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Albian ammonites from northern Pakistan

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ABSTRACT:

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The occurrence of rich Albian ammonite faunas in what is now northern Pakistan has been known for more than 80 years, but there has been no comprehensive account of the assemblages present. A total of 36 taxa are described below. The middle part of the Lumshiwal Formation yields Upper Aptian ammonites south of the Samana Range. Elsewhere, it yields *Douvilleiceras leightonense* Casey, 1962, of the lower Lower Albian *Leymeriella regularis* Zone and the *Sonneratia perinflata* and *S. kitchini* Subzones of the *Sonneratia chalensis* Zone of the northwest European sequence. The top one to two metres of the Lumshiwal yields an abundant fauna of rolled and phosphatised ammonites that includes elements from much of the Albian. Of these, *Prolyelliceras gevreyi* (Jacob, 1907) first appears in the lower Lower Albian *Leymeriella tardefurcata* Zone. The commonest ammonite is *Douvilleiceras mammillatum* (Schlotheim, 1813) *sensu lato*, which ranges from the *perinflata* Subzone of the *chalensis* Zone to the *Otohoplites bulliensis* Subzone of the *O. auritiformis* Zone of the Lower Albian. The presence of *Lyelliceras pseudolyelli* (Parona and Bonarelli, 1897) indicates the uppermost, *pseudolyelli* Subzone of the *auritiformis* Zone. The presence of *Lyelliceras lyelli* (d'Orbigny, 1841) indicates the basal Middle Albian *lyelli* Subzone of the *Hoplites dentatus* Zone. There is no evidence for the higher parts of the Middle Albian. *Dipoloceras* (*Rhytidoceras*) sp. indicates the presence of lower Upper Albian, possibly the *pricei* Zone. There is evidence, in the form of specifically indeterminate *Mortoniceras* (*Mortoniceras*) sp., of a level within the *inflatum* to *fallax* Zone inteval from a single locality, but no evidence of the succeeding parts of the upper Upper Albian. The base of the Kawagarth Formation that succeeds the Lumshiwal yields lower Upper Albian *Mortoniceras* (*M.*) *geometricum* Spath, 1932 of the *Mortoniceras pricei* Zone, northwest of Darmasand in the Samana range.

Key words: Ammonites; Cretaceous; Albian; Pakistan.

FORWARD: I never met Ali Fatmi, who died on 27 March 2012 in Karachi. We had corresponded, and occasionally spoken on the phone for more than a decade. This paper is dedicated to his memory.

INTRODUCTION

The presence of Lower Cretaceous (Albian) ammonites and other invertebrates in the Hazara Ranges and adjacent areas in the Northwest Frontier Province of what is now Pakistan (Text-figs 1, 2) was first noted by British geologists employed by the Geological Survey of India. The ammonites were briefly described and illustrated by Spath (1930, 1934a), prior to partition in 1947. One of us (ANF) revisited these areas in the 1960's, accompanied by Ms M. R. Khan and Mr I. H. Hydari of the Geological Survey of Pakistan, and collected faunas

from known localities and many new ones. These localities are in the Nizampur, the Kohat Tribal Belt, Samana, and Daramsand areas (Text-fig. 2). Fatmi (1972, 1977) redefined the stratigraphy of the Mesozoic rocks in the region, including the ammonite-bearing Lumshiwal Formation. The ammonite localities in the Kohat and Pershawar districts lie close to the east and west trending Kohat Tribal Belt that intervenes between the Pershawar district to the north and the Kohat district to the south of the Northwest Frontier Province. The outcrops in these areas are excellent, rimming the Jurassic cores of anticlinal folds, but access is severely restricted due to the tribal and semi-tribal nature of the country. Fieldwork is safer in the Kalchitta area of Punjab Province and the Hazara area of the Northwest Frontier Province, but exposures are poorer because of the vegetation cover and the isoclinal and recumbent folding of the sequence, which lies close to the main boundary fault system on the margin of the Kohat-Potwar Plateau (Text-fig. 1).

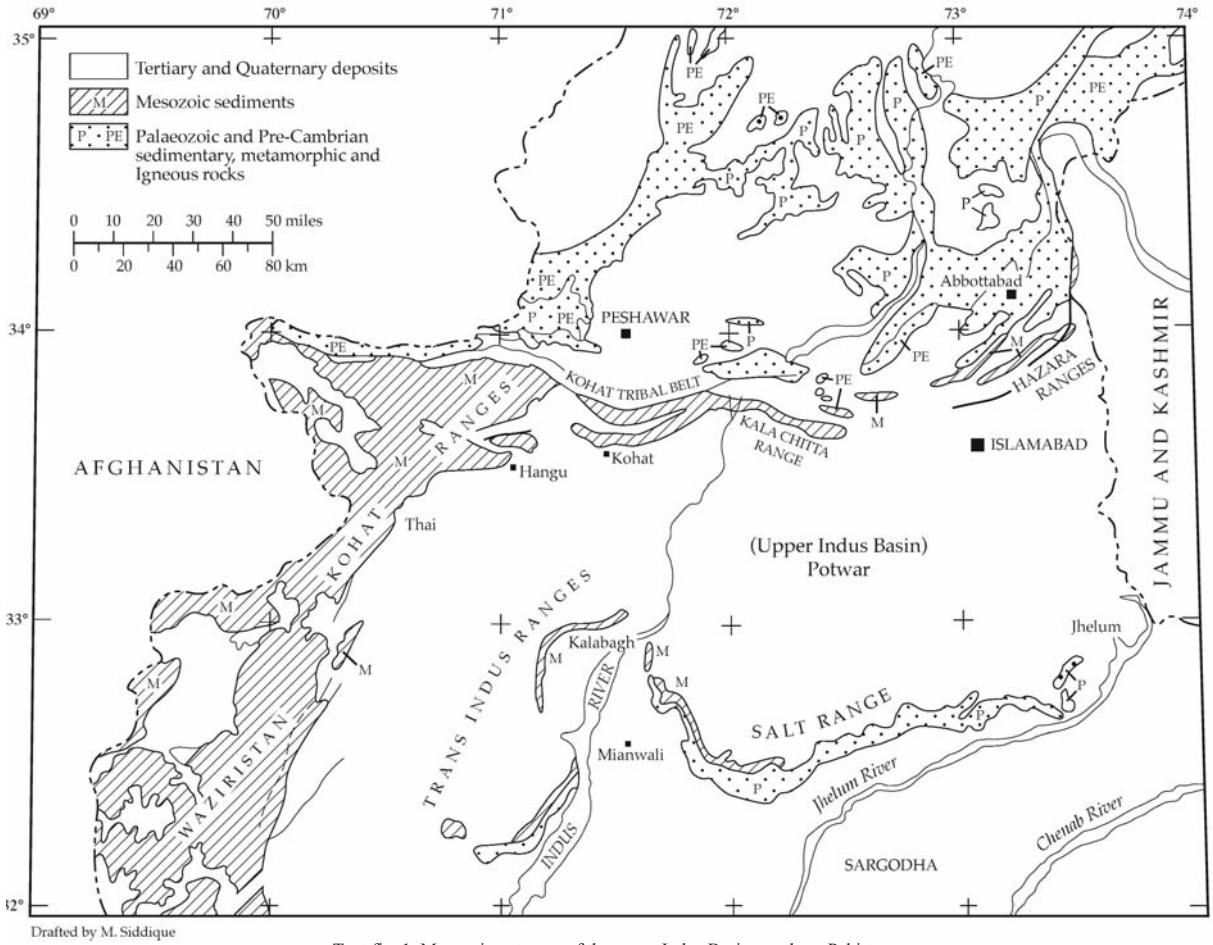
The history of the development of the stratigraphic nomenclature of the Cretaceous rocks of Hazara to the east, the central Kalachitta area, and the Samana Range to the west are summarised in Text-fig. 3.

Spath (1930) briefly described what would now be regarded as upper Middle and lower Upper Albian ammonites from the Hazara Ranges, noting the dominance of *Lyelliceras* over *Douvilleiceras* (Pascoe, 1959, pp. 1311–1313).

Cotter (1933) and his associates carried out the first detailed stratigraphic studies in the Kalchitta Range. Their fossil collections, from the upper part of the Giumal Formation (Text-fig. 3 ; = Lumshiwal Formation herein) were described by Spath (1934a; cephalopods), Cox (1935: bivalves and gastropods), and Muir-Wood (1937; brachiopods). The presence of the ammonite *Oxytropidoceras* indicated the Middle Albian.

There is no published information on the Cretaceous ammonite faunas of the Nizampur region and the adjoining Kohat Tribal Belt. General observations on these areas are to be found in Pascoe (1959, p. 1169, 1314).

Davies (1930) was the first to define the Mesozoic successions in the Samana Range (Text-fig. 2). His fossil collections were described by Spath (1930: cephalopods), Cox (1935; bivalves and gastropods), and Muir-Wood (1937: brachiopods). The upper beds of Davies' Main Sandstone Series (Text-fig. 3; = Lumshi-



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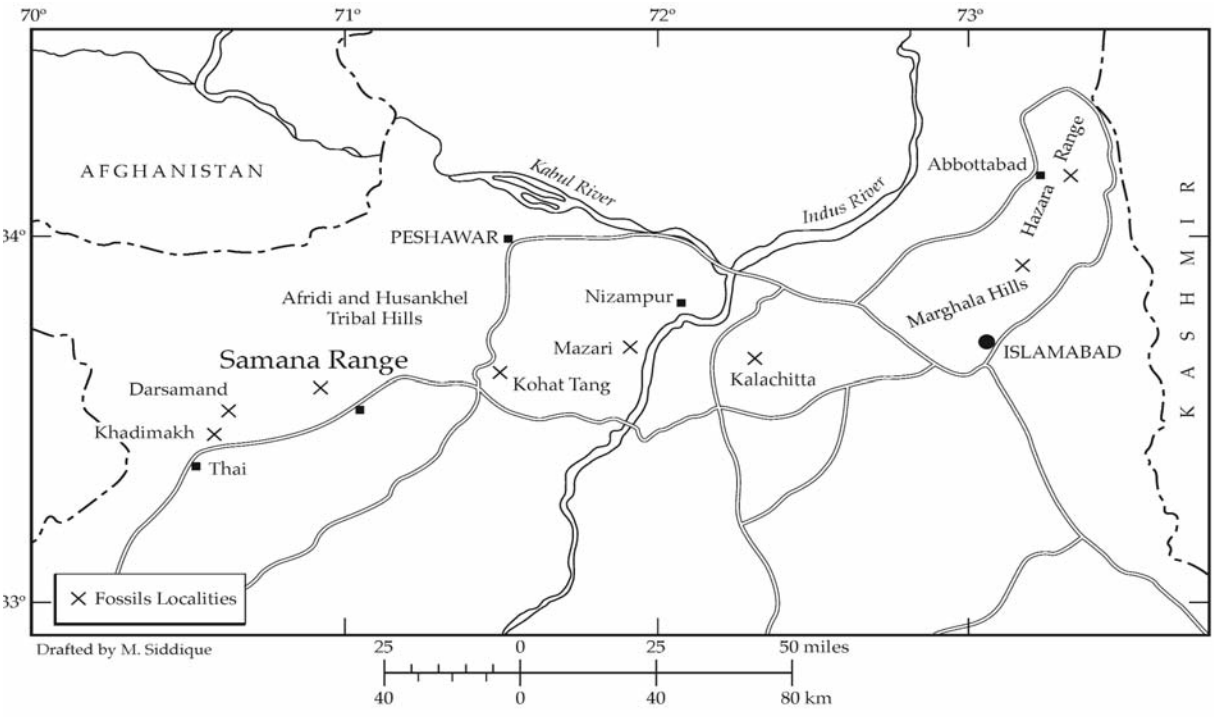
Text-fig. 1. Mesozoic outcrops of the upper Indus Basin, northern Pakistan



Text-fig. 2. Fossil localities in Hazara, Kalachitta, Nizampur, and Kohat, northern Pakistan

wal Formation herein) yielded ammonites including *Douvilleiceras*, and were regarded as Middle Albian (Pascoe 1959, p. 1296–7).

STRATIGRAPHY

Mesozoic rocks are widely exposed in the depositional basin in northern Pakistan known as the Upper Indus Basin (Text-fig. 1). The southern outcropping sections include the Salt Range (western half) and the Trans Indus Ranges (Surgar Range, Khisor Range, and Sheik Budin Hills). In these sections only Lower Cretaceous rocks are present. They are shallow marine in the lower part and continental in the upper part. They are disconformably overlain by Palaeocene sediments. The northern outcrops of Cretaceous rocks lie in the Hazara-Margala Hills (Northwest Frontier Province), Kalchitta (Punjab), Nizampur and the adjoining Kohat Tribal Belt (Northwest Frontier Province), and Western Kohat (Samana Range and adjoining Darsamand and Khodi-makh), where shallow- marine Lower Cretaceous rocks are disconformably overlain by Upper Cretaceous carbonates.

The generalised sucession in the Upper Indus Basin is as follows, although it should be noted that Upper Cretaceous rocks are absent from the southern sections in the Salt Range, Trans-Indus Ranges, and southern Kalchitta (Text-figs 4, 5):

3. Upper Cretaceous: Kawagarth Formation: open marine carbonates with planktonic foraminifera.

UNCONFORMITY

2. Aptian-Albian: Lumshiwal Formation: continental clastics in southern sections; shallow marine clastics or mixed shallow marine clastics and carbonates in northern sections.
1. Upper Jurassic to Lower Cretaceous: Chichali Formation: shallow marine clastics.

The ammonites described here come from the Lumshiwal Formation in northern sections from Hazara in the east to the Samana Range in Kohat to the west (Text-fig. 2). The Lumshiwal Formation is variable in both facies and thickness. It is mainly quartzose, glauconitic and ferruginous in the Samana Range and Darmasand in Western Kohat, Mian Ghari Korez in the Kohat Tribal Belt. At Kuhi, in the Kohat Tribal Belt, Ziarat Fateh Gul, Nizampur, northern Kalchitta, south of Attok, and the Jabri section, southern Hazara, it is made up of quartzose glauconitic calcareous sandstones and shelly limestones. In northern Hazara (Chiriala-Kalapani) it is represented by the 'Giumal' facies of Kashmir (see Lukeneder *et al*. 2013), a much reduced thickness of brownish massive calcareous ferrugineous sandstone (Text-fig. 6). The sequence reaches its maximum thickness of 204 m (670 feet) in Western Kohat, 67 m (220 feet) in Nizampur, 58 m (190 feet) in Kalchatta, 54 m (177 feet) in southern Hazara

<table>
<tr><th>AGE</th><th>HAZARA (N.W.F.P.) (Waagen and Wynne, 1872, Middlemiss, 1896, Pascoe, 1959)</th><th>KALACHITTA (Attock District) (Cotter, 1933, Pascoe, 1959)</th><th>KOHAT (N.W.F.P.) (Davies, 1930)</th><th>Present composite nomenclature (Fatmi et al. 1966, Fatmi, 1972, 1977)</th></tr>
<tr><td>Late Cretaceous</td><td>–</td><td>Shales north & Kawaghar (Palaeocene?)</td><td>Lithographic Limestone (Upper Cretaceous)</td><td>Kawagarh Formation.
Thick to thin bedded micritic limestone with cal. shale intercalation in lower half
Foraminifera (Upper Cretaceous)</td></tr>
<tr><td colspan="4"></td><td>Unconformity</td></tr>
<tr><td>Early Cretaceous</td><td>Giumal Sandstone (Lower Creatceous)</td><td>Giumal Sandstone sandy limestone and limestone undifferentiated</td><td>Main sandstone series (Lower Cretaceous)</td><td>LUMSHIWAL FORMATION
Sandstone, sandy, shelly limestone, variable in thickness and lithology with a fossiliferous (ammonites) gritty calcareous top bed
(Aptian - Albian)</td></tr>
<tr><td>Late Jurassic</td><td>Spiti Shale (Upper Jurassic to Early Cretaceous)</td><td>Spiti Shale (Upper Oxfordian to Albian)</td><td>Belemnite bed (Early Cretaceous)</td><td>CHICHALI FORMATION
Glauconitic sandstone and sandy shale with ammonites belemnites
(Late Jurassic - Early Cretaceous)</td></tr>
<tr><td colspan="4"></td><td>Unconformity</td></tr>
<tr><td>Middle Jurassic or Older (Triassic)</td><td>Kioto Limestone (Upper Triassic)</td><td>Kioto Limestone (Upper Triassic to Bajocian)</td><td>Samana Suk Limestone (Upper Jurassic)</td><td>SAMANA Suk FORMATION
(Middle Jurassic)</td></tr>
</table>

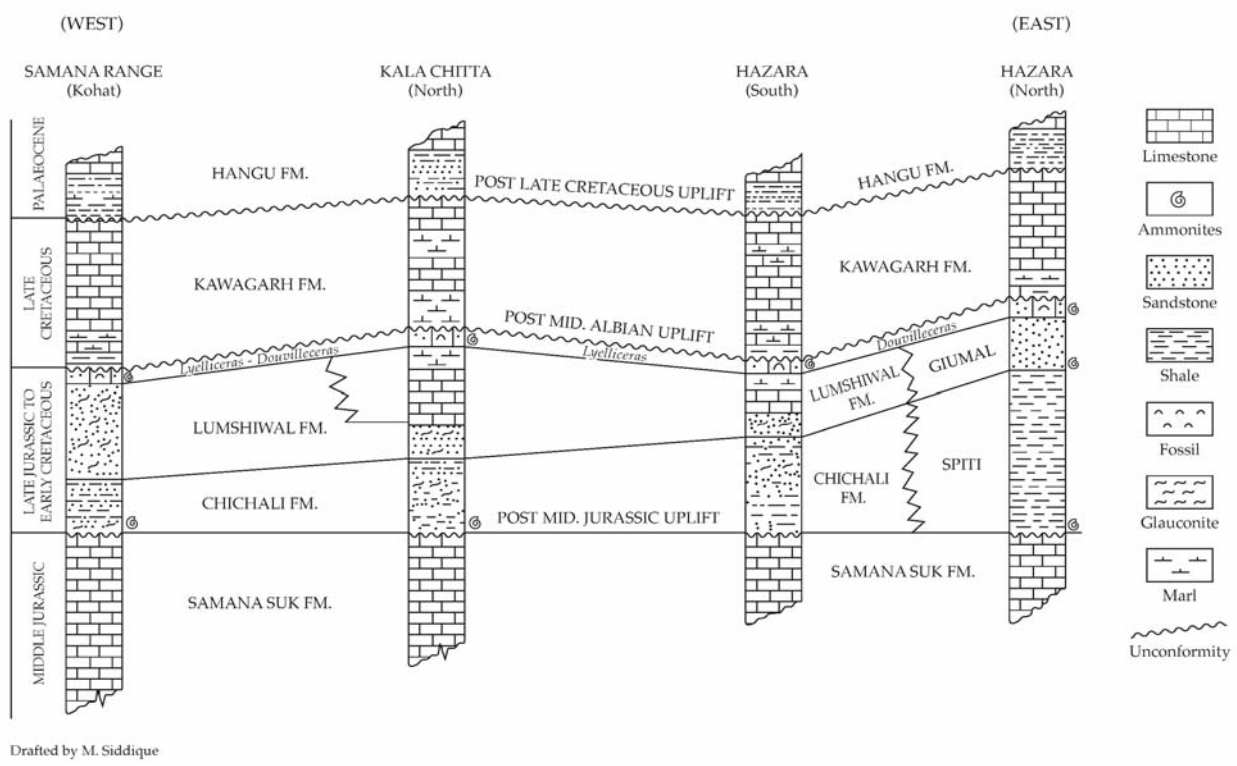
Text-fig. 3. History of development of Jurassic and Cretaceous stratigraphic nomenclature of northern areas of Pakistan: Hazara, Kalachitta, Nizampur, and Kohat

Jabri/Jabrian section, and 9.7 m (32 feet) in northern Hazara (Chiriala-Kalpani section) where Upper Jurassic and Lower Cretaceous 'Giumal' and 'Spiti' facies are developed (Text-figs 4, 6).

The Albian ammonites described here are predominantly phosphatised moulds, sometimes with phosphatised shell preserved. Most were collected from less than a metre to about two metres of the uppermost, fossiliferous unit of the Lumshiwal Formation developed in these areas. This is a well-cemented gritty, calcareous, ferruginous, glauconitic sandstone or well cemented sandy limestone. It is overlain disconformably by the Upper Cretaceous Kawagarth Formation: micritic limestones and calcareous shale containing a rich assemblage of planktonic foraminifera (*Globorotalia*, *Rotalipora*, and *Hedbergella* species). The basal slightly sandy glauconitic micritic limestone of the Kawagarth Formation yields Upper Albian *Mortoniceras* (*M.*) *geometricum* Spath, 1932, only in the Darsamand section (Text-fig. 6; Text-figs 18A–C; 19A, B, E). This indicates the *pricei* Zone of the north-west European sequence (Text-fig. 7).

The Lumshiwal Formation is generally poorly fossiliferous below the topmost unit, apart from fragmentary molluscs and echinoids. The Wuch Khar section southeast of Nizampur (Text-fig. 6) has yielded large ammonites up to 90 cm in diameter. Also present is a lower Lower Albian *Douvilleiceras leightonense* Casey, 1962 (Text-fig. 26J), which is well-dated as *regularis* Zone and *perinflata* and *kitchini* Subzones of the *chalensis* Zone in the north-west European sequence (Text- fig. 7).

The middle Lumishwal Formation in the Khadimakh section to the southwest of the Samana Range (Text-fig. 5) comprises highly glauconitic sandstones with calcareous lenses, and yields fragments of large lower Upper Aptian ammonites including *Australiceras* cf. *wandalina* Klinger and Kennedy, 1977 (Text-fig. 8D, E), *Australiceras* sp. (Text-fig. 8A, B, C, F, G), and *Cheloniceras* sp. (Text-fig. 8 H, I).



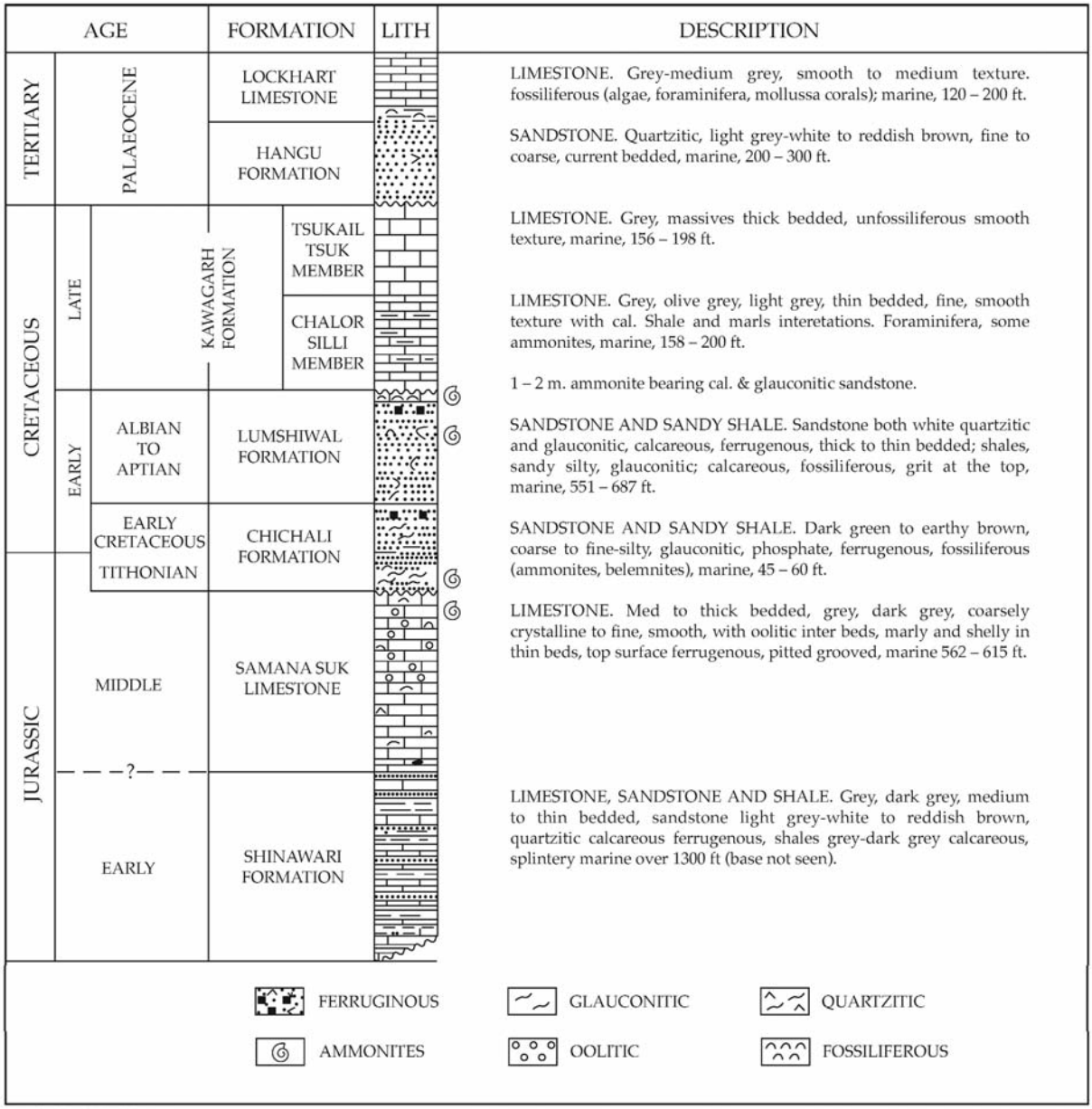
Text-fig. 4. Diagrammatic stratigraphic sections on the northern margin of the upper Indus Basin: Hazara, Kalachitta, and Kohat

The phosphatised ammonite faunas from the top one to two metres of the Lumshiwal Formation vary from locality to locality, and are listed in the section below, and their horizon discussed here in terms of the northwest European scheme shown in Text-fig. 7. The earliest forms recognised (*Prolyelliceras gevreyi* (Jacob, 1907) first appears in the lower Lower Albian *tardefurcata* Zone. The commonest ammonite is *Douvilleiceras mammillatum* (Schlotheim, 1813) *sensu lato*, which ranges from the *perinflata* Subzone of the *chalensis* Zone to the *bulliensis* Subzone of the *auritiformis* Zone of the Lower Albian. The presence of *Lyelliceras pseudolyelli* (Parona and Bonarelli, 1897) indicates the presence of the eponymous uppermost Subzone of the *auritiformis* Zone. The presence of *Lyelliceras lyelli* indicates the presence of the eponymous basal Middle Albian Subzone of the *Hoplites dentatus* Zone. There is no evidence for the higher parts of the Middle Albian. *Dipoloceras* (*Rhytidoceras*) sp. indicates the presence lower Upper Albian, possibly the *pricei* Zone. There is evidence, in the form of specifically indeterminate *Mortoniceras* (*Mortoniceras*) sp. of a level within the *inflatum* to *fallax* Zone interval from a single locality, but no evidence of the succeeding parts of the upper Upper Albian.

