Stratigraphy and ammonite faunas of the Cenomanian rocks of Northern Ireland, UK

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A B S T R A C T

A re-examination of surviving outcrops of the Cenomanian parts of the Hibernian Greensands Formation of south and east Antrim in Northern Ireland, together with a revision of the limited ammonite faunas, provide a basis for dating and interpreting the sequence. The lower part of the Belfast Marls Member yields an early Cenomanian Mantelliceras dixoni Zone assemblage, whilst other faunal elements suggest the upper part extends into the lower part of the middle Cenomanian. The succeeding Islandmagee Siltstones Member yields the index species of the middle Cenomanian Acanthoceras rhodomagense and A. jukesbrownei zones. The Collinwell Sands Member is in part, or whole, of late Cenomanian age on the basis of the occurrence of the benthic foraminiferans Orbitolina. The erosion surface at the base of the Belfast Marls Member corresponds to the Ce3 maximum flooding surface recognised in the Anglo-Paris Basin; the erosion surface at the base of the Islandmagee Siltstones to the Ce4 maximum flooding surface and the erosion surface at the base of the Collinwell Sands Member to the sub-plenus erosion surface at the base of the late Cenomanian Metoicoceras gelineanum Zone.

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1. Introduction

Cenomanian strata in Northern Ireland are restricted to south and east Antrim, and crop out between Collinwell and Glenarm (Fig. 1). They form a thin, highly condensed succession, up to 20 m in thickness and comprising the lower part of the Hibernian Greensands Formation, which underlies the Ulster White Limestone. The Hibernian Greensands Formation has been divided into three members (Fig. 2; see Griffith and Wilson, 1982). There are currently outcrops at three localities; Collin Glen, Cloghfin Port and Portmuck (Fig. 1). Early studies on the Cretaceous successions of Northern Ireland were reviewed by Tate (1865), who noted the presence of Ammonites varians (= Schloenbachia varians) in what he termed the Glaucanitic Sands. The most significant subsequent account is that of Hancock (1961), who noted all of the Cenomanian ammonites then known from the sequence in his account of the Cretaceous System in Northern Ireland. There is a general review in Wilson (1972), and a more detailed one in Griffith and Wilson (1982), who provided further details. Here we give detailed accounts of the three surviving sections, and supply an illustrated revision of the ammonite faunas. On this basis we discuss the dating of the sequence in terms of the standard early and middle Cenomanian ammonite zonation developed in western Europe (Fig. 3), and detailed knowledge of the stratigraphical distribution of non-ammonite elements of the fauna based on the records from the ‘Lower Chalk’/Grey Chalk Subgroup of southern England (Kennedy, 1969; Gale, 1990, 1995; Kennedy and Gale, 2006). Detailed logs of the sections at Collin Glen, Cloghfin Port and Portmuck are illustrated in Figs. 4, 5 and 6, respectively.

2. Description of the sequence

2.1. Belfast Marls Member

This unit (Fig. 2), formerly known as the Glaucanitic Sands (Hancock, 1961) comprises 2–3 m of dark, highly glauconitic, strongly bioturbated sandy clay, resting unconformably upon Triassic and Lower Jurassic strata; the basal part contains small quartz pebbles, while small phosphatic pebbles are present throughout. The unit is only developed along the outcrop between...
Portmuck and Belfast (Fig. 1). Fossils occur throughout, but are commoner in the higher part, being abundant at two named levels.

The first of these is termed the Carr’s Glen Ammonite Bed. Hancock (1961) collected composite moulds of the early Cenomanian ammonites *Schloenbachia*, *Mantelliceras* and *Mariella* from a bed in Carr’s Glen, which lay close to the (unexposed) base of the Belfast Marls; the section is no longer available. A level 0.6 m above the base of the unit at Collin Glen also yields ammonites, which is thought to be a correlative level; however, they are much more poorly preserved there. The presence of *Acompsoceras* (Fig. 10A–C, F), together with *Mantelliceras* (Figs. 9I–J; 10D, E) and *Mariella* (Fig. 7E–F) in the lower part of the Belfast Marls fauna demonstrate that this is of *Mantelliceras dixoni* Zone age.

The second named level is the Portmuck Oyster Bed. A concentration of oysters is present between 1.0 and 1.5 m beneath the top of the Belfast Marls at Collin Glen and Portmuck, which also yields common belemnites, calcitic bivalves and rare brachiopods. This bed was also exposed in Carr’s Glen (Hancock, 1961; material now in the Sedgwick Museum, Cambridge). At Portmuck this yielded:

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Fig. 2. Litho- and biostratigraphical classification of the Hibernian Greensands Formation.
Amphidonte obliquatum (Pulteney, 1813) (abundant)
Entolium orbiculare (J. Sowerby, 1817) (common)
Neithea cf. gibbosa (Pulteney, 1813) (2)
Neithea cometa (d’Orbigny, 1847) (1)
Oxytoma seminudum (Dames, 1874) common
Platythyris squamosa (Mantell, 1822) (1)
Praeactinocamax primus (Arkhangelsky, 1912) common
Gryphaeostrea canaliculata (J. Sowerby, 1813)

Additional species of bivalve, none of them age diagnostic, were recorded by Griffith and Wilson (1982) from unspecified localities.

