FOSSIL NAUTILOIDS FROM THE UPPER LIAS (TOARCIAN) 'JUNCTION BED' OF THE ILMINSTER AREA, SOMERSET

ANDY KING

Abstract

The Upper Lias 'Junction Bed' (Toarcian, Lower Jurassic) in Somerset has long been known as a rich source of fossils, especially ammonites, brachiopods, bivalves and belemnites. Fossil nautiloids also occasionally occur, but are less common than other molluscs. Three species of fossil nautiloid (belonging to the Order Nautilida) – *Cenoceras astacoides* (Young and Bird 1828), *Cenoceras jourdani* (Dumortier 1874) and *Cenoceras terebratum* (Dumortier 1874) – are described here from the Junction Bed of the Ilminster area. All three species are relatively well known and established within the geological literature, but this is the first time they have been 'formally recorded' from Somerset. The specimens mainly comprise internal moulds of septate phragmocones, but several retain traces of body chamber, external shell and ornament.

INTRODUCTION AND HISTORICAL RESEARCH

The Upper Lias Junction Bed (including the Marlstone) in Somerset, especially in the Ilminster area, has long been famed as a rich source of fossils, and recently ploughed surface brash in fields still yields many specimens. Fossil ammonites, brachiopods, bivalves and belemnites are extremely common at certain levels, with some horizons also containing nodules with well preserved vertebrate (especially fish) and insect remains.

Fossil nautiloids (Order Nautilida) are also encountered within the Junction Bed but, although they are often found in association with ammonites, they are typically much less common. Three species assigned to the nautilid genus *Cenoceras*, namely *C. astacoides* (Young and Bird 1828), *C. jourdani* (Dumortier 1874) and *C. terebratum* (Dumortier 1874), all from the Junction Bed around Ilminster, are described here.

A local geologist, Charles Moore, collected extensively from the Ilminster area and published his findings in a series of classic papers (Moore 1853; 1866). Moore's collection is currently housed mainly at Bath Museum, but none of the former small building-stone quarries he collected from (for example, at Strawberry Bank) are now available.

Interest in the palaeontology of the Junction Bed around Ilminster was revived following the excavation of farm buildings at Barrington and the extensive collection of ammonite faunas from these locations (Hamlet 1922; Spath 1922; Pringle and Templeman 1922). A summary of these and other exposures was given by Wilson *et al.* (1958) and a temporary, but relatively complete section seen in Stocklinch reservoir excavations was described by Howarth (Cope et al. 1980, 54, Fig. 10A, column T2). Howarth (1992) also reviewed the Barrington section in his monographic description of British Toarcian ammonite faunas.

More recently, exposures of the Junction Bed in the Ilminster area have mainly been confined to temporary exposures created by pipe-laying and bypass (A303) works, or new building excavations, such as at Green Lane End (ST 40601578). One of

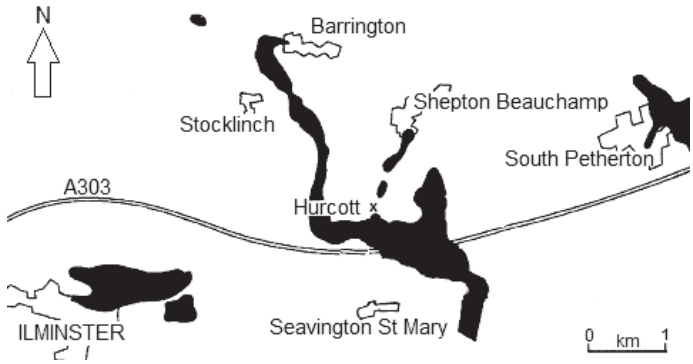


Fig. 1 Ilminster area, showing outlines of main towns and villages, with Toarcian outcrop area in black; redrawn from Boomer et al. *2009, fig. 1*

the few permanent exposures occurs in lane-side sections near Hurcott (Hurcott Lane Cutting Site of Special Scientific Interest, ST 39841601).

Boomer *et al.* (2009) reviewed the biostratigraphy of the Middle and Upper Lias strata in the Ilminster area (Fig. 1), and analysed the rich microfloras and microfaunas (especially ostracods), using the standard ammonite zonation scheme for chronostratigraphical correlation.

STRATIGRAPHY

The stratigraphical nomenclature of the Upper Pliensbachian and Toarcian limestones in south-west England, including Somerset, has had a complex history. Various names have been applied to different parts of the succession, including Junction Bed, Saurian Bed, Fish Bed, Insect Bed, Marlstone, Middle Lias and Upper Lias. These are now largely consolidated into a single formation, the Beacon Limestone Formation (Cox *et al.* 1999) with its type section designated at Thorncombe Beacon, near Seatown on the Dorset coast. In Somerset the Beacon Limestone Formation is divided into a lower Marlstone Rock Member (up to 6m thick in the Ilminster area) and an upper Barrington Member (up to 2.6m thick). Figure 2 provides a simplified summary of the stratigraphy, showing some of the lithostratigraphical units against the standard ammonite zonal and subzonal scheme.

