8, figs 1, 5.

MATERIAL: OUM KX14920, from bed 1.

REMARKS: The specimen is a half whorl with a maximum preserved diameter of 28.6 mm. It is compared to *M. mantelli* on the basis of the polygonal whorl section, fine crowded ribbing, the primary ribs with umbilical, lateral, inner and outer ventrolateral tubercles, separated by up to three intercalated ribs, the longer with lateral, inner and outer ventrolateral tubercles, the shorter with inner and outer ventrolateral tubercles only.

OCCURRENCE: Commonest in the *Mantelliceras mantelli* Zone of the Lower Cenomanian, but extending into the succeeding *Mantelliceras dixoni* Zone. The species ranges from England to Northern Ireland, France, Germany, Russia, Iran, Kazakhstan, Morocco, Algeria, Tunisia, KwaZulu-Natal in South Africa, Madagascar, southern India, and Japan.

*Mantelliceras lymense* (Spath, 1926a)
(Pl. 1, Figs 12, 13, 15, 16)

1926a. *Eucalycoceras lymense* Spath, p. 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 full synonymy).
2011. *Mantelliceras lymense* (Spath, 1926); Mosavina and Wilmsen, p. 182, text-figs 4d, e (with additional synonymy).
2015. *Mantelliceras lymense* (Spath, 1926); Kennedy in Kennedy and Gale, p. 265, pl. 3, fig. 1; pl. 7, figs, 6; pl. 8, figs 2, 6; pl. 23, fig. 2; text-fig. 14.

MATERIAL: OUM KX14916–7, from bed 1; 15014 from bed 2.

REMARKS: Fragments have whorl heights of 22–27 mm, the whorl section as wide as high or slightly compressed, the inner to middle flanks feebly convex, the outer flanks converging to the broadly rounded ventrolateral shoulders and broad, feebly convex venter. Narrow primary ribs bear small bullae, and are straight and prorsiradiate on the inner to middle flanks, flexing forwards and very feebly concave on the outermost flanks, and crossing the venter in the feeblest of convexities. The primary ribs are separated by one, occasionally two intercalated ribs. The dorsum of OUM KX15014 (Pl. 1, Figs 15, 16) reveals the presence of minute ventrolateral tubercles on the penultimate whorl of the fragment. These specimens match closely with the ontogenetic stage shown by some *Mantelliceras lymense* that lack ventral tubercles, as is the case with the lectotype (Pervinquière 1907, pl. 16, fig. 16) from north of Bargou in Central Tunisia, and comparable specimens from southern England (Wright and Kennedy 1984, pl. 23, figs 1–3). The venter of the penultimate whorl of OUM KX15014 corresponds to that of an individual of the same size figured by Wright and Kennedy (1984, pl. 22, fig. 4).

OCCURRENCE: Lower Cenomanian, *Mantelliceras mantelli* and *Mantelliceras dixoni* Zones, southern England, Northern Ireland, France from the Boulonnais south to Bouches-du-Rhône, Algeria, Tunisia, Madagascar, and possibly Germany and Iran.

*Mantelliceras* cf. *dixoni* Spath, 1926a
(Pl. 1, Figs 5, 6; Pl. 5, Figs 3, 4)

Compare:
1926a. *Mantelliceras dixoni* Spath, p. 427, 430.
1984. *Mantelliceras dixoni* Spath, 1926b; Wright and Kennedy, p. 124, pl. 37, figs 1–6; pl. 38, figs 2–5; pl. 39, figs 2–5; pl. 40, figs 1–5; text-figs 21d–f; 22a–g; 23; 25e, j; 27m, r, s (with full synonymy).
1998. *Mantelliceras dixoni* Spath, 1926b; Kaplan *et al*., p. 122, pl. 20, figs 4, 5; pl. 23, figs 1–7; pl. 24, figs 7–9; pl. 54, fig. 2 (with additional synonymy).
2013. *Mantelliceras dixoni* Spath, 1926; Kennedy *et al*., p. 639, l. 4, figs 1, 2; text-fig. 5.

MATERIAL: OUM KX14918, from bed 1; 13612–3, recorded as from bed 9, although this is questionable, as noted above.

REMARKS: OUM KX14918 (Pl. 5, Figs 3, 4) is a 60° sector of body chamber with a maximum preserved whorl height of 38 mm approximately. Parts of seven ribs are preserved on the fragment. All of the ribs are primaries, arising at the umbilical seam, sweeping back across the umbilical wall, and strengthening into small bullae perched on the umbilical shoulder. A strong, coarse, radial rib links to a stronger inner lateral tubercle, from which a straight, progressively strengthening rib links to a strong outer ventrolateral tubercle. The tubercles are linked across the venter by a strong, transverse rib. This fragment compares well with the original of Wright and Kennedy 1984, pl. 38, fig. 2.

OUM KX 13613 (Pl. 1, Figs 5, 6) is a 120° sector of body chamber with a maximum preserved whorl height of 28.7 mm. The flanks are feebly convex, the outer flanks converging to broadly rounded ventrolateral shoulders and a feebly convex venter. The costal whorl breadth to height ratio is 0.76, the greatest breadth at the inner lateral tubercles. There are nine ribs on the fragment; primary ribs bear weak umbilical and stronger inner lateral tubercles, the tubercles linked by a strong, straight rib. The ribs coarsen across the flanks, and link to a blunt inner, and a stronger, rounded to feebly clavate outer ventrolateral tubercle, the tubercles linked across the venter by a coarse, weak rib. One or two ribs intercalate around mid-flank, and have a comparable development to the primary ribs on outer flank and venter. The specimen compares well with the original of Wright and Kennedy 1984, pl. 38, fig. 4. OUM KX13612 is a worn fragment of body chamber with a maximum preserved whorl height of 29 mm, lacking an inner lateral tubercle.

Whorl section, the presence of umbilical and inner lateral tubercles linked by a strong rib, weak to effaced inner, and strong outer ventrolateral tubercles all suggest comparison with *M. dixoni*.

OCCURRENCE: *Mantelliceras dixoni* is restricted to the upper Lower Cenomanian *dixoni* Zone of southern England, the Boulonnais, Haute Normandie, Sarthe, Jura, Basses-Alpes, and Bouches-du-Rhône in France, Germany, Switzerland, Romania, Iran north of the Zagros (?), northern Mexico, El Salvador and Madagascar. The record of *M.* cf. *dixoni* from beds 1 and bed 2 is compatible with this; the record from bed 9 if correct, would indicate an extension into the lower Middle Cenomanian *Cunningtoniceras inerme* Zone.

Genus *Sharpeiceras* Hyatt, 1903

TYPE SPECIES: *Ammonites laticlavius* Sharpe, 1855, p. 31, pl. 14, fig. 1, by the original designation of Hyatt, 1903, p. 111.

*Sharpeiceras* sp.

MATERIAL: OUM KX14915, from bed 1.

REMARKS: The specimen is a fragment of the flank and venter of a large body chamber, the whorl height 110 mm as preserved, and in excess of 120 mm when complete. Parts of two ribs are present, the most complete with a coarse lateral bulla and ventrolateral horn. There is no doubt as to the generic identity of the fragment, but it is specifically indeterminate. *Sharpeiceras* has its acme in the middle of the Lower Cenomanian *Mantelliceras mantelli* Zone, but extends as high as the *Mantelliceras dixoni* Zone in southern England (*S. laticlavium*; BMNH C77706, collected by W.J.K. and the late J.M. Hancock above Gore Cliff in the Isle of Wight).

Subfamily Acanthoceratinae de Grossouvre, 1894
Genus *Acompsoceras* Hyatt, 1903

TYPE SPECIES: *Ammonites bochumensis* Schlüter, 1871, p. 1, pl. 1, figs. 1–4, by original designation by Hyatt, 1903, p. 111 = *Ammonites renevieri* Sharpe, 1857, p. 44, pl. 20, fig. 2.

*Acompsoceras renevieri* (Sharpe, 1857)
(Pl. 5, Figs 7–14)

1857. *Ammonites Renevieri* Sharpe, p. 44, pl. 20, fig. 2.
1987. *Acompsoceras renevieri* (Sharpe, 1857); Wright and Kennedy, p. 140, pl. 43, fig. 2; text-figs 34g; 35d–f; 36a–f; 37–40; 43d, e (with full synonymy).
1998. *Acompsoceras renevierii* (Sharpe, 1857); Kaplan *et al*., p. 136, pl. 10, figs 6, 7; pl. 34; pl. 35; pl. 36, figs 1–3, pl. 37, figs 4–6; pl. 38; pl. 40; pl. 41, figs 1, 5 (with additional synonymy).
2013. *Acompsoceras renevieri* (Sharpe, 1857); Wilmsen *et al*., p. 504, text-fig. 9a–e.
2013. *Acompsoceras renevieri* (Sharpe, 1857); Kennedy *et al*., p. 634, pl. 5, figs 4, 5.
2014. *Acompsoceras renevieri* (Sharpe, 1857); Walaszczyk *et al*., p. 108, text-fig. 24i, j.
2015. *Acompsoceras renevieri* (Sharpe, 1857); Kennedy in Kennedy and Gale, p. 279, pl. 12, figs 1–3, 5–7; pl. 13, figs 1, 4, 5.

MATERIAL: OUM KX14873–14908, from bed 1; 14957, from bed 3; 15181, from beds 3–7; 15104–05, 15165–68 from bed 7; 13601–6, from bed 9; 13639–40, from beds 11–13.

DISCUSSION: *Acompsoceras renevieri* is one of the commonest ammonites in the present collection. Phragmocone fragments have whorl heights of up to an estimated 120 mm. The species is highly variable. OUM KX13640 (Pl. 5, Figs 7, 8) and 14898 (Pl. 5, Figs 9, 10) are feebly ornamented variants with tiny umbilical bullae and feeble flank ribs that link to small ventral clavi. Larger fragments (OUM KX3603) are entirely smooth. Coarsely ribbed juveniles (OUM

KX13607-8 Pl. 5, Figs 11–14), have strong umbilical bullae that gives to ribs either singly or in pairs, with additional ribs intercalating, all ribs with coarse ventral clavi. There is a feeble siphonal ridge.

OCCURRENCE: Lower Cenomanian, *M. dixoni* Zone, and lower Middle Cenomanian *C. inerme* Zone. The geographic distribution extends from southern England to Germany, Haute Normandie, Sarthe, and Provence in France, Poland, Algeria, central Tunisia, Nigeria (?), and Madagascar.

## Genus *Acanthoceras* Neumayr, 1875

TYPE SPECIES: *Ammonites rhotomagensis* Brongniart, 1822, pp. 83, 391, pl. 6, fig. 2, by the subsequent designation of de Grossouvre, 1894, p. 27.

### *Acanthoceras rhotomagense* (Brongniart, 1822) (Pl. 6, Figs 1–3, 8–13)

1822. *Ammonites rhotomagensis* Defr.; Brongniart, p. 83, 391, pl. 6, fig. 2.
1987. *Acanthoceras rhotomagense* (Brongniart, 1822); Wright and Kennedy, p. 156, pl. 42, fig. 8; pl. 44, figs. 1–11; pl. 45, figs 1–5; pl. 46, figs 1–4, 6, pl. 47, figs 1, 2, pl. 48, figs 1, 2, pl. 49, figs 1, 5, 6, text-figs 47–54, 63f–j, 64a, b, 65a–d, k, 66a, f, g, j, 67a–g, 68; 69 (with full synonymy).
1998. *Acanthoceras rhotomagense* (Brongiart, 1822); Kaplan *et al.*, p. 140, pl. 41, fig. 3, pl. 42, figs 1, 2; pls 43–46; pl. 47, figs 1–3; pl. 54, figs 1, 3, 4 (with additional synonymy).
2011. *Acanthoceras rhotomagense* (Brongiart, 1822); Mosavina and Wilmsen, p. 184, figs 6a, b, 7a, b (with additional synonymy).
2015. *Acanthoceras rhotomagense* (Brongniart, 1822); Kennedy in Kennedy and Gale, p. 283, pl. 14, figs 5, 6; pl. 16, figs 8, 9.

MATERIAL: OUM KX15365, 15367–9 (cf.), from beds 3–7; 13536–43, from bed 9; 13629, from bed 10; 13747, 13771, from bed 12; 13675–66, 13679–81, from beds 11–13; 13835, from bed 13 or above 13924–28, bed 15.

DESCRIPTION: The present material includes nuclei as little as 29 mm in diameter and fragments of phragmocone with whorl heights of up to 43 mm. The smallest specimens seen (OUM KX13680; OUM KX13928: Pl. 6, Figs 1–3) have up to 20 ribs per whorl, strong, straight prorsiradiate primary ribs with small umbilical bullae, inner ventrolateral tubercles that are rounded in compressed, feebly ornamented individuals and subspinose in more inflated ones, linked by a coarse feebly prorsiradiate rib to strong outer ventrolateral clavi, linked across the venter by a transverse rib to a subequal siphonal tubercle. Primary ribs are separated by single long or short intercalated ribs, the longer reaching almost to the umbilical shoulder, all with a comparable ventrolateral ornament as the primaries. This alternation of primary and intercalated ribs extends to diameters of around 40 mm in depressed, strongly ornamented individuals. Larger fragments have whorl breadth to height ratios of up to 1.27. In individuals such as OUM KX13925 (Pl. 6, Figs 8, 9), the ribs are weak and crowded, with intercalated ribs persisting, the umbilical bullae feeble, inner ventrolateral tubercles bullate, outer ventrolaterals feeble, and the siphonal row effaced. In more robustly ornamented individuals, (OUM KX13924; Pl. 6, figs 10, 11) umbilical bulla are strong, the inner ventrolateral tubercles conical.

REMARKS: The present material differs in no significant respects from the variable material from Western Europe described by previous authors. Nuclei of *Cunningtoniceras inerme* (Pervinquière, 1907) show the appearance of intercalated ventral ribs between outer ventrolateral clavi that are linked across the venter by a pair of ribs with siphonal clavi at diameters between 29 mm (OUM KX15341; Pl. 7, Figs 1–3) and 33.5 mm (OUM KX15344 (Pl. 6, Figs 6, 7), while intercalated ribs generally disappear on nuclei of *inerme* at a diameter where they are still present in *rhotomagense*.

OCCURRENCE**:** Lower Middle Cenomanian; index of the *rhotomagense* Zone. The species occurs in Western Europe from Northern Ireland through England, France from the Boulonnais to Provence, Switzerland, Germany, Bornholm in the Baltic, northern Spain, Romania, Dagestan, Turkmenistan and northern Iran, Algeria, Tunisia, and possibly Peru and Bathurst Island, northern Australia.

## Genus *Cunningtoniceras* Collignon, 1937

TYPE SPECIES: *Ammonites cunningtoni* Sharpe, 1855, p. 35, pl. 15, fig. 2; by the original designation of Collignon 1937, p. 64 (40).

### *Cunningtoniceras inerme* (Pervinquière, 1907) (PL. 6, Figs 4–7; Pl. 7, Figs 1–11; Pl. 8, Figs 1, 2, 5, 6; Pl. 9, Figs 1, 2, 5, 6)

1855. *Ammonites sussexiensis* Mantell; Sharpe, p. 34, pl. 15, fig. 1.
1907. *Acanthoceras Cunningtoni* var. *inermis* Pervinquière, p. 277.
1987. *Cunningtoniceras inerme* (Pervinquière, 1907); Wright and Kennedy, p. 194, pl. 52, fig. 1; pl. 53, fig. 6; text-figs 74, 75, 79 (with full synonymy).
1998. *Cunningtoniceras inerme* (Pervinquière, 1907); Kaplan *et al*., p. 148, pl. 48, figs 1, 2; pl. 55, figs 1–5; pl. 56, figs 1–4 (with additional synonymy).
2015. *Cunningtoniceras inerme* (Pervinquière, 1907); Kennedy in Kennedy and Gale, p. 284, pl. 14, fig. 4; pl. 15, fig. 4; pl. 16, fig. 7; pl. 17, fig. 1; pl. 20, fig. 1 (with additional synonymy).

MATERIAL: OUM KX14988, 14992-94, 14996-98, from bed 5; 15249, 15251, 15255, 15261, 15281, 15284-5, 15289, 15303, 15307, 15310, 15313, 15317-18, 15326, 15330-38 (cf.) 15339-49 15362, 15364, from beds 3-7; 15057, 15062-64 (cf.), 15066, 15100-2, from bed 7; 13532, 13535 (cf.), from bed 9; 13745-46, from bed 12.