The co-occurrence of P. primus and common E. orbiculare and O. seminudum is strongly suggestive of precise correlation with the middle Cenomanian Cast Bed in southern England and its correlative level in France and Germany, to which P. primus is restricted (Gale, 1990, 1995; Wilmsen, 2003; Wilmsen et al., 2007), and in which the other two species are abundant. In the Cast Bed, Amphidonte occurs only as a rarity and N. cf. gibbosa is unknown. The Cast Bed, and underlying limestone, yield a fauna of Turrilites costatus Subzone age at Lewes (Sussex) and Folkstone (Kent). If this correlation is correct, it suggests that the uppermost 1.5 m of the Belfast Marls are also of Turrilites costatus Subzone age. However, in southern England, a level with common Cunningtoniceras spp. occurs between the uppermost occurrence of Mantelliceras (M. dixoni Zone) and the lowest occurrence of T. costatus and Acanthoceras rhotomagense, the Cunningtoniceras inerme Zone (Gale, 1995). In fact, it is the only level in the UK in which Cunningtoniceras inerme is present. A single specimen of C. sp. (group of cunningtoni) from Sallagh Braes, Larne (Fig. 10C), may therefore possibly be from the Belfast Marls, although the matrix is suggestive of the overlying Islandmagee Siltstones.

### 2.2. Islandmagee Siltstones Member

Formerly known as the Yellow Sandstone (Hancock, 1961), this unit comprises 5–10 m of well-indurated, poorly glauconitic siltstones. On the coast, at Cloghfin Port and Portmuck, they are conspicuously rhythmic on the scale of about 1 m, comprising hard beds of siltstone alternating with marly intervals. In contrast, they are massive, with a few weak partings, in the inland exposure at Collin Glen. The rhythms are similar to those developed in the Lower Chalk of southern England and the hard beds have conspicuously burrowed tops. Macrofauna can be collected readily at Cloghfin Port, and includes common serpulids (Rotularia sp.), less common calcite bivalves (Entolium sp., Merklinia sp.) and abundant small corals (Micrabacia coronula (Goldfuss, 1826)), at the 6.5 m level. Griffith and Wilson (1982) recorded additional species, including the echinoid Holaster cf. trecensis (Leymerie, 1842), from...
Fig. 4. The succession at Collin Glen, with possible sequence stratigraphic events indicated (UWLF: Ulster White Limestone Formation).
this member. Stratigraphically unlocalised specimens of the index species (see below) indicate the presence of the Acanthoceras rhotomagense zone in the Islandmagee Siltstones. The latter are known only from the former exposure at Magheramorne, which only exposed the upper part of the member (Hancock, 1961). The presence of Micrabacia coronula in one bed at Cloghfin Port is significant, because this species is abundant in the middle part of the Acanthoceras rhotomagense zone in southern England (Kennedy, 1969).

### 2.3. Collinwell Sands Member

This unit, formerly known as the Zone of Exogyra columba, of the Upper Glaucocitic Beds (Hancock, 1961), is up to 9 m in thickness and comprises medium to coarse, calcareous, glauconitic sands, including some gravel-grade quartz at the base, which rest disconformably on the Islandmagee Siltstones. The basal contact is a burrowed erosional surface. The Collinwell Member only occurs as isolated pockets along the outcrop from Belfast to Glenarm, and has been divided into two units, of which the lower is only developed locally. It has not yielded ammonites, but the large oyster Rhynchostreon suborbiculatum (Lamarck, 1801) is common; elsewhere it is known to range from the upper Cenomanian to mid-Turonian. The member has yielded Cenomanian brachiopods at several localities and the large benthic foraminiferan Orbitolina, also typical of the Cenomanian (Hancock, 1961). The unit is therefore largely, or entirely, of Cenomanian age, although an unlocalised record of Inoceramus ex gr. lamarcki Parkinson, 1818, is indicative of a middle Turonian date (Griffith and Wilson, 1982).

### 3. Sea level changes and sequence stratigraphy

The Cenomanian succession in the Anglo-Paris Basin contains a number of distinctive sedimentary packages, which Robaszynski et al. (1998) numbered Ce1–5, and identified as being related to eustatic sea level fluctuations. Equivalent events have also been identified in Germany (Wilmsen, 2003) and further afield (Gale et al., 2003, 2008). It is to be expected that these should be recognisable in the highly condensed, shallow-marine succession in the Antrim Basin, where sea level fluctuations are likely to be evident.

The lowermost Cenomanian strata present, i.e., the lower part of the Belfast Marls, are of Mantelliceras dixoni Zone age, so the transgressive base of the member likely represents the Ce 3 flooding surface identified elsewhere. However, the major regressive/transgressive event at the Ce3–4 boundary, which is widely represented in Europe, also falls within the Belfast Marls, coinciding temporally with the Portmuck Oyster Bed (equivalent to the Cast Bed in the Anglo-Paris Basin) and the immediately subjacent deposits. This is not marked by any facies change in Northern Ireland, and evidently had no influence on the succession, which is remarkable. The highly glauconitic, condensed Belfast Marls evidently represent the slow, initial flooding of the region, when little accommodation space was available.