Where their stratigraphical occurrence is known, the majority of the specimens of nautilids described in this paper have been recorded from the Bifrons Zone. This may be a reflection of collection bias since, although the 'Junction Bed' facies is highly condensed, in the Ilminster area the Bifrons and Serpentinum Zones are relatively well developed and have a broad outcrop area in comparison with other ammonite zones which are very thin or even missing (Boomer *et al.* 2009, fig. 2). However, in his original descriptions of *Cenoceras jourdani* and *C. terebratum*, Dumortier (1874) also recorded these species only from the Bifrons Zone of the Rhône Basin, and Howarth (1962) reported *C. astacoides* from the Bifrons Zone of the 'Alum Shale' at Whitby. Further study of these Toarcian nautilids is required to delimit more precisely their stratigraphic ranges, and to establish whether they have potential value as zonal indicators in situations where ammonites are absent.

LITHOLOGY

Lithologically, the Beacon Limestone Formation comprises relatively massive, iron-rich bioclastic calcarenitic limestones (Marlstone Rock Member) overlain by pale cream-coloured interbedded argillaceous limestones and marls (Barrington Member). Planar erosion surfaces, iron-staining and derived, worn fossils (especially ammonites) commonly occur. Both ammonites and nautilids are usually preserved as internal moulds, often with septa visible. Traces of external shell and ornament are occasionally preserved. Both the condensed sediments and fossils indicate deposition in well oxygenated, shallow marine environments which may have been subject to periodic emergence and reworking of sediments. These contrast with the deeper water dysaerobic marine conditions (characterised by thick sequences of dark, bituminous shales and mudstones) which occurred in the main depositional basins in northern England and Europe during Toarcian times.

<table>
<tr><th>SERIES</th><th colspan="2">STAGE</th><th colspan="2">AMMONITE ZONES / SUBZONES</th><th colspan="2">LITHOSTRATIGRAPHY</th><th></th></tr>
<tr><td rowspan="7">UPPER LIAS</td><td rowspan="7">TOARCIAN</td><td rowspan="2">UPPER</td><td>pseudoradiosa</td><td>levesquei</td><td>BRIDPORT or YEOVIL SANDS</td><td colspan="2">BRIDPORT SAND FORMATION</td></tr>
<tr><td colspan="2">thouarsense</td><td rowspan="5">JUNCTION BED</td><td rowspan="5">BARRINGTON MEMBER</td><td rowspan="6">BEACON LIMESTONE FORMATION</td></tr>
<tr><td rowspan="3">MIDDLE</td><td colspan="2">variabilis</td></tr>
<tr><td rowspan="2">bifrons</td><td>bifrons</td></tr>
<tr><td rowspan="3">LOWER</td><td>sublevisoni</td></tr>
<tr><td rowspan="2">serpentinum</td><td>falciferum</td></tr>
<tr><td>elegantulum</td></tr>
<tr><td>MIDDLE LIAS (part)</td><td colspan="2">PLIENSBACHIAN (part)</td><td colspan="2">tenuicostatum
spinatum</td><td>MARLSTONE</td><td>MARLSTONE ROCK MEMBER</td></tr>
</table>

Fig. 2 Summary stratigraphy of the Upper Lias sequence in the Ilminster area

NAUTILID LIFE MODE AND MORPHOLOGY

Living nautilids, represented by the genera *Nautilus* and *Allonautilus* (Ward and Saunders 1997) are entirely marine. They inhabit the deep slopes of Indo-Pacific coral reefs, occurring at depths of around 300 to 500m, but rise at night to around 100m to feed, mate and lay eggs. They are predators and feed mainly on shrimp, crustaceans and small fish, but will also scavenge. They swim by a form of underwater 'jet propulsion' in which water is drawn into and out of the living chamber by a specialist organ (the hyponome); the animal adjusts its buoyancy by osmotically pumping gas and liquid in or out of the chambers via a siphuncle which extends the whole length of the coiled shell. Unlike other cephalopods (squids, cuttlefish and octopus), nautiluses do not have particularly good vision but use olfaction and sensory tentacles for foraging, locating prey or identifying potential mates. Their lifespan may exceed 20 years.

Figure 3 illustrates the morphological terms used in the following descriptions of *Cenoceras*. The shell morphology of modern-day and Jurassic nautilids is very similar and it is tempting to think of them exhibiting comparable behaviour and life modes. However, the fossilisation of any soft tissue of cephalopods is extremely rare and this makes some direct and detailed comparisons between fossil and modern nautilids difficult.

SYSTEMATIC PALAEONTOLOGY

All the nautilids examined here were obtained from the Upper Lias of the Ilminster area between 1996 and 2005, and are deposited in collections at Somerset Heritage Service (SHS), Taunton (King Collection, accession numbers 7/2011/100–123).