LOCALITY DETAILS

Locality BMP1815, north of Mian Gahri, 7 miles (11.6 km) from the Kohat-Hangu road, top 2 m of the Lumshiwal Formation, 71° 22′ N, 33° 36′ 30′ E. *Uhligella* sp., *Cleoniceras madagascariense* Collignon, 1949, *Lemuroceras aburense* (Spath, 1933), *Lemuroceras indicum* (Spath, 1933), *Anadesmoceras* sp., *Oxytropidoceras* (*Oxytropidoceras*) *alticarinatum* (Spath, 1922a), *Tegoceras mosense* (d'Orbigny, 1841), *Prolyelliceras gevreyi* (Jacob, 1907), *Lyelliceras lyelli* (d'Orbigny, 1841), *Lyelliceras pseudolyelli* (Parona and Bonarelli, 1897), *Pseudobrancoceras transiens* Kennedy, 2004, *Pseudobrancoceras* sp., *Protanisoceras actaeon* (d'Orbigny, 1850), *Anisoceras arrogans* (Giebel, 1852), *Hamites* cf. *hybridus* Casey, 1961, *Hamites* cf. *praegibbosus* Spath, 1941, *Douvilleiceras mammillatum* (Schlotheim, 1813).

Localities 1817 and 1821, south of Fort Lockhart, Samana Range, western Kohat. Top 1–2 m of the Lumshiwal Formation, 33° 33′ N, 73°, 50′ E. *Beudanticeras* sp., *Aioloceras besairiei* (Collignon, 1949), *Lemuroceras aburense* (Spath, 1933), *Prolyelliceras gevreyi* (Jacob, 1907), *Anisoceras arrogans* (Giebel, 1852), *Hamites* cf. *praegibbosus* Spath, 1941, *Tarrantites adkinsi* (Scott, 1928), *Metahamites* sp., *Douvilleiceras mammillatum* (Schlotheim, 1813)



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Text-fig. 5. Composite stratigraphic section in the Khadimakh-Darmasand-Samana areas, western Kohat (north of the Hangu-Thal Road), northern Pakistan

Locality 1825, north of Korez, near the village of Tang Mella (Balkot), Kohat Tribal Belt, top metre of the Lumshiwal Formation, 33° 42′ 30° N, 71° 5′ E. *Lemuroceras indicum* (Spath, 1933), *Buloticeras radenaci* (Pervinquière, 1907), *Ndumuiceras variabile* Klinger and Kennedy, 2009, *Douvilleiceras* sp., together with the nautiloid *Eutrephoceras* sp.

Locality 1839, north of Darmasand, western Kohat, top two metres of the Lumshiwal Formation, 33° 27′ N, 70° 39′ 30″ E. *Puzosia quenstedti* (Parona and Bonarelli, 1897), *Desmoceras latidorsatum* (Michelin, 1838), *Oxytropidoceras* (*Manuaniceras*) *jacobi* Besairie, 1936.

Localities 1846, 1848, 1849, 1850, and 1852, north of Jabri (Jabrian) Guest House, Hazara, top 2 m of Lumshiwal Formation, 73° 11′ N, 33° 55′ E. *Oxytropidoceras* (*Venezoliceras*) sp., *Oxytropidoceras* (*Mirapelia*) *mirapelianum* (d'Orbigny, 1850), *Lyelliceras lyelli* (d'Orbigny, 1841) *Pseudobrancoceras transiens* Kennedy, 2004, *Anisoceras arrogans* (Giebel, 1852).

Locality 1851, north of Jabri Hazara, top 1m of the Lumshiwal Formation, 73° 11′ N, 33° 55′ E. *Douvilleiceras mammillatum* (Schlotheim, 1813)

Localities 1855, 1856, Chariara-Kalapani, Hazara, top 0.5 m of the Lumshiwal Formation (Giumal

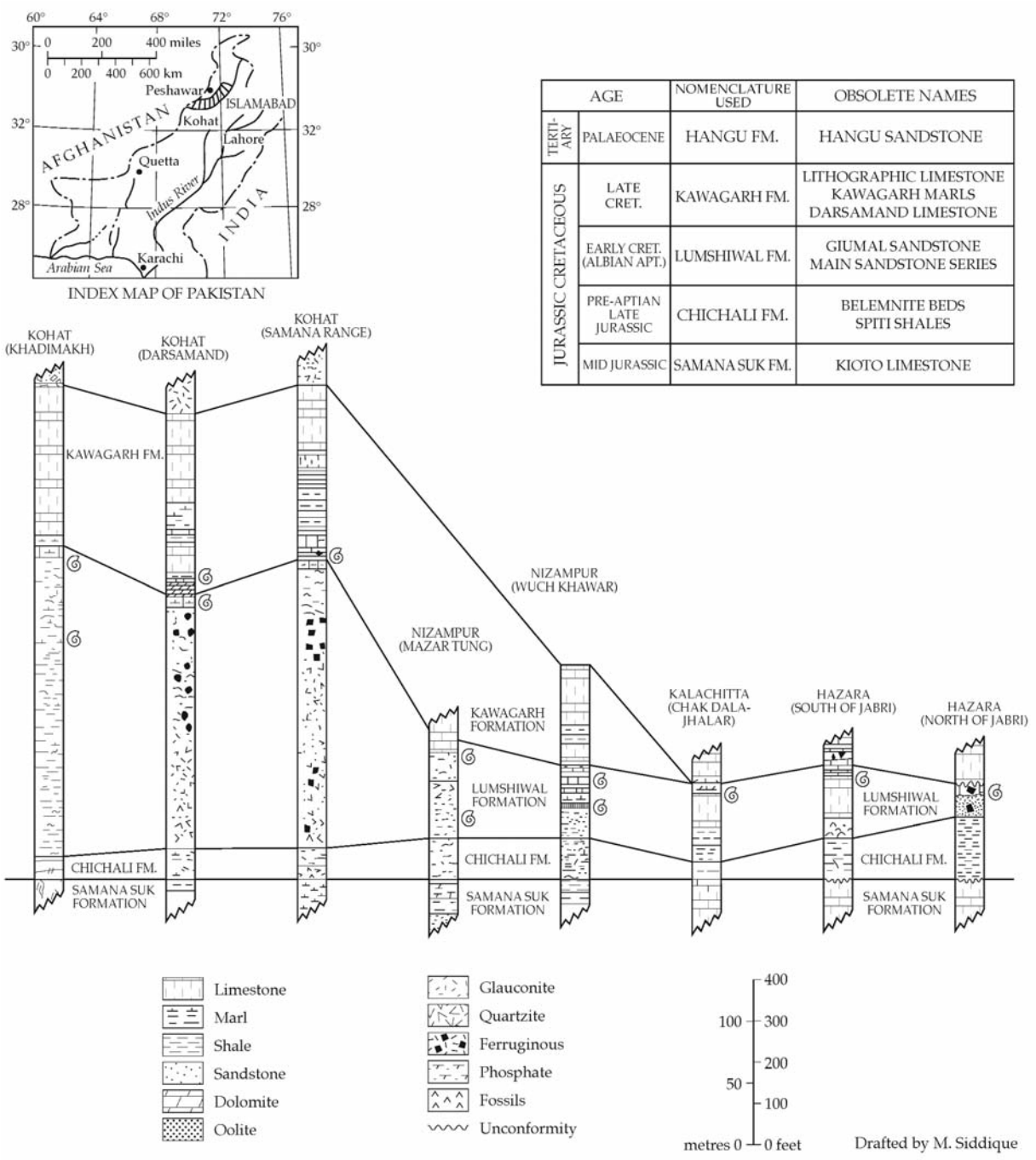
Sandstone facies), 73° 19′ N, 34° 12′ 30″ E. *Oxytropidoceras* (*Venezoliceras*) sp., *Dipoloceras* (*Rhytidoceras*) sp.

Locality 1872, south of Kuhi (Darra), Kohat Tribal Belt, Kohat, top 1 m of Lumshiwal Formation, 71° 32′ N, 33° 38′ E. *Desmoceras latidorsatum* (Michelin, 1838), *Mortoniceras* (*Mortoniceras*) sp.

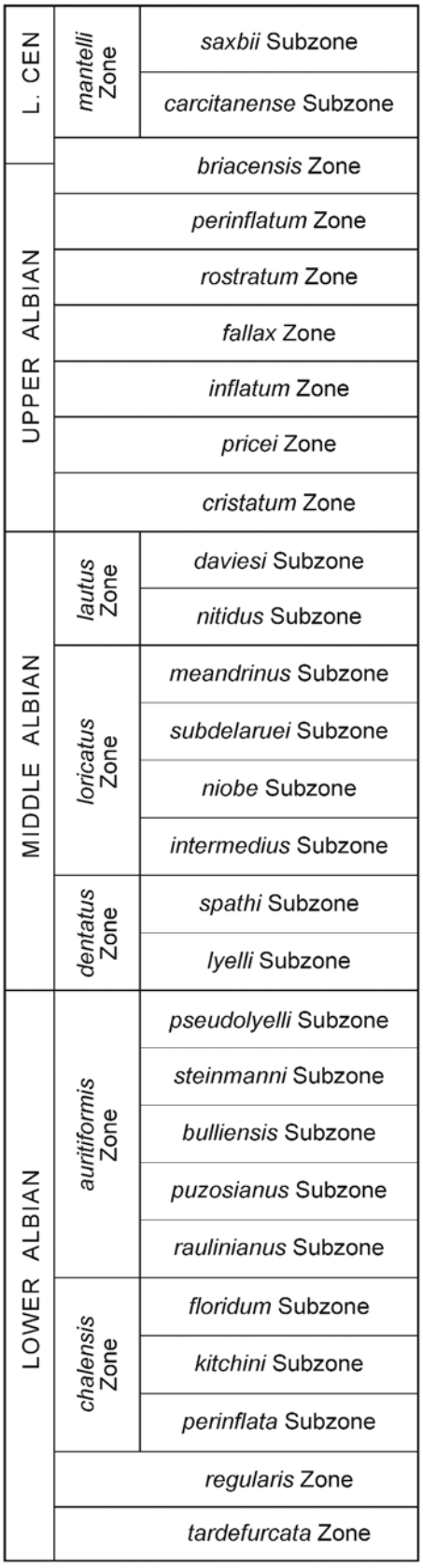
Locality 4309, northwest of Darsamand, basal sandy transgressive limestone of the Kawagarth Formation, 70° 39′ 30″ N, 33° 27′ E. *Mortoniceras* (*Mortoniceras*) *geometricum* Spath, 1932.

Locality KC3, Middle Lumshiwal Formation, Khandimak Section, Kohat Tribal Belt. Indeterminate desmoceratid, *Australiceras* cf. *wandalina* Klinger and Kennedy, 1977, *Australiceras* sp.

Locality KC3, top of Lumshiwal Formation, Khandimak Section, Kohat Tribal Belt. *Aioloceras argentinum* (Bonarelli, 1921).



Text-fig. 6. Diagrammatic stratigraphic sections, Hazara, Kalachitta, Nizampur, and Kohat, northern Pakistan



Text-fig. 7. Albian ammonite zones and subzones in the northwest European Hoplitid Province cited in the text

CONVENTIONS

GSP: Geological Survey of Pakistan Collections, Quetta.

All dimensions are given in millimetres. D = diameter; Wb = whorl breadth; Wh = whorl height; U = umbilicus. Figures in parenthesis are dimensions expressed as a percentage of the total diameter at the point of measurement. 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.

SYSTEMATIC PALAEONTOLOGY

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.

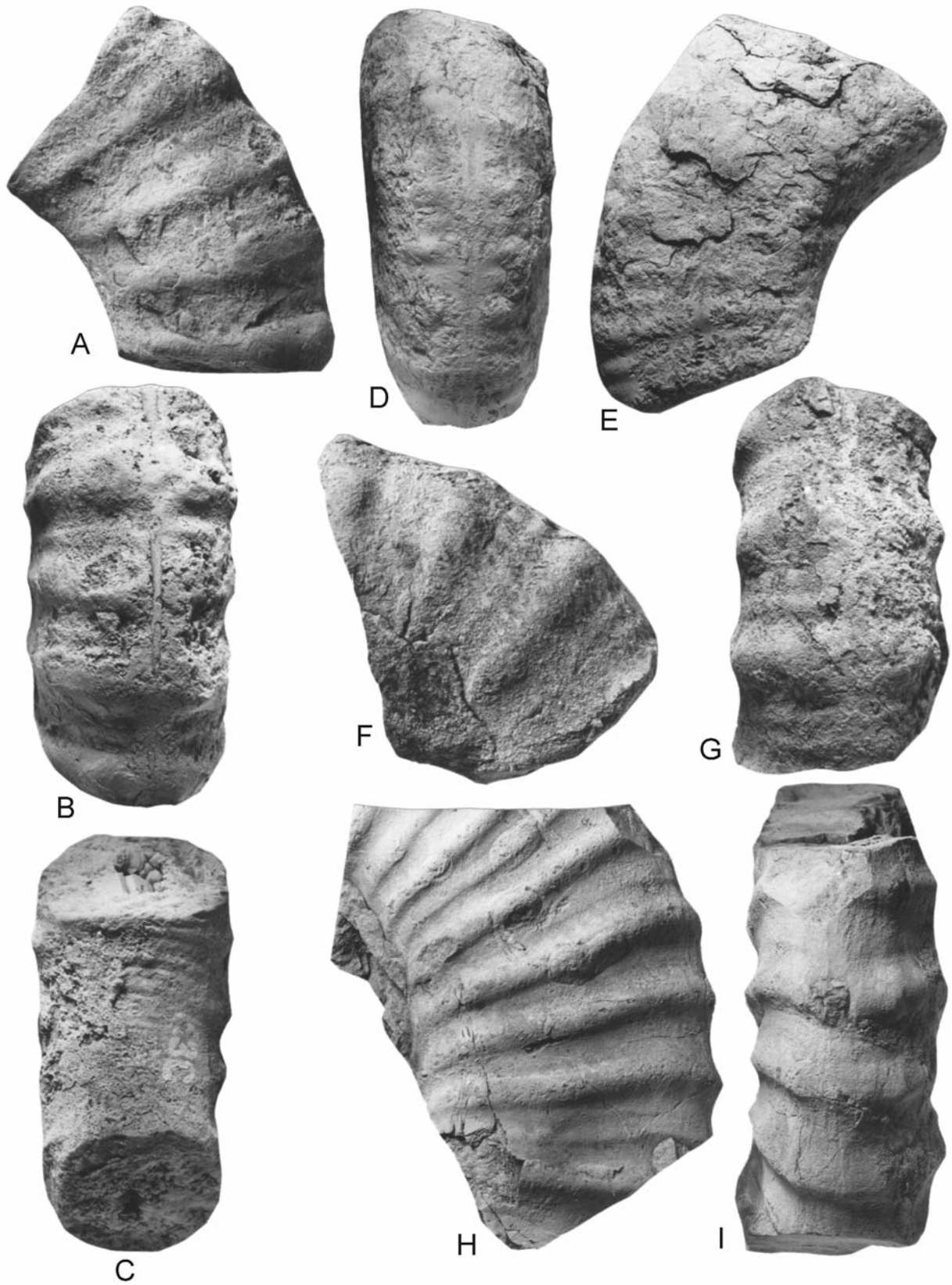
Subgenus *Hypophylloceras* Salfeld, 1924

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

Phylloceras (*Hypophylloceras*) cf. *velledae* (Michelin, 1834)
(Text-fig. 9H, I))

Compare:

1834. *Ammonites velledae* Michelin, pl. 35.
2000. *Phylloceras* (*Hypophylloceras*) *velledae* (Michelin, 1834); Joly, p. 141, pl. 35, figs 1, 2; text-figs 314–318 (with synonymy).
2006. *Phylloceras* (*Hypophylloceras*) *velledae* (Michelin, 1834); Joly *in* Gauthier, p. 101, pl. 39, fig. 1; text-fig. 54.
2006. *Euphylloceras velledae* (Michelin, 1834), Murphy and Rodda, p. 31, pl. 2, figs 1, 5; text-fig. 13.
2008. *Phylloceras* (*Hypophylloceras*) aff. *velledae* (Michelin, 1834); Joly and Delamette, p. 21, fig. 24A–E.
2011. *Phylloceras* (*Hypophlloceras*) *velledae* (Michelin, 1834); Delamette, p. 339, pl. 1, figs 1–3.



Text-fig. 8. A-C, F, G – *Australiceras* sp. A-C – GSP1099; F, G – GSP1098. D, E – *Australiceras* cf. *wandalina* Kennedy and Klinger, 1977, GSP1100. H, I – *Cheloniceras* sp. GSP1095. All specimens are from the middle Lumshiwal Formation at locality KC3. Figs A–C, F, G, are × 1; D, E, H, I are × 0.5

2011. *Phylloceras* (*Hypophlloceras*) *velledae* (Michelin, 1834); Kennedy in Gale *et al*., p. 70.

TYPE: The neotype, designated by Wiedmann, 1964, p. 209, is specimen 1896–17 in the de Vibraye collection, housed in the collections of the Laboratoire de Paléontologie of the Muséum National d'Histoire Naturelle, Paris, under the catalogue number LPMP-R4308, figured by Joly in Gauthier, 2006, pl. 39, fig. 1; it is from the Middle Albian of Epothémont, Aube, France.

MATERIAL: GSP1207, from the top metre of the Lumshiwal Formation at locality 1851.

DESCRIPTION: The specimen is a phosphatic internal mould of a phragmocone with an estimated diameter of 32.6 mm. The inner flanks are broadly convex; the outer flanks converge to the broadly rounded ventrolateral shoulders and venter. No ornament is preserved. Typically phylloceratid sutures are poorly preserved.

DISCUSSION: Whorl proportions suggest reference to this widely distributed species, but poor preservation precludes firm identification. See Joly (2000) for a full account of the species.

OCCURRENCE: *Phylloceras velledae* is known from the Lower Albian (and uppermost Aptian?) to Lower Cenomanian, France, the Balaeric Islands, Pakistan, Madagascar, KwaZulu-Natal South Africa, and California.

Suborder Ammonitina Hyatt, 1889
Superfamily Desmoceratoidea Zittel, 1895
Family Desmoceratidae Zittel, 1895
Subfamily Puzosiinae Spath, 1922b
Genus and Subgenus *Puzosia* Bayle, 1878

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

Puzosia (*Puzosia*) sp., group of *quenstedti* (Parona and Bonarelli, 1897)
(Text-fig. 9J–L)

Compare:
1897. *Desmoceras Quenstedti* Parona and Bonarelli, p. 81, pl. 11, fig. 3.
1990. *Puzosia quenstedti* (Parona and Bonarelli, 1897); Marcinowski and Wiedmann, p. 53 et seq. (with full synonymies).
2011. *Puzosia* (*Puzosia*) *quenstedti quenstedti* (Parona and Bonarelli, 1897); Klein and Vašiček, p. 86 (with full synonymy).

MATERIAL: GSP1186, from the top two metres of the Lumshiwal Formation at locality 1839.

DESCRIPTION: GSP1186 is a phosphatic internal mould of a phragmocone with a maximum preserved whorl height of 27.3 mm, and an estimated diameter of 68mm. Coiling is evolute, the umbilicus broad and shallow, with a low, flattened, subvertical wall. The umbilical shoulder is narrowly rounded. The whorls expand slowly. The whorl breadth to height ratio is 0.85, the flanks flattened, very feebly convex, subparallel, the ventrolateral shoulders and venter broadly and evenly rounded. There are widely separated constrictions that cross the venter in a broad convexity. Ornament of crowded delicate fine ribs is effaced on the inner flank, but better developed on the outer flank and ventrolateral shoulder, where they are feebly concave, sweeping forwards to cross the venter in a broad convexity.

DISCUSSION: The boundary between Albian species/subspecies of the *mayoriana-quenstedti* Group are reviewed by Wiedmann and Dieni (1968) and Marcinowski and Wiedmann (1990); the present specimen adds nothing to the debate.

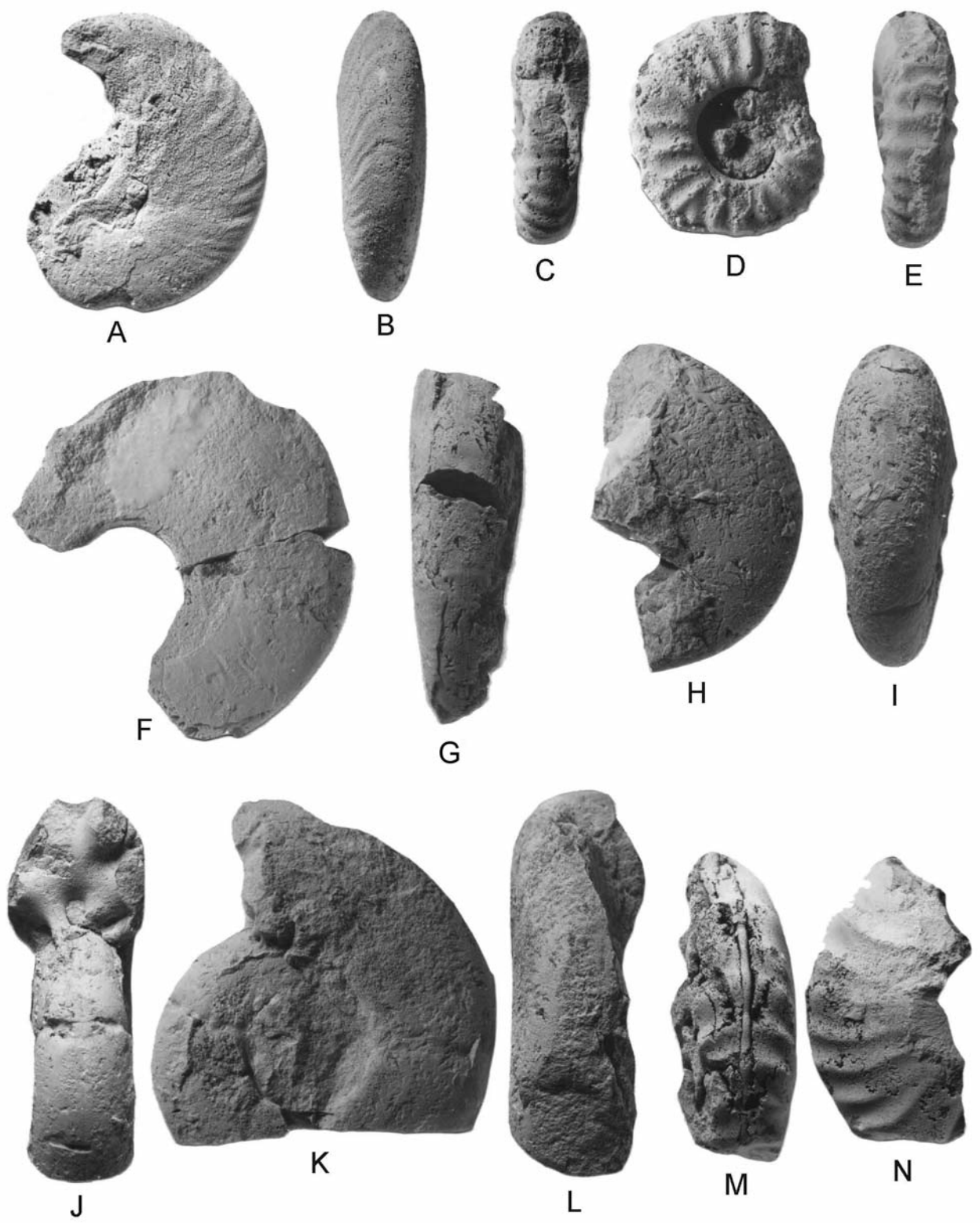
OCCURRENCE: The *quenstedti* group of *Puzosia* range from Upper Aptian to Lower Cenomanian, with records from Europe, central Asia, Pakistan, north, west, and South Africa, Madagascar, the South Atlantic, and Venezuela.

Subfamily Beudanticeratinae Breistroffer, 1953
Genus *Beudanticeras* Hitzel, 1902

TYPE SPECIES: *Ammonites beudanti* Brongniart, 1822, pp. 95, 99, 394, pl. 7, fig. 2, by the original designation of Hitzel, 1902, p. 875.

Beudanticeras sp.
(Text-fig. 9F, G)

MATERIAL: GSP1157, from the top one to two metres of the Lumshiwal Formation at locality GSP1817.



Text-fig. 9. A, B – *Anadesmoceras* sp. GSP1113, from locality 1815. C-E – *Pseudobrancoceras transiens* Kennedy, 2004, GSP1124, from locality 1815. F, G – *Beaudanticera*s sp., GSP1159, from locality 1817. H, I – *Phylloceras* (*Hypophylloceras*) cf. *velledae* (Michelin, 1834), GSP1207, from locality 1839. J-L – *Puzosia* (*Puzosia*) sp. group of *quenstedti* (Parona and Bonarelli, 1897), GSP1186, from locality 1839. M, N – *Cleoniceras madagascariense* Collignon, 1949, GSP1110, from locality 1815. All specimens are from the uppermost Lumshiwal Formation. Figs A, B, are × 2; Figs C–N are × 1

DESCRIPTION AND DISCUSSION: The specimen is a corroded phosphatic fragment of a 270° sector of phragmocone retaining extensive areas of phosphatised shell. The maximum measurable whorl height is 32 mm. Coiling is involute, the small umbilicus shallow, with a low, feebly convex umbilical wall and a narrowly rounded umbilical shoulder. The whorl section is very compressed, with very feebly convex subparallel flanks and a narrow, broadly rounded venter. The flanks are smooth. The venter bears two weak narrow ribs on the mould, possibly associated with feeble constrictions. There are indications of the former presence of a further whorl. The fragment is specifically indeterminate.

OCCURRENCE: As for material.

Genus *Uhligella* JACOB, 1907

TYPE SPECIES: *Desmoceras clansayense* Jacob, 1905, p.403, by the subsequent designation of Kilian, 1907, p. 63 (footnote).

Uhligella sp. juv.
(Text-fig. 10A–H)

MATERIAL: GSP1108, from the top two metres of the Lumshiwal Formation at locality 1815.