The boundary between the Belfast Marls and Islandmagee Siltstones Member is marked by a decrease in grain size, a considerable increase in carbonate content, and a major reduction in glauconite, all indicating significant deepening. This probably corresponds to the maximum flooding surface within Ce4, equivalent to the boundary between the classic Chalk Marl and Grey Chalk in southern England, which is also a calcimetry break (Gale, 1995; Gale and Hancock, in; Gale et al., 1997) and is approximately equivalent to the boundary between the Turrilites costatus and T. acutus subzones. The strongly developed rhythmicity seen in the coastal sections of the member (Portmuck, Cloghfin Port), and the presence of abundant Rotularia and, at one level, the small coral Micrabacia, both afford comparisons with the lower part of the Grey Chalk in successions in southern England. The Islandmagee Siltstones represent, biostratigraphically, at least parts of the

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Fig. 6. The succession at Portmuck, with possible sequence stratigraphic events indicated.
Acanthoceras rhotomagense and A. jukesbrownei zones, although the boundary between the two cannot be placed accurately in the succession. This boundary also coincides, approximately, with a sequence boundary in southern England, France and Germany (Gale, 1995; Robaszynski et al., 1998; Wilmsen, 2003), which evidently has no representation in the succession in Northern Ireland.

The erosional surface between the Islandmagee Siltstones and the Collinwell Sands represents a sequence boundary, and a significant sea level fall, with deeper-water silts beneath and coarse to medium quartz sands preserved locally above. The presence of unambiguously Cenomanian shallow-water brachiopod and echinoid taxa in this unit (Hancock, 1961) provides some limited evidence of age. The brachiopods Cyclothyris spp. and the echinoid Catopygus columbaris (Lamarck, 1816), present in the Collinwell Sands, are both common in the Sables de Bousse in Sarthe, France (Juignet, 1974) in an approximately equivalent facies, of roughly the same age and similar water depth, and are of late Cenomanian Metoicoceras geslinianum Zone age. It is therefore likely that the sub-Collinwell Sand surface represents the sequence boundary at the base of that zone (the sub-plenus erosion surface; see Robaszynski et al., 1998). The absence of highstand deposits of late Cenomanian and early Turonian age can perhaps be attributed to deep erosion during the major Turonian lowstand. The overlying Kilcoan Sands are undoubtedly of mid–late Coniacian age (Hancock, 1961) and represent a later, major transgression.

4. Repositories

BELUM – The Ulster Museum, National Museums of Northern Ireland, Belfast, Northern Ireland; BGS – British Geological Survey, Keyworth, Nottinghamshire, UK; BMNH – The Natural History
5. Systematic palaeontology

Superfamily Hoplitoidea H. Douville, 1890
Family Schloenbachidae Parona and Bonarelli, 1897
Genus Schloenbachia Neumayr, 1875
Type species: Ammonites varians J. Sowerby, 1817, p. 169, pl. 176, by subsequent designation of H. Douville (1890, p. 290).

Schloenbachia varians (J. Sowerby, 1817)

1817 Ammonites varians J. Sowerby, p. 169 (pars), p. 176 uppermost figure, left-hand figure in lowest row.
1972 Schloenbachia subvarians Spath; Wilson, p.51, pl. 6, fig. 1.
2015 Schloenbachia varians (J. Sowerby, 1817); Kennedy, p. 419, pl. 125, figs 2, 5; pls 126–135; pl. 136, fig. 1; text-figs 161–163, 164b–c, 165–167,169–173 (with full synonymy).
2015 Schloenbachia varians (J. Sowerby, 1817); Kennedy in Morel, p. 134, text-figs 129a–b, e, h–m.

Type. The lectotype, by subsequent designation of Spath (1938, p. 544), is BMNH 43962b, the original of J. Sowerby (1817, pl. 176, top figure), refigured by Kennedy (2015, pl. 125, fig. 2). It is from the Lower Chalk of an unknown locality in southern England.

Material. There are numerous specimens, including SMC B80933–80943 (ex J.M. Hancock Collection), from 2.1 m below the top of the ‘Glauconitic Sands’ at Carr’s Glen, Cave Hill, Belfast (County Antrim), BGS FD4429, 4431, 4433, 4436 and NIF 348 (the original of Wilson, 1972, pl. 6, fig. 1), also from Carr’s Glen. BELUM K655, K11480, K11487–11488, K11499, K11553–11554, K11568–11569, K11579, K11589, K11617, K11619, K11621–11623, K11635, K11652, K10695, K18456, K24792 and K24876. All specimens are from the Belfast Marls Member.

Remarks. Schloenbachia varians was comprehensively revised by Kennedy (2015), who recognised a series of formae, from robust to gracile: ventriosa, varians (sensu stricto), subtuberculata, intermedia and subplana. In southern England it is the Glauconitic Marl that is closest in facies to the Belfast Marls Member that has yielded the present material. Robust forms (ventriosa plus varians (sensu stricto)) make up only from 3 to 11 per cent of assemblages in the Glauconitic Marl and gracile forms predominate. The same predominance of gracile individuals is recognised in the present material. Unphosphatised specimens from Cave Hill (Fig. 7A–D, G, H) are all formae intermedia and subtuberculata, with passage forms between. Better-preserved phosphatised material (Figs 9A–H; 7A–D, G, H; 8A–F, H, I) includes a single robust individual, BELUM K11635 corresponding to varians (sensu stricto) (Fig. 9C–E) and two that correspond to forma subplana, BELUM K11589 (Fig. 9A, B) and BELUM K11488 (Fig. 8F–H). The latter comprises the adapertural part of the
phragmocone and adapical part of the body chamber of a microconch, with a strong constriction, comparable to an individual from Maiden Bradley figured by Kennedy (2015, pl. 128, fig. 1). Most of the other phosphatised fragments correspond to formae subtuberculata and intermedia.