With the exception of Kummel (1956) and the original type descriptions by Dumortier (1874), the following synonymy-lists include only selected British references. Occurrences are also only given for the UK.

Class CEPHALOPODA Cuvier, 1797
Order NAUTILIDA Agassiz, 1847
Family CENOCERATIDAE Tintant and Kabamba, 1983
Genus *CENOCERAS* Hyatt, 1883

Diagnosis: 'Evolute to involute, compressed lenticular to globose, depressed venter and flanks rounded to flattened; test generally bearing fine longitudinal lines and [transverse] growth lines; suture generally with shallow ventral and lateral lobes; position of siphuncle variable but never at extreme dorsal or ventral position' (Kummel 1964, K449).

Discussion: The name *Cenoceras* has been very broadly applied to a highly diverse range of nautilids that range from late Triassic to early mid Jurassic in age. Conventionally the taxon has been regarded as a 'plastic evolving complex' (eg Kummel 1956) which exhibits a wide variation in shell morphology, siphuncle position, suture and ornamentation. However, although this approach is convenient, it may actually mask a number of genuinely distinct lineages within the rapidly evolving lower Jurassic nautilid faunas.

Some previous workers (Hyatt 1894; Spath 1927) recognised a number of different morphotypes within the '*Cenoceras* complex' and provided names for some forms (including *Digonioceras*, *Ophionautilus* and *Sphaeronautilus*), but the taxonomic status of these is uncertain and in need of revision. Kummel (1956; 1964) regarded all these taxa as synonyms of

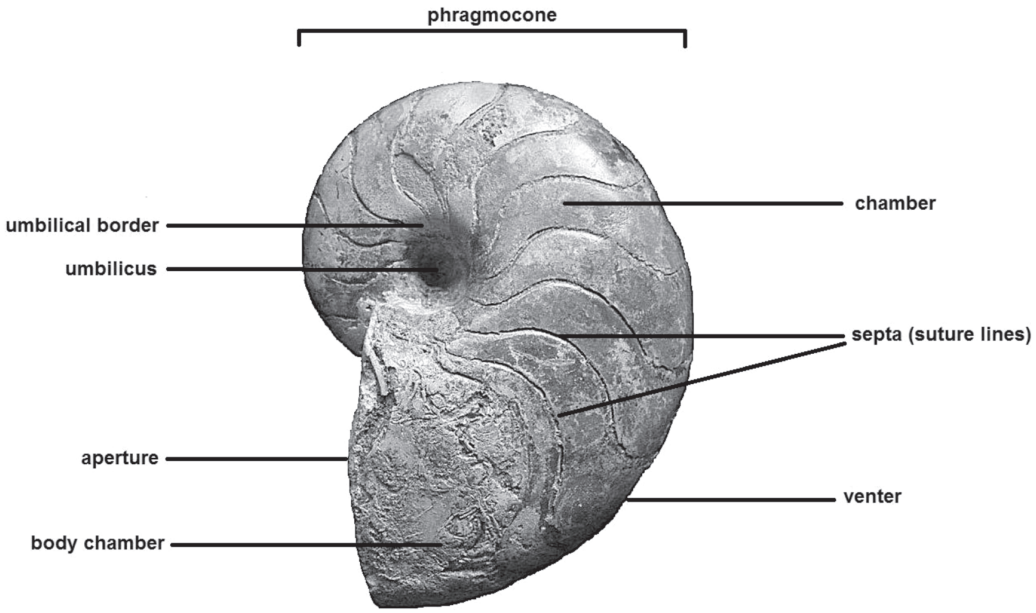


Fig. 3 Morphological terms used to describe nautilids, exemplified by Cenoceras jourdani *(Dumortier 1874)*

Cenoceras. More recently, Tintant (1984) described three subgenera within *Cenoceras* (*Cenoceras* in a restricted sense, *Hemicenoceras* and *Metacenoceras*) based on apparently consistent differences in conch form (stout, rapidly expanding or laterally compressed shells) and extent and type of external shell ornament (relatively coarse spiral raised lines (lirae) or finer, transverse growth lines).

The three species of *Cenoceras* described here from the Toarcian of the Ilminster area, all possess relatively stout, involute conchs with spiral ornament on their venter and whorl sides. Consequently they are regarded to fall within the definition of *Cenoceras* (*sensu stricto*) as exemplified by the type species *Cenoceras intermedium* (Sowerby) from the Lower Lias of the Keynsham area, and the earliest species assigned to the genus, *Cenoceras trenchmanni* (Kummel) from the Upper Triassic of New Zealand.

Occurrence: *Cenoceras* (in a broad sense) is a near cosmopolitan genus, ranging from the Upper Triassic (Carnian) to Middle Jurassic (Bajocian). A considerable number of species occur in Britain throughout the outcrop of Liassic and Inferior Oolite strata extending from the Dorset coast, via Somerset and the East Midlands, to the Yorkshire coast.