DESCRIPTION AND DISCUSSION: The specimen is a phosphatic internal mould 20 mm in diameter. Coiling is very involute, the moderately deep umbilicus comprising 22% of the diameter. The umbilical wall is convex, and inclined outwards, the umbilical shoulder is broadly rounded. The whorl section is rounded-trapezoidal, the inner flanks broadly convex, the outer flanks flattened and convergent, the relatively broad venter very feebly convex. There are an estimated six progressively strengthening bullae perched on the umbilical shoulder of the adapertural half whorl. They give rise to pairs of ribs that are weak, straight, and prorsiradiate on the inner flank, and strong and concave on the outer flank and ventrolateral shoulder. They cross the venter in a feeble convexity. There are one or two short, weak intercalated ribs. There are well-developed widely separated constrictions on the adapical half of the outer whorl, where the ribs are relatively weak. On the adapertural half whorl they appear as mere strengthened interspaces.

This juvenile is specifically indeterminate, but recalls the *Desmoceras* (*Uhligella*) *reboulei* Jacob, 1907, var., from the condensed Albian of La Balme de Rencurel, Isère, France (Jacob 1907, pl. 14, fig. 6) of comparable size.

OCCURRENCE: As for material.

Subfamily Desmoceratinae Zittel, 1895
Genus and Subgenus *Desmoceras* Zittel, 1885

TYPE SPECIES: *Ammonites latidorsatus* Michelin, 1838, p. 101, pl. 12, fig. 9, by the subsequent designation of Bőhm, 1895.

Desmoceras (*Desmoceras*) *latidorsatum* (Michelin, 1838)
(Text-fig. 11A–H)

1838. *Ammonites latidorsatus* Michelin, p. 101, pl. 12, fig. 9.
1968. *Desmoceras* (*Desmoceras*) *latidorsatum* (Michelin, 1838); Wiedmann and Dieni, p. 131, pl. 2, figs 2, 6–13, text-fig. 81 (with synonymy).
1990. *Desmoceras* (*Desmoceras*) *latidorsatum* (Michelin, 1838); Marcinowski and Wiedmann, p. 62, pl. 7, figs 2, 3 (with synonymy).
1996. *Desmoceras* (*Desmoceras*) *latidorsatum* (Michelin, 1838); Kennedy in Gale *et al*., p. 551, text-figs. 11h–j; 13d, o; 171 (*pars*).
1997. *Desmoceras latidorsatum* (Michelin); Delamette *et al*., pl. 13, fig. 8; pl. 18, fig. 1.
2000. *Desmoceras latidorsatum* (Michelin, 1838); Arkadiev *et al*., p. 107, pl. 9, figs 3–5.
2003. *Desmoceras* (*Desmoceras*) *latidorsatum* (Michelin, 1838); Kawabe and Haggart, p. 315, figs 3–5.
2006. *Desmoceras latidorsatum* (Michelin, 1838); Joly in Gauthier, p. 97, pl. 53, figs 1, 2.
2007. *Desmoceras* (*Desmoceras*) *latidorsatum* (Michelin, 1838); Kennedy and Latil, p. 458, pl. 2, fig. 1; pl. 6, figs 2, 3; text-fig. 4.
2007. *Desmoceras* (*Desmoceras*) *latidorsatum* (Michelin, 1838); Szives, p. 98, pl. 3, fig. 25; pl. 14, fig. 10; pl. 19, figs 3, 4; pl. 26, figs 1, 2; pl. 28, fig. 6.
2009. *Desmoceras* (*Desmoceras*) *latidorsatum* (Michelin, 1838); Kennedy and Bilotte, p. 46, pl. 2, figs 6, 7, 19–28; pl. 8, figs 21–23; text-fig. 4.
2011. *Desmoceras* (*Desmoceras*) *latidorsatum* (Michelin, 1838); Kennedy in Gale *et al.*, p. 75.
2011. *Desmoceras* (*Desmoceras*) *latidorsatum* (Michelin, 1838); Klein and Vašiček, p. 144 (with full synonymy).
2013. *Desmoceras* (*Desmoceras*) *latidorsatum* (Michelin, 1838); Kennedy and Klinger, p. 40, figs 1–5.

TYPE: The holotype by monotypy, and now lost, is the original of Michelin, 1838, p.101, pl. 12, fig. 9, from the Albian Gault Clay of Aube, France. Joly in Gauthier (2006, p. 97, pl. 3, fig. 1) has designated a spec-

imen in the Laboratoire de Paléontologie of the Muséum National d'Histoire Naturelle, Paris, no. B46095, *ex* d'Orbigny Collection 5773-B1, neotype. It is from the condensed Albian of Escragnolles, Var, France.

MATERIAL: GSP1184, 1185, from the top two metres of the Lumishwal Formation at locality 1839. GSP1209 and 1210 (parts of one specimen) from locality 1839. GSP1219, from the top metre of the Lumshiwal Formation at locality 1872.

DIMENSIONS:

	D	Wb	Wh	Wb/Wh	U
GSP1184	30.0 (100)	17.6 (58.7)	14.0(46.7)	1.26	– (–)
GSP1219	77.1 (100)	– (–)	38.4 (49.9)	–	12.8 (16.6)

DESCRIPTION: All specimens are phosphatised phragmocones, 30–145 mm in diameter. Coiling is very evolute, the umbilicus comprising 16% in diameter in GSP1219 (Text-fig. 11A, B), deep, with a relatively high, feebly convex umbilical wall and more narrowly rounded umbilical shoulder. The whorls are massive, the whorl section depressed, with whorl breadth to height ratios of around 1 to 1.26. The inner flanks are flattened and subparallel, the outer flanks feebly convex, converging to the broadly rounded umbilical shoulders. The venter is very broad, and very feebly convex. There are traces of distant constrictions in GSP1184 (Text-fig. 11C–E). They are weak, straight, and prorsiradiate on the flanks, sweep forwards, strengthen, deepen, and are concave on the ventrolateral shoulders, and cross the venter in a broad convexity.

DISCUSSION: See comprehensive accounts by Wiedmann and Dieni (1968) and Cooper and Kennedy (1979). It is convenient to use the following names to describe individuals, based on variations in whorl section and the presence/ absence of constrictions:

forma *complanata* Jacob, 1907 (p. 38, pl. 14 (4), fig. 10; pl. 15 (5), fig. 2);
forma *media* Jacob, 1907 (p. 37, pl. 16 (4), fig. 14);
forma *inflata* Breistroffer, 1933, p. 193 (as *nomen novum* for var *α* Kossmat, 1897, as emended by Jacob, 1907, p. 35, pl. 14 (4), fig. 13);
forma *perinflata* Cooper and Kennedy, 1979 (p. 237, figs 37–38, 39d–f).

The present specimens correspond to forma *inflata.*

OCCURRENCE: Middle Albian to Upper Cenomanian, southern England, southern France, southern Germany, Switzerland, Hungary, Serbia, Poland, Spain, Sardinia, Crimea, Mozambique, Angola, KwaZulu-Natal South Africa, Madagascar, northern Pakistan, south India, Japan, and Venezuela.

Family Cleoniceratinae Whitehouse, 1926
Genus and subgenus *Cleoniceras* Parona and Bonarelli, 1897

TYPE SPECIES: *Ammonites cleon* d'Orbigny, 1850, p. 124 = *Ammonites bicurvatus* d'Orbigny, 1841, p. 286, pl. 84, figs 1–3, *non* Michelin.

Cleoniceras (*Cleoniceras*) *madagascariense* Collignon, 1949
(Text-figs 9M, N; 10N, O; 13D–F)

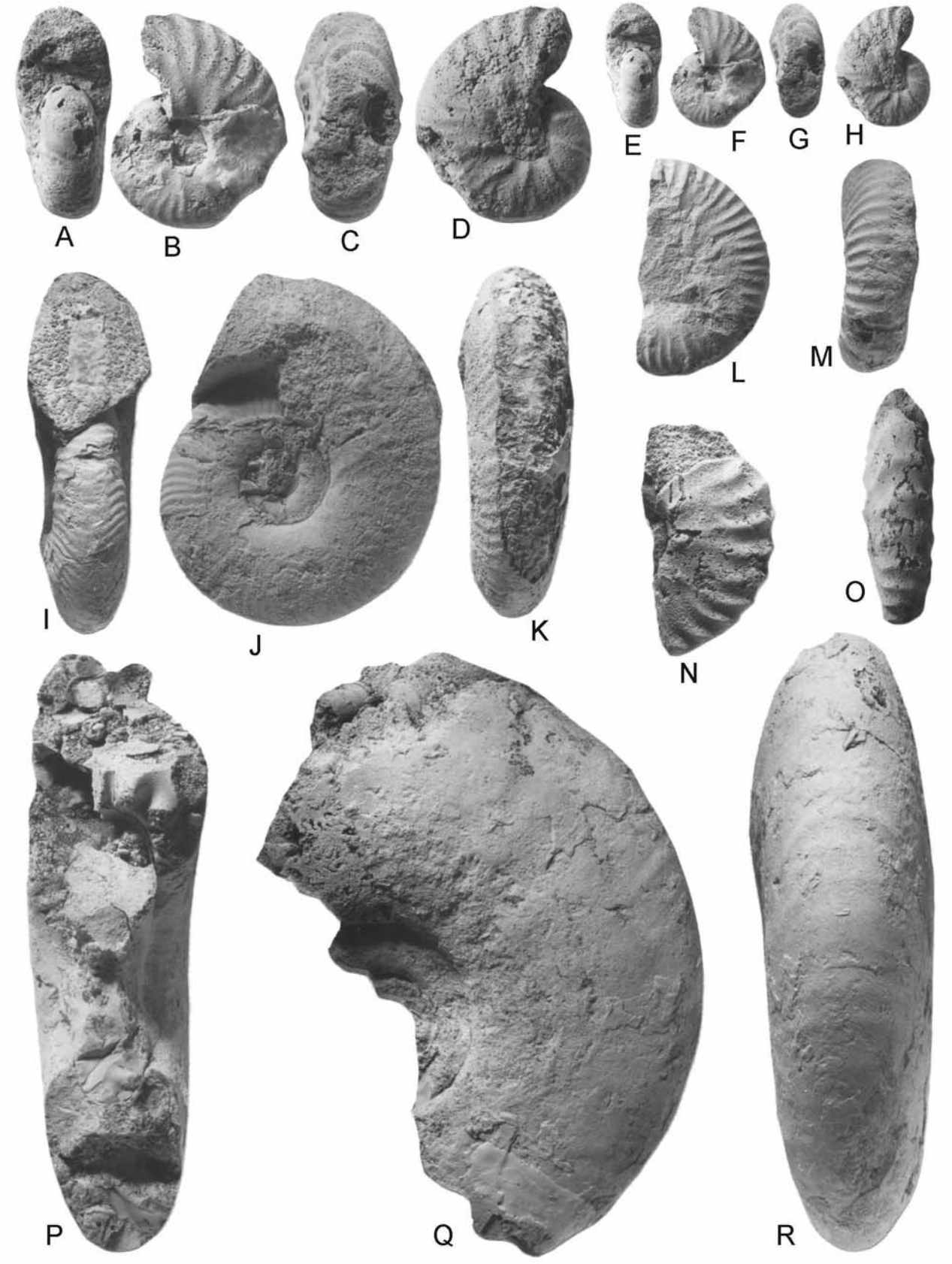
1949. *Cleoniceras madgascariense* Collignon, p. 85, pl. 17, figs 11, 12.
1963. *Cleoniceras madagascariense* Collignon; Collignon, p. 85, pl. 274, figs 1181–1183.
2002. *Cleoniceras madagascariense* Collignon; Riccardi and Medina, p. 338.
2011. *Cleoniceras madagascariense* Collignon; Klein and Vašiček, p. 204 (with full synonymy).

TYPE: The lectotype, here designated, is the original of Collignon, 1949, pl. 17, fig. 11; there are five paralectotypes, all from the Middle Albian of Ambarimaninga, Madagascar, and in the collections of the École des Mines, Paris, now housed in the Université Claude Bernard, Lyon.

MATERIAL: GSP1109 and 1110, from the top two metres of the Lumshiwal Formation at locality 1815.

DESCRIPTION: GSP1109 (Text-fig. 10N, O) is a phosphatic internal mould of a 180º whorl sector with a maximum preserved whorl height of 20 mm. Coiling appears to have been moderately involute, the umbilical wall flattened and outward-inclined, the umbilical shoulder broadly rounded, the whorl section compressed-trapezoidal in intercostal section, with a whorl breadth to height ratio of 0.6 approximately. The greatest breadth is just outside the umbilical shoulder, the flanks flattened and convergent, the ventrolateral shoulders broadly rounded, and the venter feebly convex. The greatest breadth is at the umbilical bullae in costal section. Four strong prorsiradiate elongate bullae perch on the umbilical shoulder of the fragment. They give rise to pairs of ribs that are straight on the inner flanks, strengthening markedly and concave on the outer flanks, strengthening further on the venter, where they are high, coarse, and transverse.

GSP1110 (Text-fig. 9M, N) is a larger phosphatic



fragment, lacking the umbilical margin. Parts of nine strong concave ribs are preserved on the outer flank and ventrolateral shoulder.

DISCUSSION: Although fragmentary, the strength and style of ribbing of the present material matches well with the Malagasy lectotype, shown here in Text-fig. 13D–F.

OCCURRENCE: Northern Pakistan. The type material is from the Lower Albian of Madagascar.

Genus *Aioloceras* Whitehouse, 1926
(=*Paracleoniceras* Collignon, 1963, p. 85)

TYPE SPECIES: *Cleoniceras argentinum* Bonarelli, 1921, *in* Bonarelli and Nágera, p. 24, pl. 4, figs 3, 6.

Aioloceras argentinum (Bonarelli, 1921)
(Text-fig. 12T)

1921. *Aioloceras argentinum* Bonarelli *in* BonarellI and Nágera, p. 24, pl. 4, figs 3, 6.
2002. *Aioloceras argentinum* (Bonarelli, 1921); Riccardi and Medina, p. 315, pl. 4, figs 1–7; pl. 5, figs 1–6; pl. 6, figs 1–4; figs 8a–n, 9a–l, 10, 11 (with full synonymy).
2011. *Aioloceras argentinum* (Bonarelli, 1921); Klein and Vašiček, p. 208 (with full synonymy).

TYPE: The holotype, by monotypy, is the original of Bonarelli in Bonarelli and Nágera, 1921, p. 24, pl. 4, figs 3, 6, refigured by Riccardi and Medina, 2002, pl. 4, fig. 1. It is from the upper Lower Albian Rio Mayer Formation of Cerro Meseta, Lago San Martin, Argentina, and is no. 9293 in the collections of the Servico Geológico Minero Argentino, Buenos Aires.

MATERIAL: GSP1225, from the top of the Lumshiwal Formation at locality KC3.

DESCRIPTION: GSP1225 is a phosphatic internal mould of a phragmocone 108 mm in diameter. One flank is badly corroded. Coiling is very involute, the umbilicus comprising 11.5% of the diameter, shallow, with a low, flattened wall and very narrowly rounded umbilical shoulder. The whorl section is very compressed, with an estimated whorl breadth to height ratio of 0.52. The greatest breadth is low on the flanks. The innermost flanks are feebly convex, the middle and outer flanks flattened and convergent, the ventrolateral shoulders and venter broadly rounded. Ornament is of crowded falcoid ribs. These arise as mere striae in some cases and are straight and prorsiradiate on the inner flank, broadening progressively on middle flank, where they are convex, and on the outer flank, where they are concave, sweeping forwards to reach their maximum strength on the outermost flank and ventrolateral shoulder before effacing on the venter, which is near-smooth. This ornament effaces progressively on the adapertural 90° sector of the outer whorl, part of which has been ground smooth.

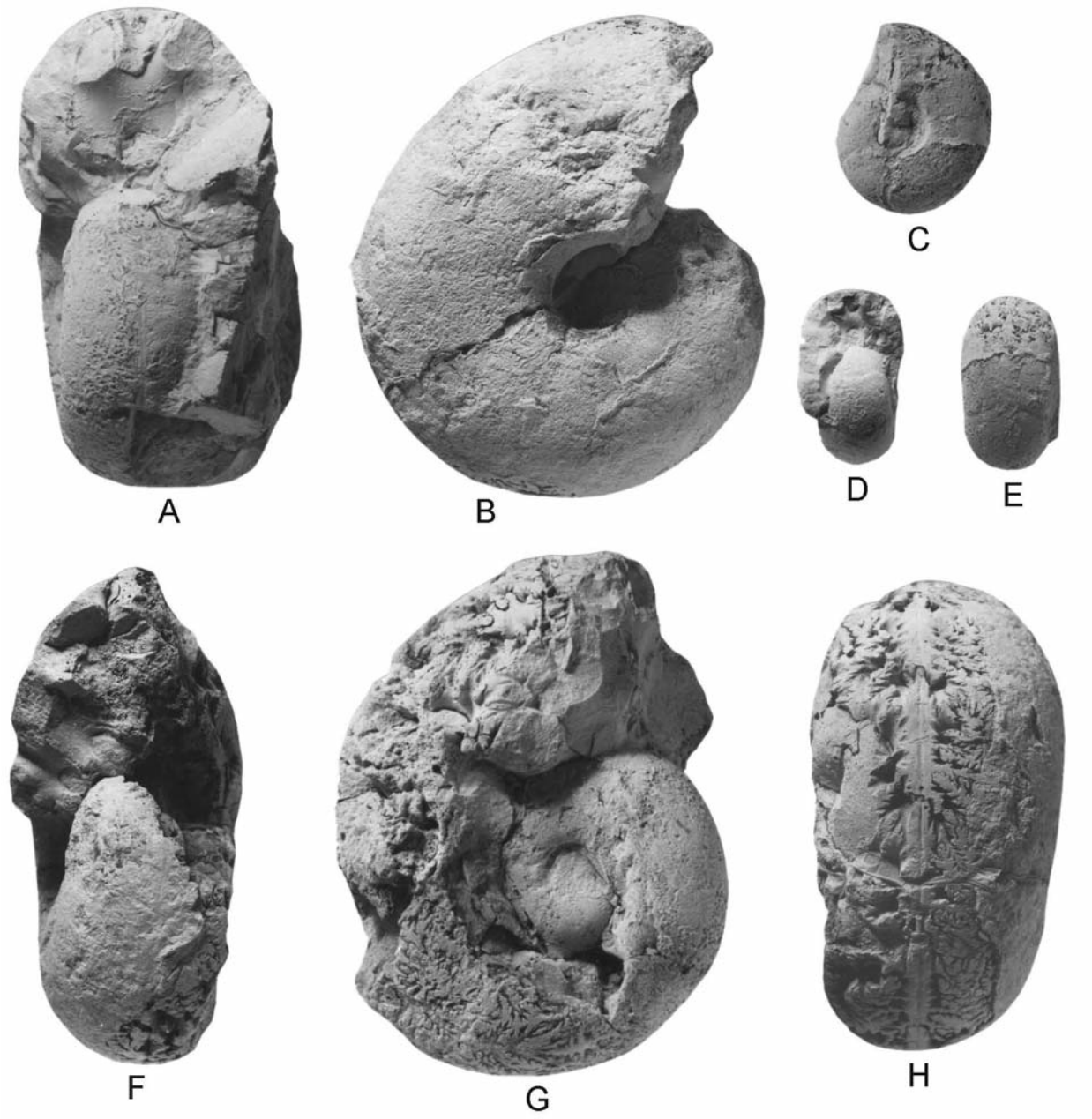
DISCUSSION: The specimen differs in no significant respects from macroconchs from Lago San Martin, Argentina, figured by Riccardi and Medina (see for example their 2002, pl. 6, fig. 1).

OCCURRENCE: Upper Lower Albian of Argentina. The present occurrence in northern Pakistan is undated in the absence of associated ammonites, but a comparable age is likely.

Aioloceras besairiei (Collignon, 1949)
(Text-figs 12M–O, R, S; 13A–C)

1949. *Cleoniceras* (*Aioloceras*) *besairiei* Collignon, p. 86, pl. 18, figs 1–3; pl. 21, fig. 7.
1963. *Cleoniceras* (*Paracleoniceras*) *inequale* Collignon, p. 86, pl. 274, fig. 1185.
1963. *Cleoniceras* (*Paracleoniceras*) *besairiei* Collignon, p. 88, pl. 275, fig. 1186, 1887; pl. 276, figs 1188, 1189.
1963. *Cleoniceras* (*Paracleoniceras*) *inequale* Collignon, p. 86, pl. 274, fig. 1185.
1963. *Cleoniceras* (*Paracleoniceras*) *cleoniforme* Collignon, p. 89, pl. 276, figs 1190–1191.
1963. *Cleoniceras* (*Paracleoniceras*) *morganiforme* Collignon, p. 89, pl. 276, fig. 1192.
1963. *Cleoniceras* (*Paracleoniceras*) *tenuicostulatum* Collignon, p. 92, pl. 277, figs 1193, 1194.
1963. *Cleoniceras* (*Paracleoniceras*) *crassefalcatum* Collignon, p. 94, pl. 278, fig. 1196.
1963. *Cleoniceras* (*Paracleoniceras*) *ambiguum* Collignon, p. 94, pl. 278, fig. 1195.
2002. *Aioloceras besairiei* (Collignon, 1949); Riccardi and Medina, p. 340.
2011. *Aioloceras besairiei* (Collignon, 1949); Klein and Vašiček, p. 209 (with full synonymy).

Text-fig. 10. A-H – *Uhligella* sp., GSP1108, from locality 1815. I, K, P-Q – *Lemuroceras aburense* (Spath, 1933). I-K – GSP1161, from locality 1821; P-R – GSP1111, from locality 1815. L, M – *Lemuroceras indicum* (Spath, 1933), GSP1179, from locality 1825. N, O – *Cleoniceras madagascariense* Collignon, 1949, GSP1109, from locality 1815. All specimens are from the uppermost Lumshiwal Formation. Figs A–D are × 2; Figs E–R are × 1



Text-fig. 11. A-H – *Desmoceras* (*Desmoceras*) l*atidorsatum* (Michelin, 1838). A, B – GSP1219; C-E – GSP1184; F-H – GSP1185, all from locality 1839. All specimens are from the uppermost Lumshiwal Formation. All figures are × 1

2012. *Aioloceras besairiei* (Collignon, 1949); Kennedy and Klinger, p. 58, text-figs 5–7, 9A–C, G–J, O, P, 9, 10A–D, F–G, 11–14.

TYPE: The holotype is the original of Collignon, 1949, pl. 18, fig. 1, from the Middle Albian of Ambarimaninga, Madagascar, in the collections of the École des Mines, Paris, now housed in the Université Claude Bernard, Lyon.

MATERIAL: GSP1109 and 1110, from the top two metres of the Lumshiwal Formation at locality 1815. GSP1160, from the top one to two metres of the Lumshiwal Formation at locality 1821; GSP1177, from the top one to two metres of the Lumshiwal Formation at locality 1817.

DIMENSIONS:

	D	Wb	Wh	Wb/Wh	U
GSP1160	74.0 (1000	22.0 (29.40	35.6 (47.6)	0.61	18.0 (24.1)

DESCRIPTION: GSP1160 (Text-fig. 12M–O) is a phosphatised internal mould 75 mm in diameter. Coiling is moderately involute, with 62% of the previous whorl covered. The umbilicus comprises 24.1% of the diameter, with a low, flattened umbilical wall and narrowly rounded umbilical shoulder. The whorl section is compressed, with a whorl breadth to height ratio of 0.61, the greatest breadth below mid-flank. There are three constrictions per half whorl. They are straight and prorsiradiate on the umbilical shoulder and inner flank, very feebly concave on the outer flank, projected forwards on the ventrolateral shoulder, and feebly convex to near transverse on the venter, where they are at their most conspicuous. On the adapical half of the outer whorl primary ribs arise as mere striae on the inner flank, where they are straight and prorsiradiate. GSP1109 is a phosphatic internal mould of an 180° whorl sector with a maximum preserved whorl height of 20 mm. Coiling appears to have been moderately involute, the umbilical wall flattened and outward-inclined, the umbilical shoulder broadly rounded, the whorl section compressed trapezoidal in intercostal section, with a whorl breadth to height ratio of 0.6 approximately. The greatest breadth is just outside the umbilical shoulder, the flanks flattened and convergent, the ventrolateral shoulders broadly rounded, and the venter feebly convex. The greatest breadth is at the umbilical bullae in costal section. Four strong, prorsiradiate, elongate umbilical bullae perch on the umbilical shoulder of the fragment. They give rise to pairs of ribs that are straight on the inner flanks, strengthening markedly and concave on the outer flanks and strengthening further on the venter, where they are high, coarse, and transverse. GSP1110 is a larger phosphatic phragmocone fragment, lacking the umbilical margin. Parts of nine strong concave ribs are preserved on the outer flank and ventrolateral shoulder.

DISCUSSION: We follow Riccardi and Medina (2003, p. 340) in regarding the various co-occurring species of *Aioloceras* (=*Cleoniceras* (*Paracleoniceras*)) described from Madagascar by Collignon (1963) as conspecific, and refer them to *Aioloceras besairiei*, the holotype of which is illustrated here as Text-fig. 12A–C. The ornament is a little coarser than that of the present material, but otherwise comparable. See Kennedy and Klinger (2012) for further illustrations of the Madagascan type material.

OCCURRENCE: Northern Pakistan; Upper Lower Albian of Madagascar and KwaZulu-Natal South Africa.

Genus *Anadesmoceras* Casey, 1954

TYPE SPECIES: *Anadesmoceras strangulatum* Casey, 1954, p. 107, by original designation.

Anadesmoceras sp.
(Text-fig. 9A, B)

MATERIAL: GSP1113, from the top two metres of the Lumshiwal Formation at locality 1815.

DESCRIPTION: The specimen is a phosphatic internal mould retaining extensive traces of phosphatised shell. Coiling is very involute, the umbilicus comprising less than 15% of the diameter. The whorl section is compressed, with the greatest breadth well below mid-flank, the inner flanks feebly convex, the outer flanks converging to the broadly rounded ventrolateral shoulders and venter. The whorl breadth to height ratio is 0.76. The inner flanks are near- smooth but for traces of very fine delicate prorsiradiate ribs. They strengthen, flex back, and are feebly convex at mid flank, flex forwards, strengthen further, and are concave on the outer flank. The very fine, crowded ribs of variable strength efface over the venter, although this may be the effect of wear. Periodic interspaces are strengthened into irregularly spaced constrictions on the ventrolateral shoulders and venter.

DISCUSSION: Whorl section, coiling, together with constrictions on the ventrolateral shoulders, indicate reference to *Anademoceras*. The specimen most closely resembles the much larger holotype of *Anadesmoceras tenue* Casey, 1966 (p. 579, pl. 96, fig. 5), from the condense Lower Albian of southern England.