Occurrence. Lower Cenomanian, mantelli and dixoni zones, with records from East Greenland, Northern Ireland, England, southern Belgium, France (Boulonnais to Alpes-Maritimes), Germany, Bornholm in the Baltic Sea, Switzerland, Poland, Bulgaria, southern Ukraine, Moldova, Russia as far east as Khrebet Pay-Koy on the Kara Sea coast, the Mangyshlak Peninsula in Kazakhstan, the Kopet Dag, Turkmenistan and Iran, north of the Zagros.

Superfamily Acanthoceratoideae Grossouvre, 1894
Family Acanthoceratidae Grossouvre, 1894
Subfamily Mantelliceratinae Hyatt, 1903

Genus Mantelliceras Hyatt, 1903
Type species: Ammonites mantelli J. Sowerby, 1814, p. 199, by original designation of Hyatt (1903, p. 113) (ICZN Specific Name No. 1634).

Mantelliceras mantelli (J. Sowerby, 1814)

Fig. 10D, E.

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. 20, figs 1–2, 4; pl. 21, figs 2, 4; pl. 24, fig. 3; pl. 36, fig. 1; text-figs 20a–d, 26a, c, e, 28a–e.
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).
2011 Mantelliceras mantelli (J. Sowerby, 1814); Mosavinia and Wilmsen, p. 178, text-figs 3a–e (with additional synonymy).
2015 Mantelliceras mantelli (J. Sowerby, 1814); Kennedy in Kennedy and Gale, p. 264, pl. 7, fig. 3; pl. 8, figs 1, 5 (with additional synonymy).
2015 Mantelliceras mantelli (J. Sowerby, 1814); Kennedy in Morel, p. 137, text-figs 102, 130a.

Type. The lectotype, by subsequent designation of Kennedy (1971, p. 52), is BMNH 43940a, from the lower Cenomanian Chalk Marl of Ringmer, near Lewes, Sussex, the original of J. Sowerby (1814, pl. 55, lower figure only), reillustrated by Wright and Kennedy (1984, pl. 18, fig. 3).
**Material.** BELUM K11565, from the Belfast Marls Member ['Glauconitic Sands'], Cave Hill, Belfast (County Antrim). The matrix suggests the specimen is from the shell bed approximately 1 m above the base of the unit.

**Remarks.** The specimen is distorted into an ellipse with a major axis 76 mm long. The original whorl proportions cannot be established. Ornament is of crowded primary and intercalated ribs. The primaries bear umbilical, lateral, inner and outer ventrolateral tubercles, the intercalated ribs bear inner and outer ventrolateral tubercles only, the latter connected over the venter by a well-developed transverse rib. The diagnostic features of *Mantelliceras mantelli* are the polygonal whorl section, the primary ribs with umbilical, lateral, inner and outer ventrolateral tubercles, the intercalated ribs with inner and outer ventrolateral tubercles only. The present specimen compares well with the original of Wright and Kennedy (1984, pl. 17, fig. 2), from Warminster in Wiltshire, UK. Those authors provided a comprehensive discussion of the species.

![Images of fossils](https://example.com/fig10)

**Fig. 10.** A–C, *Acompsoceras renevieri* (Sharpe, 1857). A–C, BELUM K11564; F, BELUM K11634, the matrix indicates that both are from the Island Magee Siltstones Member of Cave Hill, Belfast, County Antrim. D, E, *Mantelliceras mantelli* (J. Sowerby, 1814), BELUM K11565, from the Belfast Marls Member of Cave Hill.
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, North Africa, KwaZulu-Natal in South Africa, Madagascar, southern India and Japan.

**Mantelliceras cantianum** Spath, 1926

1926 **Mantelliceras cantianum** Spath, p. 82.
1984 **Mantelliceras cantianum** Spath, 1926; Wright and Kennedy, p. 103, pl. 17, fig. 2; pl. 20, fig. 3; pl. 21, fig. 3; pl. 24, figs 1–2, 4–6; pl. 25, figs 1–6; pl. 26, figs 1–2, 4–5; pl. 38, fig. 1; text-figs 25a, 27e–h, j–l, 721a–c (with full synonymy).

2015 **Mantelliceras cantianum** Spath, 1926; Kennedy in Kennedy and Gale, p. 265, pl. 10, fig. 8 (with additional synonymy).

2015 **Mantelliceras cantianum** Spath, 1926; Kennedy in Morel, p. 137, text-fig. 104.

Types. The holotype, by original designation, is BMNH 36834, from the lower Cenomanian Chalk Marl of Dover, Kent; paratype BMNH C5027 is from the same unit at Lewes, Sussex. Both were figured by Sharpe (1857, pl. 18, figs 1–2) and Wright and Kennedy (1984, pl. 24, figs 2, 6).

Material. BELUM K11618 [‘Glaucocnitic Sandstone, Cave Hill, Belfast, County Antrim’], from the Belfast Marl Member; the matrix suggests the specimen to be from the shell bed approximately 1 m above the base of the unit.

Description. BELUM K11618 is a 90° whorl sector with a maximum preserved whorl height of 23.7 mm. The whorl section is depressed, with a whorl breadth to height ratio of 1.1. The intercostal whorl section is reniform, the costal section polygonal, with the greatest breadth at the lateral tubercle. Primary ribs arise on the umbilical wall. One of them develops a strong umbilical bulba; another lacks a bulba. There is a well-developed inner lateral tubercle on the primary ribs. Single ribs intercalate between successive primaries and all ribs bear a feebly clavate outer ventrolateral tubercle, the outer ventrolateral tubercles linked across the venter by a strong, transverse rib.