CENOCERAS ASTACOIDES (Young and Bird 1828)

Figs 4A, 5A–C, 8A

1828. *Nautilus astacoides*, Young and Bird, p. 270, pl. xiii, fig. 2.
1835. *Nautilus astacoides*, Young and Bird 1828; Phillips, p. 166, pl. xii, fig. 16.
1854. *Nautilus astacoides*, Young and Bird 1828; Morris 1854, p. 306.
1876. *Nautilus astacoides*, Young and Bird 1828; Blake (Tate and Blake, p. 313).
1891. *Nautilus astacoides*, Young and Bird 1828; Foord, p. 199–200.
1956. *Cenoceras astacoides* (Young and Bird 1828); Kummel, p. 364, fig. 9L.
1962. *Cenoceras astacoides* (Young and Bird 1828); Howarth, p. 96–7, pl. 13, figs 3a–b, pl. 14, fig. 1.

Type material: The holotype (Whitby Museum, WM 61) comprises a wholly septate phragmocone, 282mm across, from the Alum Shale (Bifrons Zone) of the foreshore east of Whitby. Suture lines are almost straight, and preserved shell fragments exhibit well developed longitudinal striae.

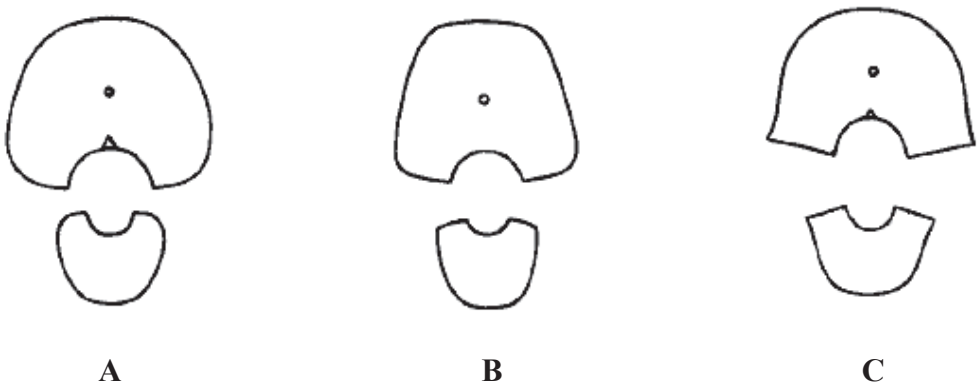


Fig. 4 Shell cross-sections of: A. Cenoceras astacoides *(Young and Bird 1828); B.* Cenoceras jourdani *(Dumortier, 1874); C.* Cenoceras terebratum *(Dumortier 1874). Redrawn from Pia (1914) and from Ilminster specimens*

Specific diagnosis: Inflated *Cenoceras*, with relatively narrow chambers, nearly straight septa and large umbilicus with rounded margins.

Material studied: A single septate phragmocone (SHS, 7/2011/100), lacking body chamber, 61mm in diameter, from the 'Upper Lias (surface brash) of the Ilminster area' (exact location uncertain).

Description: Shell inflated, slightly compressed at the sides and on the venter, the whorls wider than high, the widest part occurring a little below the midline. Umbilicus distinct and relatively large, accounting for *c*. 15% of the shell diameter, umbilical margins rounded. Siphuncle subcentral or located slightly below the centre. Septa number *c*. 20 to a whorl, suture lines very weakly sinuous, almost straight. The shell is ornamented throughout with strong, well developed irregular longitudinal striae, crossed by transverse indistinct flexuous lines which form a ventral sinus.

Occurrence: Upper Lias of Somerset (Ilminster area) and Yorkshire (Whitby). The species is known to occur within the Bifrons Zone, but may extend above or below this.

CENOCERAS JOURDANI (Dumortier 1874)

Figs 4B, 6A–E, 8C–D

1874. *Nautilus Jourdani*, Dumortier, p. 44–5, pl. vii, figs. 1–5.
1890. *Nautilus Jourdani*, Dumortier; Foord and Crick, p. 268, fig. 2.
1891. *Nautilus Jourdani*, Dumortier; Foord, p. 202–3, fig. 35.
1956. *Cenoceras jourdani* (Dumortier); Kummel, p. 0364, fig. 9N.

Type material: The syntypes comprise four specimens (housed in collections at Musée de Lyon) ranging from partial to subcomplete phragmocones from the 'Lias Supérieur' (Bifrons Zone) at Saint-Romain and La Verpillière, Rhône Basin, France.

Specific diagnosis: Moderately inflated *Cenoceras* with flattened whorl sides and venter, septa strongly sinuous with relatively deep, conspicuous lateral saddle.