DESCRIPTION: The present material provides new information on the development and dimorphism of the species. OUM KX 15341, 15344, and 15371 (Pl. 6, Figs 4–7; Pl. 7, Figs 1–3) are typical nuclei, 14–17 mm in diameter. The intercostal whorl section is depressed oval, the costal whorl section depressed polygonal, with the greatest whorl breadth at the umbilical bullae. In the earliest growth stages seen, strong, straight, prorsiradiate primary ribs have strong umbilical bullae, strong, conical to subspinose inner ventrolateral tubercles, linked by a broad, feebly prorsiradiate rib to strong outer ventrolateral clavi, linked across the venter by a low, broad, transverse rib to a strong siphonal clavus. Single intercalated ribs, which disappear at an early stage, have a comparable ventrolateral and ventral tuberculation. At diameters as small as 19 mm, the outer ventrolateral clavi are associated with a pair of ribs, with small rounded siphonal tubercles, and an intercalated rib appears on the venter, separating successive outer ventrolateral clavi and their associated siphonal tubercles.

Fragments such as OUM KX14955 continue the phragmocone ontogeny. Relatively weak umbilical bullae give rise to very feeble ribs that expand across the flanks and link to strong inner ventral spines. OUM KX14981 (Pl. 9, Figs 5, 6) is a slightly distorted juvenile with a maximum preserved diameter of 90 mm, retaining a 120° sector of body chamber. There are 10 primary ribs on the adapertural half whorl, arising at the umbilical seam and strengthening into variable but generally weak umbilical bullae. A straight, prorsiradiate, progressively strengthening rib links to a conical inner ventrolateral tubercle, from which a low, broad, triangular rib links to a well-developed outer ventrolateral clavus. A pair of ribs, the adapical feebly concave, the adapertural transverse, link the clavi across the venter, and bear a feeble siphonal tubercle. Single transverse ventral ribs intercalate between the outer ventrolateral clavi and are restricted to the venter, with a blunt siphonal tubercle on the phragmocone that effaces progressively on the body chamber. OUM KX15284/15364 (Pl. 7, Figs 8, 9; two fragments of the same specimen) is a180° sector of body chamber with a rounded-rectangular intercostal whorl section and a polygonal costal section. There are 10 primary ribs that arise at the umbilical seam, sweep forwards and strengthen across the umbilical wall into umbilical bullae, well developed at the adapical end of the fragment, but weakening and effacing at the adapertural end. They give rise to narrow, straight, prorsirdiate ribs that link to strong conical inner ventrolateral tubercles, in turn linked by a strong rib to a strong outer ventrolateral clavus. At the adapical end of the fragment, a pair of ribs link the clavi across the venter, with a single ventral rib intercalating, the ribs with feeble siphonal clavi. This style of ventral ornament is succeeded by the development of a low, blunt siphonal ridge, strengthened into blunt siphonal clavi between the outer ventrolateral clavi of the primary ribs. Occasional additional tubercles are briefly present before being lost. There are a number of comparable body chamber fragments (OUM KX14009: Pl. 8, Figs 1, 2; 15307; 14987; Pl. 7, Figs 6, 7; 14994) that show the same ornament of primary ribs with umbilical, inner and outer ventrolateral and siphonal tubercles, with traces of a siphonal ridge in some, and intercalated ribs in the smallest (OUM KX14987 (Pl. 7, Fig. 6). These specimens are interpreted as fragments of macroconchs. OUM KX15102 (Pl. 7, Figs 10, 11), a 120° whorl sector of body chamber, has comparable ornament to these large fragments, but with a maximum preserved whorl height of only 25.5 mm; it is interpreted as a microconch.

REMARKS: The larger fragments in the present collection overlap in size with, and differ in no significant respects from the larger, but indifferently preserved holotype (Wright and Kennedy, 1987, pl. 52, fig. 1; text-fig. 74). The individual interpreted as a microconch (OUM KX15102) corresponds to the holotype of *Acanthoceras* (*Acanthoceras*) *vergonsense* Thomel, 1972 (p. 158, pl. 79, figs 5–7; see Wright and Kennedy 1987, text-fig. 46a–c) which we also interpret as an adult microconch.

Small phragmocones of *Cunningtoniceras inerme* are readily distinguished from those of co-occurring

*Cunningtonicers africanum* (Pervinquière, 1907) (compare Pl. 6, Figs 4–7; Pl. 7, Figs 1–3 and Pl. 9, Figs 1, 2, with Pl. 9, Figs 3, 4, 7, 8 and Pl. 10, Figs 1–4, 8, 9) , which have a very depressed, reniform intercostal whorl section , the outer ventrolateral tubercles conical rather than clavate, the mid-venter elevated into a distinctive siphonal ridge. Pairs of ribs loop between the outer ventrolateral tubercles, and a single additional rib intercalates, the siphonal tubercles transversely elongated, and reducing and effacing to producing a ventral ornament of dense even ribs with feeble to effacing siphonal tubercles. Inner and outer ventrolateral tubercles merge into horns on the adapical part of adult phragmocones, with as few as six ribs per half whorl, the multiple ventral ribbing persisting on the adapical part, the horns linked across the venter by two or three looped ribs, with additional ribs intercalating between (as in the lectotype: Pervinquière 1907, pl. 15, fig. 3; Kennedy and Gale 2015, pl. 15, fig. 5), until ultimately replaced by primary ribs only, as in the paralectotype (Pervinquière 1907, pl. 15, fig. 4). In contrast, *Cunnningtoniceras inerme* is characterised, when adult, by the rectangular costal whorl section, the reversion to a simple, *Acanthoceras*-like style of ribbbing and tuberculation, with primary ribs only with umbilical, inner and outer ventrolateral and siphonal tubercles on the adapical part of the adult body chamber, the ventrolateral and siphonal tubercles weakening or effacing on the adapertural part.

*Cunningtoniceras inerme* differs from the type species, *C. cunningtoni* (see revision in Wright and Kennedy 1987, p. 196, pl. 52, fig. 2; pl. 53, fig. 4; text-figs 76–78) in its a more quadrate whorl section, lower expansion rate, more numerous primary ribs (up to 20 per whorl), less exaggerated ventrolateral tuberculation, not developing massive horns, and more numerous ventral riblets and siphonal tubercles .

OCCURRENCE: Lower Middle Cenomanian, index of the *inerme* Zone. The species is known from southern England, Sarthe and Provence in France, Switzerland, Germany, Turkmenistan, Morocco, northeastern Algeria, Central Tunisia, Hokkaido, Japan, and Texas in the United States.

*Cunningtoniceras africanum* (Pervinquière, 1907)
(Pl. 8, Figs 3, 4; Pl. 9, Figs 3, 4, 7–10; Pl. 10, Figs 1–11)

1903. *Acanthoceras cunningtoni* Sharpe; Perinquière, p. 67.
1907. *Acanthoceras meridionale* Stoliczka var. *Africana* Perinquière, p. 279 (*pars*), pl. 15, figs 3, 4 (*non* 2, = *Lotzeites elegans* Kennedy, 2015), text-fig. 106.
1907. *Acanthoceras cunningtoni* Sharpe; Pervinquière, p. 277, pl. 15, fig. 1.
1987. *Cunningtoniceras* sp. Wright and Kennedy, p. 195, pl. 53, figs 5, 7.
2015. *Cunningtoniceras africanum* (Pervinquière, 1907); Kennedy in Kennedy and Gale, p. 287, pl. 15, figs 2, 4, 5, 6; pl. 16, figs 4, 6; pl. 17, fig. 2; text-figs 23, 24.

TYPES: The lectotype, by the subsequent designation of Kennedy (in Kennedy and Gale, 2015, p. 287), is an unregistered specimen in the Sorbonne Collections, *ex* Flick Collection, the original of Pervinquière 1907, pl. 15, fig. 3, from Kef Si Abd el Kader, Djebel Mrhila, Central Tunisia (Kennedy and Gale 2015, pl. 15, fig. 5).There are two figured paralectotypes, the original of Pervinquière 1907, pl. 15, fig. 4 (Kennedy and Gale 2015, pl. 15, fig. 6), and the original of his pl. 15, fig. 2 (Kennedy and Gale 2015, pl. 16, fig. 3) the latter the holotype of *Lotzeites elegans* Kennedy, 2015, in the same collections and from Foum el Guelta, Central Tunisia.

MATERIAL: OUM KX14952-55, from bed 3; 14982-84, 14986, 14989, 14990 (cf.), 14991, 14995, 14998, from bed 5;15227-38, 15240-45 15252-54, 15256-60, 15262-69, 15271-73, 15276, 15278, 15283, 15287-88, 15290-98, 15300, 15305 (cf.), 15308-9, 15311 (cf.), 15316, 15321-24, 15340, 15350-52, 15359-60 (cf.),15361, from beds 3-7;15055-15056 (cf.), 15058-59, 15061 (cf.) 15096-15098, 15103, 15106, from bed 7; 13525-26, 13528, from bed 9; 13509-12, from beds 3–9.

DESCRIPTION: The abundant specimens in the present collections clarify the interpretation of this species. Well-preserved fragments of phragmocone have a very depressed rounded-rectangular whorl section, with whorl breadth to height ratios of up to 1.4. The costal whorl section is rounded-polygonal with a raised mid-venter, the greatest breadth at the inner ventrolateral tubercles. There are six primary ribs per half whorl that arise at the umbilical seam and are narrow and widely separated on the umbilical wall, which they pass straight across, and strengthen into well-developed long umbilical bullae that give rise to strong, feebly prorsiradiate primary ribs that link to inner ventrolateral spines, damaged in most specimens. A feeble, broad transverse rib links to a conical to feebly clavate outer ventrolateral tubercle. A pair of narrow ribs link these tubercles across the venter, and strengthen into a much weaker, transversely elongated siphonal tubercle. Single ribs intercalate, with a comparable siphonal tubercle. As size increases, the mid-venter is marked by a distinct siphonal ridge, and the siphonal tubercles may weaken. OUM KX15296 (Pl.

10, Figs 10, 11) is a 100° sector of body chamber with a maximum preserved whorl height of 44.5 mm and an intercostal whorl breadth to height ratio of 1.2. Three widely separate primary ribs, and part of a fourth rib are preserved. There are strong umbilical bullae. The inner and outer ventrolateral tubercles of the phragmocone are replaced by a ventrolateral horn. The mid-ventral ridge bears a total of 16 short transverse ribs, strengthened at mid-venter into poorly differentiated transversely elongated tubercles. OUM KX15291 (Pl. 10, Figs 6, 7), a fragment with a slightly smaller maximum preserved whorl height, shows the partial fusion of inner and outer ventrolateral tubercles. OUM KX15232 (Pl. 9, Figs 9, 10) is a slightly larger 120° fragment from the adapical end of the body chamber. Four ribs are preserved, with umbilical and ventrolateral tuberculation as in the previous specimen, the ventrolateral horns here linked by two or three looped ribs, the specimen thus corresponding closely to the lectotype. These large fragments are interpreted as parts of macroconchs. OUM KX14982 (Pl. 10, Fig. 5) is interpreted as an adult microconch, with a 240° sector of body chamber. The final sector of the phragmocone has the distinctive ventral ribbing of other phragmocone fragments, while the body chamber bears widely separated primary ribs with strong umbilical bullae and massive ventrolateral horns; the ventral ornament is not preserved. OUM KX15059 is also a microconch, with at least a 90° sector of body chamber preserved. The adapertural sector of the phragmocone has the characteristic crowded ventral ribbing noted above, and several of the ventrolateral spines well-preserved.

DISCUSSION: Differences from other species of *Cunningtoniceras* are discussed by Kennedy (in Kennedy and Gale 2015, p. 290) to whom reference should be made.

OCCURRENCE: Lower Middle Cenomanian, Central Tunisia, adjacent parts of eastern Algeria, New Guinea, and Devon, England.

## Genus and Subgenus *Calycoceras* Hyatt, 1900
(ICZN Generic Name No. 1352)

TYPE SPECIES: By designation under the Plenary Powers (ICZN Opinion No. 557) *Ammonites naviculari*s Mantell, 1822, p. 198, pl. 22, fig. 5 (ICZN Specific Name No. 1633).

Subgenus *Calycoceras* (*Gentoniceras*) Thomel, 1972
TYPE SPECIES: *Ammonites gentoni* Brongniart, 1822, pp. 83, 392, pl. 6, fig. 6 from the lower Middle Cenomanian of Rouen, Seine-Maritime, France, by original designation by Thomel, 1972, p. 65.

### *Calycoceras* (*Gentoniceras*) cf. *gentoni* (Brongniart, 1822)
(Pl. 11, Figs 1, 2)

Compare;

1822. *Ammonites gentoni* Brongniart, p. 83, 392, pl. 6, fig. 6.
1926b. *Eucalycoceras subgentoni* Spath, p. 83.
1990. *Calycoceras* (*Gentoniceras) gentoni* (Brongniart, 1822); Wright and Kennedy, p. 219, pl. 56, figs 1–3, 6–8; pl. 57, figs 2, 3, 8; pl. 58, fig. 7; pl. 66, figs 1, 2; text-figs 88a, c; 89a, b; 90a–c (with synonymy).
1990. *Calycoceras* (*Gentoniceras*) *subgentoni* (Spath, 1926a); Wright and Kennedy, p. 226, pl. 56, figs 4, 5; pl. 57, fig. 4; pl. 58, figs 5, 6; pl. 59, figs 1–4; text-figs 88k; 90d–f (with synonymy).
1994. *Calycoceras* (*Gentoniceras*) *gentoni* (Brongniart, 1822); Kennedy and Juignet, p. 30, figs 1a; 2d, e; 6d, e, j, k; 7a–l; 8a–e; 22a, b.
1998. C*alycoceras* (*Gentoniceras*) *gentoni* (Brongniart, 1822); Kaplan *et al*., p. 156, pl. 26, figs 3–5.
2010. *Calycoceras* (*Gentoniceras*) *gentoni* (Brongniart, 1822); Kennedy and Klinger, p. 9, text-fig. 31.
2015. *Calycoceras* (*Gentoniceras*) cf. *gentoni* (Brongniart, 1822); Kennedy in Kennnedy and Gale, p. 294, pl. 10, fig. 6; pl. 22, fig. 1.

MATERIAL: OUM KX13743, from bed 12; 13657, from beds 11–13.

REMARKS: OUM KX13743 is 120° sector of phragmocone with a maximum preserved whorl height of 25.3 mm. Coiling is evolute, the umbilicus of moderate depth, the umbilical wall feebly convex, the umbilical shoulder broadly rounded, the intercostal whorl section slightly depressed, reniform. Primary ribs arise on the umbilical wall and strengthen across the shoulder into very feeble bullae. These give rise to primary ribs, straight and feebly prorsiradiate on the inner flank, flexing forwards and feebly convex on the outermost flank and ventrolateral shoulder, and crossing the venter in a very feeble convexity. One, occasionally two long or short ribs intercalate, and strengthen to match the primaries on the ventrolateral shoulders and across the venter. OUM KX13657 is a smaller, but comparable fragment.

The present interpretation follows that of Kennedy and Juignet (1994, p. 30) who regarded *gentoni* of Brongniart and *subgentoni* of Spath as synonyms. The

specimen finds a match in specimens from southern England, such as the holotype of *C.* (*G.*) *subgentoni* (Wright and Kennedy, 1990, pl. 58, fig. 5).

OCCURRENCE: *C.* (*G.*) *gentoni* ranges from lower Middle to lower Upper Cenomanian. There are records from southern England, Haute-Normandie, Sarthe and Provence in France, Spain, the Münster Basin in Germany, northern KwaZulu-Natal in South Africa and, possibly, northeastern Algeria, Central Tunisia, and Iran.

Subgenus *Calycoceras* (*Newboldiceras*) Thomel, 1972

TYPE SPECIES: *Acanthoceras newboldi* Kossmat, 1897, p. 5(112), pl. 1 (12), figs 2, 3; pl. 3 (14), fig. 2, by original designation by Thomel 1972, p. 105 = *Acanthoceras rhotomagense* var. *asiatica* Jimbo, 1894, p. 177, pl. 20, fig. 1 (*fide* Wright and Kennedy 1990, p. 239).

*Calycoceras* (*Newboldiceras*) *asiaticum asiaticum*
(Jimbo, 1894)
(Pl. 11, Figs 5, 6)

1894 *Acanthoceras rhotomagense* var. *asiatica* Jimbo, p. 177, pl. 20, fig. 1.
1990. *Calycoceras* (*Newboldiceras*) *asiaticum asiaticum* (Jimbo, 1894); Wright and Kennedy, p. 239, pl. 58, fig. 1; pl. 64, figs 1, 2; pl. 65, figs 1–3, 5, 7; pl. 72, fig. 3; text-figs 87a–c, 88f; 97, 98 (with full synonymy).
2010. *Calycoceras* (*Newboldiceras*) *asiaticum asiaticum* (Jimbo, 1894); Kennedy and Klinger, p. 11, figs 32, 33a–f, 34j–l, p, q, 36–38, 44d, e, h, 57a–f (with additional synonymy).
2014. *Calycoceras* (*Newboldiceras*) *asiaticum asiaticum* (Jimbo, 1894); Kennedy and Bilotte, p. 24, text-figs 4d–f, 6j.
2015. *Calycoceras* (*Newboldiceras*) *asiaticum asiaticum* (Jimbo, 1894); Kennedy in Kennedy and Gale, p. 295, pl. 10, fig. 9; pl. 20, fig. 6; pl. 23, fig. 3.