Discussion. The present fragment differs from co-occurring Mantelliceras mantelli in the strong lateral tubercle and absence of an inner ventrolateral tubercle. These are characteristics of Mantelliceras cantianum. Reference is made to Wright and Kennedy (1984, p. 103) for a full discussion of the species.

Occurrence. Lower Cenomanian, Mantelliceras mantelli and M. dixoni zones. The geographical distribution extends from southern England across France, northern Spain, Germany, Switzerland, Romania(?), Iran, central Tunisia, KwaZulu-Natal in South Africa, to near Lindi in Tanzania, Madagascar and Japan.

Subfamily Acanthoceratinae de Grossouvre, 1894

Genus *Acompsoceras* Hyatt, 1903

Type species: *Ammonites bochhensis* Schlüter, 1871, p. 1, pl. 1, figs 1–4, by original designation (Hyatt, 1903, p. 111).

**Acompsoceras renevieri** (Sharpe, 1857)

Fig. 10A–C, F.

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 renevieri* (Sharpe, 1857); Kaplan et al., p. 136, pl. 10, figs 6–7; pl. 34; pl. 35, figs 1–3; pl. 37, figs 4–6; pl. 38; pl. 40; pl. 41, figs 1, 5 (with additional synonymy).

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 (with additional synonymy).

2015 *Acompsoceras renevieri* (Sharpe, 1857); Kennedy in Morel, p. 139, text-figs 107, 132b–c.

Types. The lectotype, designated by Wright and Wright (1951, p. 38), is GSM 7753 (figured by Wright and Kennedy, 1987, pl. 43, fig. 2), from Blackdown, Isle of Wight, the original of Sharpe (1857, pl. 20, fig. 2). The paralectotypes have not been traced.

Material. BELUM K11634, from [Cave Hill, Belfast], County Antrim and BELUM K11564, also from [Cave Hill, Belfast], County Antrim. The matrix of both specimens suggest them to be from the Belfast Marl Member.

Remarks. BELUM K11634 (Fig. 10F) is a composite mould of a 120° whorl sector with a maximum whorl height of 23 mm. The whorl section is compressed, with feebly convex, subparallel inner and mid-flanks, convergent outer flanks, broadly rounded ventrolateral shoulders and a feebly convex venter. There are seven ribs on the fragment. Two are primaries, one with a well-developed umbilical bulba. They are straight, prorsiradial, broadened markedly across the flanks and are separated by narrower interspaces. Two long or short ribs intercalate between, one with an incipient bulba, the other without. All ribs link to a well-developed ventrolateral clavus. The clavi are linked across the venter by a low, broad, transverse rib with suggestions of very feeble siphonal clavi in places. BELUM K11564 (Fig. 10A–C) is a much larger fragment, lacking the umbilical margin, with a maximum preserved whorl height of 44 mm. The whorl section is very compressed, the flanks flattened and subparallel, the ventrolateral shoulders broadly rounded, the narrow venter flattened. Parts of six low, broad, prorsiradial ribs are preserved on the fragment. It is not possible establish which are primaries and which are intercalated. All bear well-developed feebly clavate inner, and stronger, markedly clavate outer ventrolateral tubercles. There is a marked siphonal ridge, strengthened into clavi that correspond to the outer ventrolaterals.

BELUM K11634, which lacks inner ventrolateral tubercles, corresponds to the feebly ornamented variants of the species, comparing well with the lectotype (Wright and Kennedy, 1987, pl. 43, fig. 2). BELUM K11634, with well-developed inner and outer ventrolateral and siphonal tubercles, agrees well with the original of their text-fig. 43d–e, from the Lower Chalk of Ventnor, Isle of Wight. Acompsoceras inconstans (Schlüter, 1871) (p. 7, pl. 3, figs 1–5; see revisions in Wright and Kennedy, 1987, p. 143, pl. 42, figs 4, 6–7; pl. 43, fig. 1; text-figs 34c, 41–42, 43a–c, 44; Kaplan et al., 1998, p. 138, pl. 10, figs 8–10; pl. 33, figs 1–2; pl. 36, figs 4–5; pl. 37, figs 1–3; pl. 39; pl. 42, figs 3–4; Kennedy in Kennedy and Gale, 2015, p. 281, pl. 12, fig. 5; pl. 13, figs 2–3) is easily distinguished from the present species in having a lateral tubercle.

Occurrence. Lower Cenomanian, Mantelliceras dixoni Zone, and lower middle Cenomanian Cunningtoniceratina inermee Zone. The geographical distribution extends from Northern Ireland to southern England, Germany, France (Haute Normandie, Sarthe and Provence), Germany, Poland, Iran, Algeria, central Tunisia, Nigeria(?) and Madagascar.

Genus *Cunningtoniceras* Collignon, 1937

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

*Cunningtoniceras* sp. (group of cunningtoni (Sharpe, 1855))

Fig. 14C.
**Material.** BELUM K11839, possibly from the Islandmagee Siltstones Formation ['Yellow Sandstone'] of Sallagh Braes, Larne (County Antrim).