Material studied: Twenty specimens (SHS, 7/2011/103–123) varying from septate parts of phragmocones to near complete shells (reaching a diameter of 148mm) with apical portions of body chambers attached; several conchs retain traces of the external shell ornament. All are from the 'Junction Bed' of the Ilminster area, including: Hurcott Lane Cutting (ST 3984 1601); temporary exposures near Green Lane End (ST 4060 1578); surface brash from fields near Barrington and Dillington (ST 3753 1505); and old quarries at Stocklinch and near Donyatt. Many of the specimens were found in association with fossil ammonites including *Hildoceras bifrons* (Bruguière) and

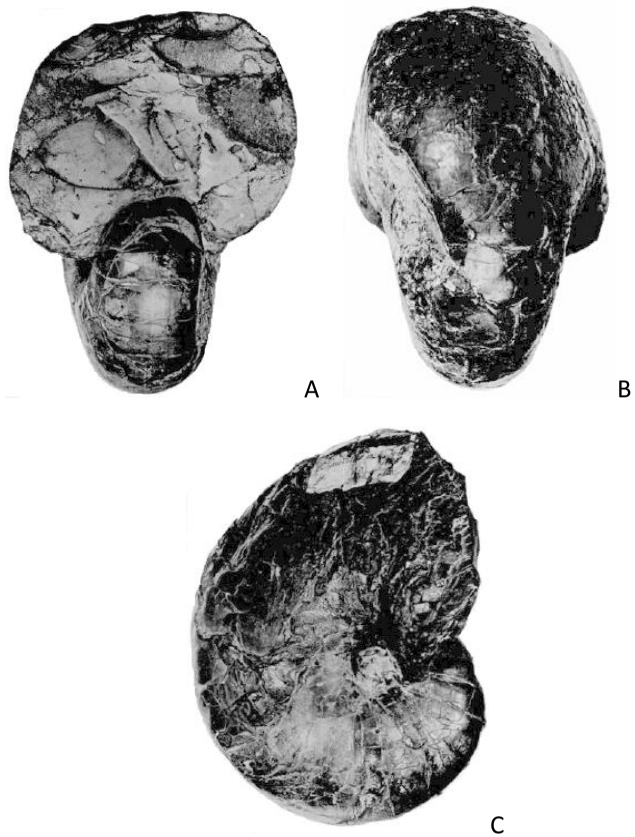


Fig. 5 Cenoceras astacoides *(Young and Bird, 1828). A–C. Holotype (or paratype) specimen (WM 61, Whitby Museum), diam. 282mm, from the Bifrons Zone, Whitby Mudstone Formation, foreshore east of Whitby (figured by Howarth 1962, pl. 13, figs 3a–b, and pl. 14, fig. 1)*

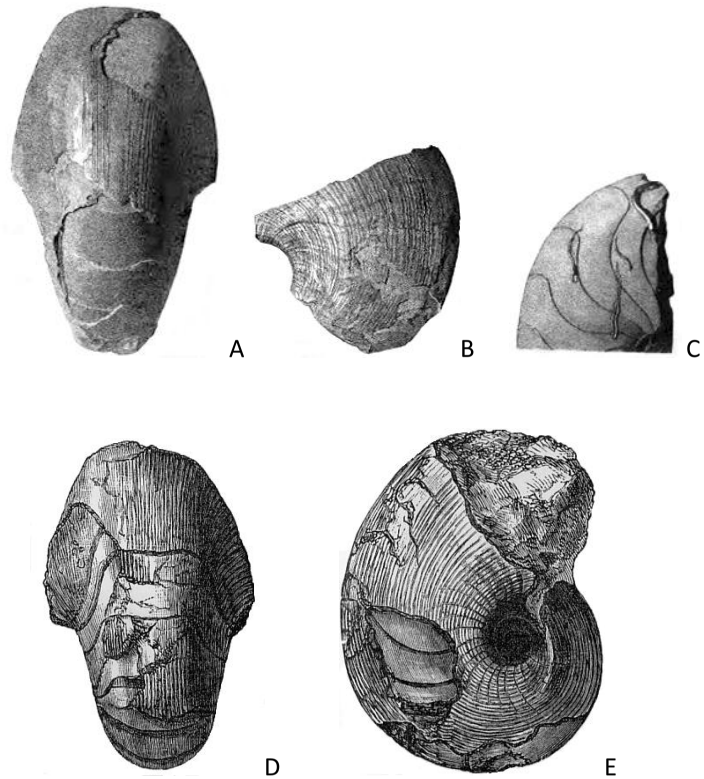


Fig. 6 Cenoceras jourdani *(Dumortier 1874). A–C. Syntype specimens (Musée de Lyon) the largest with diam. 130mm, from the Bfirons Zone at La Verpillière and Saint-Romain, Rhône Basin (after Dumortier 1874, pl. vii, figs 1, 3 and 5) D–E. Specimen in the Natural History Museum (C. 19587), diam. c. 140mm, from the Upper Lias at Floore (now Flore), near Northampton (figured by Foord 1891, figs 35 a–b)*