TYPE: The holotype by monotypy is the original of Jimbo, 1894, pl. 20, fig. 1, no. 1–105 in the Collections of the Geological Institute, Tokyo University, from the Middle Cenomanian *Trigonia* Sandstone of the Ikushumbets, Hokkaido, Japan.

MATERIAL: OUM KX13907, from bed 15.

REMARKS: The specimen is a 200° sector of phragmocone with a maximum diameter of 55 mm approximately. The whorl section is depressed, and polygonal in costal section. There are 17–18 ribs per whorl. Relatively narrow, straight, prorsiradiate primary ribs bear small umbilical bullae, rounded inner ventrolateral tubercles and outer ventrolateral and siphonal clavi. One or two long or short ribs intercalate between successive primaries, with a comparable ventrolateral and ventral development of tubercles as the primary ribs. The specimen closely resembles the specimen from Djebel Bireno in Central Tunisia figured by Pervinquière 1907 (pl. 13, fig. 1; see also Kennedy and Gale 2015, pl. 23, fig. 3).

OCCURRENCE: Middle and lower Upper Cenomanian, southern England, northern and southern France, Spain, Romania, Bulgaria, Algeria, Central Tunisia, KwaZulu-Natal in South Africa, Madagascar, south India, and Japan, with possible records from Poland, Israel, and China.

*Calycoceras* (*Newboldiceras*) *planecostatum*
(Kossmat, 1897)
(Pl. 11, Figs 11, 12)

1897. *Acanthoceras Newboldi* var. *planecostata* Kossmat, p. 9 (116), pl. 2 (13), fig. 1.
1990. *Calycoceras* (*Newboldiceras*) *planecostatum* (Kossmat, 1897); Wright and Kennedy, p. 252, pl. 61, figs 2, 3; pl. 67, figs 1–4; text-figs 101c–e (with full synonymy).
1994. *Calycoceras* (*Newboldiceras*) *planecostatum* (Kossmat, 1897); Kennedy, p. 228, pl. 10, figs 2, 3.
1994. *Calycoceras* (*Newboldiceras*) *planecostatum* (Kossmat, 1897); Kennedy and Juignet, p. 50, text-figs 1c, 18a–c, 19a–c.
1996. *Calycoceras* (*Newboldiceras*) *planecostatum* (Kossmat, 1897); Kennedy, Bilotte and Hansotte, p. 314, pl. 40, fig. 3.
1998. *Calycoceras* (*Newboldiceras*) *planecostatum* (Kossmat, 1897); Kaplan *et al*., p. 158, pl. 26, figs 9–11.
2004. *Calycoceras* (*Newboldiceras*) *planecostatum* (Kossmat, 1897); Kennedy and Jolkičev, p. 376, pl. 3, figs 2–6, 8, 9.
2010. *Calycoceras* (*Newboldiceras*) *planecostatum* (Kossmat,1897); Kennedy and Klinger, p. 14, text-figs 34d, g, h; 35k, l, p, q; 44f, g, 46–54; 56a–k; 57h; 61a, b.
2014. *Calycoceras* (*Newboldiceras*) *planecostatum* (Kossmat,1897); Kennedy and Bilotte, p. 26, text-figs 4a–c.
2015. *Calycoceras* (*Newboldiceras*) *planecostatum* (Kossmat,1897); Kennedy in Kennedy and Gale, p. 297, pl. 20, fig. 7.

MATERIAL: OUM KX13974, from beds 17–19.

| | D | Wb | Wh | Wb:Wh | U |
|---|---|---|---|---|---|
| OUM KX13974 | 96.5(100) | 51.7(53.6) | 41.3(79.9) | 1.25 | 33.1(32.1) |

DESCRIPTION: The specimen is an almost wholly septate half whorl with a maximum preserved diameter of 97.5 mm. Coiling is moderately evolute, the umbilicus deep, with a broadly rounded umbilical shoulder. The whorl section is depressed reniform in intercostal section, with the greatest breadth below mid-flank. The costal whorl breadth to height ratio is 1.25. There are fourteen primary ribs on the half whorl. They arise on the umbilical wall and strengthen across the umbilical shoulder, developing into the feeblest of umbilical bullae. These give rise to one, or in one case, two recti to feebly prorsirsdiate ribs that flex slightly forwards across the ventrolateral shoulders and pass across the venter in a very feeble convexity. Short ribs intercalate below or at mid-flank, and strengthen to match the primaries. At the adapical end of the fragment, there are weak inner and outer ventrolateral tubercles, the former lost at the greatest preserved diameter.

OCCURRENCE: Upper Middle and lower Upper Cenomanian, southern England, France, Germany, northern Spain, Iran, Morocco, northeastern Algeria, Central Tunisia, KwaZulu-Natal in South Africa, Madagascar, South India and James Ross Island (Antarctica).

*Calycoceras* (*Newboldiceras*) *algeriense* sp. nov.
(Pl. 11, Figs 3, 4, 7–10; Pl. 12, Figs 1–9; Pl. 123, Figs 4, 5, 8–11; Pl. 14, Figs 7–9)

TYPES: The holotype is OUM KX13948 (Pl. 13, Figs 4, 5, 8–11; Pl. 14, Figs 7–9), from bed 17. Paratypes are OUM KX13655 (Pl. 13, Figs 6, 7), 13658, 13704, from beds 11-13; KX13740 from bed 12, KX13894 (Pl. 11, Figs 9, 10) and 13899 from bed 15; KX13893 (Pl. 11, Figs 7, 8) from bed 19; KX14119 (Pl. 11, Figs 3, 4) from bed 26.

MATERIAL: OUM KX13653-55, 13661-63, 13656(cf.), 13667 from beds 11-13; 13739, 13741-42, from bed 12; 13895, 13899, 13904, from bed 15; 13946, from bed 17; 13976 (cf.), 13980, from beds 17-19; 13896, from bed 20; 14092-93, from bed 24.

DIMENSIONS:

| | D | Wb | WH | Wb:Wh | U |
|---|---|---|---|---|---|
| OUM KX13948c | 49.5(100 | 29.9(60.4) | 22.2(44.8) | 1.34 | –(–) |
| at c | 62.7(100) | 4.2(54.5) | 26.6(42.4) | 1.29 | 18.6(29.7) |
| at c | 96.6(100) | 51.8(53.6) | 40.0(41.4) | 1.30 | 32.8(34.0) |
| OUM KX13983c | 72.2(100) | 42.2(58.4) | 30.2(41.8) | 1.40 | 22.8 (31.5) |
| OUM KX13899c | 75.7(100) | 42.4(56.0) | 35.2(46.5) | 1.2 | – (–) |

DIAGNOSIS: A *Calycoceras* (*Newboldiceras*) in which the adapertural parts of the phragmocone and the adapical part of the body chamber have primary ribs with strong umbilical bullae alternating with single intercalated ribs, all ribs with strong inner ventrolateral tubercles , the outer ventrolateral tubercles weak to effaced, the venter very broad and feebly convex.

DESCRIPTION: Coiling is evolute, the umbilicus deep, with a convex wall and broadly rounded umbilical shoulder. The whorl section is depressed reniform in intercostal section, and rounded-trapezoidal in costal section with the greatest breadth at the umbilical bullae, the venter very broad and convex. Costal whorl breadth to height ratios range from 1.2 to 1.4. Primary ribs, eight to nine per half whorl, arise at the umbiilical seam, strengthen across the umbilical wall, and link to well-developed umbilical bullae. These give rise to strong, straight prorsiradiate ribs, either singly or in pairs, with additional ribs intercalating both low and high on the flanks. In the early growth stages, well-shown by the inner whorls of the holotype (Pl. 13, Figs 4, 5, 11; Pl. 14, Figs 7–9). There are small conical inner ventrolateral tubercles, linked across the venter by a very feebly convex rib to feeble transversely elongated outer ventrolateral and siphonal tubercles. These decline and are near-effaced or lost by a diameter of 50 mm. Beyond this, ornament is of strong, straight, prorsiradiate primary ribs with strong umbilical bullae alternating with single intercalated ribs, all ribs bearing strong inner ventrolateral tubercles, linked across the broad convex venter by a strong transverse rib. The inner ventrolateral tubercles increase in strength progressively, the ribs becoming more widely spaced at the greatest preserved phragmocone diameters. The costal whorl section of the largest fragments is distinctive, with concave flanks. The holotype (Pl. 13, Figs 8–10) and other large phragmocone fragments are interpreted as macroconchs. OUM KX13655 (Pl. 13, figs 6, 7) is a 120° sector of body chamber , interpreted as that of a microconch, with a maximum preserved whorl height of 34 mm. The primary ribs retain the strong umbilical and inner ventrolateral tubercles of phragmocones, but the intercalated ribs have weaker inner ventrolateral tubercles.

The suture is moderately incised, with a broad, bifid E/A and narrow A.

DISCUSSION: *Calycoceras* (*Newboldiceras*) *algeriense* sp. nov. most closely resembles *C.* (*N.*) *asiaticum spinosum* (Kossmat, 1897) (p. 7 (114), pl. 2 (13), figs 2,3; pl. 3 (14), fig. 1; see revision in Wright and Kennedy 1990 ( p. 249, pl. 64, fig. 3; pl. 65, figs 4, 6; pl. 66, figs 3, 4; pl. 79, fig. 1; pl. 70, fig. 3; text-figs 87a–c; 88d, l; 99; 100; 102;107k); they differ in the persistence of strong outer ventrolateral tubercles to maturity in the latter.

OCCURRENCE: Beds 11, 11–13, 15, 17, 17–19, 20, 24, and 26 of the section.

*Calycoceras* (*Newboldiceras*) *tunisiens*e Kennedy, 2015
(Pl. 12, Figs 1–9; Text-fig. 10)

1907. *Acanthoceras jimboi* var. *tunetana* Pervinquière, p. 268, pl. 13, fig. 4.
2015. *Calycoceras* (*Newboldiceras*) *tunisiens*e Kennedy, p. 298, pl. 21, fig. 5; text-fig. 27.

TYPE: The holotype, by monotypy is the original of *Acanthoceras jimboi* var. *tunetana* of Pervinquière, 1907, pl. 14, fig. 2, refigured by Kennedy and Gale 2015, pl. 21, fig. 5; text-fig. 27, an unregistered specimen in the Sorbonne Collections, from Kef Si Abd El Kader, Djebel Mrhila, in Central Tunisia.

MATERIAL: OUM KX13631 (cf.), from bed 10; 13723-24, 13736, 13738, from bed 12; 13646-49, from beds 11–13;13828, 13831from bed 13 or above; 13841 (cf.) 13849, 13851,13860, from bed 15; 13937-41, 13743-4 from bed 17; 13954, 13956, 13961, 13966,13972, from beds 17–19; 13990, 14031 (cf.), 14041,14043, 14044 (cf.) from bed 20; 14016 from bed 22;14001-03, from beds 20–22; 14049, 14050 (cf.) from bed 23; 14066-67, 14079, from bed 24.

DIMENSIONS:

| | D | Wb | Wh | Wb:Wh | U |
|---|---|---|---|---|---|
| KX13819c at51.7 | 51.9(100) | 26.4(50.8) | 25.6(49.3) | 1.04 | 13.1(25.2) |
| KX13944 | 62.6(100) | 34.8(55.6) | 29.2(46.7) | 0.84 | 17.9(28.6) |
| KX14041c | 63.9(100) | 31.4(48.4) | 34.0(52.4) | 0.92 | 18.4(28.8) |
| KX13961c | 72.3(100) | 39.1(54.0) | 35.1(48.5) | 1.1 | 18.1(25.0) |
| KX14043 | 92.0(100) | 46.7(50.1) | 41.9(45.5) | 1.1 | 24.5(26.6) |

DESCRIPTION: Coiling is moderately evolute, the umbilicus comprising 25.2–28.8% of the diameter on phragmocones. The whorl section is oval in intercostal section, the flanks feebly convex, the ventrolateral shoulders broadly rounded, the venter feebly convex. The costal whorl section varies from slightly compressed to slightly depressed, polygonal, with the greatest breadth

Text-fig. 10. The holotype of *Calycoceras* (*Newboldiceras*) *tunisiense* Kennedy, 2015, the original of *Acanthoceras jimboi* var. *tunetana* of Pervinquière, 1907, pl. 14, fig. 2, an unregistered specimen in the Sorbonne Collections, from Kef Si Abd El Kader, Djebel Mrhila, in Central Tunisia. The figures are × 1

at the umbilical bullae. There are 14–16 strong umbilical bullae per whorl, linked to the umbilical seam by a well-developed rib. The bullae give rise to one or two straight ribs that vary from feebly prorsiradiate to feebly rursiradiate between individuals, while one or two long or short ribs intercalate. All link to well-developed conical to feebly bullate inner ventrolateral tubercles. A strong broad transverse rib extends across the venter with strong, equal outer ventrolateral and siphonal clavi. In one phragmocone, OUM KX13944 (Pl. 12, Figs 4, 5), a few of the inner ventrolateral tubercles give rise to pairs of ribs that also bear outer ventrolateral and siphonal clavi. OUM KX14043 (Pl. 12, Figs 8, 9) overlaps in size with the holotype, and retains a 120° sector of body chamber. At the adapertural end of the outer whorl, strong bullae give rise to single ribs separated by one or two long intercalated ribs, with well-developed inner ventrolateral bullae and weaker outer ventrolateral and siphonal tubercles borne on the markedly convex venter. The holotype (Text-fig. 10) is a 90° sector of phragmocone with a maximum preserved whorl height of 63.5 mm, a costal whorl breadth to height ratio of 0.87 and an intercostal whorl breadth to height ratio of 0.8. The umbilicus is of moderate depth, with a broadly rounded wall and shoulder, the intercostal whorl section compressed oval, the costal section compressed polygonal. Six broad, blunt primary ribs arise at the umbilical seam and strengthen across the umbilical wall and shoulder, where they bear strong, sharp umbilical bullae. Each gives rise to a pair of ribs. The adapical rib of each pair is strong, straight and rectiradiate, the adapertural one much weaker, and only tenuously linked to a bulla. The differentiation into strong adapical and weak adapertural ribs persists to the ventrolateral shoulder, where all of the strong and some of the weaker ribs bear sharp inner ventrolateral bullae. A low, broad, blunt rib connects to a weak, feebly clavate outer ventrolateral tubercle, and a broad, coarse rib passes straight across the venter, with a faint suggestion of a siphonal tubercle on some of the ribs.

The suture has a broad, bifid, deeply incised E/A, and a narrow, deeply incised A.

DISCUSSION: The holotype appears to be from the adapertural end of an adult phragmocone. When compared to *Calycoceras* (*Newboldiceras*) *asiaticum asiaticum*, the less massive compressed whorl section, arched venter, and tendency of the ribs to arise in pairs from umbilical bullae are distinctive. *C.* (*N.*) *asiaticum spinosum* differs by its spinose ventrolateral tubercles. *C.* (*N.*) *asiaticum hunteri* (Kossmat, 1897) (p. 116 (90), pl. 3 (14) fig. 4; see revision in Wright and Kennedy, 1990, p. 251, text-figs 90g, h;103; 104; 110b) has primary ribs only at the same size as the lectotype of *tunisiense*.

OCCURRENCE: Upper Middle Cenomanian of northeastern Algeria and Central Tunisia.

## Genus *Eucalycoceras* Spath, 1923
(ICZN Generic Name no. 1354)

TYPE SPECIES: *Ammonites pentagonus* Jukes-Browne, 1896, p. 156, pl. 5, fig. 1, by the original designation of Spath 1923, p. 144 (ICZN Specific name no. 1635).

### *Eucalycoceras batnense* (Collignon, 1937)
(Pl. 15, Figs 1–13; Pl. 16, Figs 1–7)

1937. *Protacanthoceras batnense* Collignon, p. 36, pl. 2, figs 3, 4 (var. *tenuis*), pl. 8, fig. 4.
1972. *Pseudocalycoceras* (*Pseudocalycoceras*) *batnense* (Collignon), 1937; Thomel, p. 88.
2015. *Eucalycoceras batnense* (Collignon, 1937); Kennedy in Kennedy and Gale, p. 306, pl. 21, fig. 6; pl. 22, fig. 9; text-figs 31c–e.

TYPE: The holotype, by monotypy is the original of Collignon 1937, pl. 2, fig. 3, from the Cenomanian of Batna in northestern Algeria. We have not traced this specimen. The original of var. *tenuis* Collignon 1937, pl. 2, fig. 4, is refigured here as Pl. 15, Figs 2, 3, and is currently housed in the collections of the Université de Bourgogne, Dijon.