**Remarks.** The specimen is a highly deformed fragment of a 180° whorl sector, 58 mm long. The whorl section appears to have originally been depressed, oval in intercostal section and polygonal in costal section, with the maximum breadth at the inner ventrolateral tubercles. There are seven primary ribs on the fragment. They arise at strong umbilical bullae and are coarse and straight, linking to strong conical inner ventrolateral tubercles, all of which are damaged, but appear to have been circular in cross section. A broad rib links to a large, feebly clavate outer ventrolateral tubercle. These are linked across the venter by a very low transverse rib, the adapical and adapertural edges of which are strengthened, to produce a pair of riblets linking the outer ventrolateral clavi. There is a well-developed siphonal clavus on the adapical riblet. Kennedy (in Kennedy and Gale, 2015) described the early developmental stages of Cunningtoniceras, recognising an initial stage with inner and outer ventrolateral and siphonal tubercles that are equal in number, with a single ventral rib bearing the outer ventrolateral and siphonal tubercles, as in Acanthoceras Neumayr, 1875, succeeded by a stage in which pairs of ribs link the outer ventrolateral tubercles across the venter. Two groups were recognised, that of Cunningtoniceras cunningtoni, in which there are fewer outer ventrolateral than siphonal clavi, and the group of Cunningtoniceras meridionale (Stoliczka, 1864), in which there are equal numbers of outer ventrolateral and siphonal tubercles. The present specimen has developed pairs of riblets between the outer ventrolateral clavi, but only the adapical riblet has developed a tubercle, in what is interpreted as the transitional phase between the first and second ontogenetic stages. It is suggested that it is a member of the cunningtoni group, although specifically indeterminate.

**Occurrence.** As for material. Representatives of the cunningtoni group are restricted to the lower middle Cenomanian inerme Zone in northern Europe.

**Genus Acanthoceras Neumayr, 1875**

Type species: *Ammonites rhomagensis* Brongniart, 1822, pp. 83, 391; pl. 6, fig. 2, by subsequent designation of de Grossouvre (1894, p. 27).

**Acanthoceras rhomagensis** (Brongniart, 1822)

Fig. 11.

1822 *Ammonites rhomagensis* Defr.; Brongniart, pp. 83, 391, pl. 6, fig. 2.
1987 *Acanthoceras rhomagensis* (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, 67g, 68–69 (with full synonymy).

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2011 *Acanthoceras rhotomagense* (Brongniart, 1822); Mosavinia 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 (with additional synonymy).

2015 *Acanthoceras rhotomagense* (Brongniart, 1822); Kennedy in Morel, p. 140, text-fig. 133a–f.

**Type.** The lectotype, by subsequent designation by R. Douvillé (1912), is MNHP F.J04190, the original of Brongniart (1822, pl. 6, fig. 2), ex Sorbonne Collections, from Rouen, Seine-Maritime. It was figured by, amongst others, Wright (1996, text-fig. 119/3a–b).

**Material.** BELUM K1681, from the 'Chloritic Sands' of County Antrim. The matrix indicates the specimen to be from the Islandmagee Siltstones Formation.

**Remarks.** The specimen is a massive fragment of a composite mould of a flank and the ventral region that is almost wholly septate, lacking the umbilical margin. The maximum whorl height is an estimated 95 mm. Parts of six ribs are preserved. They are strong, coarse and feebly prorsiradiate. There is a trace of a large umbilical bulla on one rib and indications of a strong inner ventrolateral tubercle. The specimen is referred to *Acanthoceras rhotomagense* on the basis of the presence of primary ribs only, their strength and style finding a match in large specimens from southern England (Wright and Kennedy, 1987).

**Occurrence.** Lower middle Cenomanian *Acanthoceras rhotomagense* Zone. The species occurs in western Europe from Northern Ireland through England, France (Boulonnais to Provence), Switzerland, Germany, Bornholm in the Baltic Sea, northern Spain, Romania, Daghestan, Turkmenistan and northern Iran, Algeria, Tunisia, New Guinea, Japan and possibly Peru and Bathurst Island (northern Australia).

*Acanthoceras jukesbrownei* (Spath, 1926)

**Figs. 12–13.**

1867 *Ammonites hippocastanum* Sowerby; Sharpe, p. 37, pl. 17, figs 2–4.

1926 *Protacanthoceras jukesbrownei* Spath, p. 82.

1961 *Acanthoceras cf. sherborni* Spath; Hancock, p. 15.

1987 *Acanthoceras jukesbrownei* (Spath, 1926a); Wright and Kennedy, p. 191, pl. 49, figs 2–4; pl. 50, figs 1–5; pl. 51, figs 1–7; text-figs 55–62, 65e–f, h –j, l, m, 66e, 67h–q (with full synonymy).

1998 *Acanthoceras jukesbrownei* (Spath, 1926a); Kaplan et al., p. 144, pl. 48, figs 3–4; pl. 49, fig. 1; pl. 50, figs 1–2; pl. 62, fig. 3 (with additional synonymy).

2015 *Acanthoceras jukesbrownei* (Spath, 1926); Kennedy in Morel, p. 140, text-fig. 133I.

**Type.** The holotype, by monotypy, is BMNH 50162, the original of Sharpe (1857, pl. 17, fig. 2), from the middle Cenomanian Chalk Basement Bed of Man O’War Cove, Dorset. It was refigured by Wright and Kennedy (1987, pl. 50, fig. 3).

**Material.** SMC B80989–80991 (ex J. M. Hancock Collection), from the Islandmagee Siltstones Formation ['Yellow Sandstone'] of Magheramorne (County Antrim).