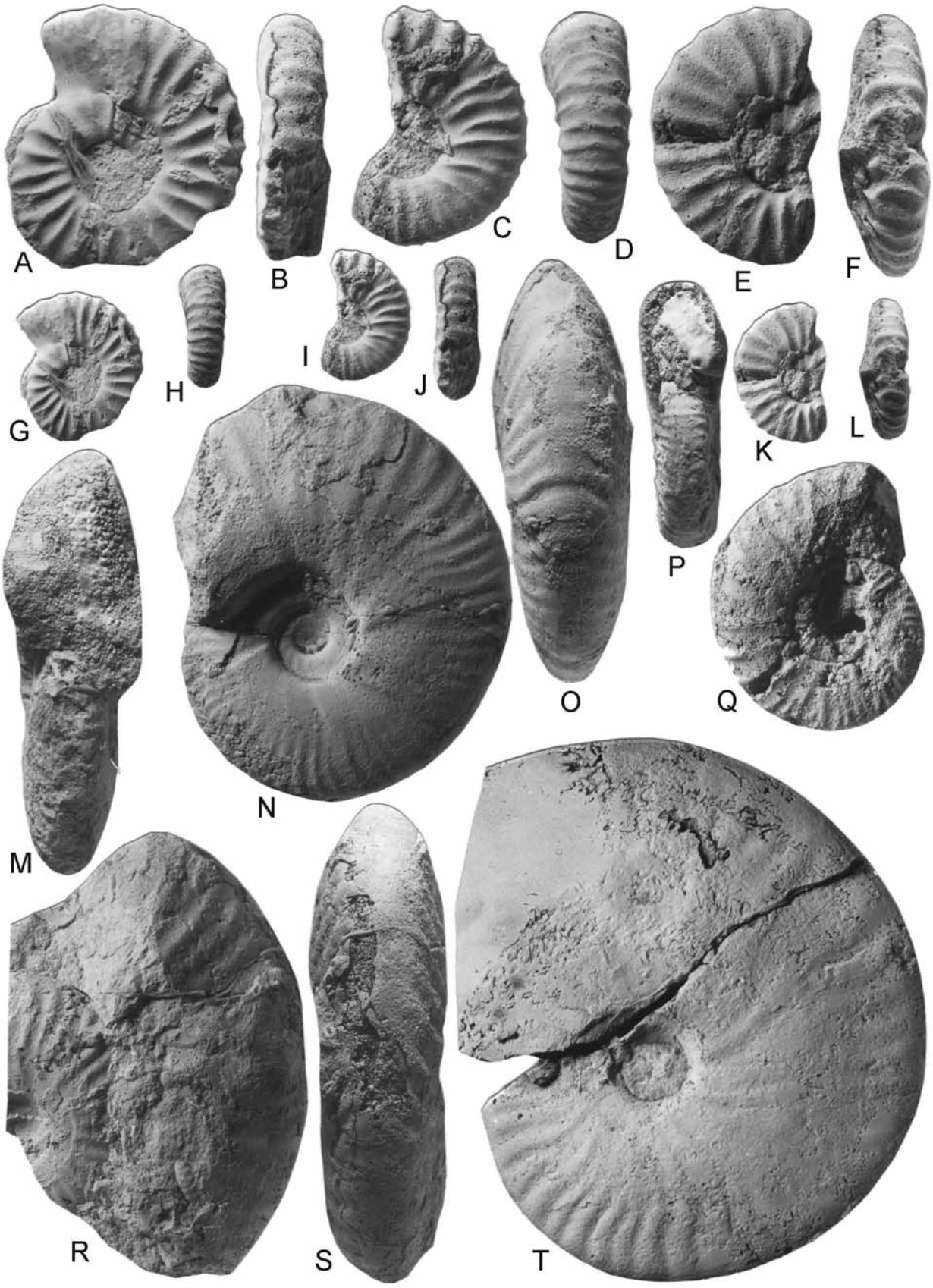
OCCURRENCE: As for material.

Genus *Lemuroceras* Spath, 1942

TYPE SPECIES: *Pseudohaploceras* (*Deshayesites*?) *aburense* Spath, 1933, p. 801, pl. 128, fig. 6, by original designation by Spath, 1942, p. 687.

Lemuroceras indicum (Spath, 1933)
(Text-figs 10L, M; 12P, Q)

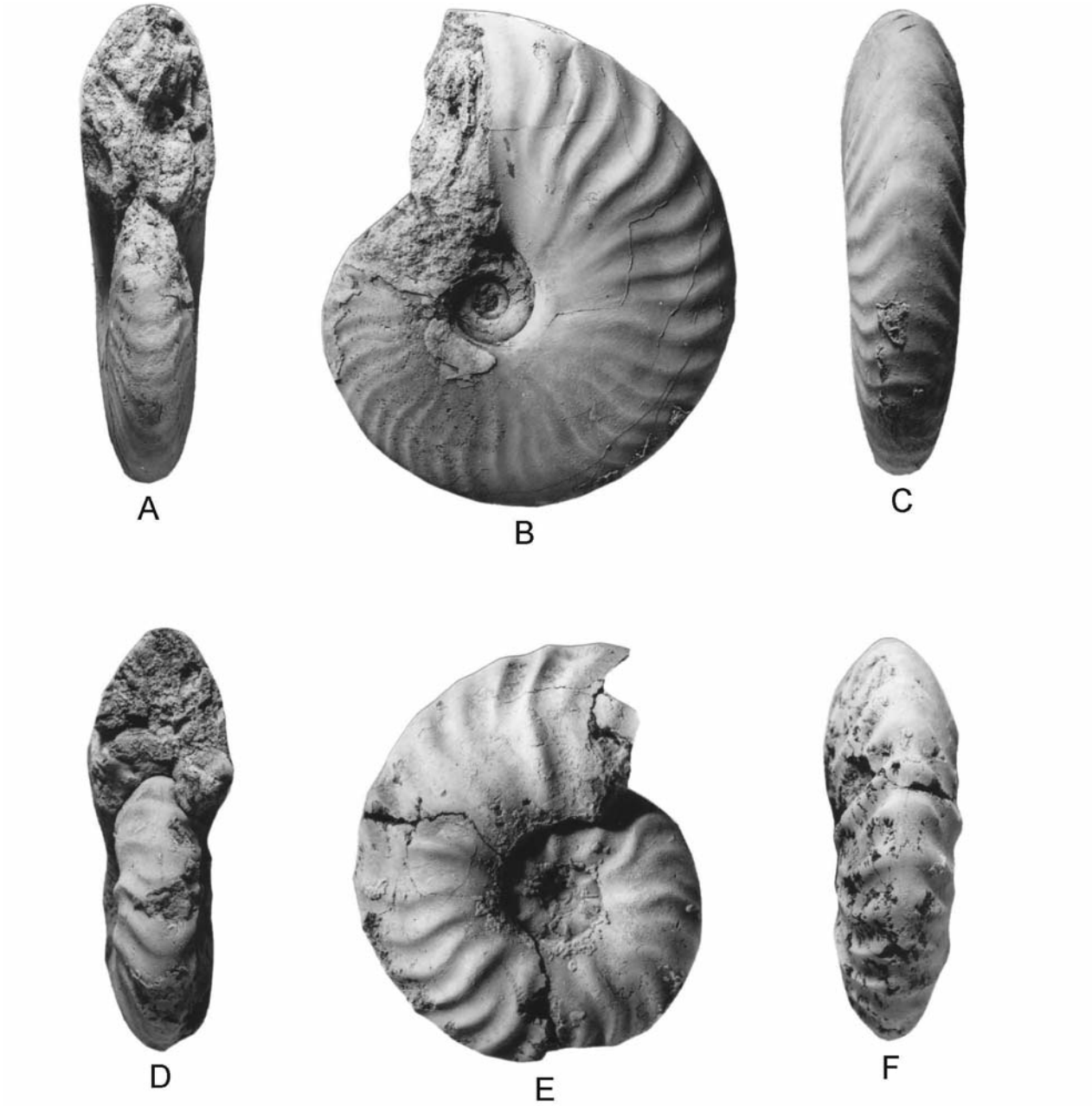
1933. *Pseudohaploceras* (*Deshayesites*?) *indicum* Spath, p. 801, pl. 128, figs 4, 5.
1949. *Lemuroceras indicum* (Spath); Collignon, p. 68, pl. 12, fig. 2; pl. 14, fig. 2.
1963. *Lemuroceras indicum* (Spath); Collignon, p. 96, pl. 279, fig. 1198; p. 97, pl. 258, fig. 1202.



2011. *Lemuroceras indicum* (Spath, 1933); Klein and Vašiček, p. 218.

TYPE: The holotype, by original designation, is the original of *Pseudohaploceras* (*Deshayesites*?) *indicum* Spath, 1933, p. 801, pl. 128, fig. 4, from the Abur Group near Jaisalmir, Rajasthan [Rajputana], India, in the collections of the Geological Survey of India, Kolkata.

MATERIAL: GSP1112 from the top two metres of the Lumshiwal Formation at locality 1815. GSP1179, from the top metre of the Lumshiwal Formation at locality 1825.



Text-fig. 13. A-C – *Aioloceras besairiei* (Collignon, 1949), the holotype, the original of Collignon, 1949, pl. 18, fig. 1. D-F – *Cleoniceras madagascariense* Collignon, 1949, the lectotype, the original of Collignon, 1949, pl. 17, fig. 11. Both specimens are from the Middle Albian of Ambarimaninga, Madagascar, and are in the collections of the École des Mines, now housed in the Université Claude Bernard, Lyon. All figures are × 1

Text-fig. 12. A, B, E- H, K, L – *Pseudobrancoceras transiens* Kennedy, 2004. A, B, G, H – GSP1123, from locality 1815; E, F, K, L – GSP1213, from locality 1846. C, D, I, J – *Pseudobrancoceras* sp. nov., GSP1122, from locality 1815. M-O, R, S – *Aioloceras besairiei* (Collignon, 1949). M-O – GSP1160, from locality 1821; R, S – GSP1177, from locality 1817. P, Q – *Lemuroceras indicum* (Spath, 1933), GSP1112, from locality 1815. T – *Aioloceras argentinum* (Bonarelli, 1921), GSP1225, from locality KC3. All specimens are from the uppermost Lumshiwal Formation. Figs A–F are × 2; Figs G–T are × 1

DESCRIPTION: GSP1179 (Text-fig. 10L, M) is an apparently un- or only slightly phosphatised 180° sector of phragmocone with a maximum preserved diameter of 37.3 mm, the umbilical region damaged. The whorl section appears to have been only slightly compressed, the flanks, ventrolateral shoulders and venter broadly rounded. An estimated 26–28 narrow, crowded ribs are preserved on the fragment. Primary ribs bifurcate low on the flanks and long and short ribs intercalate between. The ribs are flexuous, feebly convex on the inner flank and concave on the outer flank, across which they strengthen progressively, projecting forwards across the ventrolateral shoulders and passing across the venter in a broad convexity. GSP1112 (Text-fig. 12P, Q) is a very corroded phosphatic internal mould of a phragmocone 48 mm in diameter, the broad shallow umbilicus comprising 35% of the diameter, the umbilical wall low, the whorl section compressed, with feebly convex flanks, broadly rounded ventrolateral shoulders and a feebly convex venter. Where best preserved, ornament consists of flexuous ribs that bifurcate low on the flanks, with long and short intercalated ribs separating successive pairs of bifurcating ribs. The ribs strengthen across the flanks, sweep forwards, and cross the venter in a very shallow convexity.

DISCUSSION: These two fragments are of comparable size to the holotype (Spath, 1933, pl. 128, figs 4, 5), which is a little more coarsely and distantly ribbed on the adapertural half whorl. They more closely resembling Spath's second specimen (1933, pl. 128, fig. 5), and Madagascan material of the same size (Collignon, 1949, pl. 12, fig. 2; 1963, pl. 280, fig. 1202).

OCCURRENCE: Northern Pakistan, Rajasthan [Rajputana], India, upper Middle Albian of Madagascar.

Lemuroceras aburense (Spath, 1933)
(Text-figs 10I–K, P-R; 14A–E; 15)

1933. *Pseudohaploceras* (*Deshayesites*?) *aburense* Spath, p. 801, pl. 128, figs 3, 6; pl. 129, fig. 10; pl. 130, fig. 6.
1942. *Lemuroceras aburense* Spath sp; Spath, p. 687.
1949. *Lemuroceras aburense* (Spath); Collignon, p. 65, pl. 12, fig. 6; pl. 14, fig. 1.
1963. *Lemuroceras aburense* (Spath); Collignon, p. 96, pl. 279, fig. 1197; p. 97, pl. 280, fig. 1201.
2011. *Lemuroceras aburense* (Spath, 1933); Klein and Vašiček, p. 218.

TYPE: The holotype is the original of Spath, 1933, p. 801, pl. 129, fig. 10; pl. 130, fig. 6, from the Abur Group of Kuchri, Rajasthan [Rajputana], India, no. G 282/11in the collections of the Geological Survey of India, Kolkata.

MATERIAL: GSP1111 from the top two metres of the Lumishwal Formation at locality 1815. GSP1161–1163, from the top one to two metres of the Lumshiwal Formation at locality 1821.

DIMENSIONS:

	D	Wb	Wh	Wb/Wh	U
GSP1161 at	52.9 (100)	18.3 (34.0)	32.0 (43.5)	0.8	15.3 (28.9)
GSP1163	200 (100)	– (–)	89.5 (44.7)	–	51.0 (25.5)

DESCRIPTION: All specimens are phosphatic internal moulds of phragmocones, some with phosphatised shell, and range from 62–200 mm in diameter. GSP1161 (Text-fig. 10I–K) retains phosphatised shell and is preserved to a maximum diameter of 62 mm, with most of the surface badly corroded. Coiling is moderately evolute, the umbilicus comprising 28.9% of the diameter, shallow, with a low, flattened, outward-inclined wall and broadly rounded umbilical shoulder. The whorl section is compressed, the whorl breadth to height ratio 0.8, the greatest breadth below mid-flank. The inner flanks are broadly convex, the outer flanks feebly convergent. The ventrolateral shoulders and venter are broadly and evenly rounded. The poorly preserved ornament comprises narrow crowded falcoid ribs that bifurcate on the umbilicolateral margin, are straight and prorsirasdiate on the umbilical shoulder and inner flank, concave and prorsiradiate across the middle and outer flank, projecting forwards across the ventrolateral shoulder, and broadly convex over the venter. There are occasional unbranched primary and shorter intercalated ribs.

GSP1162 (Text-fig. 14A–E) has an estimated original diameter of 140–150 mm. The ornament of the inner whorls is well-preserved in places, showing the falcoid branching and intercalating flank ribs, as in GSP1161, although effaced over the venter. The opposite flank shows the ornament of the inner whorls at a somewhat greater diameter, the ribs coarsening and becoming very markedly prorsiradiate on the umbilical shoulder and inner flank, and thereafter effacing. The outer whorl of this specimen has a maximum preserved whorl height of 69 mm, and a whorl breadth to height ratio of 0.65. The flat umbilical wall inclines outwards, producing a crater-like umbilicus. The greatest whorl breadth is below mid-flank, the inner flanks feebly convex, the outer flanks convergent. The surface of the mould is smooth.

GSP1111(Text-fig. 10P–R) is a phragmocone intermediate in size between the two previous specimens,

with an estimated original diameter 115 mm, a maximum preserved whorl height of 50 mm, and a whorl breadth to height ratio of 0.63. The penultimate whorl shows the same inner flank ornament as the previous specimen. The outer whorl shows effacing falcoid flank ribs and constriction-like folds. The ribs are most obvious on the ventrolateral shoulders and venter. GSP1163 (Text-fig. 15) is a phragmocone 200 mm in diameter, without ornament on the outer whorl, but with traces of the same style of ornament on the adapical half of the penultimate whorl, as is seen in the previous specimens.

DISCUSSION: GSP1161 (Text-fig. 10I–K) and the inner whorls of GSP1162 (Text-fig. 14A) are identical to those of Spath's 'finely ribbed variety' (1933, pl. 128, fig. 3) at the same diameter. The other, large specimens (Text-figs 10P–R; 14A–E; 15) find a close match in the Madagascan material of comparable size (Collignon, 1949, pl. 14, fig. 1).

OCCURRENCE: Northern Pakistan, Rajasthan [Rajputana], India; upper Middle Albian of Madagascar.

Superfamily Acanthoceratoidea de Grossouvre, 1894
Family Brancoceratidae Spath, 1934b (1900)
Subfamily Mojsisovicsiinae Hyatt, 1903
Genus *Oxytropidoceras* Stieler, 1920
(=*Pseudophacoceras* Spath, 1921, p. 218)
Subgenus *Oxytropidoceras* (*Oxytropidoceras*)
Stieler, 1920

TYPE SPECIES:*Ammonites roissyanus* d'Orbigny, 1841, p. 302, pl. 89, by the original designation of Stieler, 1920, p. 346.

Oxytropidoceras (*Oxytropidoceras*) *alticarinatum*
(Spath, 1922a)
(Text-fig. 16E, F, I, J)

1858. *Ammonites roissyanus* d'Orb.; Pictet and Campiche, pp. 173–176 (*pars*), pl. 21, figs 3a, 3b, 4.
1922a. *Pseudophacoceras alticarinatum* Spath, p. 98.
1978. *Oxytropidoceras alticarinatum* (Spath); Casey, p. 630, pl. 99, figs 13, 14; text-fig. 240 (with additional synonymy).
2011. *Oxytropidoceras alticarinatum* (Spath, 1922); Kennedy and Klinger, p. 70, text-figs 1A–G.
?2011. *Mirapelia* cf. *alticarinata* (Spath, 1922); Latil, p. 356, pl. 6, fig. 4 (with additional synonymy).

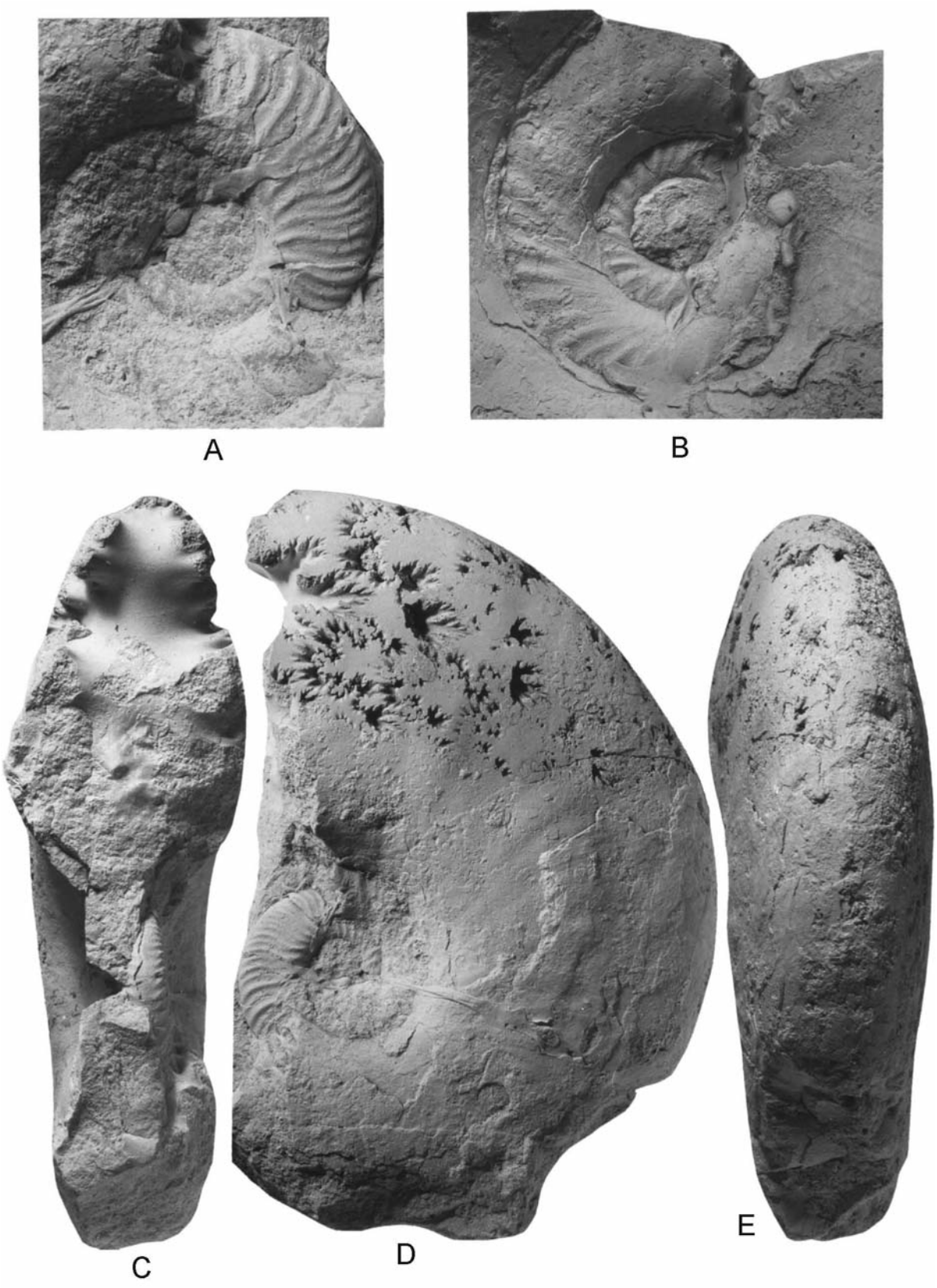
TYPE: The lectotype, by the subsequent designation of Casey, 1978, p. 631, is the original of Pictet and Campiche, 1858, p. 173, pl. 3a, 3b, from the 'Gault Moyen' of Sainte-Croix, Vaud, Switzerland. One of the original figures of the lectotype is reproduced by Casey (1978, fig. 240a). The original syntypes of Pictet and Campiche have not been traced, and they may have decomposed, for as the authors stated they were 'à l'état de moules pyriteuse.' The occurrence of '*Ammonites mammillatus'* (Pictet and Campiche, 1858, p. 208) in pyritic preservation in the 'Gault Moyen' dates the material no more precisely than upper Lower to basal Middle Albian.

MATERIAL: GSP1114, from the top two metres of the Lumshiwal Formation at locality 1815.

DESCRIPTION: The specimen is a phosphatic internal mould of three camerae and a 180° sector of body chamber. The maximum preserved diameter is 28.2 mm; the greatest preserved whorl height is 16 mm. Coiling is very involute. The umbilicus comprises an estimated 15% of the diameter. The whorl section is very compressed, with a whorl breadth to height ratio of 0.56. The inner to middle flanks are feebly convex, the greatest breadth below mid-flank. The outer flanks converge to the narrowly rounded ventrolateral shoulders; the venter is fastigiate, with a very high, sharp siphonal keel. There are 13–14 ribs per half whorl. They arise at the umbilical seam and strengthen across the umbilical wall and shoulder and are narrow, straight and prosrsiradiate, strengthening progressively across the flanks. They are straight on the inner flank, feebly convex across the mid flank region, flexing back and concave on the outer flank and projecting forwards on the outermost flanks and venter to produce an acute ventral chevron, although not extending to reach the siphonal keel, from which they are separated by a narrow flanking groove.

DISCUSSION: This small specimen compares well with comparably sized individuals from southern England (Casey, 1978, pl. 99, figs 13, 14), and northern KwaZulu-Natal in South Africa (Kennedy and Klinger 2011, fig. 1A–G).

OCCURRENCE: Northern Pakistan; the KwaZulu material is associated with *Lyelliceras lyelli* (d'Orbigny, 1841), and thus dated as basal Middle Albian. The English records are from the condensed *Cleoniceras floridum-Protohoplites puzosianus* Zone fauna of the main *mammillatum* bed at Folkestone, Kent. Records from Isère in France are from a condensed Lower and lower Middle Albian unit at la Balme de



Text-fig. 14. A-E – *Lemuroceras aburense* (Spath, 1933), GSP1162, from the uppermost Lumshiwal Formation at locality 1821. Figs A, B, are × 2; Figs C–E are × 1

Rencurel (Breistroffer 1947). A fragment compared to this species by Latil (2011) comes from his mid-Lower Albian *Prolyelliceras gevreyi* Zone in Tunisia.

Subgenus *Manuaniceras* Spath, 1925

Type species: *Pseudophacoceras manuanese* Spath, 1921, p. 281, pl. 25, figs 1a–d, by the original designation of Spath, 1925, p. 182.

Oxytropidoceras (*Manuaniceras*) *jacobi* Besarie, 1936
(Text-fig. 17)

1932. *Manuaniceras jacobi* Besarie, p. 12, pl. 5, fig. 3.
1934b. *Manuaniceras jacobi* Besairie; Spath, p. 461, text-fig. 158e.
1936. *Manuaniceras jacobi* Besairie; Besairie, p. 188, pl. 16, figs 4–6; text-fig. 12b.
1963. *Manuaniceras jacobi* Besairie; Collignon, p. 134, pl. 293, fig. 1275.

TYPE: The holotype is the original of Besairie, 1932, p. 12, pl. 5, fig. 3, from the Middle Albian of Androiavy, Madagascar, housed in the collections of the Sorbonne, Paris.

MATERIAL: GSP1183, from the top two metres of the Lumshiwal Formation at locality 1839.

DESCRIPTION: The specimen is a phosphatised internal mould of a 120° sector of phragmocone with a maximum preserved whorl height of 80 mm. Coiling is very involute, the umbilical shoulder damaged. The whorl section is very compressed, lanceolate, with a whorl breadth to height ratio of 0.5, the greatest breadth below mid flank. The inner and middle flanks are broadly convex, the outer flanks converging to the strong, high siphonal keel. The surface of the mould is near-smooth, but for low broad fold-like ribs, concave and most prominent on the outer flank. The suture is well-preserved, deeply incised, with a broad, asymmetrically bifid E/A.

DISCUSSION: This large fragment represents a growth stage between the holotype (Besairie 1932, pl. 5, fig 3; re-illustrated by Collignon, 1963, pl. 293, fig. 12745) and the large, near-smooth phragmocone illustrated by Besarie in 1936 (pl. 16, fig. 6).

OCCURRENCE: Northern Pakistan; Middle Albian of Madagascar.

Subgenus *Mirapelia* Cooper, 1982

TYPE SPECIES: *Ammonites mirapelianus* d'Orbigny, 1850, p. 1124, by the original designation of Cooper, 1982, p. 291.