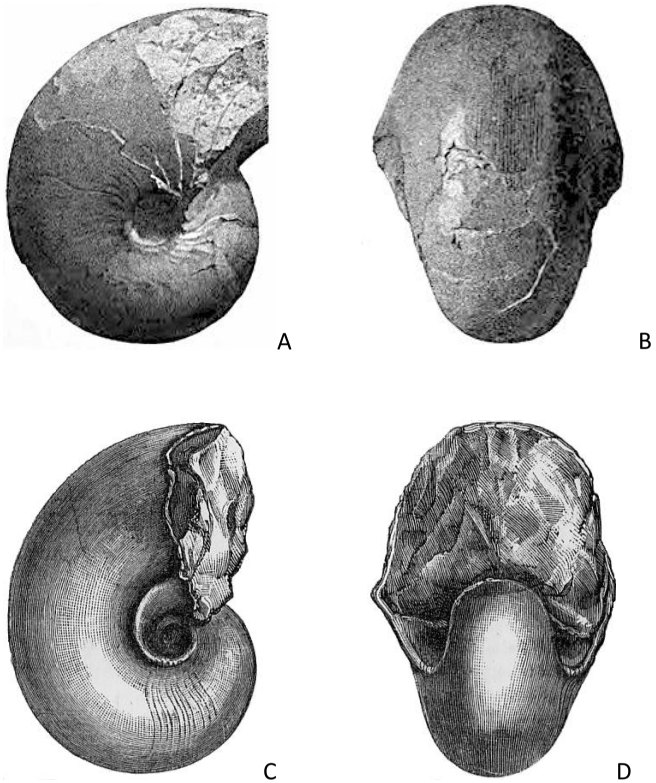


Fig. 7 Cenoceras terebratum *(Dumortier 1874). A–B. One of the syntype specimens (in the Thollière Collection, Musée de Lyon), diam. 98mm, from the Bifrons Zone at La Verpillière , Rhône Basin (after Dumortier 1874, pl. vi, figs 1–2). C–D. Specimen in the Natural History Museum (C. 3096), diam. c. 75mm, from the Upper Lias near Lincoln (figured by Foord, 1891, figs 36 a–b)*

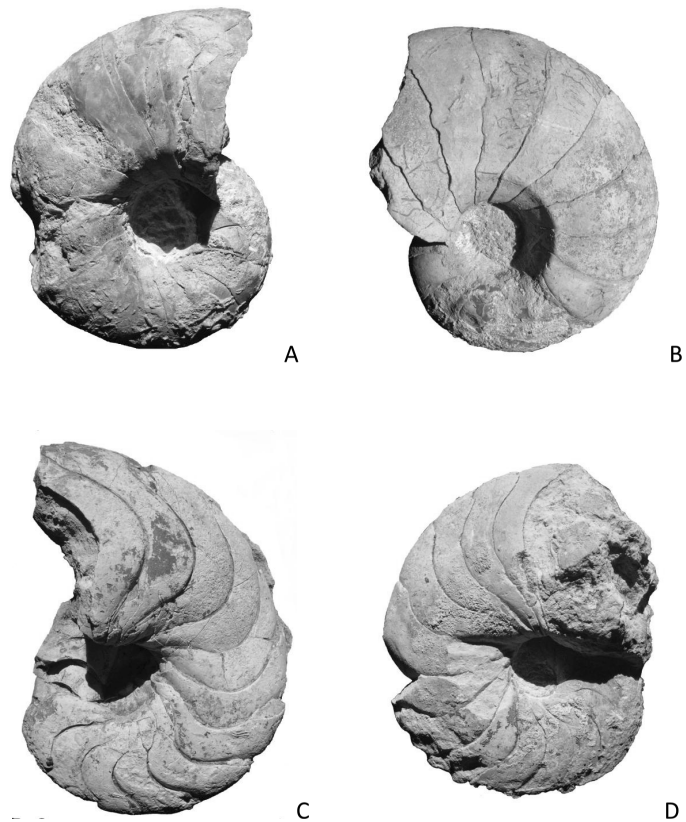


Fig. 8 A. Cenoceras astacoides *(Young and Bird 1828), SHS 7/2011/100, diam. 61mm, Upper Lias, Ilminster area. B.* Cenoceras terebratum *(Dumortier 1874), SHS 7/2011/102, diam. 67mm, Upper Lias (possibly Serpentinum Zone), Ilminster area. C.* Cenoceras jourdani *(Dumortier, 1874), SHS 7/ 2011/103, diam. 148mm, Bifrons Zone, near Green Lane End (ST 40601578). D.* Cenoceras jourdani *(Dumortier 1874), SHS 7/2011/ 122, diam. 94mm, Junction Bed, Stocklinch*

Dactylioceras ex. gp. *commune* (Sowerby), confirming a stratigraphic horizon within the Bifrons Zone.