**Remarks.** SMC B80989 (Fig. 12) is interpreted as a robustly ornamented variant of the species. It is a composite mould with a
maximum preserved diameter of 140 mm. The whorls are massive, the whorl section depressed, with a whorl to breadth to height ratio of 1.25. Five ribs are preserved on either flank of the fragment, with massive umbilical bullae that give rise to single coarse, prorsiradiate ribs that link to massive conical inner ventrolateral tubercles, with ill-preserved indications of an outer ventrolateral clavus borne on a coarse transverse rib that is prominent on the ventrolateral shoulders but effaced over most of the venter. This specimen corresponds to that from Chard in Somerset figured by Wright and Kennedy (1987, text-fig. 59). SMC B80991a–b (Fig. 13) is interpreted as a feebly ornamented variant of the species. It is a composite mould, approximately 115 mm in diameter, the whorl section slightly compressed, the whorl breadth to height ratio 0.9. Coiling is moderately evolute, with 45 per cent of the previous whorl covered. The umbilicus is of moderate depth, the umbilical shoulder quite narrowly rounded. The flanks are flattened and subparallel, the ventrolateral shoulders broadly rounded, the venter flattened. There are 7–8 blunt umbilical bullae per half whorl; they give rise to single low, broad, straight, prorsiradiate ribs that link to blunt inner ventrolateral tubercles. A low, blunt rib sweeps forwards across the ventrolateral shoulder and links to a low, blunt outer ventrolateral clavus, there is a faint siphonal ridge. There are indications of short intercalated ribs between successive primaries, but preservation is defective. This specimen corresponds to that from the Chalk Basement Bed at Osmington in Dorset figured by Wright and Kennedy (1987, text-fig. 60). SMC B80900a–b is a large battered fragment with a maximum preserved diameter of 155 mm approximately, with single intercalated rib at the greatest preserved diameter. It corresponds to the original of Wright and Kennedy (1987, text-fig. 61). Those authors provided an extensive account of the species and discussed differences from others referred to the genus.

Occurrence. Upper middle Cenomanian Acanthoceras jukesbrownei Zone, with records from Northern Ireland, southern England, France (Boulonnais, Haute-Normandie, Sarthe and Provence), Germany, Poland and the Kopet Dag in Turkmenistan.

Genus Calycoceras Hyatt, 1900 (ICZN Generic Name No. 1352) Type species: Ammonites navicularis Mantell, 1822, p. 198, pl. 22, fig. 5. By designation under the Plenary Powers (ICZN Opinion No. 557)

Calycoceras sp.

Fig. 14A–B.

Material. BELUM 1890-306 from the Islandmagee Siltstones Formation ['Yellow Sandstone'] of Whitehead (County Antrim). Remarks. The present specimen is that referred to by Hancock (1961, p. 18) as being from sands presumed to be below the Inoceramus band, 'an indigenous ammonite cast, indeterminable even generically, but comparable to an inflated Calycoceras'. It is a wholly septate fragment, with a maximum preserved whorl breadth of 55 mm approximately, the whorl section depressed the flanks convex, the venter broadly rounded. There are six worn ribs, preserved on the mid-to outer flank, ventrolateral shoulders and ventral regions, with indications of small inner and clavate outer ventrolateral tubercles. Hancock (1961) correctly assigned it to Calycoceras, but a more precise identification is not possible.

Occurrence. As for material.

Subgenus Newboldiceras Thomel, 1972

Type species: Acanthoceras newboldi Kossmat, 1897, p. 5 (112), pl. 1 (12), figs 2–3; pl. 2 (14), fig. 2, by original designation of Thomel (1972, p. 105 = Acanthoceras rhotomagense var. asiatica Jimbo, 1894, p. 177, pl. 20, fig. 1) (see Wright and Kennedy, 1996, p. 239).

Calycoceras (Newboldiceras) asiaticum asiaticum (Jimbo, 1894)

Fig. 14D–F.
1865 *Ammonites Rotomagensis* Defrance; Stoliczka, p. 66 (*pars*), including *typicus* (p. 68) (*pars*), *subcompressus* (p. 68), pl. 34, figs 3–4; pl. 35, fig. 1; pl. 36, fig. 1; pl. 37, figs 1–2.

1894 *Acanthoceras rhotomagense* var. *asiatica* Jimbo, p. 177, pl. 20, fig. 1.

1996 *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, 88a, 97–98 (with full synonymy).

2010 *Calycoceras* (*Newboldiceras*) *asiaticum asiaticum* (Jimbo, 1894); *Kennedy and Klinger*, p. 10, figs 32, 33a–f, 34j–l, p, q, 36–38, 44d–e, h, 57a–f (with additional synonymy).

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 (with additional synonymy).

2015 *Calycoceras* (*Newboldiceras*) *asiaticum asiaticum* (Jimbo, 1894); *Kennedy in Morel*, p. 141, fig. 135f.

**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 Ikushumbets, Hokkaido, Japan. A cast was figured by *Wright and Kennedy* (1996, text-fig. 97) and *Kennedy and Klinger* (2010, text-fig. 38).

**Material.** BELUM K11578, from Collin Glen, County Antrim. The matrix indicates the specimen to be from the Islandmagee Siltstones Formation.

**Remarks.** The specimen is crushed and the umbilical and inner flank regions are concealed by matrix. The maximum preserved diameter is 85 mm. The original whorl section appears to have been polygonal in costal section. There are 20 ribs per half whorl at the ventrolateral shoulder, primaries, long and short intercalatories. The ribs are crowded, narrow, straight and prorsiradiate. The primary ribs bear small umbilical bullae, and all ribs bear small conical inner, and feebly clavate outer ventrolateral tubercles. The outer

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**Fig. 14.** A, B, *Calycoceras* sp., BELUM 1890-306, from the Island Magee Siltstones Member of Whitehead, County Antrim. C, *Cunningtoniceras* sp. group of *cunningtoni* (Sharpe, 1855), the matrix suggests the specimen is from the Island Magee Siltstones Member of Sallagh Braes, Larne, County Antrim. D–F, *Calycoceras* (*Newboldiceras*) *asiaticum asiaticum* (Jimbo, 1894), BELUM K11578, from the Island Magee Siltstone Member of Collin Glen, County Antrim.