Oxytropidoceras (*Mirapelia*) *mirapelianum* (d'Orbigny, 1850)
(Text-fig. 16C, D, K–P)

1850. *Ammonites mirapelianus* d'Orbigny, p. 124.
1982. *Ammonites mirapelianus* d'Orbigny, 1850; Cooper, p. 291, text-fig. 14d, e.
1997. *Oxytropidoceras* (*Mirapelia*) *mirapelianum* (d'Orbigny, 1850); Kennedy, Bilotte and Hansotte, p. 466, pl. 2, fig. 9; pl. 3, fig. 5; pl. 5, figs 12, 13; pl. 7, fig. 4; pl. 10, fig. 12; pl. 11, fig. 12.
2011. *Mirapelia mirapelianum* (d'Orbigny, 1850); Latil, p. 356, pl. 6, figs 6–7 (with additional synonymy).

TYPE: The surviving original of d'Orbigny, 1850, p. 124, from the condensed Albian of Collette de Clar, Var, France, no 5758 (d'Orbigny Collection) in the collections of the Laboratoire de Paléontologie of the Muséum National d'Histoire Naturelle, Paris, is presumed to be the holotype by monotypy. It was figured by Cooper (1982, figs 14D, E), and Kennedy *et al*. (1997, pl. 5, figs 12, 13).

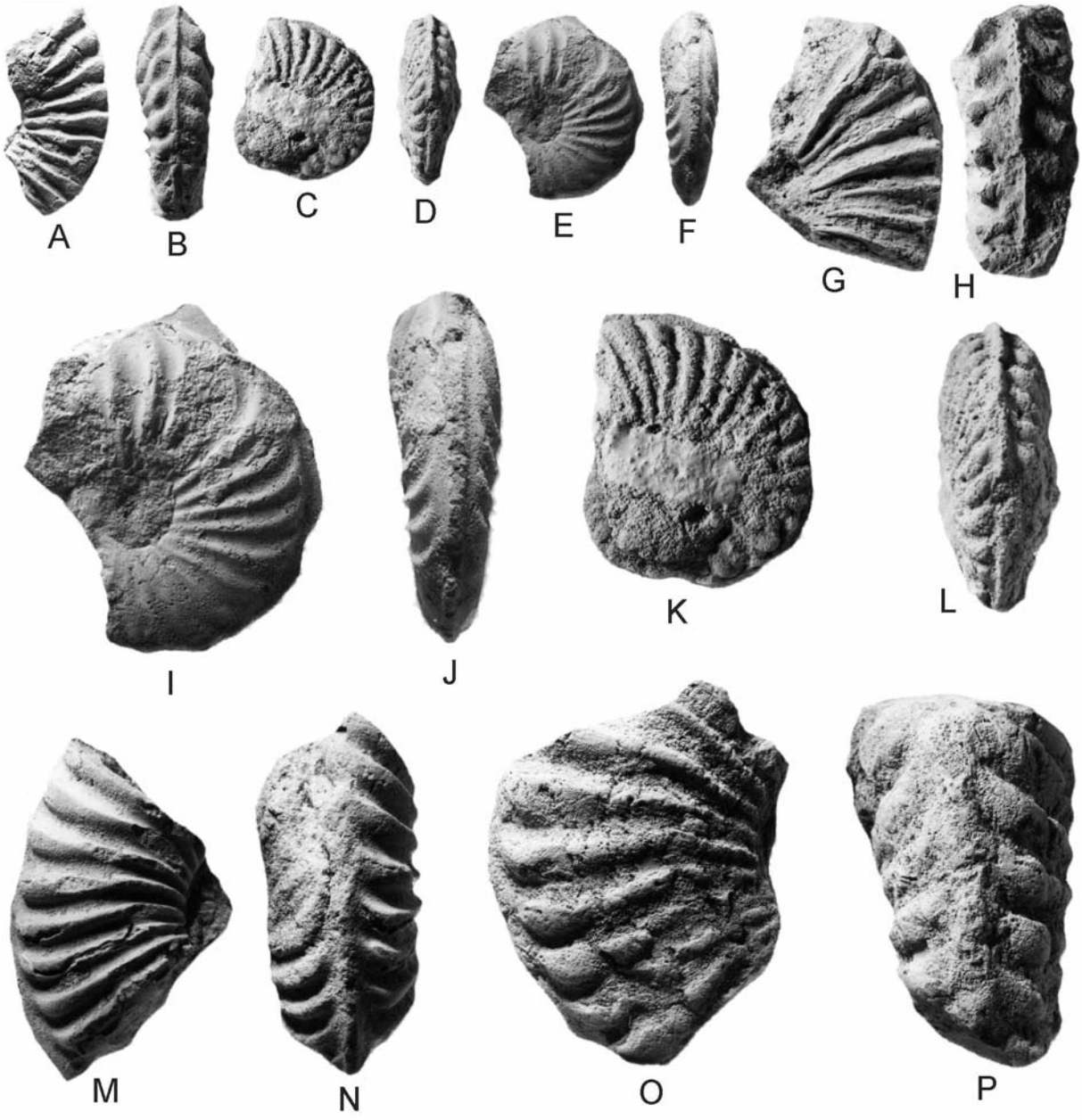
MATERIAL: GSP1193-1198, from the top two metres of the Lumshiwal Formation at locality 1850.

DESCRIPTION: All specimens are phosphatic internal moulds. The smallest specimen, GSP1197, is a half whorl 18.4 mm in diameter, with a maximum preserved whorl height of 9 mm and a whorl breadth to height ratio 0.55. The flanks are feebly convex, the venter fastigiate in costal section, with a strong, high siphonal keel. Parts of 18 primary ribs are preserved on the fragment. They arise at the umbilical seam and strengthen and broaden across the flanks where they are markedly flexuous, convex on the inner flank and concave on the outer flank. They strengthen markedly on the ventrolateral shoulder, becoming broad and spatulate, thence sweeping forwards and declining on the venter, where they form a chevron with the siphonal keel at the apex. The largest fragments have whorl heights of up to 42 mm, and whorl breadth to height ratios of 0.61–0.81. The flanks are strongly convex. Strong flexous primary ribs strengthen markedly on the ventrolateral shoulder, project forwards and decline on the venter to form an obtuse chevron.

DISCUSSION: The variably flexuous ribs, thickening markedly on the outermost flank and ventrolateral shoulder of the present specimens matches that of the crushed material from the Corbières in southeastern France described by Kennedy *et al*. (1997, p. 466, pl. 2, fig. 9; pl. 3, fig. 5; pl. 7, fig. 4; pl. 10, fig. 12; pl. 11, fig. 12), while our largest fragments (Text- fig. 16M–P) correspond well to d'Orbigny's surviving type (Kennedy *et al.* 1997, pl. 5, figs 12, 13).

OCCURRENCE: Northern Pakistan; Southern England, southeast France, Tunisia, and Peru; lower Middle Albian where well-dated.

Text-fig. 15. *Lemuroceras aburense* (Spath, 1933), GSP1166, from the uppermost Lumshiwal Formation at locality 1821. The figure is × 1



Text-fig. 16. A, B, G, H – *Oxytropidoceras* (*Venezoliceras*) sp. A, B – GSP1215, from locality 1848; G, H – GSP1217, from locality 1850. C, D, K-P – *Oxytropidoceras* (*Mirapelia*) *mirapelianum* (d'Orbigny, 1850). C, D, K, L – GSP1198, from locality 1850; M, N – GSP1194, from locality 1850; O, P – GSP1193, from locality 1850. E, F, I, J – *Oxytropidoceras* (*Oxytropidoceras*) *alticarinatum* (Spath, 1922), GSP1114, from locality 1815. All specimens are from the uppermost Lumshiwal Formation. Figs A–H, M–P are × 1; Figs I–L are × 2

Subgenus *Venezoliceras* Spath, 1925
(=*Lophoceras* Van Hoepen, 1931, p. 40, *non* Hyatt, 1893, p. 466; *Tarfayites* Collignon, 1977, p. 13 (1963, p.142, *nomen nudum*).

TYPE SPECIES: *Oxytropidoceras venezolanum* Stieler, 1920, p. 394, from the lower Upper Albian of Venezuela, by original designation.

Oxytropidoceras (*Venezoliceras*) sp.
(Text-fig. 16A, B, G, H)

MATERIAL: GSP1215, from the top two metres of the Lumshiwal Formation at locality 1848. GSP1217, from the top 0.5 m of the Lumishiwal Formation at locality 1856.

DESCRIPTION: GSP1215 (Text-fig. 16A, B) is a 120° sector of body chamber with a maximum preserved whorl height of 15.1 mm. Coiling appears to have been moderately involute. The umbilical wall is low, outward inclined, and feebly convex, the umbilical shoulder broadly rounded. The whorl section is compressed, with the greatest breadth around mid-flank, and a whorl breadth to height ratio of 0.76. The flanks are broadly convex. Only parts of the ribs are preserved on the fragment. They arise at the umbilical seam and are straight, narrow, high and prorsiradiate across the flanks, strengthening progressively into a spatulate rib termination that bears a strong ventrolateral clavus. A broad rib sweeps forwards from the clavus and declines, forming an obtuse ventral chevron with a strong siphonal keel at the apex. GSP1217 (Text-fig. 16G, H) is a 60° sector of body chamber with a maximum preserved whorl height of 27.5 mm and a whorl breadth to height ratio of 0.68. The ornament is as in the previous specimen, but differentiated into stronger ribs, slightly flared on the inner flank, separated by two weaker ribs.

DISCUSSION: Renz (1968) described numerous co-occuring *Oxytropidoceras* (*Venezoliceras*) species from Venezuela. At a comparable size the present fragments compare most closely to *O*. (*V*.) *clavicostatum* Renz, 1968 (p. 649, pl. 11, figs 2, 3; text-fig. 8).

OCCURRENCE: Northern Pakistan.

Genus *Dipoloceras* Hyatt, 1900

TYPE SPECIES: *Ammonites cristatus* Brongniart, 1822, p. 95, 395, pl. 6, fig. 9.

Subgenus *Rhytidoceras* Van Hoepen, 1931

TYPE SPECIES: *Rhytidoceras elegans* Van Hoepen, 1931, p. 43, text-figs 4–7.

Text-fig. 17. *Oxytropidoceras* (*Manuaniceras*) *jacobi* Besairie, 1936, GSP1183, from the uppermost Lumshiwal Formation at locality 1839. Figures are × 1

Dipoloceras (*Rhytidoceras*) sp.
(Text-fig. 18A)

MATERIAL: GSP1216, from the top 0.5 m of the Lumshiwal Formation at locality 1855.

DESCRIPTION: The specimen is an unphosphatised partially septate corroded fragment, 80 mm long. Coiling appears to have been evolute, the umbilical wall low and feebly convex, the umbilical shoulder more narrowly rounded. The whorl section is compressed, with a whorl breadth to height ratio of 0.8. The greatest breadth is below mid-flank, the flanks very feebly convex, subparallel. The ventrolateral shoulders are broadly rounded, the venter flattened, with a strong siphonal keel. Primary ribs arise at the umbilical seam and strengthen across the umbilical wall and shoulder, where they develop into feeble elongated bullae. These give rise to pairs of ribs, while additional long and short ribs intercalate. The ribs are feebly rursiradiate, straight on the inner flank and concave on the outer flank, strengthening into poorly developed ventrolateral bullae, from which progressively declining ribs sweep forwards and efface across the venter. There are traces of spiral notching on the ribs on the outermost flanks.

DISCUSSION: Although only a fragment, there are clear similarities to the inner whorls of the holotype of *Rhytidoceras elegans* Van Hoepen, 1931 (p. 43, fig. 4). GSP1106, a battered fragment from the basal Karagwath Formation of locality D4A may also belong here.

OCCURRENCE: Northern Pakistan; closely related material from northern KwaZulu- Natal in South Africa is from the lower Upper Albian.

Subfamily Mortoniceratinae H. Douvillé, 1912
Genus and Subgenus *Mortoniceras* Meek, 1876

TYPE SPECIES: *Ammonites vespertinus* Morton, 1834, p. 40, by the original designation of Meek, 1876, p. 448.

Mortoniceras (*Mortoniceras*) *geometricum* Spath, 1932
(Text-figs 18B, C; 19A, B, E)

1932. *Mortoniceras* (*Pervinquieria*) *geometricum* Spath, p. 395, pl. 44, fig. 12.

TYPE: The holotype, by original designation, is the original of Spath, 1932, p. 395, pl. 44, fig. 12, no. 70376 in the collections of the Natural History Museum, London, from the lower Upper Albian *Mortoniceras pricei* Zone of Folkestone, Kent.

MATERIAL: GSP1102, 1103-4 (parts of one specimen), 1105, 1107, from the basal Kawagarh Formation of locality 4309.

DESCRIPTION: All specimens are fragments of unphosphatised composite internal moulds with whorl heights of 25–55 mm, corresponding to a maximum diameter, when complete, of 160 mm. The coiling is very evolute, the umbilicus comprising 45–50% of the diameter. The whorl section is very compressed, with whorl breadth to height ratios of 0.6–0.63, the greatest breadth below mid-flank. The umbilical wall is low, convex, and inclined outwards. The umbilical shoulder is broadly rounded, the inner flanks feebly convex, the outer flanks flattened and convergent, the venter obtusely fastigiate with a strong siphonal keel On the smallest fragment, GSP1107, the ribs arise at the umbilical seam and strengthen across the umbilical wall, developing into weak umbilical bullae. The bullae give rise to a single rib or a pair of ribs, while occasional ribs intercalate low on the flanks. The ribs are strong, straight and prorsirdiate, crowded, strengthen progressively across the flanks and develop into rounded-clavate ventrolateral tubercles, from which a low, broad, progressively declining rib extend across the venter. One flank of the inner whorl of GSP1103 shows a striking pathological modification of the ornament (Text-fig. 19E). Damage to the ventroalteral shoulder region in life has resulted in the development of strongly concave prorsiradiate flank ribs that flex back at the point of damage to produce a marked acute chevron, the ribs sweeping back and concave on the ventrolateral shoulder. The ornament on the opposite flank (Text-fig. 19A) shows no such modification.

DISCUSSION: These large fragments overlap in size with the crushed holotype, and have identical ornament.

OCCURRENCE: Northern Pakistan; the type material, from Folkestone, Kent, comes from Spath's *varicosum* Subzone, equivalent to the *pricei* Zone of the present scheme (Text-fig. 7)

Mortoniceras (*Mortoniceras*) sp.
(Text-fig. 19C, D)

MATERIAL: GSP 1220 and 1221, from the top metre of the Lumshiwal Formation at locality 1872.

DESCRIPTION: GSP1221 is a phosphatic internal mould of a phragmocone with a maximum preserved whorl height of 28.8 mm. GSP1220 (Text-fig. 19C, D) is a larger fragment with a maximum preserved whorl height of 52.5 mm. Coiling appears to have been moderately evolute. The whorl section is slightly depressed, rounded-trapezoidal in intercostal section and trapezoidal in costal section. The whorl breadth to height ratio of 1.2 approximately; the greatest breadth is at the lateral tubercle. Ornament, best-preserved in GSP1220, consists of coarse, distant, straight, prorsiradiate ribs. The umbilical region of the fragments is damaged. There are well developed lateral bullae. The ribs sweep forwards across the ventrolateral shoulder, where they thicken and strengthen into a pronounced node, differentiated into a conical inner ventrolateral tubercle and poorly defined outer ventrolateral clavus.

DISCUSSION: These fragments are specifically indeterminate, but the tubercle development suggests a horizon well above the base of the Upper Albian, corresponding to the *inflatum* or *fallax* Zone of the present scheme.

OCCURRENCE: Northern Pakistan.

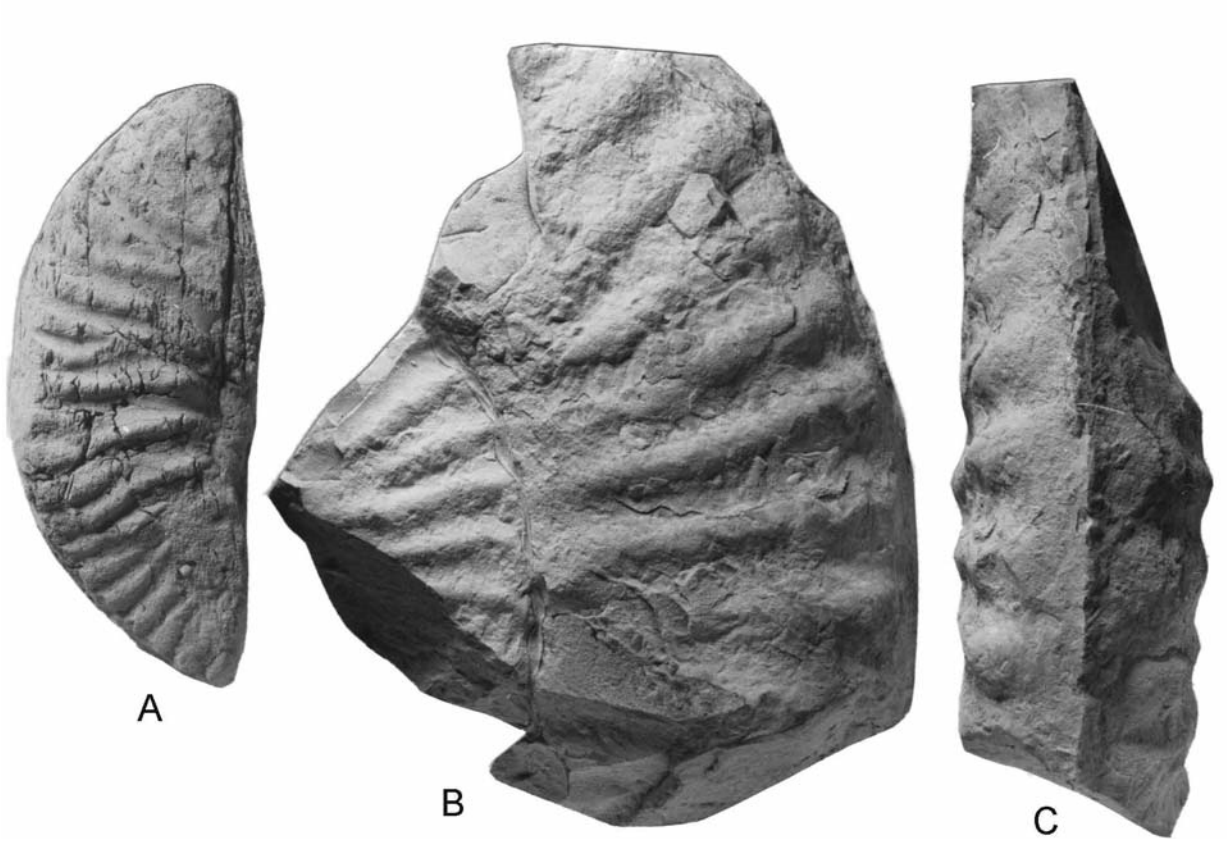
Family Prolyelliceratidae Latil, Robert and Bulot, 2009
Genus *Prolyelliceras* Spath, 1930
(= *Ralphimlayites* Etayo-Serna, 1979, p. 81)

TYPE SPECIES: *Prolyelliceras peruvianum* Spath, 1930, p. 65, = *Acanthoceras prosocurvatum* R. Douvillé, 1906, p. 144, pl. 2, fig. 1, *non* Gerhardt, 1897, by original designation.

Prolyelliceras gevreyi (Jacob, 1907)
(Text-figs 20Q–S; 21S,T)

1860. *Ammonites Lyelli* Leymerie; Pictet and Campiche, p. 198, pl. 24, fig. 7 only.
2008. '*Lyelliceras*' *flandrini* Dubourdieu, 1953; Kennedy and Klinger, p. 76, text-fig. 13H–GG.
2009. *Prolyelliceras gevreyi* (Jacob, 1907); Latil, Robert and Bulot, p. 342, text-figs 1–3 (with full synonymy).
2011. *Prolyelliceras gevreyi* (Jacob, 1907); Latil, p. 358, pl. 6, figs 10–15; text-figs 30H–GG.

TYPE: The holotype, by monotypy, is noAV-38-19053 in the collections of the Muséum d'Histoire Naturelle de



Text-fig. 18. A – *Dipoloceras* (*Rhytidoceras*) sp., GSP1197, from the uppermost Lumshiwal Formation at locality 1855. B, C – *Mortoniceras* (*Mortoniceras*) *geometricum* Spath, 1922, GSP1222, from the basal Kawagarh Formation at locality 4309. All figures are × 1

Genève, the original of Pictet and Campiche, 1860, pl. 24, fig. 7, from the condensed Albian of La Perte du Rhône, Bellegard, Ain, France. It was refigured by Latil *et al*., 2009, text-fig. 2c, d.

MATERIAL: GSP1164, from the top one to two metres of the Lumshiwal Formation at locality 1821, and GSP1118 from the top two metres of the Lumshiwal Formation at locality 1815.

DIMENSIONS:

	D	Wb	Wh	Wb/Wh	U
GSP1164c	60.2 (100)	15.2 (25.2)	21.2 (25.20	0.72	24.7 (41.0)

DESCRIPTION: GSP1164 (Text-fig. 20Q–S) is a calcite spar filled phragmocone with phosphatised shell largely preserved, and a 240° sector of phosphatised body chamber retaining phosphatised shell. Coiling is evolute, the broad umbilicus comprising 41% of the diameter, shallow, with a low outward-inclined umbilical wall and shoulder. The whorl section is very compressed, rounded-trapezoidal in intercostal section, the greatest breadth close to the umbilical shoulder. The costal whorl section is compressed polygonal with the greatest breadth below mid flank, the whorl breadth to height ratio 0.72. There are 24 ribs on the penultimate whorl, predominantly primaries that arise at the umbilical seam and strengthen across the umbilical wall and shoulder. They are of variable strength without developing clearly differentiated bullae. The ribs are recti- to feebly rursiradiate on the flanks, across which they strengthen progressively and are convex across the inner and middle flank. There are 24 ribs, all primaries, on the outer whorl. On the phragmocone part they arise at the umbilical seam and strengthen across the umbilical wall, shoulder, and flanks. The ribs are prorsiradiate, feebly convex on the inner flank and feebly concave on the outer flank. An umbilicolateral strengthening on some ribs barely merits the term bulla. All ribs sweep forwards across the ventrolateral shoulders and bear strong ventrolateral clavi from which the ribs sweeps forwards to produce an obtuse ventral chevron with a strong siphonal clavus at the apex. Sucessive clavi are linked by a blunt siphonal ridge. The coiling of the body chamber is slightly eccentric. The elevation of the umbilical wall decreases, the ribs crowd and are markedly flexuous and the ventolateral clavi weaken towards the aperture. The partially exposed suture includes a moderately incised E/A and A/U_2 and a narrower A and U_2

GSP1118 (Text-fig. 21S, T) is a phosphatised body chamber 47 mm in diameter. Coiling is evolute; the umbilicus comprises 33.4% of the diameter. The costal whorl section is depressed polygonal, with the greatest breadth below mid-flank. On the adapical half of the body chamber the ribs are coarse and distant, straight and rectiradiate on the inner flank, strengthening and projected forwards and feebly concave on the outer flank, where they strengthen into coarse ventrolateral bullae, linked by a broad wedge- shaped ventral rib to strong siphonal clavi. On the adapertural half of the body chamber the ribs crowd, the ventrolateral clavi efface, and the broad wedge-shaped ventral ribs are replaced by narrow transverse ribs with an obtusely fastigiate section. The siphonal clavi progressively reduce, and ultimately become near effaced.

DISCUSSION: The specimens are interepreted as near-complete adults; GSP1164 the macroconch, GSP1118 the microconch. Kennedy and Klinger (1998, p. 76) provide a comprehensive review of the affinities of '*Lyelliceras*' *flandrini*, a synonym, as do Latil *et al.* (2009, p. 342) who demonstrated that *gevryi* of Jacob is the prior name for the species. See also Latil (2011).

OCCURRENCE: Northern Pakistan; the species was previously known from Austria, southeastern France, Algeria, Tunisia, Venezuela, Peru, and Colombia. It ranges from the base of the lower Lower Albian *Leymeriella tardefurcata* Zone as used here into the succeeding *chalensis* Zone. In Tunisia it is the index species of a lower Lower Albian *gevreyi* Zone.

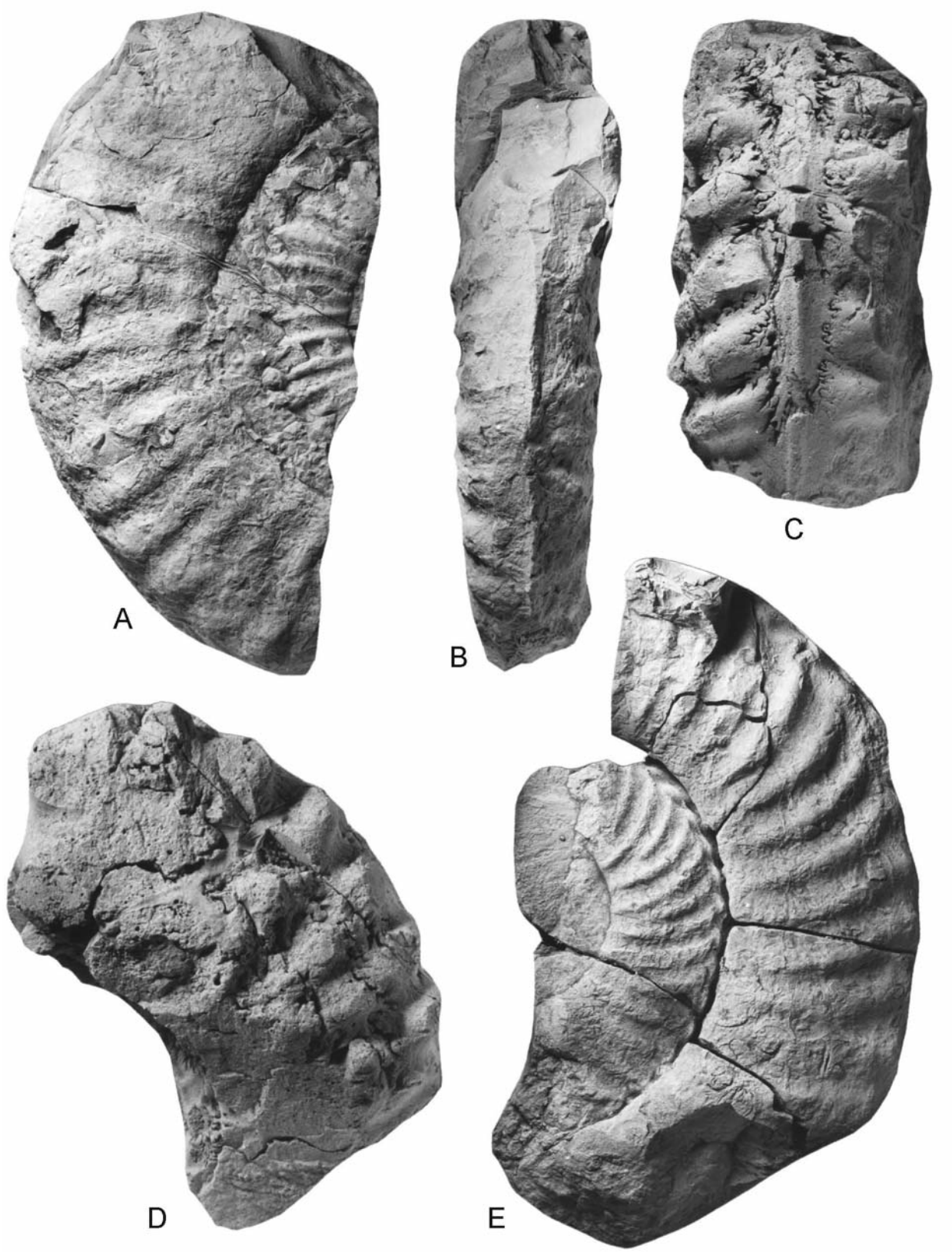
Gnus *Buloticeras* Latil, 2011

TYPE SPECIES: *Prionotropis radenaci* Pervinquière (1907, p. 251, pl. 12, fig. 4; text-fig. 10) by the original designation of Latil (2011, p. 360).