Description: Shell moderately inflated, the greatest width being in the umbilical area; whorls flattened on the sides and on the venter; whorl section approximately equidimensional. Umbilicus accounts for 9–12% of the shell diameter, umbilical margins with steep sides and subangular borders, the external shell in this region being very thick. Siphuncle subcentral, or positioned slightly below the centre. Septa number *c*. 13–15 to a whorl and strongly sinuous, forming a distinct deep, wide lateral saddle and a broad, shallow saddle on the venter (Figs 6C–E). The shell is ornamented with numerous fine, thread-like longitudinal ridges, *c*. 1mm apart, but becoming slightly more widely spaced on the ventral areas, and fade on larger shells where the diameter exceeds 120mm. Fine growth lines are also present, especially in the umbilical region where they also occur with fine radiating flexuous ridges which are convex adorad and directed forwards towards the lateral flanks.

Occurrence: Upper Lias of Somerset (Ilminster area including Hurcott) and Northamptonshire (Floore, now spelt Flore). The species is currently only recorded from the Bifrons Zone.

CENOCERAS TEREBRATUM (Dumortier 1874)

Figs 4C, 7A–D, 8B

1874. *Nautilus terebratus*, Dumortier, p. 42–4, pl. vi, figs 1–4.
1890. *Nautilus terebratus*, Dumortier; Foord and Crick, p. 269, figs 3–4.
1891. *Nautilus terebratus*, Dumortier; Foord, p. 204–5, figs 36–7.
1956. *Cenoceras terebratus* (Dumortier); Kummel, p. 364, fig. 9H.

Type material: The syntypes comprise three specimens (housed in the Thiollière Collection, Musée de Lyon) ranging from partial to nearly complete phragmocones from the 'Lias Supérieur' (Bifrons Zone) at La Verpillière, Rhône Basin, France.

Specific diagnosis: Inflated, subglobose, widely camerate *Cenoceras* with deep umbilicus possessing an angular border with thickened rim.

Material studied: Two specimens (SHS, 7/2011/101–102), comprising septate phragmocones (59mm and 67mm diameter respectively) with some external shell ornament present, from field surface brash (Junction Bed, Bifrons Zone) between Hurcott Lane Cutting (ST 39841601) and Green Lane End (ST 4060 1578), and from the Upper Lias (Junction Bed, possible Serpentinum Zone) of the Ilminster area.

Description: Shell relatively inflated, subglobose, moderately rapidly expanding, weakly compressed on the sides, and very weakly compressed ventrally. Whorl section wider than high; siphuncle located centrally. Umbilicus open, approximately 12–14% of shell diameter, exposing the inner whorls and very deep, with steep sides and a very distinct angular border with thickened rim. Septa relatively distant, being nearly 15mm apart on the venter, where the whorl height is 25mm; the septa number between 15 and 20 to a whorl. Sutures very slightly sinuous laterally, and forming a broad, shallow ventral sinus. External shell relatively thin, ornamented on the venter with fine, close-set longitudinal lirae, and traversed by fine lines of growth, the latter covering the whole of the shell surface.

Occurrence: Upper Lias of Somerset (Hurcott area, near Ilminster), Leicestershire (Tilton Railway Cutting) and Lincolnshire (near Lincoln). The species is known to definitely occur within the Serpentinum Zone at Tilton Railway Cutting and within the Bifrons Zone (and possible Serpentinum Zone) of the Ilminster area.

ACKNOWLEDGEMENTS

I am grateful to another nautiloid specialist, Dr Dave Evans, for reading and providing comments on an earlier draft of this manuscript, and to Dennis Parsons for providing Somerset Museum (now Somerset Heritage Service) collection facilities. I also thank both Dave and Dennis for their assistance collecting specimens in the fields and sections around Ilminster. Hugh Prudden supplied some additional specimens of *Cenoceras*, Dr Ian Boomer (University of Birmingham) kindly provided additional location information and permission to utilise data from Boomer *et al*. 2009, and Dr Tim Palmer (Palaeontological Association) granted permission to reproduce the images of the type of

Cenoceras astacoides. I also thank Simon Leach (SANHS) for his assistance during the writing and production process.

The original idea for this paper arose during a conversation in the summer of 2008 between the author and the late Pat Hill-Cottingham; Pat wanted to see 'more geology in the SANHS Proceedings' – and this paper is dedicated to her memory.

Author contact

Dr Andy King, Geckoella environmental consultants, Suite 323, 7 Bridge Street, Taunton, Somerset, UK; and 71/10 Dodanwella Passage, Asgiriya, Kandy 20000, Sri Lanka (email: geckoella@gmail.com).

REFERENCES

Agassiz, J.L.R., 1847. *Introduction to the study of Natural History, in a series of lectures delivered in the hall of the college of physicians and surgeons*, New York.

Boomer, I, Lord, A.R., Page, K., Bown, P., Lowry F.M.D., and Riding, J.B., 2009. 'The biostratigraphy of the Upper late Pliensbachian – Toarcian (Lower Jurassic) sequence at Ilminster, Somerset', *Journal of Micropalaeontology*, 28, 67–85.