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ventrolateral clavi are linked across the venter by a strong, transverse rib; there are small siphonal tubercles. Ribbing style, density, and tuberculation indicate this specimen to be a *Newboldiceras*. It compares well with better-preserved specimens from southern India, as with the original of pl. 65, fig. 7 in *Wright and Kennedy* (1996) from the middle Cenomanian Chalk Basement Bed of Ringstead, Dorset. Reference is made to that paper (p. 239) for a discussion of differences from other species and subspecies within the genus.

**Occurrence.** Upper middle and lower upper Cenomanian, with records from Northern Ireland, southern England, northern and southern France, Spain, the Czech Republic, Romania, Bulgaria, Algeria, Tunisia, KwaZulu-Natal in South Africa, Madagascar, southern India, Papua-New Guinea and Japan, and possibly Poland, Israel and China.

Suborder Ancyloceratina *Wiedmann*, 1966
Superfamily Turrilitoidea *Gill*, 1871
Family Turrilitidae *Gill*, 1871

Genus and subgenus *Mariella* *Nowak*, 1916
Type species: *Turrilites bergeri* *Brongniart*, 1822, p. 395, pl. 7, fig. 3, by original designation of *Nowak* (1916, p. 10).

**Mariella (Mariella) essenensis** (Geinitz, 1849) *Fig. 7E–F.*

1849 *Turrilites essenensis* Geinitz, p. 122, pl. 6, figs 1–2.
1996 *Mariella (Mariella) essenensis* (Geinitz, 1849); *Wright and Kennedy*, p. 332, pl. 102, fig. 4; pl. 108, fig. 15; pl. 110, fig. 7; text-figs 136f, 141c–d, f–g (with full synonymy).

1998 *Mariella (Mariella) essenensis* (Geinitz, 1849); *Kaplan et al.*, p. 200, pl. 60, figs 1–2; pl. 61, figs 1–2; pl. 64, fig. 6; pl. 66, fig. 11.

Type. The holotype, by monotypy, is the original of *Geinitz* (1849, pl. 6, figs 1–2), from the unterre[n] Quadermergel, that is to say the Essent Giesensand of Essen, Nordrhein-Westfalen, Germany.

**Material.** SMC B80944–80945 (ex J.M. Hancock Collection), from 2.1 m below the top of the Belfast Marls Member [*Glauconitic Sands*] at Carr’s Glen, Cave Hill, Belfast (County Antrim).

**Remarks.** SMC B80944 (*Fig. 7E*) is a crushed whorl with a maximum preserved whorl height of 10 mm and a diameter of 18.6 mm. Ornament consists of a row of larger rounded tubercles just above the middle of the outer, exposed whorl face, a second row of smaller, spirally elongated tubercles, below and displaced adaperturally, and a third row, also spirally elongated, and displaced adaperturally of the second row. SMC B80945 (*Fig. 7F*) is a fragment with a maximum preserved whorl height of 11.6 mm, with three rows of tubercles, as in the previous specimen. The presence of only three rows of tubercles, their relative strengths and shapes indicate these fragments to be *M. (M.) essenensis*, and distinguish the species from all other European Cenomanian representatives of the genus. Reference is made to *Wright and Kennedy* (1996, p. 332) for further discussion.

**Occurrence.** Lower Cenomanian, *Mantelliceras saxbii* Subzone of the *M. mantelli* Zone and *M. dixonii* Zone where well dated. There are records from Northern Ireland, southern England, northern France, Germany, Poland, Romania, Iran, Turkmenistan, Madagascar and, possibly, Mozambique.

### 6. Conclusions

A re-examination of previously collected ammonites from the Cenomanian parts of the Hibernian Greensands demonstrated the presence of key markers for the lower Cenomanian, *Mantelliceras dixonii* Zone and the middle Cenomanian *Cunningtoniceras inerne*, *Acanthoceras rotmonagense*, and *A. jukesbrownei* zones. Taken together with other faunal evidence, the succession can be related to the standard sequence boundaries of the Anglo-Paris Basin. The transgressive base of the Belfast Marls is interpreted as corresponding to the Ce3 flooding surface of *Robaszynski et al.* (1998); the Belfast Marls-Island Magee Siltstones boundary to the maximum flooding surface within Ce4, whilst the erosional boundary between the Island Magee Siltstones and the Colinwell Sands may correspond to the sub-plenus erosion surface.

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### References


Sowerby, J., 1812–1822. The Mineral Conchology of Great Britain. 1 pls 1–9 (1812); 2, pls 10–44 (1813); 3, pls 45–78 (1814); 4, pls 79–102 (1815); 5, pls 103–114 (1815); 6, pls 115–150 (1816); 7, pls 151–186 (1817); 8, pls 187–203 (1818); 3, pls 204–221 (1818); 8, pls 222–253 (1819); 9, pls 254–271 (1820); 10, pls 272–306 (1821); 4, pls 307–318 (1821); 11, pls 319–383 (1822). The author, London.


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