Prolyelliceras radenaci (Pervinquière, 1907) (Text-fig. 20O, P, T, U)

1907. *Prionotropis radenaci* Pervinquière, p. 251, pl. 12, fig. 4; text-fig. 10.
2008. '*Prionotropis*' *radenaci* Pervinquière, 1907; Kennedy and Klinger, p. 79 text-fig. 13A–G.
2009. *Prolyelliceras radenaci* (Pervinquière, 1907); Latil e*t al*., p. 342, 344.
2011. *Buloticeras radenaci* (Pervinquière, 1907); Latil, p. 360, pl. 7, figs 1–24; text-figs 30A–G, 32–35.

TYPE: The lectotype, by the subsequent designation of Kennedy and Klinger, 2008, p. 79, is the original of Pervinquière, 1907, p. 251, pl. 12, fig. 4; text-fig. 100, from the Lower Albian of Djebel Hameima,



Text-fig. 19. A, B, C – *Mortoniceras* (*Mortoniceras*) *geometricum* Spath, 1922. A, B – GSP1102; E – GSP1103, both from the basal Kawagarh Formation at locality 4309. C, D – *Mortoniceras* (*Mortoniceras*) sp., GSP1220, from the uppermost Lumshiwal Formation at locality 1872. Figs A, B, E, are × 0.67; C, D, are × 1

Tunisia, as is the paralectotype. Both are in the Sorbonne Collections, currently housed in the Laboratoire de Paléontologie of the Muséum National d'Histoire Naturelle, Paris. It was refigured by Kennedy and Klinger (2008, text-fig. 13A–G) and Latil (2011, text-figs 30A–G, 32).

MATERIAL: GSP1180, from the top metre of the Lumshiwal Formation at locality 1825.

DESCRIPTION: The specimen appears to be unphosphatised, and consists of a nucleus 15.6 mm in diameter and a 120° sector of body chamber with a maximum preserved whorl height of 12.7 mm. Coiling is moderately evolute, the umbilicus of moderate depth with a convex wall that merges imperceptibly with the umbilical shoulder. The intercostal whorl section of the outer whorl fragment is compressed oval-trapezoidal and compressed trapezoidal-polygonal in costal section, with the greatest breadth just outside the umbilical shoulder. The flanks are convex, the ventral section fastigiate, and concave on either side of the siphonal ridge and clavi. Parts of seven ribs are preserved on the outer whorl fragment. They arise at the umbilical seam and strengthen across the umbilical wall and shoulder, developing into feeble umbilical bullae, from which narrow distant strong rursirsdiate ribs arise. They are convex across the umbilical shoulder concave on the flanks, and sweep forwards across the ventrolateral shoulders where they bear small conical to bullate inner ventrolateral tubercles, from which a broadening rib sweeps forwards to a much stronger outer ventrolateral clavus. The outer ventrolateral clavi are linked across the venter by a low broad rib that bears a strong siphonal clavus borne on a subdued siphonal ridge that links successive clavi.

The nucleus bears bullate primary ribs separated by up to three non-bullate long or short ribs. There are well-developed outer ventrolateral and siphonal clavi, and barely detectable inner ventrolateral tubercles. The poorly exposed sutures include little-incised lobes separated by narrower saddles.

DISCUSSION: See Kennedy and Klinger (2008, p. 79) for a description of the type material of this species, and Latil *et al*. (2009) and Latil (2011) for discussion. The present material is distinguished from that referred to *Prolyelliceras gevreyi* on the basis of the presence of an inner ventrolateral tubercle.

OCCURRENCE: Northern Pakistan; the type material is from the Lower Albian of Tunisia, where it is the index species of an upper Lower Albian *radenaci* Zone.

Family Lyelliceratidae Spath, 1921
Genus *Tegoceras* Hyatt, 1903

TYPE SPECIES: *Ammonites mosensis* d'Orbigny, 1841, p. 237, pl. 67, figs 5–7, by the original designation of Hyatt, 1903, p. 84.

Tegoceras mosense (d'Orbigny, 1841)
(Text-fig. 20A–N)

1841. *Ammonites Mosensis* d'Orbigny, p. 237, pl. 67, figs 5–7.
2008. *Tegoceras mosense* (d'Orbigny, 1841); Kennedy and Klinger, p. 80, pl. 1, figs 10–13; text-figs 3H–O, R–T (with full synonymy).
2010. *Tegoceras mosense* (d'Orbigny, 1841); Colleté, p. 164, fig. 117A–E.
2011. *Tegoceras mosense* (d'Orbigny, 1841); Latil, p. 362, pl. 8, fig. 1.

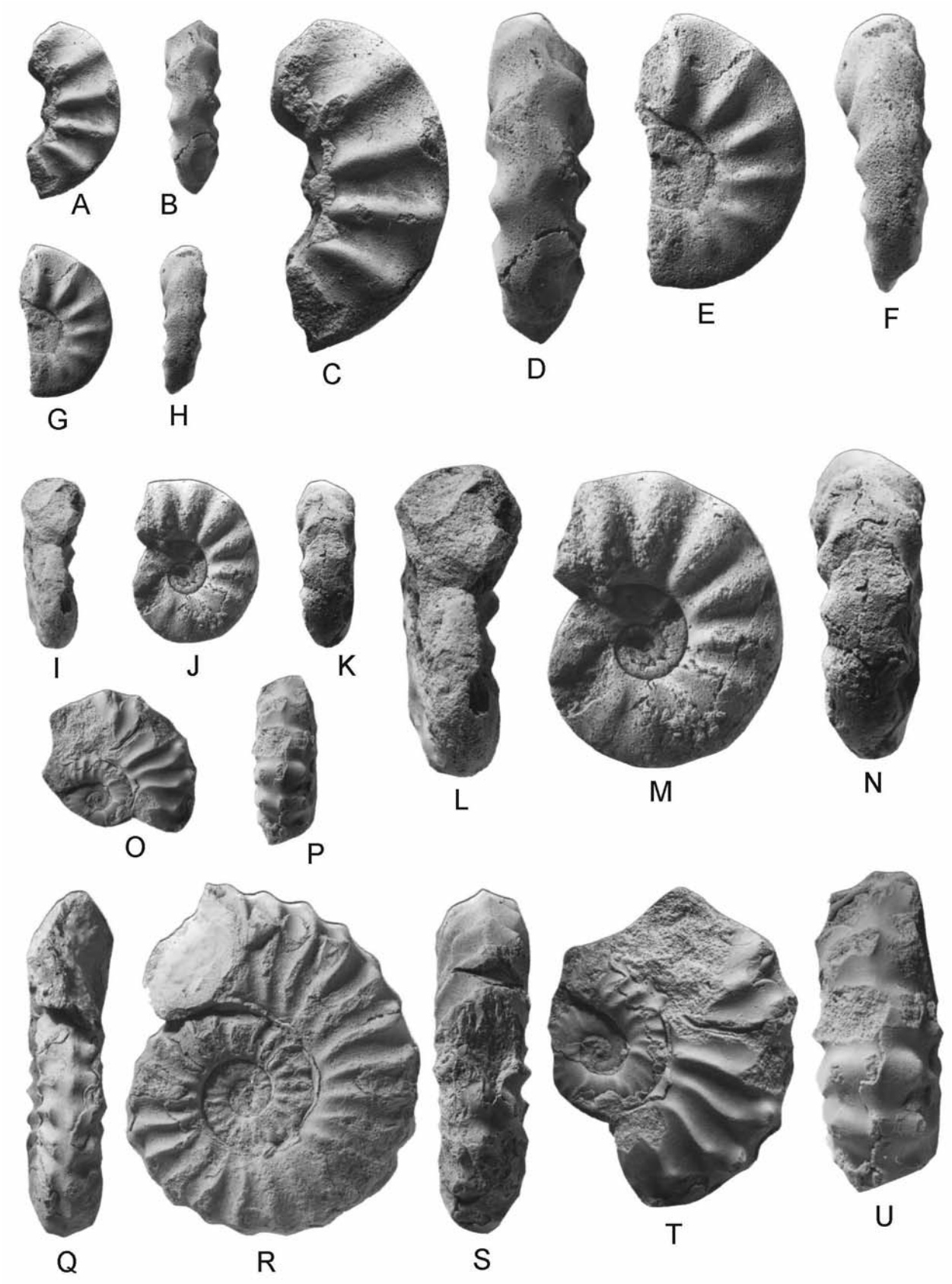
TYPE: The holotype, by monotypy, is specimen no A.1396 in the Collections of the École des Mines, Paris, currently housed in the Université Claud Bernard, Lyon, the original of d'Orbigny, 1841, p. 237, pl. 67, figs 5–7, from Varennes, Meuse, France It was refigured by Kennedy and Klinger (1988, text-figs 3H, N, O).

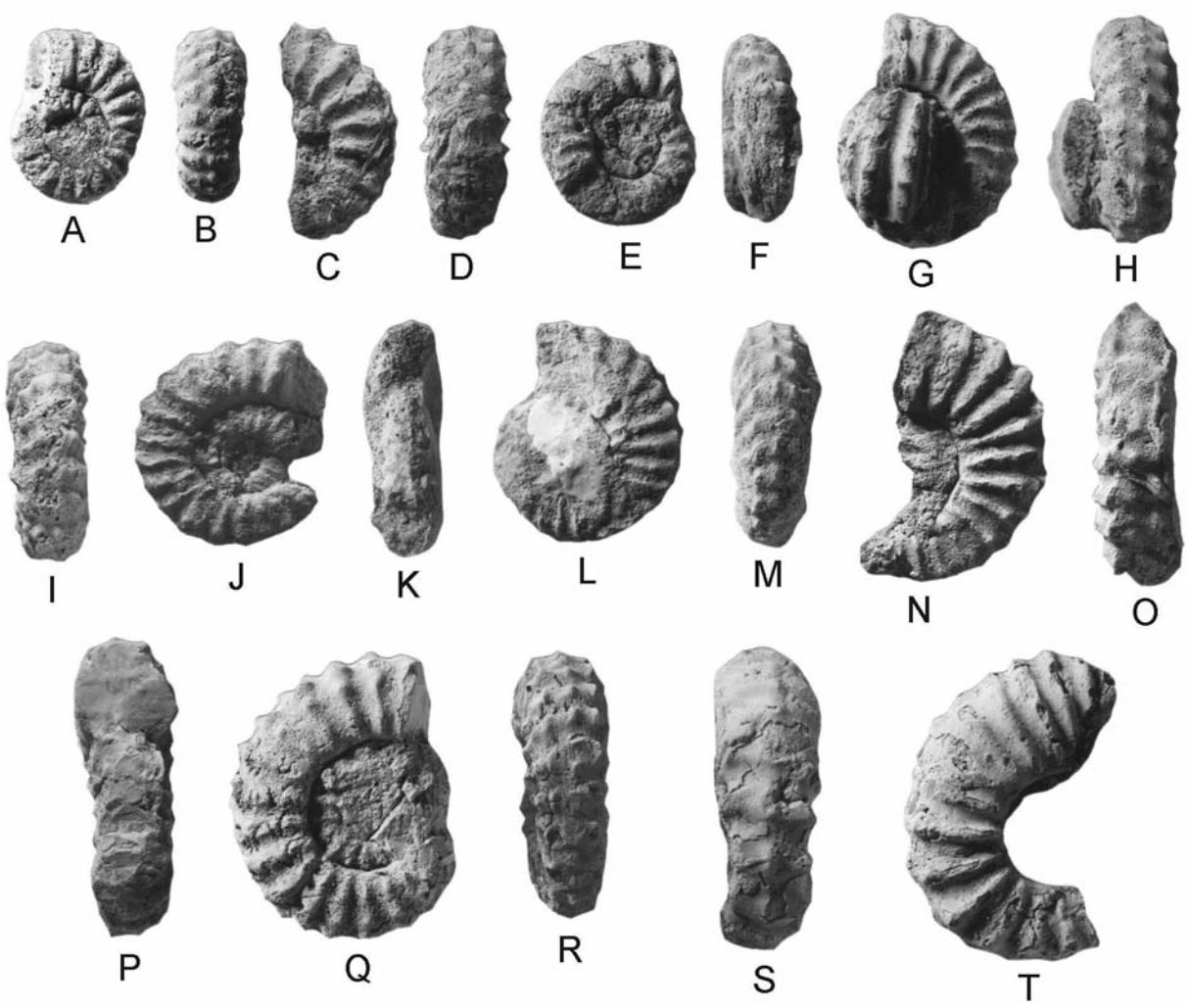
MATERIAL: GSP1115-1117, from the top two metres of the Lumshiwal Formation at locality1815.

DIMENSIONS:

	D	Wb	Wh	Wb/Wh	U
GSP1117	26.8 (100)	– (–)	10.9 (40.1)	–	8.7 (32.5)

DESCRIPTION: GSP1117 (Text-fig. 20I–N) is a complete individual 26.8 mm in diameter. As much as 270° of the outer whorl may be body chamber; the position of the final septum cannot be established with any certainty. Coiling is evolute, the umbilicus comprising 32.5% of the diameter. The umbilical wall is low, the umbilical shoulder broadly convex, the costal whorl section compressed, oval-trapezoidal, the greatest breadth below mid-flank. The costal whorl profile is asymmetric as a result of the alternate position of the ribs on the flanks. There are seven primary ribs on the adapical half of the outer whorl. They arise at the umbilical seam, strengthen across the umbilical shoulder, develop into a blunt umbilical bulla, and are coarse, straight and prorsirsdiate on the flanks, across which they broaden markedly and link to a broad, blunt, thickened ventral tubercle. The ventral tubercles are linked by a low, broad, zigzag ventral rib. GSP1116 (Text-fig. 20 E–H) comprises half a whorl of body





Text-fig. 21. A-D, G-O – *Lyelliceras lyelli* (d'Orbigny, 1841). A, B – GSP1192, from locality 1821; C, D – GSP1211, from locality 1815; G, H – GSP1191, from locality 1815; I, J – GSP1214, from locality 1852; K-M – GSP1212, from locality 1852; N, O – GSP1189, from locality 1848. E, F, P-R – *Lyelliceras pseudolyelli* (Parona and Bonarelli, 1897). E, F – GSP1191; P-R – GSP1119, both from locality 1815; S, T – *Prolyelliceras gevreyi* (Jacob, 1907), GSP1118, from locality 1815. All specimens are from the uppermost Lumshiwal Formation. All figures are × 1

chamber with a maximum preserved diameter of 25.2 mm. One flank is badly worn. The whorl section is more compressed than that of the previous specimen, the umbilicolateral bullae better developed, with 7 ribs per half whorl. GSP1115 (Text-fig. 20A–D) is a body chamber fragment of a somewhat larger individual with stronger but narrower ribs than those of GSP1117, and the umbilical and ventrolateral tubercles better differentiated.

DISCUSSION: This species is comprehensively reviewed by Kennedy and Klinger (1998).

OCCURRENCE: The geographic distribution extends from southern England to France, Tunisia, northern Pakistan, Venezuela, and KwaZulu-Natal in South Africa. The species is well-dated in the Boreal Hoplitid Faunal province, where it occurs mainly in condensed phosphatic units. The record in more expanded sequences indicates a range within the Lower Albian from the *Cleoniceras floridum* Subzone of the *Sonneratia chalensis* Zone to the *Protohoplites puzosianus* Subzone of the *Otohoplites auritiformis* Zone, the mid-*Douvilleiceras mammillatum* Zone of authors.

Text-fig. 20. I-N – *Tegoceras mosense* (d'Orbigny, 1841). A-D – GSP1115; E-H – GSP1116; I-N – GSP1117, all from locality 1815. O, P, T, U – *Buloticeras radenaci* (Pervinquière, 1907), GSP1180, from locality 1825. Q-S – *Prolyelliceras gevreyi* (Jacob, 1907), GSP1164, from locality 1821. All specimens are from the uppermost Lumshiwal Formation. Figs A, B, G–K, O–S are × 1; Figs C–F, L–N, T, U, are × 2

Genus *Lyelliceras* Spath, 1921

TYPE SPECIES: *Ammonits lyelli* d'Orbigny, 1841, p. 255, pl. 74, figs 1, 2, by the original designation of Spath, 1921, p. 222, footnote.

Lyelliceras lyelli (d'Orbigny, 1841)
(Text-fig. 21A–D, G–R)

1841. *Ammmonites lyelli* Leymerie; d'Orbigny, p. 255 (*pars*), pl. 74, fig. 3 (*pars*), fig. 4, ?fig. 5; *non* figs 1, 2, 3.
2008. *Lyelliceras lyelli* (d'Orbigny, 1841); Kennedy and Klinger, p. 86, pl. 3, figs 1–11, 17–21; pl. 4, figs 1–5, 7–9, 11–14, 17, 18; pl. 5, figs 1–11, 14–20; pl. 6, figs 1–16, 19, 20; pl. 7, figs 1, 2, 5, 9; pl. 8, figs 13, 16–20; text-figs 9.3 (*pars*), 4; 10, 11A–G; 12P–R; 24P–Y; BB–GG; 25A–C, I, P, Q, U; 26A–D (with full synonymy).
2010. *Lyelliceras lyelli* (d'Orbigny, 1841); Colleté, p. 170, fig. 120a–h.
2011. *Lyelliceras lyelli* (d'Orbigny, 1841); Latil, p. 365, pl. 8, fig. 11.

TYPES: The lectotype, by the subsequent designation of Guérin-Franiatte *in* Gauthier, 2006, p. 92, is no. R4308 (d'Orbigny Collection no. 5792-D-1), in the collections of theLaboratoire de Paléontologie of the Muséum National d'Histoire Naturelle, Paris, and from Clars, commune d'Escragnolles, Alpes-Maritimes, France. It was illustrated by Guérin-Franiatte *in* Gauthier (2006, pl. 39, fig. 3) and Kennedy and Klinger (2008, text-fig. 24BB–DD).

MATERIAL: GSP1120 and 1191 from the top two metres of the Lumshiwal Formation at locality 1815. GSP1192 from top one or two metres of the Lumshiwal Formation at locality 1821. GSP1189 from top two metres of the Lumshiwal Formation at locality 1848. GSP1190 from top two metres of the Lumshiwal Formation at locality 1849. GSP1211, 1212 and 1214 from the top two metres of the Lumshiwal Formation at locality 1852.

DESCRIPTION: All specimens are variably corroded phosphatic internal moulds that range from 19.8 to 38 mm in diameter. Coiling is very evolute, the relatively shallow umbilicus comprising up to 44% of the diameter. The umbilical wall and shoulder are broadly rounded. The intercostal whorl section is rounded-oval with the greatest breadth below mid-flank. The costal whorl section is polygonal with the greatest breadth at the umbilical bullae, and varies from slightly compressed to slightly depressed. There are 12–14 ribs per half whorl. The ribs arise at the umbilical seam and strengthen across the umbilical wall and shoulder. They are strong, straight, and prorsiradiate across the flanks, bearing small umbilicolateral bullae, stronger conical inner ventrolateral tubercles and outer ventrolateral clavi that are stronger still. The outer ventrolateral clavi are opposite across the venter, and linked to subequal siphonal clavi by a low, broad, transverse rib. GSP1192 (Text-fig. 21A, B) has one rib that intercalates between sucessive primaries, but this is present on one flank only.

DISCUSSION: See Kennedy and Klinger (2008) for a comprehensive review of this species, and a discussion of differences from other species. *Lyelliceras lyelli* differs from *Lyelliceras pseudolyelli*, (discussed below) which also occurs in the present faunas in that the ribs and ventrolateral clavi of *pseudolyelli* are alternate rather than opposite over the venter, with siphonal clavi more numerous than ventrolateral, and linked by an irregular zigzag rib throughout ontogeny.

OCCURRENCE: The first occurrence of *Lyelliceras lyelli* defines the base of the Middle Albian, where it defines a distinct Zone/Subzone. The geographic distribution extends from southern England to France, Switzerland, northern Spain, offshore Spain at 40° 57.6' N, 10° 43.1' W, south of Vigo Seamount, central Iran, Tunisia Madagascar, KwaZulu-Natal in South Africa, northern Pakistan, and Venezuela.

Lyelliceras pseudolyelli (Parona and Bonarelli, 1897)
(Text-fig. 21E, F)

1841. *Ammonites Lyelli* Leymerie; d'Orbigny, p. 255 (*pars*), pl. 74, figs 1, 2, 3 (*pars*) only.
1897. *Acanthoceras pseudolyelli* Parona and Bonarelli, p. 99 (47), pl. 14 (5), figs 1, 2.
2008. *Lyelliceras pseudolyelli* (Parona and Bonarelli, 1897); Kennedy and Klinger, p. 91, pl. 3, figs 12–16; pl. 4, figs 6, 10, 15, 16; pl. 5, figs 12, 13; pl. 6, figs 5, 8–10; pl. 7, figs 3, 4, 6–8, 10–17; pl. 8, figs 1–15; Text-figs 6. 1a, b; 8. 1, 2; 9. 1, 2, 3 (*pars*); 11H–K; 12A–F, J–O, S–U; 24A–GG; 25D–H, J–O, R–T; 27A, B; 28 (with full synonymy).
2010. *Lyelliceras pseudolyelli* (Parona and Bonarelli, 1897); Colleté, p. 168, fig. 119a–f.
2011. *Lyelliceras pseudolyelli* (Parona and Bonarelli, 1897); Latil, p. 363, pl. 8, figs 6–10.

TYPES: The lectotype, by the subsequent designation of Spath, 1931, p. 320, is the original of Parona and Bonarelli, 1897, p. 99 (47), pl. 14 (5), fig.2 (Fig. 8.2),

from the condensed Albian of Escragnolles, Var, France. The specimen is said to be housed in the collections of the Museo Geologico, Turin. There are three paralectotypes from Escragnolles, including the original of Parona and Bonarelli, 1897, pl. 14 (4), fig. 1 (fig. 8.1), and four from Eza, Var, France.

MATERIAL: GSP1119, 1121, from the top two metres of the Lumshiwal Formation at locality 1815. GSP1176, from the top one to two metres of the Lumshiwal Formation at locality 1821.

DESCRIPTION: GSP1119 (Text-fig. 212P–R) is a phosphatic internal mould 44.6 mm in diameter; the adapertural 60° sector of the outer whorl is body chamber. Coiling is very evolute, the umbilicus comprising 43% of the diameter, shallow, with a low, broadly convex umbilical wall, and more narrowly rounded umbilical shoulder. The intercostal whorl section is rounded-oval, with the greatest breadth below mid-flank. The costal section is polygonal, with the greatest breadth at the umbilical bullae. There are 12 ribs on the adapertural half whorl of the specimen. They arise at the umbilical seam and strengthen across the umbilical wall and shoulder. They are strong, narrow, straight and prorsirsdiate across the flanks, bearing weak umbilical bullae, stronger conical inner ventrolateral tubercles and even stronger outer ventrolateral clavi that alternate in position across the venter. There are strong siphonal clavi that are more numerous than the outer ventrolateral, to which they are linked by a low, broad ventral rib that zigzags irregularly between them. GSP1176 is a well-preserved juvenile 23.7 mm in diameter, with 17–18 ribs per whorl, the outer ventrolateral clavi offset across the venter, the siphonal clavi more numerous than the outer ventrolateral, the ventral ribbing showing the characteristic zigzag pattern. GSP1121 (Text-fig. 21E, F) is a very corroded specimen 25 mm in diameter, showing traces of zigzag ventral ribbing.

OCCURRENCE: *Lyelliceras pseudolyelli* is best known from condensed units in southeast France such as Escragnolles (Alpes-Maritimes), Les Rimets (Isère), and Sainte-Croix in Switzerland. In expanded sections as in Aube, France, it is the index of the highest, *pseudolyelli* Subzone of the uppermost Lower Albian *Otohoplites auritiformis* Zone and survives as a rarity into the base of the succeeding *Lyelliceras lyelli* Subzone of the lower Midle Albian *Hoplites dentatus* Zone of the NW European standard sequence. There are also records from southern England (Owen, 1971, p. 154), Switzerland, Tunisia, Venezuela, northern Pakistan, KwaZulu-Natal in South Africa, and Madagascar.

Genus *Pseudobrancoceras* Kennedy, 2004

TYPE SPECIES: *Ammonites versicostatus* Michelin, 1838, p. 101, pl. 12, fig. 10, from the lower Middle Albian *Hoplites dentatus* Zone, *Lyelliceras lyelli* Subzone Argiles Tegulines of Le Gaty, Aube, France.

Pseudobrancoceras transiens Kennedy, 2004 (Text-fig. 12A, B, E, F, K, L)

2004. *Pseudobrancoceras transiens* Kennedy, p. 254, pl. 2, figs 9–10, 14–20; text-figs 2A–E, 3A–F.
2010. *Pseudobrancoceras transiens* Kennedy; Colleté, p. 170, fig. 120j–l.

TYPES: The holotype is no 5792A-1 in the d'Orbigny Collection, from the Lower Middle Albian of Maurepaire, Aube, as is paratype 5792A-2, both housed in the collections of the Laboratoire de Paléontologie of the Muséum National d'Histoire Naturelle, Paris. Paratypes 2061–2068 in the collections of the Institut Dolomieu, Grenoble, are from the condensed Albian of Le Rimet, Isère, France. Paratype 37630 in the collections of the Natural History Museum, London, is from Clars/Escragnolles, Alpes-Maritimes, France.

MATERIAL: GSP1213 from the top two metres of the Lumshiwal Formation at locality 1846. GSP1123 and 1124 from the top two metres of the Lumshiwal Formation at locality 1815.