Cope, J.C.W., Getty, T.A., Howarth, M.K., Morton, N., and Torrens, H.S., 1980. *A correlation of Jurassic rocks in the British Isles. Part One: Introduction and Lower Jurassic,* Geological Society of London Special Report, 14, 1–73.

Cox, B.M., Sumbler, M.G., and Ivimey-Cook, H.C., 1999. 'A formational framework for the Lower Jurassic of England and Wales (Onshore Area)', *British Geological Survey Research Report*, RR/99/01: 1–25.

Cuvier, G., 1797. *Tableau élementaire de l´histoire naturelle des animaux*, Baudouin, Paris.

Dumortier, E., 1874. *Études paléontologiques sur les depots jurassiques du basin du Rhone. Quatriéme Partie, Lias-Supérieur*, Paris.

Foord, A.H., 1891. *Catalogue of the fossil Cephalopoda in the British Museum (Natural History), Part 2, containing the remainder of the suborder Nautiloidea, consisting of the families Lituitidae, Trochoceratidae and Nautilidae with a supplement,* London.

Foord, A.H., and Crick, G.C., 1890. 'Descriptions of new and imperfectly-defined species of Jurassic Nautili contained in the British Museum (Natural History)', *Annals of the Magazine of Natural History (6th Series)*, 5, 265–91.

Hamlet, J., 1922. 'On sections in the Lias exposed in two quarries at Barrington', *SANH*, 67, 72–5.

Howarth, M.K., 1962. 'The Yorkshire type ammonites and nautiloids of Young and Bird, Phillips, and Martin Simpson', *Palaeontology*, 5, 93–136.

Howarth, M.K., 1992. *The ammonite family Hildoceratidae in the Jurassic of Britain,* Palaeontographical Society Monograph.

Hyatt, A., 1883–1884. 'Genera of fossil cephalopods', *Proceedings of the Boston Natural History Society*, 22, 253–72 [published 1883], 273–338 [published 1884].

Hyatt, A., 1894. 'Phylogeny of an acquired characteristic', *Proceedings of the American Philosophical Society*, 32, 349–647.

Kummel, B., 1956. 'Post-Triassic nautiloid genera', *Bulletin of Harvard Museum of Comparative Zoology*, 114 (7), 319–494.

Kummel, B., 1964. Nautilida. *In:* Treatise on Invertebrate Paleontology, Part K. Mollusca 3 (Moore, R.C., Editor), *Geological Society of America and University of Kansas Press*, K383–456, New York and Lawrence.

Moore, C., 1853. 'On the palaeontology of the Middle and Upper Lias', *SANH*, 3, 61–76.

Moore, C., 1866. 'On the Middle and Upper Lias of the south west of England', *SANH*, 13, 119–245.

Morris, J., 1854. *A Catalogue of British Fossils, with reference to their geological distribution and the localities in which they have been found,* 2nd edn, London.

Phillips, J., 1835. *Illustrations of the Geology of Yorkshire; or, a description of the strata and organic remains of the Yorkshire Coast* (2nd edn), London.

Pia, J., 1914. 'Untersuchungen über die Liassischen Nautiloidea', *Beitrag Paläontologie Geologische Osterreich-Ungarns und des Orients*, 27, 19–86.

Pringle, J., and Templeman, A, 1922. 'Two new sections in the Middle and Upper Lias at Barrington, near Ilminster, Somerset', *Quarterly Journal of the Geological Society, London*, 78, 450–1.

Spath, L.F., 1922. 'Upper Lias succession near Ilminster, Somerset', *Quarterly Journal of the Geological Society, London*, 78, 449–50.

Spath, L.F., 1927. 'Revision of the Jurassic cephalopod fauna of the Kachh (Cutch)', *Memoirs of the Geological Survey of India (Palaeontologica Indica)*, New Series, 9 (2), 1–84.

Tate, R., and Blake, J.F., 1876. *The Yorkshire Lias*, London.

Tintant, H., 1984. 'Contribution a la connaissance des nautilaces Jurassique 1. - Le sous-genre *Cenoceras* Hyatt dans le Lias du Sud-Est de la France', *Geologie de France*, 1–2, 29–66, Paris.

Tintant, H., and Kabamba, M., 1983. 'Le Nautile, fossile vivant ou forme cryptogene? Essai sur l'évolution et la classification des nautilacés', *Bulletin de la Société Zoologique de la France,* 108, 569–79.

Ward, P.D., and Saunders, W.B., 1997. 'Allonautilus: A new genus of living nautilid cephalopod and its bearing on phylogeny of the Nautilida', *Journal of Paleontology*, 71 (6), 1054–64.

Wilson, V., Welch. F.B.A., Robbie, J.A., and Green, G.W., 1958. *Geology of the Country around Bridport and Yeovil*, Memoirs of the Geological Survey of Great Britain (Sheets 327 and 312).

Young, G.M., and Bird, J., 1828. *A geological survey of the Yorkshire Coast; describing the strata and fossils occurring between the Humber and the Tees, from the German Ocean to the Plain of York,* (2nd edn), Whitby.