MATERIAL: OUM KX13630 (cf.) from bed 10; 13707-11, from bed 11; 13721-22, 13726 (cf.), 13728-34, 13736-7, from bed 12; 13642-45, from beds 11–13; 13825-27, 13829-30, from bed 13 or above; 13836-40, 13844-47, 13854-56, 13858, 13862-66, 13869-70, from bed 15; 13955, 13958-60 (cf.), 13965, 13968, from beds 17-19; 13982 from bed 19; 13985, 13990 (cf.), 13993-95, from bed 20; 14013, 14015, 14018-9, 14022, 14030, 14032, 14034, 14036, 14042, from bed 22; 14004, from beds 20-22;14048, from bed 23; 14063-64, 14065 (cf.), 14069-71, 14073 (cf.), 14075-78, from bed 24; 14110-11, 14118, from bed 26.

DESCRIPTION: Phragmocone fragments range from whorl heights of 15 to 49 mm. Coiling is very involute, with an umbilicus that comprises around 25% of the diameter, shallow, with narrow convex wall and broadly rounded umbilical shoulder. Compressed individuals such as OUM KX13837 (Pl. 16, Fig. 3), which retains a short section of body chamber, has a whorl breadth to height ratio of 0.67, the greatest breadth at the umbilical bullae, the inner flanks very feebly convex in intercos-

tal section and subparallel, the outer flanks flattened and converging to the broadly rounded ventrolateral shoulders and narrow, feebly convex venter. Closely spaced umbilical bullae perch on the umbilical shoulder, and give rise to straight, prorsiradiate ribs that flex back slightly below mid-flank, broaden, and link to very feeble rounded inner ventrolateral tubercles, connected in turn by a low broad rib to small, better differentiated outer ventrolateral clavi, linked across the venter by a very broad, transverse rib with a feeble blunt siphonal clavus. There are up to four long and short intercalated ribs between successive primaries. Other specimens, such as OUM KX13721 (Pl. 16, Figs 4, 5) are similarly compressed, the ribs more flexuous, with fewer intercalated ribs. OUM KX13722 (Pl. 16, Figs 1, 2) is an adult body chamber of a compressed variant. The umbilical bullae weaken progressively and efface, the primaries separated by one or two long or short intercalated ribs. Traces of ventrolateral and ventral tuberculation, present at the adapical end of the body chamber, efface, the ventrolateral part of the ribs broadens markedly, becomes flat-topped, and as wide as, or wider than the interspaces. Stouter phragmocone fragments have whorl breadth to height ratios of up to 0.86. Small fragments (OUM KX13866: Pl. 15, Figs 4, 5) have small rounded-bullate inner ventrolateral tubercles that are much better differentiated than in more compressed individuals. The stoutest fragments referred to the species (Pl. 15, Figs 10–13) have whorl breadth to height rations of up to 1, the tubercles stronger still, and persisting onto the adapical part of the body chamber. Specimens such as OUM KX13722, 13837, and 14087 (Pl. 16, Figs 1–5) are interpreted as macroconchs; OUM KX13721 (Pl. 16, Figs 6, 7) is interpreted as a fragment of the body chamber of a microconch.

The suture is moderately incised, with broad, bifid E/A and a deep, narrow A; A/U2 is relatively large, and bifid.

DISCUSSION: The blunt, flexuous ribs distinguish *Eucalycoceras batnense* from previously described species of *Eucalycoceras*, including *E. pentagonum*, *E. rowei* (Spath, 1926a), and *E. gothicum* (Kossmat, 1895) (see revision in Wright and Kennedy, 1990), the last of these also distinguished by the umbilical tubercles, that project into the umbilicus (Kossmat 1895, pl. 25 (11), fig. 3), *Eucalycoceras denizoti* (Fabre, 1940, p. 223, pl. 6, figs 5, 6; text-fig. 31) and its synonym *E. breistrofferi* (Fabre, 1940, p. 224, pl. 6, figs 7, 8; text-fig. 32), the types of which were refigured by Wright and Kennedy (1990, text-fig. 124) have blunt ribbing, but the rib density is higher than in the present species, the ribs crowded, straight rather than markedly flexuous, and narrow, rather than broadening across the flanks.

OCCURRENCE: Upper Middle Cenomanian, northeastern Algeria and Central Tunisia.

## Subfamily Euomphaloceratinae Cooper, 1978
## Genus *Lotzeites* Wiedmann, 1960

TYPE SPECIES: *Acanthoceras aberrans* Kossmat, 1895, p. 202 (106), pl. 24 (10), fig. 4, by the original designation of Wiedmann 1960, p. 731.

### *Lotzeites elegans* Kennedy, 2015
(Pl. 13, Figs 1–3; Pl. 14, Figs 1–6, 10, 11; Text-fig. 11)

1907. *Acanthoceras meridionale* Stoliczka variété *Africana* Pervinquière, p. 279 (*pars*), pl. 15, fig. 2 only.
2015. *Lotzeites elegans* Kennedy in Kennedy and Gale, p. 307, pl. 16, figs 2, 3.

TYPE: The holotype, by the original designation, is an unregistered specimen in the Sorbonne Collections (*ex* Flick Collection), the original of Pervinquière 1907, p. 279 (*pars*), pl. 15, fig. 2 only, from Foum el Guelta, Djebel Mrhila, Central Tunisia (Text-fig. 11).

MATERIAL: OUM KX13906, from bed 15; 13984, 13987 (cf.), from bed 20; 14025, from bed 22; 14098, from bed 24; 14121 (cf.), from bed 26.

DIMENSIONS:

| | D | Wb | Wh | Wb;Wh | U |
|---|---|---|---|---|---|
| OUM KX13906c | 43.1(1000 | 24.7(57.3) | 17.7 (41.1) | 1.40 | 13.5 (31.3) |
| OUM KX13984c | 64.4 (100) | 41.7 (64.8) | 27.9 (43.3) | 1.49 | 21.0 (32.6) |

DESCRIPTION: Coiling is very evolute, the umbilicus comprising up to 34% of the diameter, deep, with a convex wall and broadly rounded umbilical shoulder. The whorl section is depressed, reniform in intercostal section, with the greatest breadth below mid-flank. The costal whorl section is very depressed, with a whorl breadth to height ratio of up to 1.49, the greatest breadth at the inner ventrolateral tubercles, the venter very broad, and feebly convex. OUM KX13906 (Pl. 13, Figs 1–3) is 47 mm in maximum preserved diameter. There are 13–14 umbilical bullae of variable strength on the outer whorl. They give rise to single strong, narrow, straight prorsirsdiate ribs, that link to subspinose inner ventrolateral bullae. These give rise to a single rib or a pair of ribs that pass straight

across the venter, the paired ribs looping between the inner ventrolateral tubercles. There are small outer ventrolateral and siphonal bullae, well-developed on the adapical half of the outer whorl of the specimen, but declining in strength on the adapertural half. Additional long and short ribs intercalate, some of the longer tenuously linked to an umbilical bulla, to give a total of 22–23 ribs per whorl on the outer flank. The intercalated ribs lack an inner ventrolateral tubercle, but have outer ventrolateral and siphonal tubercles like those on the primary ribs. There are an estimated 32 ribs per whorl on the venter. The interspaces adapertural of the paired ribs are deepened into feeble constrictions on the venter. OUM KX13974 (Pl. 14, Figs 1–4) has a comparable pattern of ribs, tubercles, and feebly expressed constrictions, as in the previous specimen, on the adapical half of the outer whorl. On the adapertural half of the outer whorl, the outer ventrolateral tubercles weaken and are eventually lost, the siphonal tubercles also weaken and are barely detectable at the greatest preserved diameter. OUM KX 14025 (Pl. 14, Figs 10, 11), the largest specimen seen, is a 120° fragment of phragmocone with a maximum preserved whorl height of 43 mm and a costal whorl breadth to height ratio of 1.38. There are well-developed umbilical and inner ventrolateral tubercles on six strong, narrow, relatively widely separated primary ribs. The inner ventrolateral tubercles give rise to pairs of ribs that loop across the venter and link to the corresponding tubercle on the opposite flank. Additional ribs that lack an inner ventrolateral tubercle intercalate, to give a total of 13–14 ribs on the venter. Outer ventrolateral and siphonal tubercles are absent, or indicated by the merest accentuation of the rib profile.

The suture is quite deeply incised, with a large, asymmetrically bifid E/A, narrow, deep A, and relatively broad A/U2.

Text-fig. 11. The holotype of *Lotzeites elegans* Kennedy, 2015, an unregistered specimen in the Sorbonne Collections (*ex* Flick Collection), the original of *Acanthoceras meridionale* var. *africana* of Pervinquière, 1907, p. 279 (*pars*), pl. 15, fig. 2 only, an unregistered specimen in the Sorbonne Collections, from Foum el Guelta, Djebel Mrhila, Central Tunisia. The figures are × 1

DISCUSSION: The present material clarifies the relationship of the present species to the type species, *Lotzeites aberrans* (Kossmat, 1895, p. 202 (106), pl. 24 (10), fig. 4; see revision in Wright and Kennedy, 1990, p. 292, pl. 85, figs 3–6, 8, 10; text-figs 94f–h, with full synonymy). The presence of well-developed outer ventrolateral and siphonal tubercles on the inner whorls of *elegans* at a diameter where *aberrans* lacks them is the most obvious difference between the two.

OCCURRENCE: Upper Middle Cenomanian, northeastern Algeria and Central Tunisia.

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 plicatile* (J. Sowerby, 1819)
(Pl. 17, Figs 1, 2)

1819. *Hamites plicatilis* J. Sowerby, p. 281, pl. 234, fig. 1.
1995. *Anisoceras plicatile* (J. Sowerby, 1819); Wright and Kennedy, p. 305, pl. 89, figs 5–7, 9–10; pl. 90, figs 1, 3, 6, 8–10, 12; pl. 91, figs 5–7, 10–12; text-figs 130K; 131A, P; 132E, F (with full synonymy).
1998. *Anisoceras plicatile* (J. Sowerby, 1819); Kaplan *et al.*, p. 178, pl. 58, figs 4, 6; pl. 59, figs 1, 3, 4, 5; pl. 60, fig. 5.

TYPES: The lectotype, designated by Kennedy 1971, p. 12, is the original of J. Sowerby 1819, p. 281, pl. 234, fig, 1, from the Chalk Marl of Bishopstrow near Warminster, no. 72991 (BC 528), in the collections of the Academy of Natural Sciences of Philadelphia (Wright and Kennedy 1996, text-fig. 130K). The paralectotype, BMNH 44000, is probably from the Upper Albian Upper Greensand of the Isle of Wight and is closer to *A. pseudoelegans* (see Spath 1939, p. 557, pl. 60, fig. 2).

MATERIAL: OUM KX13770, from bed 12.

REMARKS: The single fragment is 30mm long, with a maximum preserved whorl height of 13.6 mm. The intercostal whorl section is ovoid, the dorsum more narrowly rounded than the venter, the whorl breadth to height ratio 0.8. Flat-topped lateral and ventral tubercles are linked by pairs of delicate ribs, with additional

ribs intercalating between. The fragment compares well with material from Western Europe listed in the synonymy.

OCCURRENCE: The species ranges through the Middle Cenomanian. There are records from southern England, France, Germany, Poland, Romania, Algeria, Angola, Madagascar, and possibly Texas and Colorado in the United States.

Family Turrilitidae Gill, 1871
Genus *Hypoturrilites* Dubourdieu, 1953, p. 44

TYPE SPECIES: *Turrilites gravesianus* d'Orbigny, 1842, p. 596, pl. 144, figs 3–5, by original designation by Dubourdieu 1953, p. 123.

*Hypoturrilites tuberculatoplicatus* (Seguenza, 1882)
(Pl. 17, Figs 7, 13)

1882. *Turrilites tuberculato-plicatus* Seguenza, p. 53, pl.5, fig. 3.
1996. *Hypoturrilites tuberculatoplicatus* (Seguenza, 1883); Wright and Kennedy, p. 374, pl. 108, fig. 7; pl. 113, figs 3, 4, 6, 8, 9 (with full synonymy).

TYPE: The holotype, by monotypy, is the original of Seguenza, 1882, pl. 5, fig. 3, from the Cenomanian of San Georgio, near Brancaleone, Calabria, Italy.

MATERIAL: OUM KX14921–22, from bed 1; 13569, from bed 9.

DESCRIPTION: OUMKX14921 and OUM KX13569 (Pl. 17, Fig. 7) have whorl heights of between 20 and 31mm. The outer, exposed whorl face is markedly convex. Delicate prorsiradiate ribs arise at the junction of the upper and outer whorl faces, and link in pairs at large, rounded, mid-lateral tubercles, with an additional rib or ribs intercalating between. The ribs extend downwards, and are weakened at a shallow spiral groove, succeeded by a spiral ridge, where the ribs link to small rounded to spirally elongated tubercles. A second groove separates this row from a third row of tubercles of comparable size and shape to those in the second row, with a fourth row of rounded tubercles, equal in number to those in the second and third rows, on the lower whorl face. These give rise to radial ribs that extend across the lower whorl face. OUM KX14922 (Pl. 17, Fig. 13) is a much larger, crushed fragment from the adapical end of the body chamber, with a diameter in excess of 62 mm. The pattern of ribbing and tuberculation is as in the previous specimens, the ribbing on the upper part of the outer whorl face particularly well developed.

DISCUSSION: *Hypoturrrilites tubercuatoplicatus* shares a combination of ribs and tubercles with *Hypoturrilites laevigatus* (Coquand, 1862), of which *H. tenouklensis* Pervinquière, 1910, is a synonym, based on a better preserved type specimen (see revision in Wright and Kennedy 1996, p. 373; pl. 102, fig. 2; text-figs 146k–m, p, q); they differ in that *laevigatus* has only three rows of tubercles, an upper row of few, large tubercles, and two rows of smaller, more numerous tubercles.

OCCURRENCE: The species is well-dated as upper Lower Cenomanian, *Mantelliceras dixoni* Zone, in southern England, and, possibly Ukraine (Crimea). The present specimens come from both the *dixoni* Zone and the lower Middle Cenomanian.

Genus *Turrilites* Lamarck, 1801

TYPE SPECIES: *Turrilites costatus* Lamarck, 1801, p. 102, by original designation by Lamarck, 1801, p. 102.

*Turrilites scheuchzerianus* Bosc, 1801
(Pl. 17, Figs 3, 12, 16, 18)

1708. *Turbinites* Langius, p. 112, fig. 6.
1801. *Turrilites scheuchzerianus* Bosc in Buffon, p. 190 (copy of Langius).
1996. *Turrilites scheuchzerianus* Bosc, 1801; Wright and Kennedy, p. 349, pl. 106, figs 7, 8, 11, 12; pl. 107, figs 1–7; text-figs 137g, j, 138c, d, f, g, h, i, n; 139d–I; 140a, d, e, f, g, h, i; 143h; 147a, b (with full synonymy).
1998. *Turrilites scheuchzerianus* Bosc; Kaplan *et al*., p. 213, pl. 59, figs 12–14; pl. 64, figs 4, 7, 10, 11; pl. 65, figs 1–3, 6 (with additional synonymy).
2014. *Turrilites scheuchzerianus* Bosc, 1801; Walaszczyk *et al*., text–fig. 24c, d (with additional synonymy).
2015. *Turrilites scheuchzerianus* Bosc, 1801; Kennedy in Kennedy and Gale, p. 314, pl. 24, figs 6–8, 11–13, 16, 19.

TYPE: Bosc's figure is a copy of Langius 1708, pl. 112, fig. 6. The status and whereabouts of the type material of this species has not been established.

MATERIAL: OUM KX14931-48 from bed 3; 15001-9, from bed 5; 13254-13363, 13364 (collective of 25 specimens), 13365-68, 15375-85, from beds 3–7;

15021-54, 15107-117, from bed 7; 13493-13508, from beds 7–9; 13562-68, 13570-86, 13587 (collective of 12 specimens), 13588-93, from bed 9; 13632, from bed 10; 13684-85 from beds 11–13;13757, from bed 12.

REMARKS: *Turrilites scheuchzerianus* occurs in flood abundance at some levels in the section. The material shows the typical ontogenetic stages, the first with the ribbing interrupted by a spiral groove below mid-flank, the second, which characterises the adapertural part of the adult body chamber, has the ribbing uninterrupted, and occurs on fragments with whorl heights of up to 49 mm. One specimen (OUM KX13562: Pl. 17, Fig. 18) has what is interpreted as a pathological condition, with two minor spiral grooves interrupting the ribbing on the lower part of the outer whorl face.

OCCURRENCE: Upper Lower and Middle Cenomanian. There are records from Bornholm in the Baltic, England, France, Switzerland, Germany, Poland, Spain, southern Italy, Crimea, Iran, Kazakhstan, Turkmenistan, Iran, Morocco, Algeria, central Tunisia, Israel, Nigeria, KwaZulu-Natal in South Africa, Madagascar, Tibet, Japan, the U.S. Gulf Coast and Western Interior.