DESCRIPTION: Specimens range from 19.6 to 26 mm in diameter. Coiling is very evolute, the whorls expanding slowly, the broad umbilicus comprising 30–35% of the diameter, shallow, with a low convex wall. The whorl section is compressed oval, with a whorl breadth to height ratio of around 0.8, the flanks feebly convex, subparallel, the ventrolateral shoulders and venter broadly and evenly rounded. There are up to 22 primary ribs per whorl. They arise at the umbilical seam or on the umbilical shoulder, and are narrow, straight and prorsiradiate on the flanks, strengthening progressively, and passing straight across the venter, where they either terminate on the ventrolateral shoulder of the opposite flank as an intercalated rib, or link to a primary rib that extends to the umbilical shoulder or seam. In some cases a rib on one flank link to a single rib on the opposite flank as a result of which the ventral ribbing is irregular and incipiently zigzag in some cases. There are incipient to poorly differentiated ventrolateral and siphonal tubercles.

DISCUSSION: *Pseudobrancoceas transiens* is believed to be a paedomorphic dwarf offshoot of *Lyelliceras pseudolyelli*, from which it differs in being smaller at maturity, lacking umbilical and inner ventrolateral tubercles, and having a simpler suture line.

OCCURRENCE: Northern Pakistan; Lower Middle Albian of Aube, and condensed Albian of Escragnolles, Var, and Le Rimet, Isère, France.

Pseudobrancoceras sp. nov.
(Text-fig. 12C, D, I, J)

MATERIAL: GSP1122 from the top two metres of the Lumshiwal Formation at locality 1815.

DESCRIPTION: GSP1122 is a phosphatic internal mould of a body chamber and the three adapertural camerae of the phragmocone, with a total diameter of 22 mm. Coiling is evolute, the umbilicus comprising 35.7% of the diameter, shallow, with a low, feebly convex umbilical wall. The whorl section is compressed oval, with broadly rounded flanks, ventrolateral shoulders and venter, the greatest breadth around mid-flank, the whorl breadth to height ratio 0.88. There are 11 primary ribs per half whorl. They arise at the umbilical seam, strengthen across the umbilical wall, project forwards and are prorsiradiate, straight on the inner flank, convex at mid flank and concave on the outermost flank and ventrolateral shoulder. They projected forwards on the venter, which they cross near-transverse. One, rarely two ribs that arise on the middle and outer flank intercalate between successive primary ribs, some incipiently linked to an adjacent primary. As a result, there are 19–20 ribs per whorl at the ventrolateral shoulder. There are well differentiated ventrolateral and siphonal tubercles on all ribs. In one instance, an intercalated rib arises at a ventrolateral tubercle and loops across the venter.

DISCUSSION: The present specimen differs from associated *Pseudobrancoceras transiens* in the delicate, more flexuous ribbing and the better differentiated tubercles. More materal is needed to fully characterise what appears to be a new species of the genus.

OCCURRENCE: As for material.

Suborder Ancyloceratina Wiedmann, 1966
Superfamily Turrilitoidea Gill, 1871

Family Anisoceratidae Hyatt, 1900
Genus and subgenus *Protanisoceras* Spath, 1923

TYPE SPECIES: *Hamites raulineanus* d'Orbigny, 1842, p. 546, pl. 134, figs 5–11, by original designation by Spath, 1923, p. 75
.

Protanisoceras (*Protanisoceras*) *cantianum* Spath, 1939
(Text-fig. 23C–E)

1939. *Protanisoceras cantianum* Spath, p. 567 (*pars*), pl. 63, fig. 10, text-fig. 201a–d only.
1961. *Protanisoceras* (*Protanisoceras*) *cantianum* Spath; Casey, p. 104, pl. 23, figs 1, 2; pl. 25, fig. 3; text-figs 35q, r, 36a (with full synonymy).
? 2002. *Protanisoceras cantianum* Spath (1939); Robert, p. 189, pl. 36, fig. 5.
2010. *Protanisoceras* (*Protanisoceras*) *cantianum* Spath; Colleté, p. 188, pl. 131c.

MATERIAL: GSP1130, from the top two metres of the Lumshiwal Formation at locality 1815.

TYPE: The holotype, by original designation is the original of Spath, 1939, text-fig. 201a, b, from the condensed Lower Albian *Cleoniceras floridum* Subzone-*Otohoplites raulinianus* Subzone fauna, foreshore outcrops at Copt Point, Folkestone, Kent.

DESCRIPTION: The specimen is a 13.2 mm long fragment of a phosphatic internal mould with a maximum preserved whorl height of 11 mm. The whorl section is depressed oval with a whorl breadth to height ratio of 1.2, the greatest breadth around mid flank. The dorsum is flattened to feebly convex, the flanks strongly convex, the venter broad and feebly convex. The rib index is 4–5. The ribs are weak and transverse on the dorsum, strengthen and pass straight across the dorsolateral margin and are feebly prorsiradiate on the flanks, across which they strengthen and pass straight across the venter, developing feeble bullate tubercles that are present on all ribs.

DISCUSSION: The specimen closely resembles the original of Casey, 1961, text fig. 35q–r, a topotype.

OCCURRENCE: Northern Pakistan; the species ranges from the *floridum* Subzone of the *chalensis* Zone to the *puzosianus* Subzone of the *auritiformis* Zone of the Lower Albian in southern England and also occurs in the condensed Lower Albian of southeast France, and, possibly, Peru.

Protanisoceras (*Protanisoceras*) *actaeon* (d'Orbigny, 1850)
(Text-figs 22A–R; 23U–V; 24L–N)

1850. *Hamites actaeon* d'Orbigny, p. 126.
1961. *Protanisoceras* (*Protanisoceras*) *actaeon* (d'Orbigny, 1850); Casey, p. 109, pl. 24, figs 1–4; text-figs 35o, 36d (with full synonymy).
?2002. Protanisoceras cf. *actaeon* d'Orbigny, 1850); Robert, p. 189,
?2011. *Protanisoceras* (*Protanisoceras*) cf. *actaeon* (d'Orbigny, 1850); Latil, p. 366, pl. 8, figs 17–30; text-figs 17–30.

TYPE: The lectotype, by the subsequent designation of Casey (1961, p. 109) is the original of his, text-fig. 35 o, p, a specimen in the d'Orbigny collection, housed in the Muséum National d'Histoire Naturelle, Paris, from the condensed Albian of Clars, near Escragnolles, Var, France.

MATERIAL: GSP 1129, 1131–42, from the top two metres of the Lumshiwal Formation at locality 1815.

DESCRIPTION: GSP 1129 (Text-fig. 23U, V) is part of a curved sector and an adapertural shaft 22.5 mm long, with a maximum preserved whorl height of 10.1 mm and a whorl breadth to height ratio of 1, the whorl section circular. The rib index is five. The middorsum is near-smooth, the ribs appearing on the outer margin and dorsolateral area, where they are narrow, straight and transverse. The ribs strengthen markedly and are straight and strongly rursiradiate on the flanks and coarse and transverse across the venter. All ribs bear feeble ventral clavi, effaced through wear. The ventral rib is flattened between the clavi. GSP1131–1142 (Text-figs 22A–R; 24L–N) are also phosphatised fragments, with whorl heights of 7.4–18 mm. The whorl section varies from subcircular to slightly depressed, with a whorl breadth to height ratio of up to 1.1. Most of the fragments are straight; GSP1135 and 1141 (Text-fig. 22A–C) are slightly curved. Ribbing is near effaced at mid-dorsum, but strengthens across the dorsolateral margin, where it is feebly concave. The rib index is 3, the ribs straight, prorsiradiate and narrow on the inner flanks, but becoming very coarse on the ventrolatral shoulders and venter. In most of these specimens there is a slight angulation on the ventrolateral shoulder and sometimes an incipient bulla. The rib between the angulation/incipient bulla is broad, coarse, and flattened to varying degrees between specimens. The largest fragment, GSP1136 (Text-fig. 22P–R), is 50 mm long, and bears eight strong, coarse, prorsiradiate ribs on the flanks that thicken markedly on the ventrolateral shoulder, where they are rounded, show no trace of ventrolateral tuberculation, and are separated by narrower interspaces.

DISCUSSION: GSP1129 closely resembles the much larger fragment figured by Casey (1961, pl. 24, fig. 2). The remaining fragments, with incipient tubercles or no tubercles are more problematic, resembling the specimens from Aube, France, illustrated by Destombes (1979, pl. 4–2, figs 2–4).

OCCURRENCE: Northern Pakistan; in southern England the species is precisely dated to the Lower Albian *floridum* Subzone of the *chalensis* Zone, and also occurs in the condensed Lower Albian of southeast France. There is a possible record from Peru.

Genus *Anisoceras* Pictet, 1854

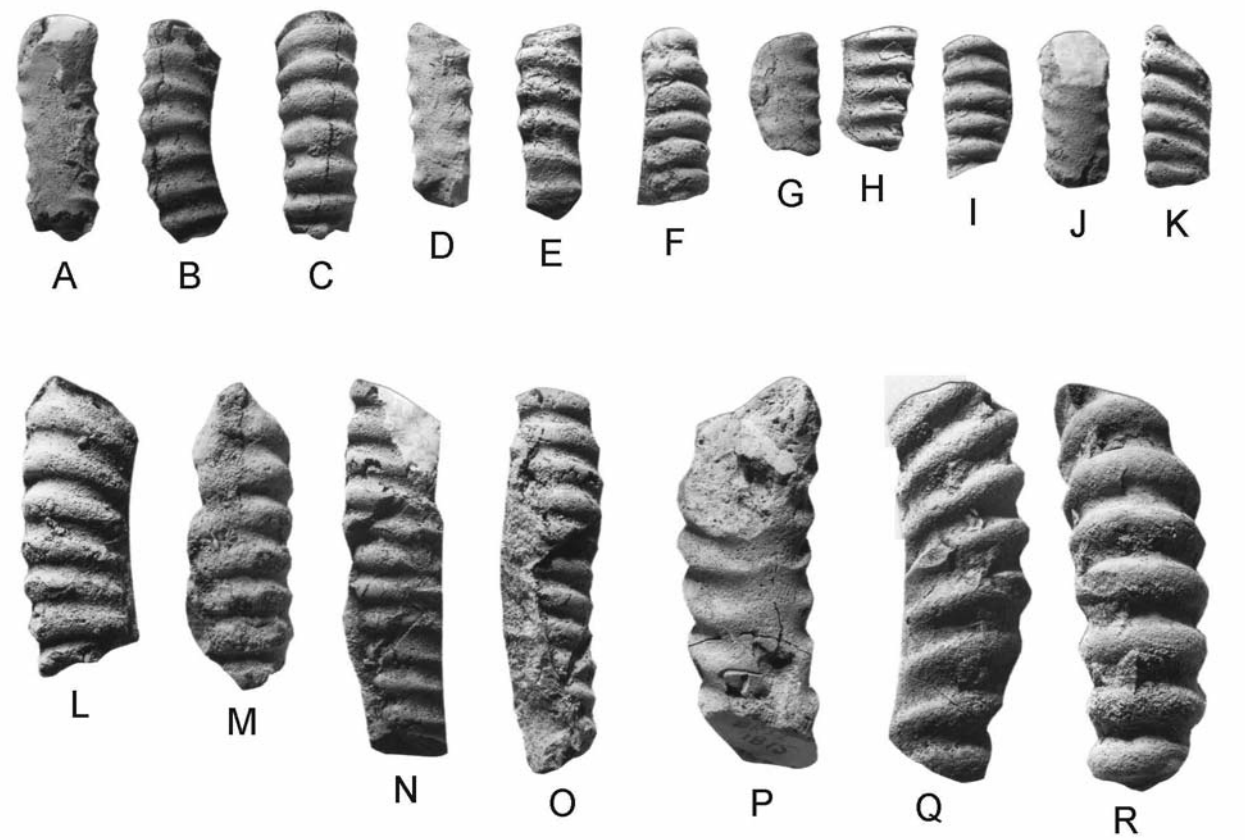
TYPE SPECIES: *Hamites saussureanus* Pictet in Pictet and Roux, 1847, p. 118, pl. 13, figs 1–4, by the original designation of Pictet, 1854, p. 705.

Anisoceras arrogans (GiebeL, 1852)
(Text-fig. 23F–K, N, O)

1842. *Hamites elegans* d' Orbigny, p. 542, pl. 133, figs 1–5 (*non* Parkinson, 1819)
1852. *Hamites arrogans* Giebel, p. 305.
1968. *Anisoceras* (*Anisoceras*) *arrogans* (Giebel); Wiedmann and Dieni, p. 69, pl. 7, fig. 10; pl. 8 figs 5, 7, 11; text-figs 46–50 (with synonymy).
1997. *Anisoceras arrogans* (Giebel, 1852); Kennedy in Kennedy *et al*., p. 468, pl. 2, fig. 11; pl. 3, figs 2, 6.
2006. *Anisoceras arrogans* (Giebel, 1852); Kennedy and Juignet in Gauthier, p. 159, pl. 47, figs 1–5.

TYPES: The lectotype, by the subsequentdesignation of Kennedy and Juignet, in Gauthier, 1996, p. 159, is no. 5808-A-3 in the d'Orbigny collection collection, housed in the Muuséum National d'Histoire Naturelle, Paris, from the condensed Albian of Escragnolles, Alpes-Maritimes, France. There are numerous paralectotypes.

MATERIAL: GSP1125, from the top two metres of the Lumshiwal Formation at locality 1815. GSP1165, from the top one to two metres of the Lumshiwal Formation at locality 1821. GSP1199, from the top two metres of the Lumshiwal Formation at locality 1849.



Text-fig. 22. A-R – *Protanisoceras actaeon* (d'Orbigny, 1820), A-C – GSP1141; D-F– GSP1142; G-I – GSP1133; J, K – GSP1131; L, M – GSP1137, N, O – GSP1139; P-R – GSP1136. All specimens are from the uppermost Lumshiwal Formation at locality 1815. All figures are × 1

DESCRIPTION: GSP1125 (Text-fig. 23I–K) and 1165 (Text-fig. 23F–H) are phosphatised fragments of straight shafts; the former is the better preserved, 24.8 mm long with a maximum preserved whorl height of 11.5 mm and whorl breadth to height ratio of 0.78, the whorl section compressed oval. The rib index is 13, the ribs narrow and crowded, barely weakened on the dorsum, where they are feebly concave, sweeping forwards on the dorsolateral margin, straight and prorsiradiate across the flanks and passing straight across the venter. Two or three ribs are linked at circular flat-topped tubercles, and up to three nontuberclate ribs separate tuberculate groups. GSP1199 (Text-fig. 23N, O) is a curved sector with a septal face at the adapical end. The maximum preserved whorl height is 15.8 mm; the whorl breadth to height ratio 0.73, the whorl section compressed oval. The venter of the specimen is somewhat abraded. The ribbing is coarser, and the rib index lower than in the other specimens.

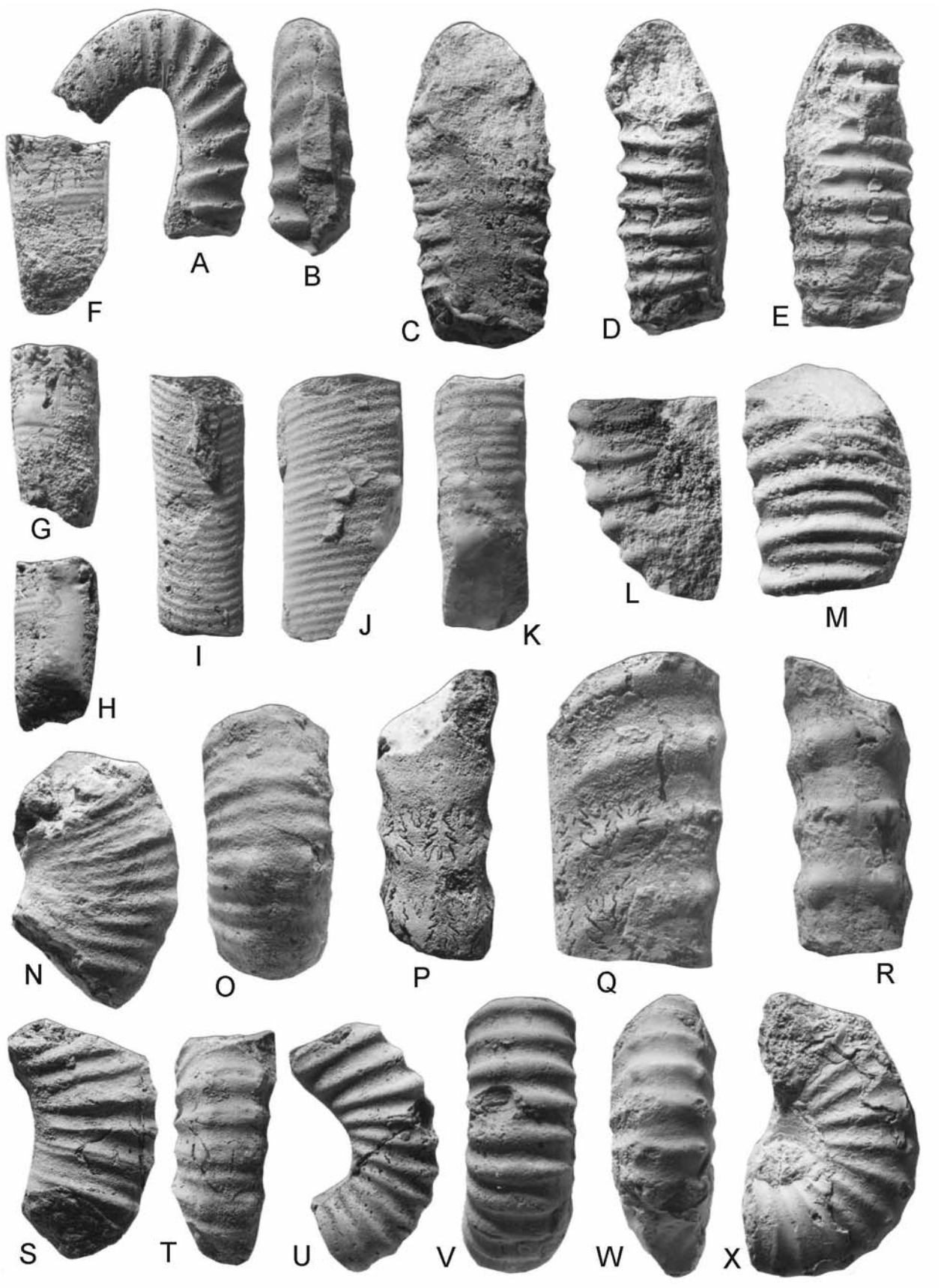
DISCUSSION: The smaller specimens, GSP1125 and 1165 closely resemble the paratypes figured by Kennedy and Juignet *in* Gauthier (2006, pl. 47, figs 1–4), the larger fragment, GSP1199 agrees well with their pl. 47, figs 2 and 5.

OCCURRENCE: Northern Pakistan; the type material comes from the condensed Lower to Middle Albian of southeast France, and there are additional records from Switzerland and Sardinia. In southern England the species is precisely dated as lower Middle Albian, *spathi* Subzone of the *dentatus* Zone

TYPE SPECIES: *Hamites sablieri* d'Orbigny, 1842, p. 543, pl. 133, figs 6–10.

DISCUSSION: It should be noted that the image of what is said to be *Metahamites sablieri* in the 1996 volume of the Treatise (Wright 1996, fig. 186. 1a) is not a copy of

Text-fig. 23. A, B – *Metahamites* sp., GSP1168, from locality 1821. C-E – *Protanisoceras cantianum* Spath, 1939, GSP1130, from locality 1815. F-K, N, O – *Anisoceras arrogans* (Giebel, 1852). F-H – GSP1165, from locality 1849; I-K – GSP1125, from locality 1815; N, O – GSP1199, from locality 1849. L, M – *Astiericeras* sp., GSP1218, from locality 1859. P-R – *Tarrantites adkinsi* (Scott, 1928), GSP1167, from locality 1821. S, T, W, X – *Ndumuiceras variabile* Kennedy and Klinger, 2009. S, T – GSP1188; W, X – GSP1181, both from locality 1849. U, V – *Protanisoceras actaeon* (d'Orbigny, 1850), GSP1129, from locality 1815. All specimens are from the uppermost Lumshiwal Formation. Figures A–R, U–X are × 2; S, T, are × 1



one of d'Orbigny's original figures of *Hamites sablieri* (1842, p. 543, pl. 133, figs 6, 10) but that of his *Hamites elegans* (d' Orbigny, p. 542, pl. 133, figs 1 (*non* Parkinson, 1819), that is to say *Hamites arrogans* (Giebel, 1852).

Metahamites sp.
(Text-fig. 23A, B)

MATERIAL: GSP1168, from the top two metres of the Lumshiwal Formation at locality 1815.

DESCRIPTION: The specimen consists of a short section of adapical shaft, a curved sector and part of a straight adapertural shaft 16 mm long. The whorl section is compressed oval, the costal whorl breadth to height ratio 0.8. Ornament on the adapical shaft consists of delicate crowded ribs, well developed and feebly concave across the dorsum, sweeping forwards on the dorsolateral margin and straight and prorsiradiate across the flanks, across which they strengthen progressively. Every fourth rib is strengthened compared to the others, and bears incipient ventral tubercles. The ribs strengthen and coarsen markedly around the curved sector, and their direction changes from prorsirsdiate to strongly rursiradiate. The rib index is four on the flanks of the adapical shaft. The ribs are coarse, rounded, becoming concave on the outer flank, and pass straight across the venter; some show the development of incipient ventral tubercles. The ornament on the dorsum is distinctive, with fine crowded convex ribs that link in pairs to the flank ribs and intercalate between.

DISCUSSION: The change in ornament between the two shafts and the differentiation of the ribs on the penultimate shaft, with periodic stronger ribs, show this specimen to be a *Metahamites*. The ribbing on the adapertural shaft is stronger than in the type material of the type species (Kennedy and Juignet *in* Gauthier, 2006, pl. 42, figs 3–5); accordingly, the specimen is left in open nomenclature.

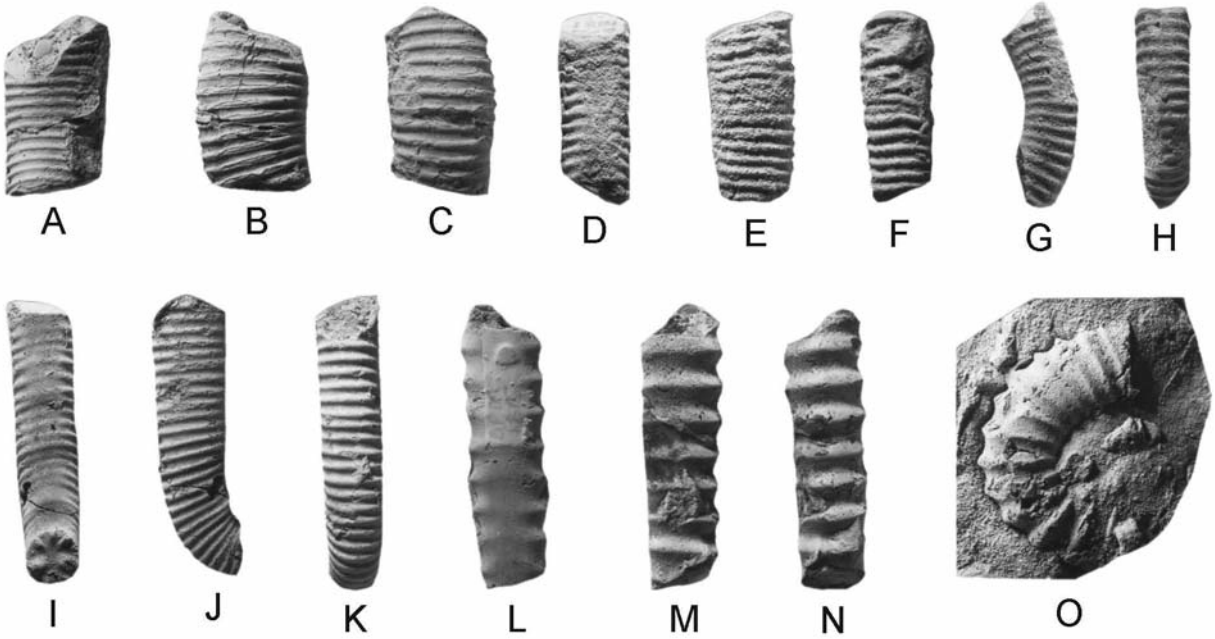
OCCURRENCE: Northern Pakistan; species of *Metahamites* are Middle Albian where well dated.

Genus *Ndumuiceras* Kennedy and Klinger, 2009

TYPE SPECIES: *Ndumuiceras varibile* Kennedy and Klinger, 2009, p. 44, text-figs 1A–K, by original designation.

Ndumuiceras varibile Kennedy and Klinger, 2009
(Text-figs 23S, T, W, X; 24O)

2009. *Ndumuiceras varibile* Kennedy and Klinger, p. 44, text-figs 1A–K.



Text-fig. 24. A-F, I-K – *Hamites praegibbosus* Spath, 1941. A-C – GSP1128, from locality 1815; D-F – GSP1166, from locality 1821; I-K – GSP1127, from locality 1815. G, H – *Hamites* cf. *hybridus* Casey, 1961, GSP1126, from locality 1815. L-N – *Protanisoceras actaeon* (d'Orbigny, 1850), GSP1134, from locality 1815. O – *Ndumuiceras variabile* Kennedy and Klinger, 2009, GSP1187, from locality 1846. All specimens are from the uppermost Lumshiwal Formation. All figures are × 1

TYPES: The holotype, by original designation is the original of Kennedy and Klinger (2009, p. 44, text-fig. 1A–D), no KX9940 in the collections of the Oxford University Museum of Natural History, from the Lower Albian Mzinene Formation south-west of Ndumu, northern KwaZulu-Natal, South Africa. There are several paralectotypes (loc. cit, p. 44).

MATERIAL: GSP1181, from the top two metres of the Lumshiwal Formation at locality 1825. GSP1187, from the top two metres of the Lumshiwal Formation at locality 1846. GS1188 from the top two metres of the Lumshiwal Formation at locality 1849.