### *Turrilites wiestii* Sharpe, 1857
(Pl. 17, Figs 4, 6, 8)

1857. *Turrilites wiestii* Sharpe, p. 67 (*pars*), pl. 27, fig. 8 only.
1996. *Turrilites wiestii* Sharpe, 1857; Wright and Kennedy, p. 353, pl. 105, figs 7, 8, 11, 15, 18; pl. 108, figs 5, 9, 10, 13 (with full synonymy).

TYPE: The lectotype, by the subsequent designation of Wright and Kennedy, 1996, p. 353, is the original of Sharpe, 1857, pl. 27, fig 8, BGS GSM Geol. Soc. 7783, from the Lower Chalk of Ventnor, Isle of Wight.

MATERIAL: OUM KX14949–50, from bed 3; 15199–212, from beds 3–7.

REMARKS: The material consists of whorl fragments only. As Wright and Kennedy (1996, p. 354) note, *wiestii* has generally been regarded as a junior synonym of *acutus* of Passy (1832; see below), of which it is a homoeomorph. It is however significantly older, and differs from *acutus* in the fewer rows of tubercles per row in juveniles, and the lack of, or variable development of, the third and lowest row of tubercles. This variability is shown by the present material.OUM KX15203 (Pl. 17, Fig. 4), from the adapical party of a body chamber, has 15 tubercles per whorl. Those in the upper row are transversely elongated, those in the row below more rounded, with a very weak, third, radially elongated row on the lower whorl face. In OUM KX14949 (Pl. 17, Fig. 8), also a body chamber, there are 15 tubercles per whorl, with two rows well-developed, but the third row on the lower whorl face effaced or reduced to delicate ribs only. In OUM KX15200 (Pl. 17, Fig. 6) the third and lowest row is well-developed.

OCCURRENCE: Upper Lower Cenomanian *Mantelliceras dixoni* Zone in southern England; condensed Albian-Cenomanian of central Iran. The present material comes from the *dixoni* Zone and the lower Middle Cenomanian.

### *Turrilites costatus* Lamarck, 1801
(Pl. 17, Figs 5, 10, 14)

1801. *Turrilites costata* Lamarck, p. 102 (*pars*).
1996. *Turrilites costatus* Lamarck, 1801; Wright and Kennedy, p. 354, pl. 103, figs 1, 2, 5; pl. 104, figs 1–4, 6, 8–10, pl. 105, figs 1, 5, 6, 10, 12, 13, 16, 17, 19; pl. 106, figs 1–6, 9, 10; text-figs 137c; 139a–c; 142a, f, g; 143a–g, i–p (with full synonymy).
1998. *Turrilites costatus* Lamarck, 1801; Kaplan *et al*., p. 214, pl. 64, fig. 3; pl. 65, figs 7, 8.
2015. *Turrilites costatus* Lamarck, 1801; Kennedy in Kennedy and Gale, p. 316, pl. 24, figs 5, 9 (with additional synonymy).

MATERIAL: OUM KX 13686–13689, from beds 11–13; 13756, 13768–69, from bed 12; 13909–18, from bed 15; 13996, from bed 20.

REMARKS: Fragments have whorl heights of up to 20 mm, with 20 ribs per whorl, extending across the upper half of the outer whorl face, and ending in a well-developed tubercle. The ribs terminate at a spiral groove, below which is a second row of tubercles. The inter-whorl suture is crenulated, the crenulations housing a third, row of smaller tubercles, very weak in some specimens, and borne on a spiral ridge (OUM KX13686; Pl. 17, Fig. 10). Differences from *Turrilites scheuchzerianus* are noted above. There are passage forms to *Turrilites acutus*, which succeeds *costatus*, but typical representatives of the latter differ in having tubercles dominant over the ribbing.

OCCURRENCE: Index of the lower Subzone of the lower Middle Cenomanian *Acanthoceras rhotomagense* Zone, extending as a rarity into the upper Middle and lower Upper Cenomanian, although records from

condensed basement beds in Western Europe may be remanié individuals. The geographic distribution extends to England, France, Germany, Switzerland, Poland, Spain, Portugal, Romania, Ukraine (Crimea), Russia, Kazakstan and Kopet Dag, Turkmenia, Iran, Algeria, Central Tunisia, the Middle East, Nigeria, Angola, KwaZulu-Natal in South Africa, Mozambique, Madagascar, South India, Tibet, northern Australia, Mexico, the U.S. Gulf Coast and California.

*Turrilites acutus* Passy, 1832
(Pl. 17, Figs 9, 11, 15, 17)

1832. *Turrilites acutus* Passy, p. 9, pl. 16, figs 3, 4.
1996. *Turrilites acutus* Passy, 1832; Wright and Kennedy, p. 358, pl. 103, fig. 3; pl. 104, figs 5, 7, 11; pl. 105, fig. 21; pl. 108, figs 1–4, 8, 11, 12; text–figs 138m, 141a, 146n–o (with full synonymy).
1998. *Turrilites acutus* Passy, 1832; Kaplan *et al*., p. 216, pl. 60, fig. 4, pl. 63, figs 1–5, pl. 64, fig. 2.
2011. *Turrilites acutus* Passy, 1832; Kennedy *et al*., p. 231, text-fig. 20.
2015. *Turrilites acutus* Passy, 1832; Kennedy in Kennnedy and Gale, p. 318,

TYPE: The lectotype by the subsequent designation of Juignet and Kennedy, 1976, p.65, is the original of Passy, 1832, pl. 16, fig. 3, an unregistered specimen in the Sorbonne Collections, refigured by Wright and Kennedy, 1996, pl. 108, fig. 8.

MATERIAL: OUM KX14051–52, from bed 23; 14103, from bed 24.

REMARKS: Fragments have whorl heights of up to 35 mm. Differences from *T. costatus* are noted above.

OCCURRENCE: Middle Cenomanian, index of the upper Subzone of the *Acanthoceras rhotomagense* Zone to lower Upper Cenomanian *Calycoceras guerangeri* Zone. The geographic distribution extends from England to France, Germany, Poland, Spain, northern Russia, Kazakhstan, Turkmenia, Iran, Algeria, Central Tunisia, Tibet, Texas, the U.S. Western Interior and California.

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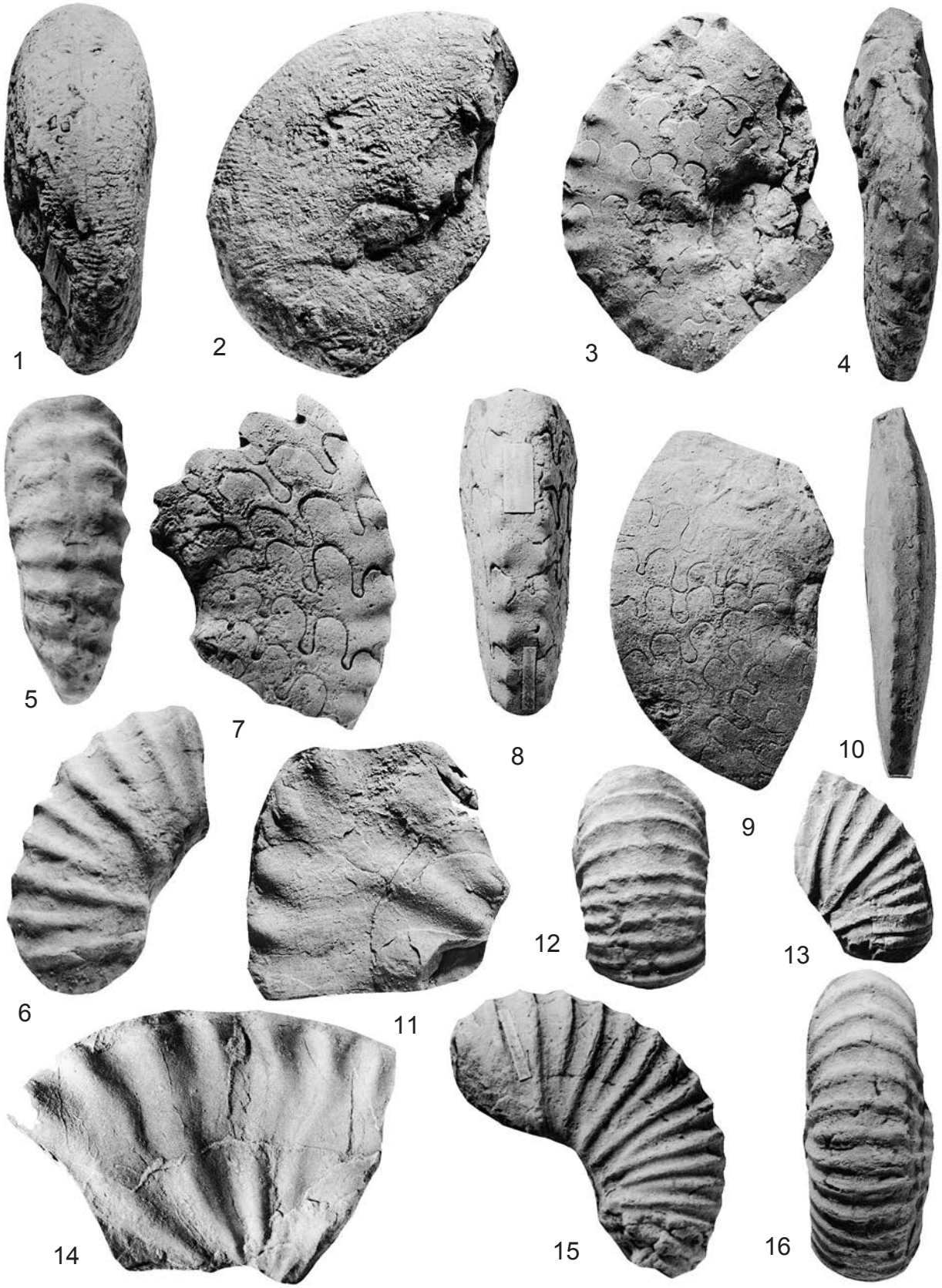
PLATES 1–17

# PLATE 1

**1, 2** – *Phylloceras* (*Hypophylloceras*) *velledae velledae* (Michelin, 1834); OUM KX15185, from beds 3–7. **3, 4, 7-10, 11, 14** – *Neolobites fourtaui* Pervinquière, 1907. **3, 4** – OUM KX13617, from bed 9; 7, 8 – OUM KX15189, from beds 3–7; 9, 10 – OUM KX15086, from bed 7; 11, OUM KX15188, from beds 3 – 7; 14, OUM KX15186, from beds 3–7. **5, 6** – *Mantelliceras dixoni* Spath, 1926, OUM KX13613, from bed 9. **12, 13, 15, 16** – *Mantelliceras lymense* (Spath, 1926). 12, 13 – OUM KX14917, from bed 1; 15, 16 – OUM KX15014, from bed 2.

All specimens are from the Fahdene Formation north of Bou Khadra in northeastern Algeria.
All figures are × 1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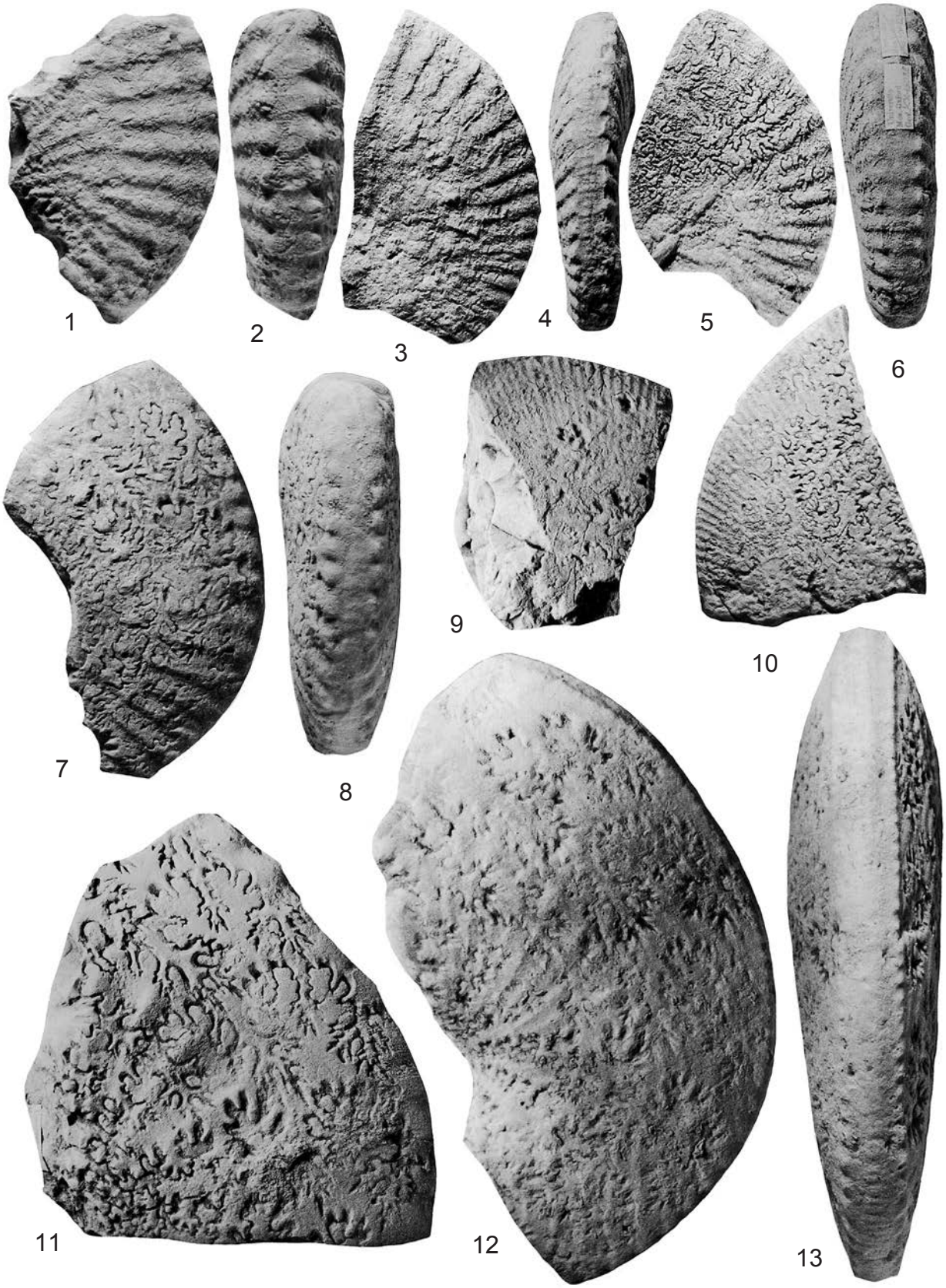
# PLATE 2

**1-8** – *Forbesiceras chevillei* (Pictet and Renevier, 1866). 1, 2 – OUM KX13820, *ex situ*. 3, 4 – OUM KX13623, from bed 9. 5, 6 – OUM KX15092, from bed 7. 7, 8 – OUM KX13881, from bed 14**. 9, 10** – *Forbesiceras largilliertianum* (d'Orbigny, 1841). 9 – OUM KX15170, from beds 3-7. 10 – OUM KX15196, from beds 3–7. **11** – *Forbesiceras subobtectum* (Stoliczka, 1864), OUM KX13822, ex situ. **12, 13** – *Forbesiceras obtectum* (Sharpe, 1853), OUM KX13821, ex situ.

All specimens are from the Fahdene Formation north of Bou Khadra in northeastern Algeria.
All figures are × 1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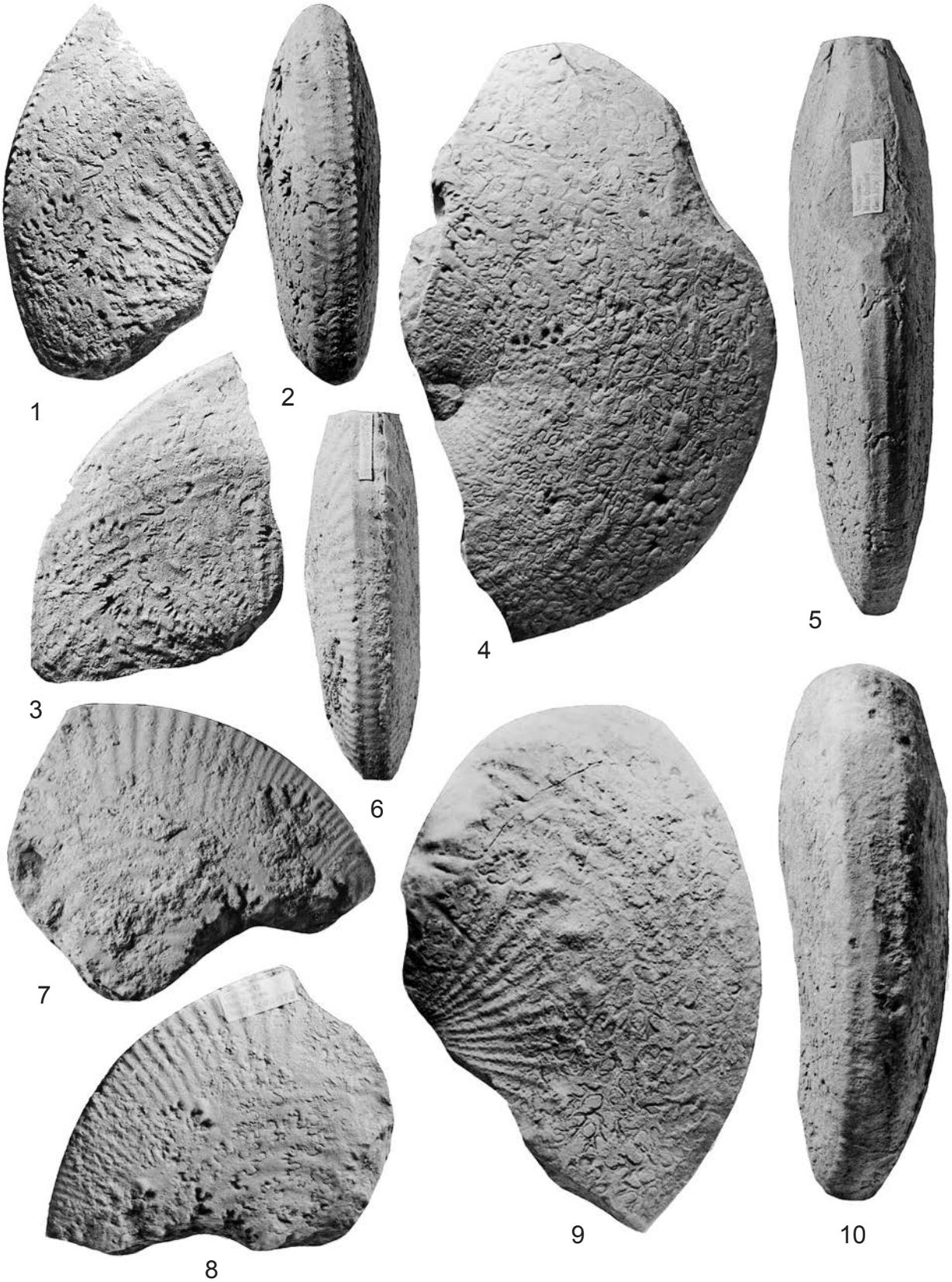
# PLATE 3

**1-5, 9, 10** – *Forbesiceras obtectum* (Sharpe, 1853). **1-3** – OUM KX13952, from bed 17. 4, 5 – OUM KX14055, from bed 28. 9, 10 – OUM KX13875, from bed 15. **6-8** – *Forbesiceras reversum* sp. nov., OUM KX 14978, the holotype, from bed 5.

All specimens are from the Fahdene Formation north of Bou Khadra in northeastern Algeria.
All figures are × 1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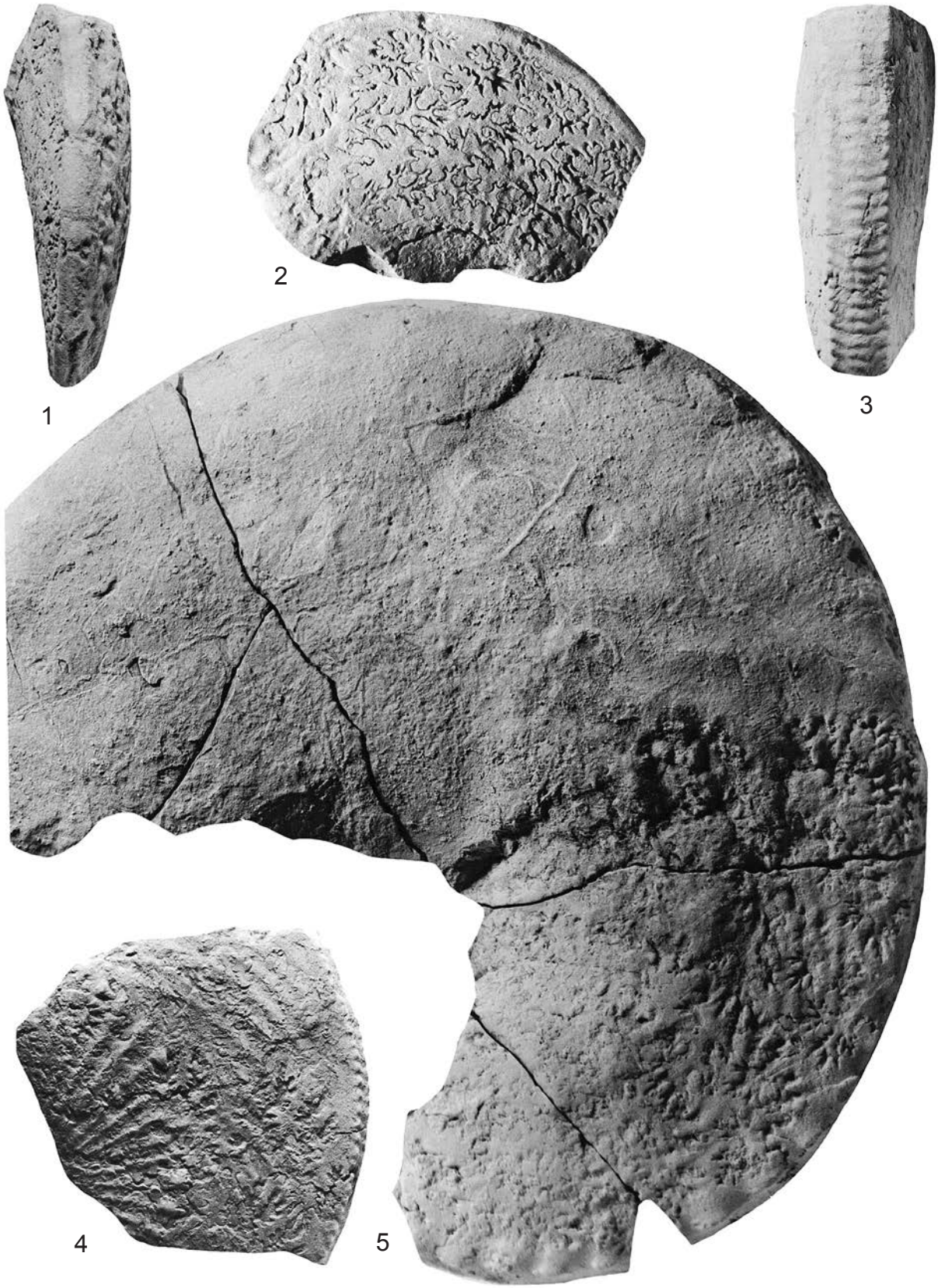
# PLATE 4

**1-4** – *Forbesiceras obtectum* (Sharpe, 1853). 1, 2 – OUM KX13872, from bed 15. 3, 4 – OUM KX13873, from unit 15. **5** – *Forbesiceras subobtectum* (Stoliczka, 1864) OUM KX14980, from bed 5.

All specimens are from the Fahdene Formation north of Bou Khadra in northeastern Algeria.
All figures are × 1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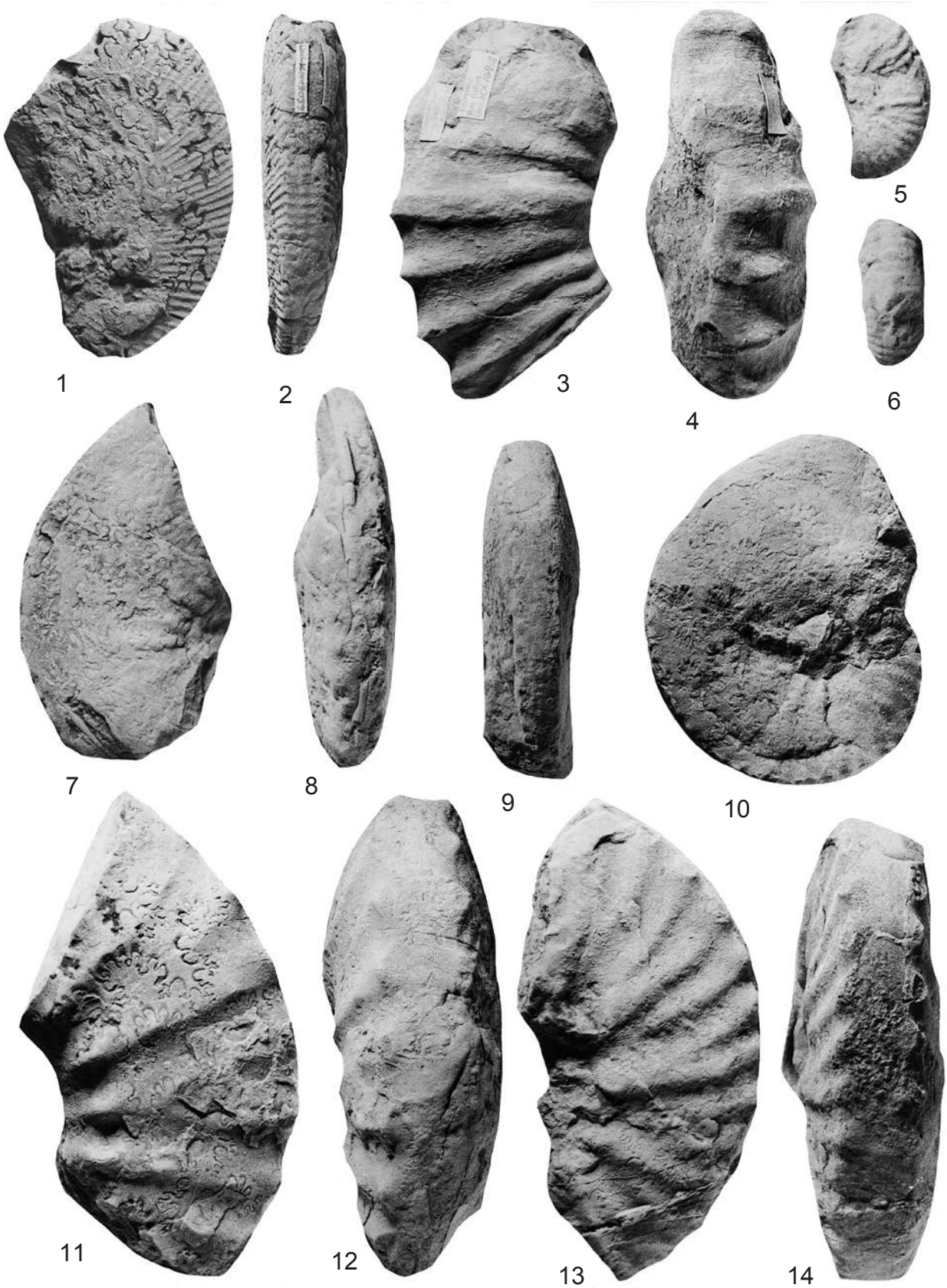
# PLATE 5

**1, 2** – *Forbesiceras reversum* sp. nov., paratype, OUM KX15171, from beds 3–7. **3, 4** – *Mantelliceras* cf. *dixoni* Spath, 1926, OUM KX14918, from bed 1. **5, 6** – *Mantelliceras* sp. juv., cf. *mantelli* (J. Sowerby, 1814), OUM KX14919, from bed 1. **7-14** – *Acompsoceras renevieri* (Sharpe, 1857). 7, 8 – OUM KX13640, from beds 11-13. 9, 10 – OUM KX14898, from bed 1. 11, 12 – OUM KX13608, from bed 9. 13, 14 – OUM KX13607, from bed 9.

All specimens are from the Fahdene Formation north of Bou Khadra in northeastern Algeria.
All figures are × 1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# PLATE 6

**1-3, 8-13** – *Acanthoceras rhotomagense* (Brongniart. 1822). 1-3 – OUM KX13928, from bed 15. 8, 9 – OUM KX13925, from bed 15. 10, 11 – OUM KX13924, from bed 15. 12, 13 – OUM KX13835, from bed 13 or above. **4-7** – *Cunningtoniceras inerme* (Pervinquière, 1907). 4, 5 – OUM KX15371, from beds 3–7. 6, 7 – OUM KX15344, from beds 3–7.

All specimens are from the Fahdene Formation north of Bou Khadra in northeastern Algeria.
All figures are × 1


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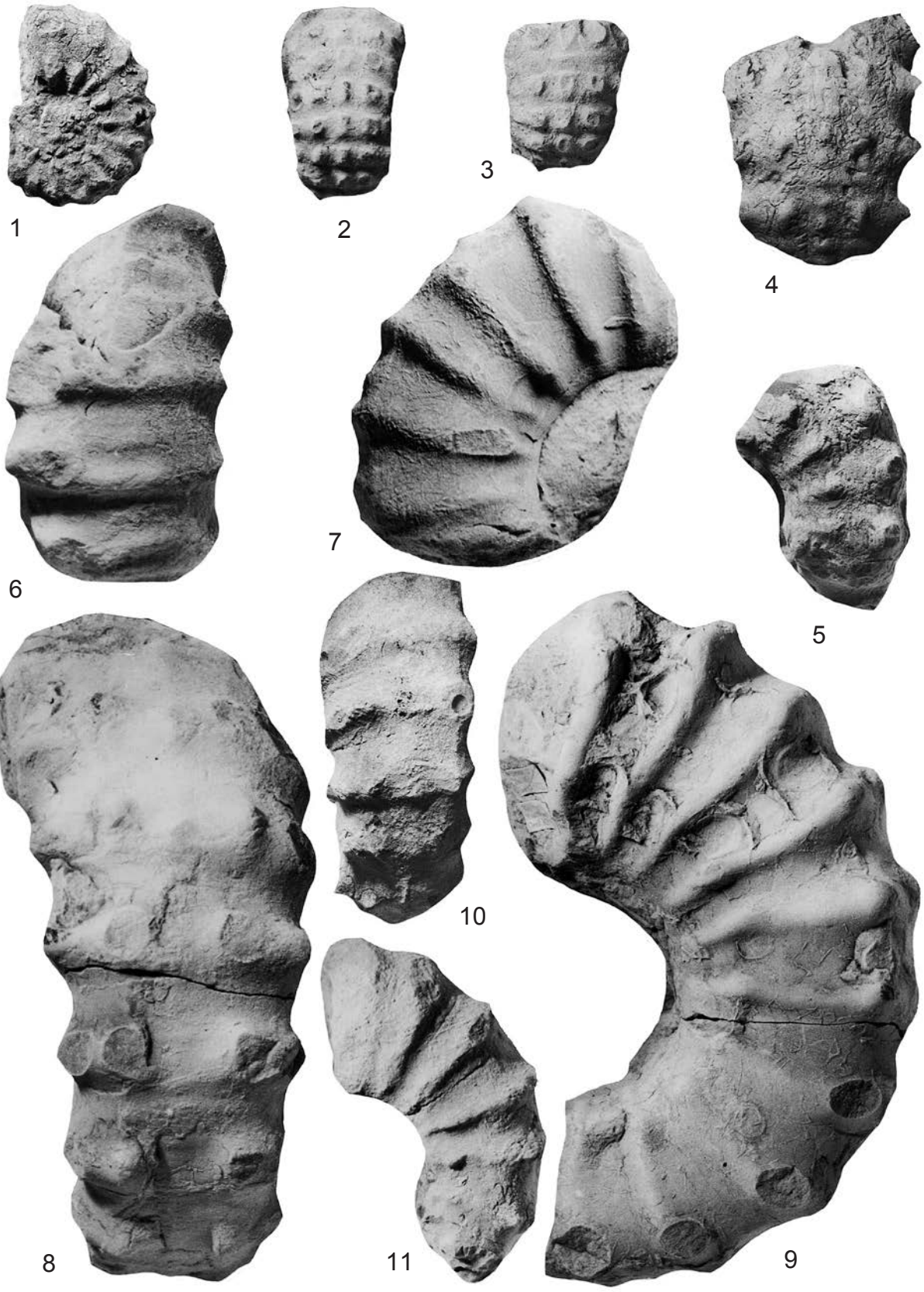
# PLATE 7

*Cunningtoniceras inerme* (Pervinquière, 1907)

**1-3** – OUM KX15341, from beds 3–7. **4, 5** – OUM KX15392, from beds 3–7. **6, 7** – OUM KX14897, from bed 5. **8, 9** – OUM KX15284, from beds 3–7. **10, 11** – OUM K15102, from bed 7.

All specimens are from the Fahdene Formation north of Bou Khadra in northeastern Algeria.
All figures are × 1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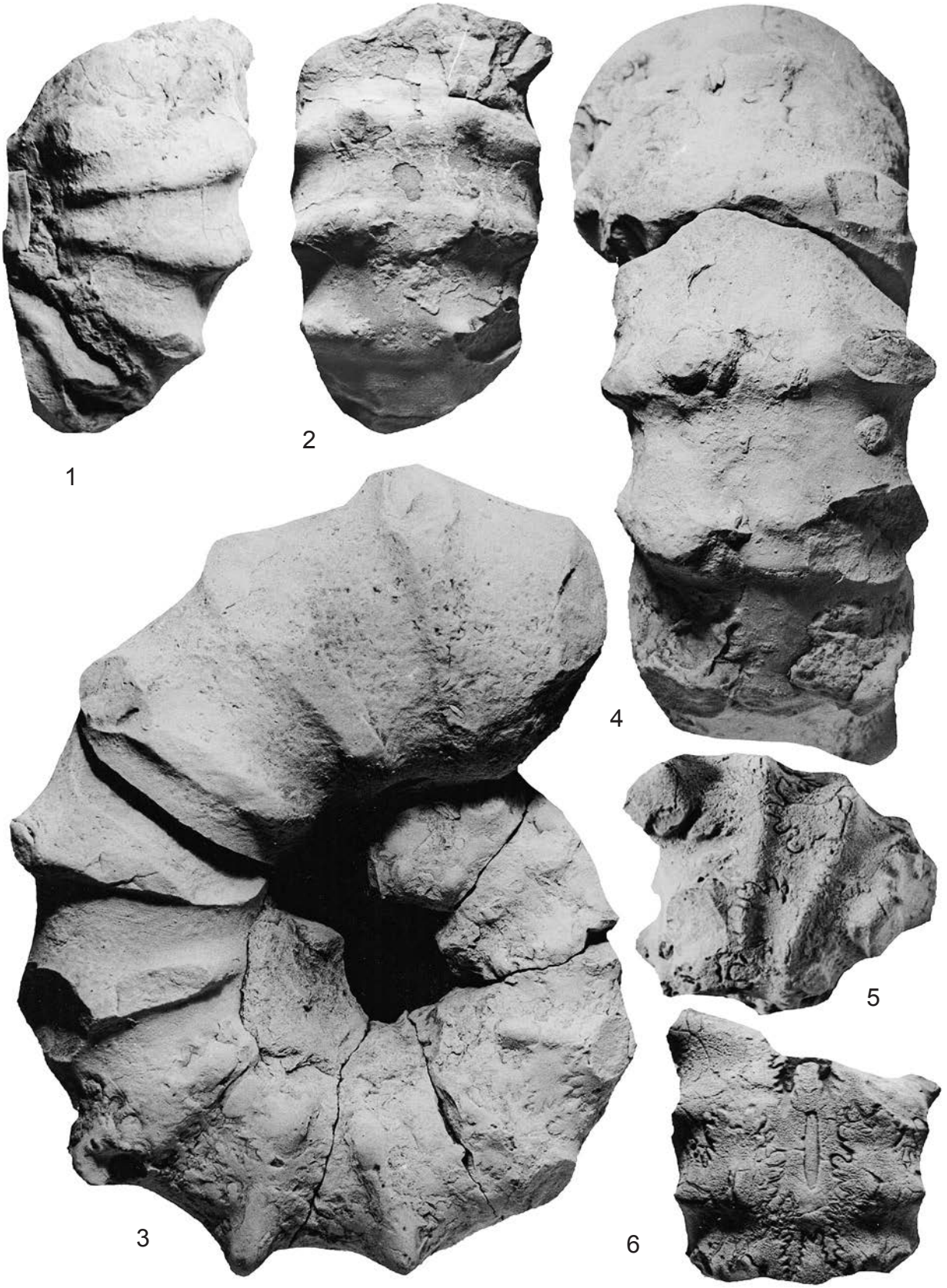
# PLATE 8

**1, 2, 5, 6** – *Cunningtoniceras inerme* (Pervinquière, 1907). 1, 2 – OUM KX14900, from bed 5. 5, 6 – OUM KX13755, from bed12. **3, 4** – *Cunningtoniceras africanum* (Pervinquière, 1907), OUM KX15325, from bed 12.

All specimens are from the Fahdene Formation north of Bou Khadra in northeastern Algeria.
All figures are × 1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# PLATE 9

**1, 2, 5, 6** – *Cunningtoniceras inerme* (Pervinquière, 1907). 1, 2 – OUM KX15255, from beds 3–7. 5, 6 – OUM KX14981, from bed 5. **3, 4**, **7-10** – *Cunningtoniceras africanum* (Pervinquière, 1907). 3, 4 – OUM KX15257, from beds 3–7. 7, 8 – OUM KX14995, from bed 5. 9, 10 – OUM KX15232, from beds 3–7.

All specimens are from the Fahdene Formation north of Bou Khadra in northeastern Algeria.
All figures are × 1

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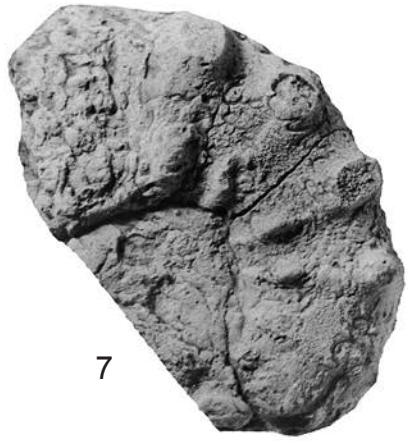

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# PLATE 10

*Cunningtoniceras africanum* (Pervinquière, 1907)

**1, 2** – OUM KX14995, from bed 5. **3, 4** – OUM KX15253, from beds 3–7. **5** – OUM KX14982, from bed 5. **6, 7** – OUM KX15291, from beds 3–7. **8** – OUM KX15254, from beds 3–7. **9** – OUM KX15263, from beds 3-7. **10, 11** – OUM KX15296, from beds 3–7.

All specimens are from the Fahdene Formation north of Bou Khadra in northeastern Algeria.
All figures are × 1

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# PLATE 11

**1, 2** – *Calycoceras* (*Gentoniceras*) *gentoni* (Brongniart, 1822), OUM KX13743, from bed 13. **3, 4, 7-10** – *Calycoceras* (*Newboldiceras*) *algeriense* sp. nov. 3, 4 – paratype OUM KX14119, from bed 26. 7, 8 – paratype OUM KX13983, from bed 19. 9, 10 – paratype OUM KX13894, from bed 15. **5, 6** – *Calycoceras* (*Newboldiceras*) *asiaticum asiaticum* (Kossmat, 1897), OUM KX13907, from bed 15. **11, 12** – *Calycocera*s (*Newboldiceras*) *planecostatum* (Kossmat, 1897), OUM KX13974, from beds 17–19.

All specimens are from the Fahdene Formation north of Bou Khadra in northeastern Algeria.
All figures are × 1


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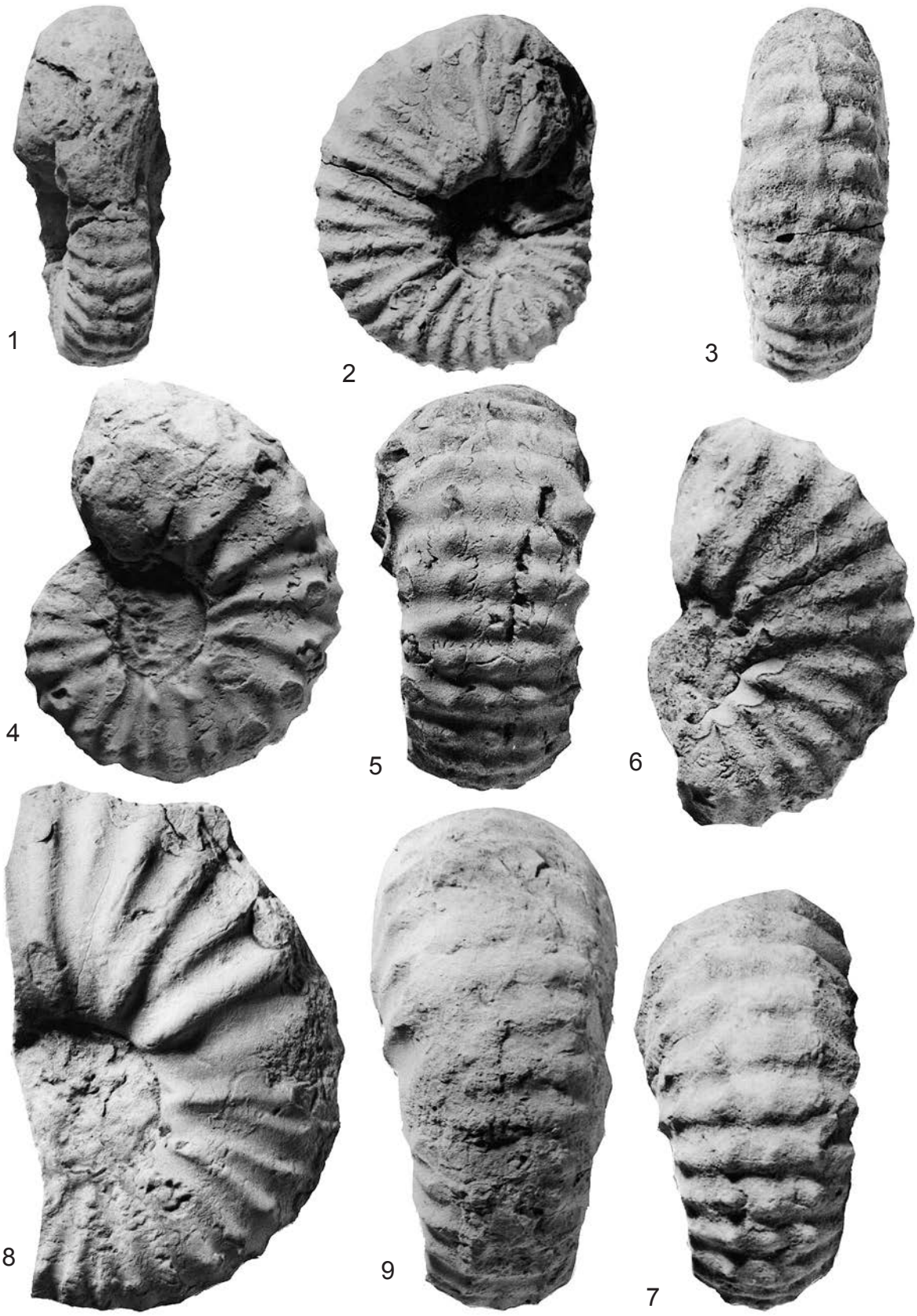
# PLATE 12

**1-9** – *Calycoceras* (*Newboldiceras*) *tunisiense* Kennedy, 2015. 1-3 – OUM KX14096, from bed 24. 4, 5 – OUM KX13944, from bed 17. 6, 7 – OUM KX13961, from beds 17–19. 8, 9 – OUM KX14043, from bed 22.

All specimens are from the Fahdene Formation north of Bou Khadra in northeastern Algeria.
All figures are × 1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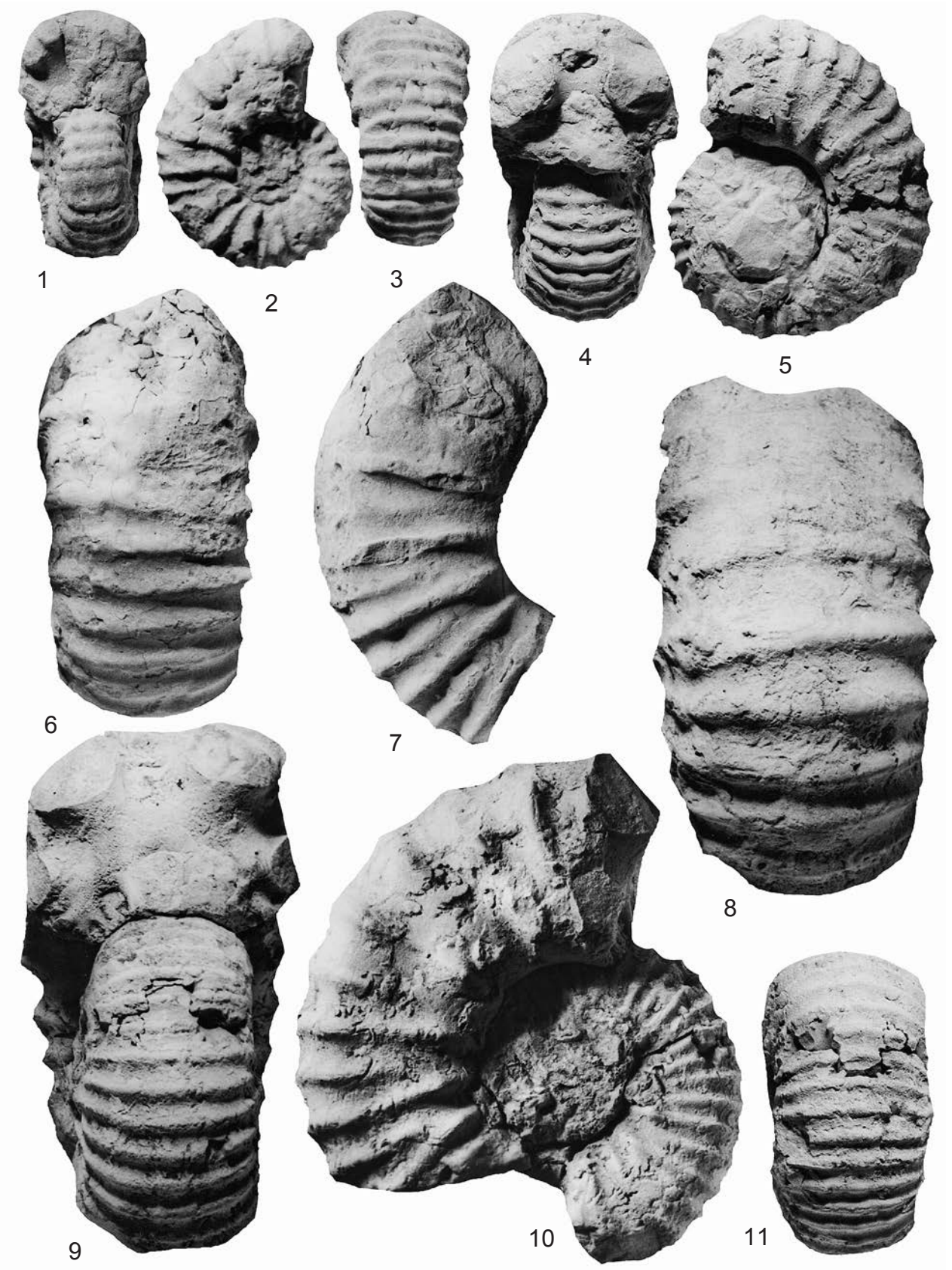
# PLATE 13

**1-3** – *Lotzeites elegans* Kennedy, 2015, OUM KX13906, from bed 15. **4-11** – *Calycoceras* (*Newboldiceras*) *algeriense* sp. nov. 4, 5, 8-11 – the holotype, OUM KX13948, from bed 17. 6, 7 – paratype OUM KX13655, from beds 11–13.

All specimens are from the Fadene Formation north of Bou Khadra in northeastern Algeria.
All figures are × 1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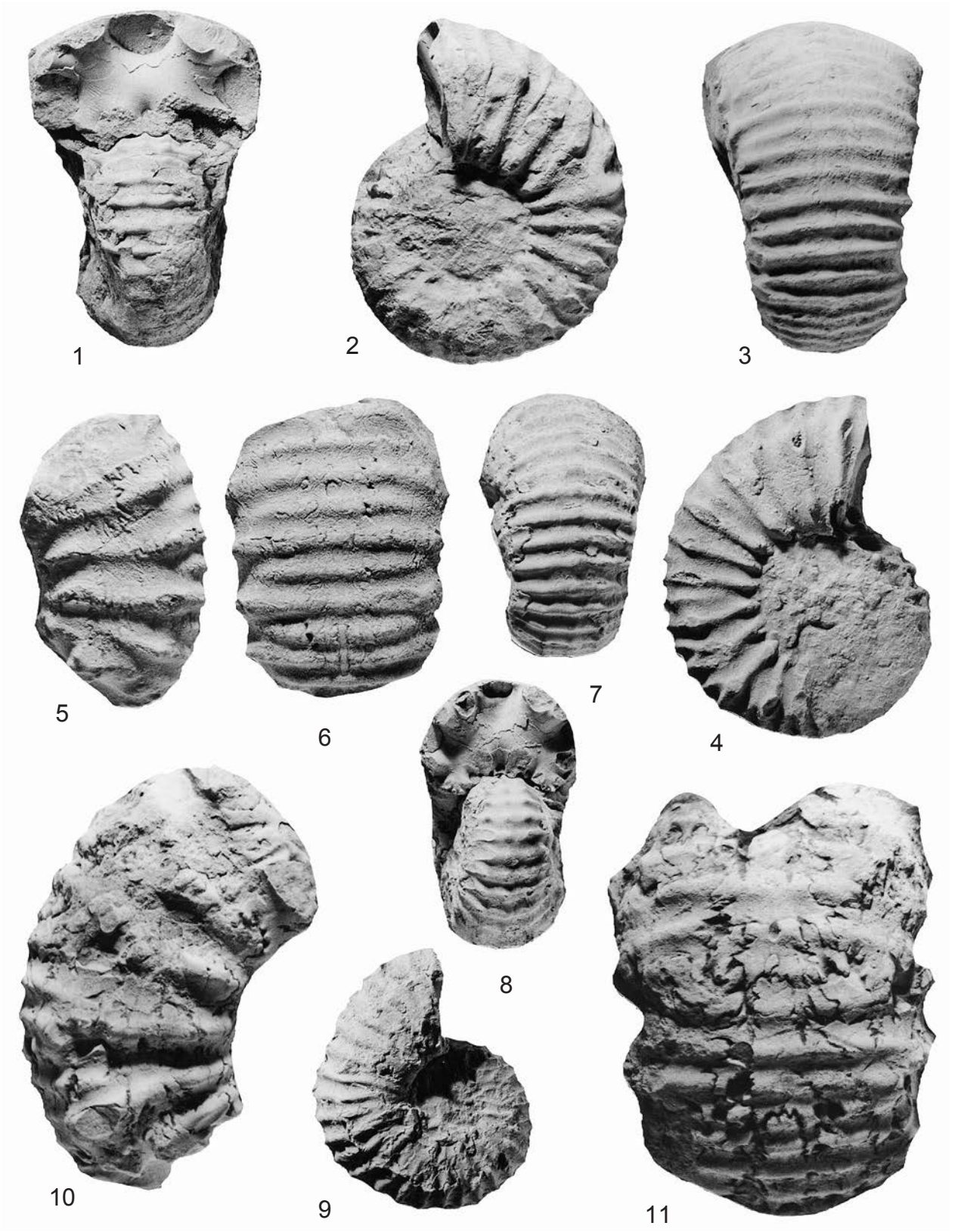
# PLATE 14

**1-6, 10, 11** –*Lotzeits elegans* Kennedy, 2015. 1-4 – OUM KX13974, from beds 17–19. 5, 6 – OUM KX14098, from bed 24. 10, 11 – OUM KX14025, from bed 22**. 7-9** – *Calycoceras* (*Newboldiceras*) *algeriense* sp. nov., inner whorls of the holotype, OUM KX13948, from bed 17.

All specimens are from the Fahdene Formation north of Bou Khadra in northeastern Algeria.
All figures are × 1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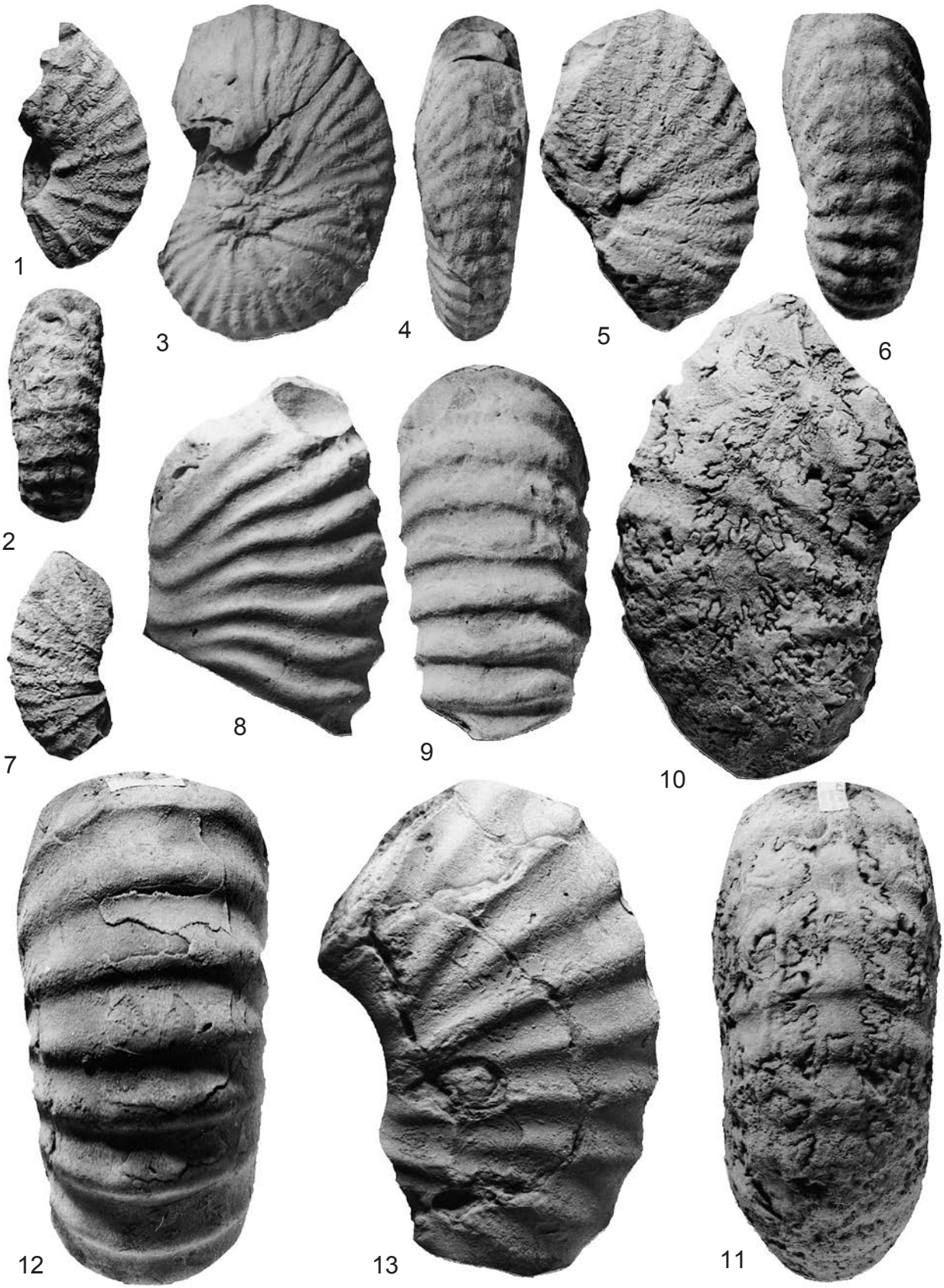
# PLATE 15

*Eucalycoceras batnense* (Collignon, 1937)

**1, 2** – OUM KX14070, from bed 26. **3, 4** – the original of *Protacanthoceras batnense* var. *tenuis* Collignon, 1937, pl. 2, fig. 4, from Batna in northeastern Algeria, the original is the Sorbonne Collections, and currently housed in the Université de Bourgogne, Dijon. **5, 6** – OUM KX13866, from bed 15. **7** – OUM KX14069, from bed 24. **8, 9** – OUM KX13968, from beds 17–19. **10, 11** – OUM KX13708, from beds 11–13. **12, 13** – OUM KX13940, from bed 17.

The originals of figs 1, 4-13 are from the Fahdene Formation north of Bou Khadra in northeastern Algeria.

All figures are × 1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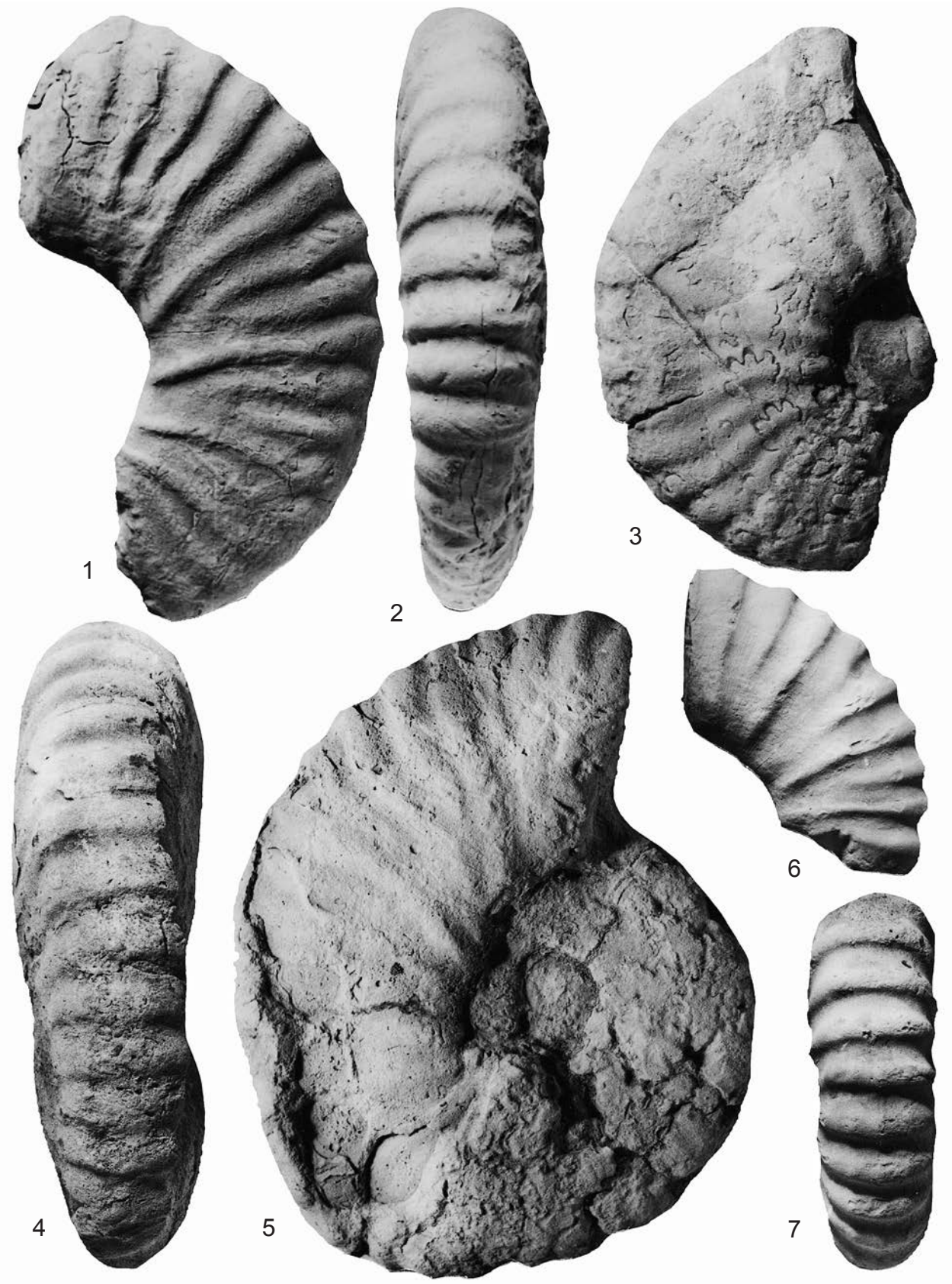
# PLATE 16

*Eucalycoceras batnense* (Collignon, 1937)

**1, 2** – OUM KX13722, from bed 12. **3** – OUM KX13837, from bed 15. **4, 5** – OUM KX14078, from bed 24. **6, 7** – OUM KX13721, from bed 15.

All specimens are from the Fahdene Formation north of Bou Khadra in northeastern Algeria.
All figures are × 1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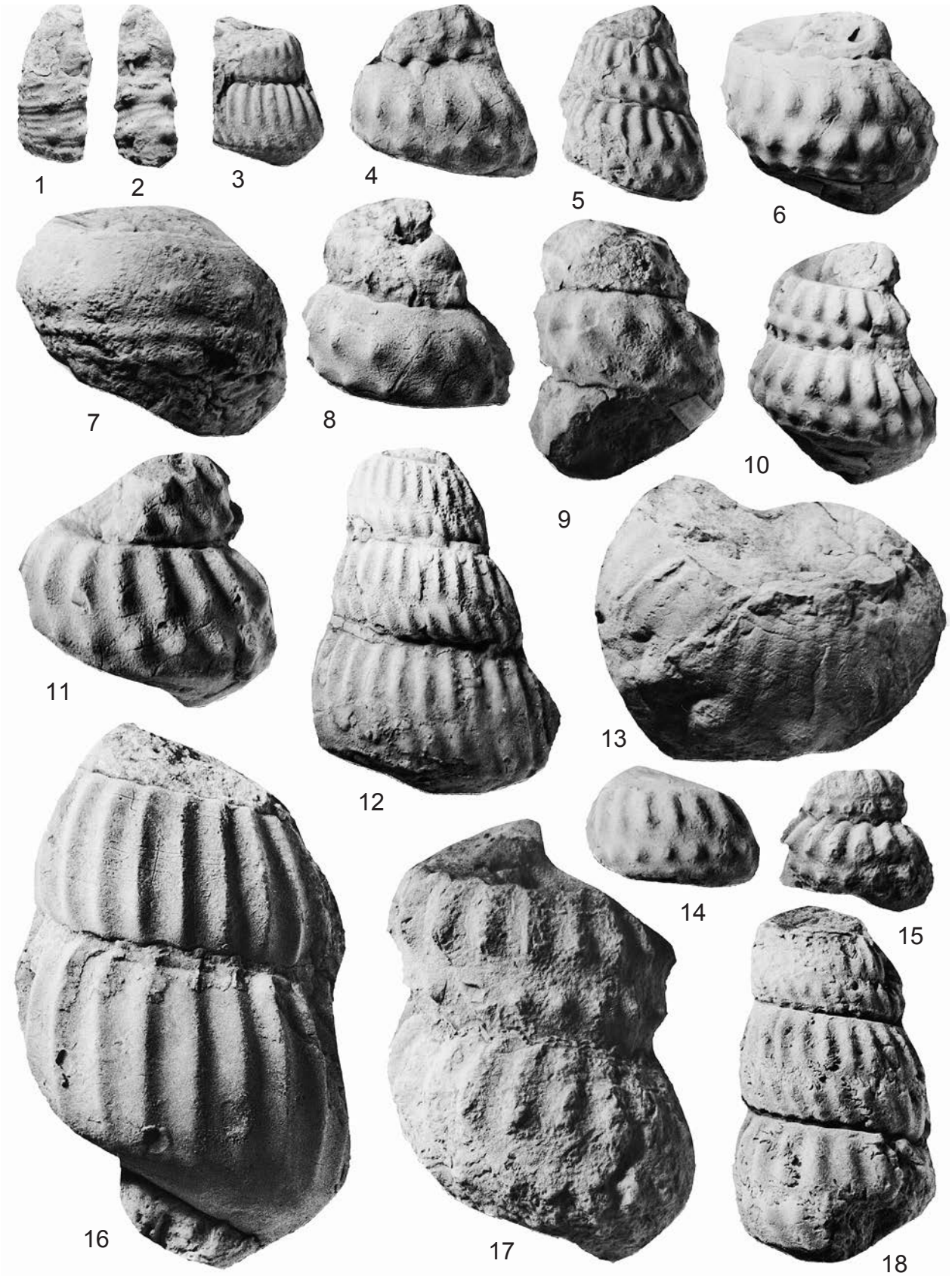
# PLATE 17

**1, 2** – *Anisoceras plicatile* (J. de C. Sowerby, 1819), OUM KX13770, from bed 12. **3, 12, 16, 18** – *Turrilites scheuchzerianus* Bosc, 1801. 3 – OUM KX13312, from beds 3–7. 12 – OUM KX13584, from bed 9. 16 – OUM KX13586, from bed 9. 18 – OUM KX13562, from bed 9. **4, 6, 8** – *Turrilites wiestii* Sharpe, 1857. 4 – OUM KX15203, from beds 3–7. 6 – OUM KX15200, from beds 3–7. 8 – OUM KX14949, from bed 3. **5, 10, 14** – *Turrilites costatus* Lamarck, 1801. 5 – OUM KX13918, from bed 15. 10 – OUM KX13686, from beds 11–13. 14 – OUM KX13756, from bed 12. **7, 13 –** *Hypoturrilites tuberculatoplicatus* (Seguenza, 1883). 7 – OUM KX13569, from unit 9. 13 **–** OUM KX14922, from bed 1. **9, 11, 15, 17** – *Turrilites acutus* Passy, 1832. 9 – OUM KX14051, from bed 23. 11 – OUM KX14103, from bed 24. 15 – OUM KX14026, from bed 22. 17 – OUM KX14054, from beds 24–26.

All specimens are from the Fahdene Formation north of Bou Khadra in northeastern Algeria.
All figures are × 1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