DESCRIPTION: GSP1181 (Text-fig. 23S, T) is a short curved body chamber fragment with a maximum preserved whorl height of 10.9 mm. The whorl breadth to height ratio is 0.88. The flanks are feebly convex and subparallel, the ventrolateral shoulders broadly rounded, the venter feebly convex. The rib index is 5. The dorsum is concealed by matrix. The ribs strengthen across the umbilicolateral margin, where they are narrow, sharp, and prorsiradiate, and separated by wider interspaces. They are straight and feebly convex on the adapical part of the fragment, strengthening across the ventrolateral shoulders and developing into small, well-differentiated ventral clavi. The clavi are linked across the venter by a broad, coarse transverse rib. GSP1187 (Text-fig. 24O) is partially embedded in matrix. It is part of a planispiral whorl with a maximum estimated diameter of 30 mm and a maximum preserved whorl height of 10.5 mm. The ribbing and ventral tuberculation are relatively coarse at the adapical end of the fragment, becoming finer and narrower at the adapertural end. GSP1188 (Text-fig. 23S, T) is a much larger body chamber fragment, 41 mm long, with a maximum preserved whorl height of 20.4 mm, and a whorl breadth to height ratio of 0.78 in intercostal section. The dorsum is broad and very feebly convex. The inner to middle flanks are subparallel, the outer flanks converge to broadly rounded ventrolateral shoulders. The venter is feebly convex and narrower than the dorsum. The rib index is six to seven. The ribs are reduced to mere striae on the dorsum, strengthen across the dorsolateral margin, where they are feebly concave, and are straight and strengthen progressively across the flanks, where they are narrower than the interspaces. The ribs broaden markedly on the ventrolateral shoulders and bear well developed ventral clavi. These are linked across the venter by a broad transverse rib that is split into a pair of riblets. Single weaker nontuberculate ribs intercalate between the tuberculate ribs at the adapical end of the fragment.

DISCUSSION: *Ndumuiceras variabile* was previously known only from the type material from northern KwaZulu-Natal, South Africa. GSP1188 is strikingly similar to the holotype (Kennedy and Klinger 2009, text-fig. 1A–D). The other two specimens match well with one of the paratypes (Kennedy and Klinger 2009, text-fig. 1E, F, J, K).

OCCURRENCE: Northern Pakistan; the type material, from northern KwaZulu-Natal, is well-dated as upper Middle Albian (equivalent of the upper *auritiformis* Zone of Text-fig. 7) and basal Middle Albian (equivalent of the *lyelli* Subzone of Text-fig. 7).

Genus *Tarrantites* Klinger, Kennedy and Minor, 2010

TYPE SPECIES: *Hamites adkinsi* Scott, 1928, p. 116, pl. 16, figs 10, 13, by original designation.

Tarrantites adkinsi Scott, 1928
(Text-fig. 23P–R)

1928. *Hamites adkinsi* Scott, p. 116, pl. 16, figs 10, 13
2010. *Tarrantites adkinsi* (Scott, 1928); Klinger, Kennedy and Minor, p. 92, text-figs 1–4.

TYPE: The holotype, by monotypy, is no. 19465 in the collections of the University of Texas at Austin, the original of Scott, 1926, p. 116, pl. 16, figs 10, 13, from the Albian Comanche Peak Limestone near Valley Mills, Bosque and McLennan Counties, Texas. It was refigured by Klinger *et al*. (2010, text-fig. 2A–F, 3A).

MATERIAL: GSP1167, from the top one to two metres of the Lumshiwal Formation at locality 1821.

DESCRIPTION: The specimen is a 28.6 mm long phosphatic fragment of a straight phragmocone shaft. The maximum preserved whorl height is 15.7 mm; the costal whorl breadth to height ratio is 0.7, the greatest breadth around mid flank. The dorsum is broadly rounded; the flanks are feebly convex and subparallel. The venter is feebly convex in intercostal section and feebly concave in costal section. Parts of five ribs are preserved; the rib index is three. The ribs are weak, broad, and feebly concave on the dorsum. They strengthen across the dorsolateral margin and are feebly convex, becoming straight and prorsiradiate on the flanks, where they are low, broad and coarse, but narrower than the interspaces. They strengthen into well-developed ventral clavi, linked across the venter by a

low transverse rib. The suture is moderately incised, with bifid E/A, A, and A/U.

DISCUSSION: The ribbing of this specimen is identical to that of the smaller holotype of *adkinsi* in strength, direction and spacing. Although referred to *Hamites* by Scott, and regarded as a synonym of *Hamites intermedius* J. de C. Sowerby, 1814, by both Swensen (1963) and Clark (1965), the holotype appears to show ventral tubercles in the side view (Clark 1965 pl. 1, fig. 14), and new material from Texas, described by Klinger *et al*. (2009) confirm the presence of tubercles, which Scott noted only an indication of on some of the finer ribs of the short adapertural shaft of the holotype. These show *adkinsi* to be neither *Hamites* nor *Idiohamites*, but *Tarrantites*, a distinct Lower Albian genus of Anisoceratidae.

OCCURRENCE: Northern Pakistan; the type material is from the upper Middle Albian (*Oxytropidoceras carbonarium* Zone) of Tarrant County, Texas.

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

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

Hamites cf. *hybridus* Casey, 1961
(Text-fig. 24G, H)

Compare:
1961 *Hamites* cf. *hybridus* Casey, p. 97, pl. 22, figs 1, 2; text-fig. 33d–f.
2010. *Hamites hybridus* Casey, 1961; Colleté, p. 188, fig. 131d.

TYPE: the holotype by original designation is no. Zm2195 in the collections of the British Geological Survey, Keyworth, Nottinghamshire, the original of Casey, 1961, pl. 22, fig. 2, from the phosphatised fauna of the condensed Lower Albian *Cleoniceras floridum* Subzone-*Otohoplites raulinianus* Subzone fauna, foreshore outcrops at Copt Point, Folkestone, Kent.

MATERIAL: GSP1126, from the top two metres of the Lumsihwal Formation at locality 1815.

DESCRIPTION: The specimen is a 28 mm long curved fragment of an open helix. The maximum preserved whorl height is 8.3 mm. The whorl section is compressed subcircular, with a whorl breadth to height ratio of 0.87. The rib index is six. The ribs are transverse and effaced on the dorsum, strengthening on the dorsolateral margin, narrow, straight, and recti- to feebly prorsirsdiate on the flanks, across which they strengthen slightly, and pass straight across the venter.

DISCUSSION: Coiling mode, rib style and density separate this fragment from others in the collection. The specimen finds a close match in the smaller of the two toptypes figured by Casey (1961, pl. 22, fig. 1, lower fragment).

OCCURRENCE: Northern Pakistan; in southern England, the species occurs in the condensed Lower Albian *floridum* Subzone to *raulinianus* Subzone, foreshore outcrops at Copt Point, Folkestone, Kent.

Hamites cf. *praegibbosus* Spath, 1941
(Text-fig. 24A–F, I–K)

Compare:
1941. *Hamites praegibbosus* Spath, p. 627, 72, figs 13–15; text-fig. 227a–f.
1961. *Hamites praegibbosus* Spath; Casey, p. 94, pl. 22, figs 4, 5; text-fig. 33a, b (with full synonymy).
1997. *Hamites praegibbosus* Spath, 1941; Kennedy in Kennedy *et al*., p. 468, pl. 6, figs 22–24.

TYPE: The holotype, by original designation, is no. C47441 in the collections of the Natural History Museum, London, the original of Spath, 1941, text-fig. 227a–c, from from the condensed Lower Albian *Cleoniceras floridum* Subzone-*Otohoplites raulinianus* Subzone fauna, foreshore outcrops at Copt Point, Folkestone, Kent.

MATERIAL: GSP1127 and 1128, from the top two metres of the Lumshiwal Formation at locality 1815. GSP1166, from the top one to two metres of the Lumshiwal Formation at locality 1821.

DESCRIPTION: GSP1127 (Text-fig. 24I–K) is a straight shaft and curved sector with a maximum preserved length of 39 mm. The maximum preserved whorl height is 10.4 mm; the whorl breadth to height ratio is 0.87.The whorl section is compressed oval. The rib index is seven. The ribs are weak and feebly convex on the dorsum, strengthening across the dorsolateral margin, straight and feebly rursiradiate on the flanks,

across which they strengthen, and straight and transverse across the venter. GSP1166 (Text-fig. 24D–F) is a 25 mm long fragment with a maximum preserved whorl height of 11.5 mm and a rib index of six. GSP1128 (Text-fig. 24A–C) is a much larger fragment, with a maximum preserved whorl height of 15.5 mm, and a whorl breadth to height ratio of 0.82. The rib index is eight, the ribs feebly recti- to feebly rursirdiate.

DISCUSSION: These specimens have the whorl section, rib density and coiling mode of *Hamites praegibbosus*. The ribs are much more rursiradiate than those of the holotype (Spath 1939, text-fig 227a–c; Casey 1961, pl. 22, fig. 4); the present material more closely resembling the topotype figured by Casey (1961, pl. 22, fig. 5).

OCCURRENCE: Northern Pakistan; it is well-dated as upper Lower Albian, *raulineanus* Subzone of the *auritiformis* Zone in southern England, and also occurs in the condensed Albian of Macheromenil (Ardennes), Peille and Gourdon (Alpes-Maritimes), France.

Superfamily Douvilleiceratoidea Parona and Bonarelli, 1897
Family Douvilleiceratidae Parona and Bonarelli, 1897
Genus *Douvilleiceras* de Grossouvre, 1894

TYPE SPECIES: *Ammonites mammillatus* Schlotheim, 1813, p. 11, by original designation by de Grossouvre, 1894, p. 26. ICZN generic name no 1014; ICZN specific name no. 764.

Douvilleiceras mammillatum (Schlotheim, 1813) *sensu lato*
(Text-figs 25A–K; 26A–I, K–L)

1813. *Ammonites mammillatus* Schlotheim, p. 111.
1962. *Douvilleiceras mammillatum* (Schlotheim); Casey, p. 205, pl. 40, fig. 4; pl. 41, fig. 4; pl. 42, figs 6, 9; text-fig. 102a–b (with full synonymy).
1962. *Douvilleiceras mammillatum* (Schlotheim) var. *aequinodatum* (Quenstedt); Casey, p. 271, pl. 40, fig. 5; pl. 41, figs 5–7; pl. 42, fig. 10; text-figs 94a–c, 95a, b, 102d 103a–b (with full synonymy).
1962. *Douvilleiceras mammillatum* (Schlotheim) var. *praecox* Casey, p. 272, pl. 41, fig. 8; text-figs 94d–e, 102c.
1997. *Douvilleiceras mammillatum* (Schlotheim, 1813); Kennedy in Kennedy *et al*., p. 469, pl. 6, figs 20, 21.
2008. *Douvilleiceras mammillatum aequinodatum* (Quenstedt, 1849); Latil, p. 257, pl. 2, figs 4, 5 (with additional synonymy).

TYPE: The neotype is no. C12491 in the collections of the Natural History Museum, London, figured by Casey, 1962, pl. 41, fig. 4, from from the condensed Lower Albian *Cleoniceras floridum* Subzone-*Otohoplites raulinianus* Subzone fauna, foreshore outcrops at Copt Point, Folkestone, Kent.

MATERIAL: More than 36 specimens. GSP1143–1158, 1223, from the top two metres of the Lumshiwal Formation at locality 1815. GSP1169–1175, from the top one to two metres of the Lumshiwal Formation at locality1821. GSP1200–1206, from the top metre of the Lumshiwal Formation at locality 1851. GSP1208, from the top two metres of the Lumshiwal Formation at locality 1839.

DESCRIPTION: *Douvilleiceras* is the commonest ammonite in the phosphatised fauna from the top of the Lumshiwal Formation. Many are fragments, or are poorly preserved. They range from 17.5 to 95 mm in diameter. Coiling is evolute, the umbilicus deep, with a feebly convex wall and broadly rounded umbilical shoulder, the whorl section depressed reniform in intercostal section. In the smallest specimens, up to a diameter of 20 mm, there are 20 to 24 ribs per whorl. All primaries, they arise at the umbilical seam and strengthen across the umbilical wall and shoulder, and are low, coarse, straight and prorsirsdiate on the flanks and pass straight across the venter. At the adapical end of the outer whorl of the smallest specimens the ribs bear a strong conical umbilicolateral tubercle and a weak to effaced ventrolateral bulla. The latter increase rapidly in strength as size increases, and by a diameter of 17–20 mm becomes stronger than the conical-bullate umbilicolateral tubercles. Beyond 20mm diameter a delicate umbilical bulla appears, and strengthens progressively as size increases. GSP1144 (Text-fig. 25G, H) is a fragment with a maximum preserved whorl height of 18 mm. At this size two tiny tubercles have appeared on the umbilical shoulder/innermost flank, below the much larger umbilicolateral tubercle of the previous ontogenetic stage, while the ventrolateral shoulders bear a greatly strengthened rib/bulla, now subdivided into three by grooves, to produce long narrow clavi. A broad low rib extends across the venter, which is concave in costal section. Larger specimens- to a diameter of 80mm- have four rows of tubercles between the umbilical wall and the ventrolateral shoulder, to give a total of eight rows of tubercles, those on the flank rounded-conical, those on the ventrolateral shoulder clavate and borne on a variably strengthened rib. The ventral sulcus in the costal whorl section weakens in these larger speicmens. There is some variation in the strength of the ventrolateral ribs and tubercles between specimens. GSP1158 (Text-fig. 25I) preserves one flank of a much larger phragmocone, 195

mm in diameter. Fifteen low blunt bullae perch on the umbilical shoulder, and give rise to one, occasionally two ribs, with single short ribs intercalating between successive primaries to give a total of 27 ribs at the ventrolateral shoulder. The ribs are low, broad and prorsiradiate, and bear traces of several rows of low, blunt, effacing tubercles, in addition to the umbilical bullae.

DISCUSSION: The species is interpreted quite widely here. There are a host of *Douvilleiceras* species in the literature, many of them from condensed levels in southern England and France, as documente by Casey (1962). Cooper (1982) attempted a rationalisation of the genus, but recognition of species limits is hindered by a lack of assemblages from expanded, rather than condensed sequences (see also Latil 2008, 2010). The present material also from condensed sequences, does not take the matter forwards.

OCCURRENCE: *Douvilleiceras mammillatum* as recognised here ranges from the *perinflata* Subzone of the *chalensis* Zone to the *bulliensis* Zone of the *auritiformis* Zone according to Owen (1988), and may range more widely. The geographic distribution extends from western Europe to Turkmenistan, Khazakhstan, northern Pakistan, KwaZulu-Natal in SouthAfria, Madagascar, Angola, and California.

Douvilleiceras leightonense Casey, 1962
(Text-fig. 26J)

1962 *Douvilleiceras leightonense* Casey, p. 274, pl. 41, fig. 1; pl. 42, fig. 3; text-figs 96, 97, 102i, 103e–h (with synonymy).
2000. *Douvilleiceras leightonense* Casey, 1962; Kennedy in Kennedy *et al*., p. 692, fig. 45a, c.
2008. *Douvilleiceras leightonense* Casey, 1962; Latil, p. 258, pl. 1, fig. 11.
2010. *Douvilleiceras leightonense* Casey, 1962; Colleté, p. 182, fig. 17a.

TYPE: The holotype is no. 13587 in the C. W. and E. V. Wright collection, housed in the Natural History Museum, London, the original of Casey, 1962, pl. 41, fig. 1, from the condensed Lower Albian of Leighton Buzzard, Bedfordshire.

MATERIAL: GSP1101, from the Middle Lumshiwal Formation of the Uchakhawar section, Nizampur.

DESCRIPTION: The specimen is a composite internal mould of a phragmocone 240 mm in diameter, crushed and distorted into an ellipse by *post-mortem* compaction. Coiling is involute, the very deep umbilicus comprising an estimated 27% of the diameter, with a high, flat, outward-inclined umbilical wall and quite narrowly rounded umbilical shoulder. The original whorl section has been modified by compaction, and now appears compressed, with feebly convex inner and middle flanks, convergent outer flanks and broadly rounded ventrolateral shoulders and venter. Only a small fragment of the penultimate whorl is preserved, with traces of coarse prorsirdiate ribs with three rows of relatively coarse umbilical and lateral tubecles visible. On the outer whorl primary ribs arise at the umbilical seam and sweep back across the umbilical wall, strengthening progressively and developing into a small bulla, perched on the umbilical shoulder. The bullae give rise to single primary ribs that are feebly concave on the innermost flank, straight and prorsiradiate on the remainder of the flanks and pass straight across the venter. At the beginning of the outer whorl there are traces of up to five rows of lateral /ventrolateral tubercles that are soon lost. The adapertural half whorl bears 12 primary ribs. One two or three intercalated ribs separate successive primaries, and intercalate both low and high on the flanks.

DISCUSSION: This large specimen is strikingly similar to the large specimens figured by Casey (1962) as his text-figs 96 and 97, and on this basis are referred to the species.

OCCURRENCE: Northern Pakistan, Aube, Nièvre and Drôme in France; the species is well-dated in southern England, where it occurs in the lower lower Albian *regularis* Zone and the *perinflata* and *kitchini* Subzones of the succeeding *chalensis* Zone.

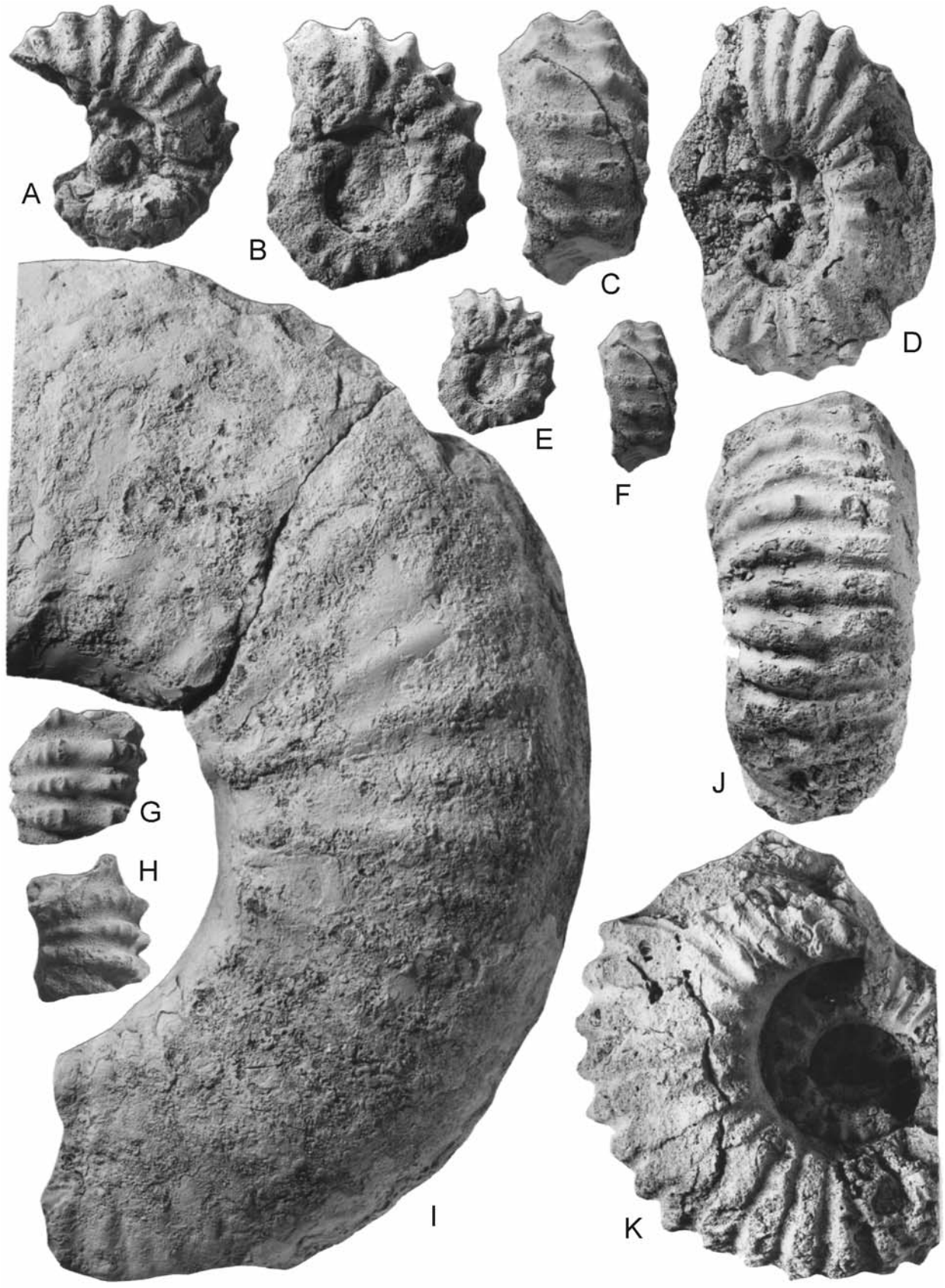
Family Astiericeratidae Breistroffer, 1953
Genus *Astiericeras* Parona and Bonarelli, 1897

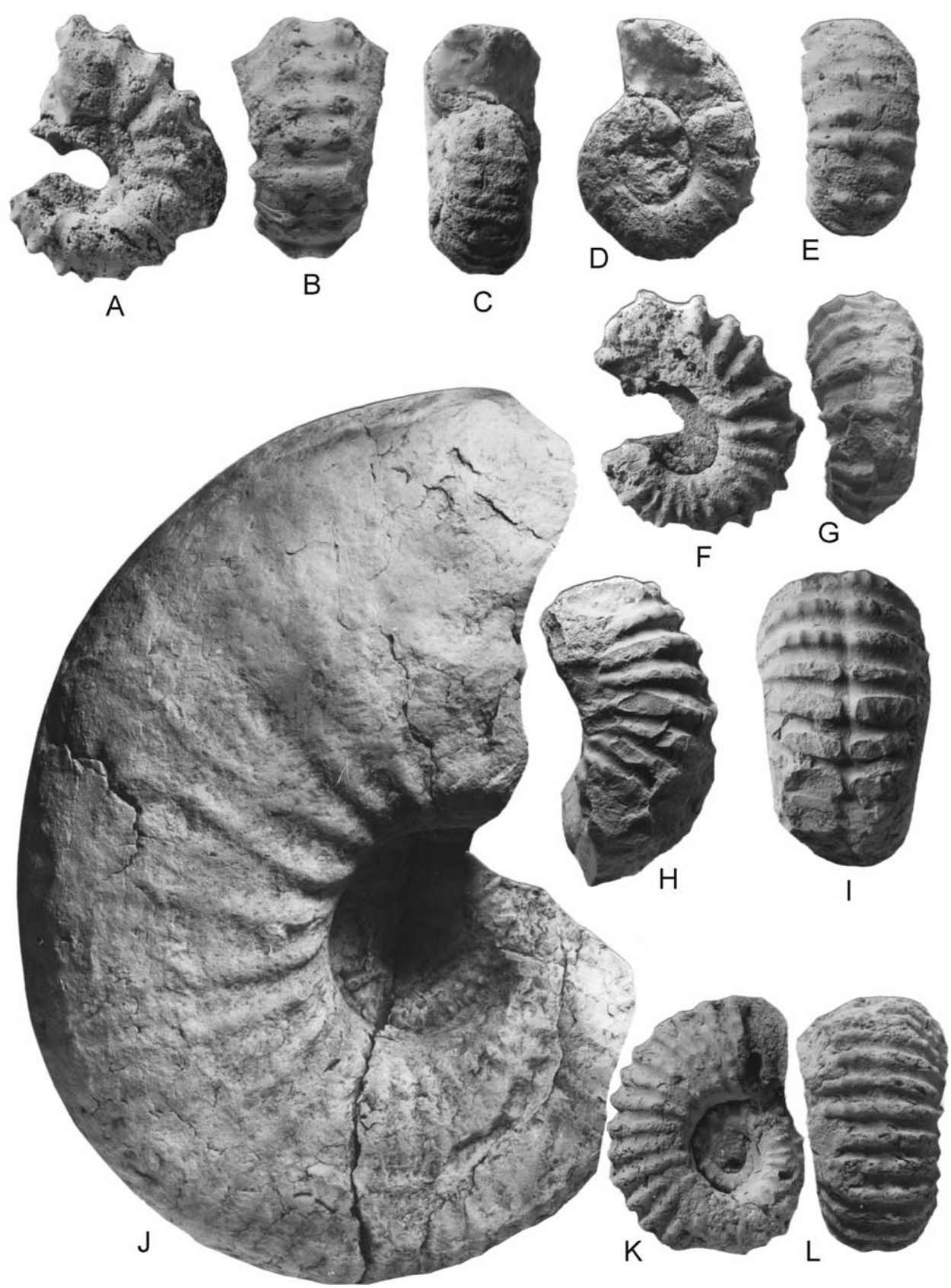
TYPE SPECIES: *Scaphites astierianus* d'Orbigny, 1842, pp. 526, 624, by original designation.

Astiericeras sp.
(Text-fig. 23L, M)

1930. Gen nov. (*Astiericeras*?) sp. ind. Spath, pl. 8, fig. 13.

Text-fig. 25. A-K – *Douvilleiceras mammillatum* (Schlotheim, 1813), A – GSP1149, from locality 1815, B, C, E, F – GSP1153, from locality 1815; D – GSP1175, from locality 1821; G, H – GSP1144, from locality 1815; I – GSP1158, from locality 1815; J, K – GSP1170, from locality 1821. All specimens are from the uppermost Lumshiwal Formation. Figs A, D, E–K are × 1; Figs B, C, are × 2





MATERIAL: GSP1218, from the top metre of the Lumshiwal Formation at locality 1859.

DESCRIPTION: The specimen is a 17 mm long fragment of phosphatised internal mould of body chamber, seemingly slightly curved at the presumed adapical end. The whorl section, is incompletely preserved, but appears to have been circular. Five ribs are present on the incompletely preserved flanks of the fragment. They are straight, radial, sharp, and much narrower than the interspaces. All bear a well-developed bullate ventral tubercle, the tubercles linked over the feebly convex venter by a pair of narrow ribs, the adapical one transverse, the adapertural one feebly convex.

DISCUSSION: The ornament and whorl section of the fragment most closely resembles the adapical end of the shaft of a macroconch *Astiericeras*, like those figured by Kennedy (1986, text-fig. 1.36–1.40) and Kennedy and Juignet *in* Gauthier (2006, pl. 41, fig. 9). A fragment of *Astiericeras* from Hazara was figured by Spath in 1930 (pl. 8, fig. 13).

OCCURRENCE: Northern Pakistan; *Astiericeras* is also known from Aube and Basses-Alpes in France; where well-dated it is lower Middle Albian, *lyelli* Subzone.

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Text-fig. 26. A-I, K, L – *Douvilleiceras mammillatum* (Schlotheim, 1813), A, B – GSP1154, from locality 1815; C-E – GSP1156, from locality 1815; F, G – GSP1147, from locality 1815; H, I – GSP1208, from locality 1839; K, L – GSP1173, from locality 1821. All these specimens are from the uppermost Lumishwal Formation. J – *Douvilleiceras leightonense* Casey, 1962, GSP1101, from the middle of the Lumshiwal Formation of the Uchakhawar section, Nizampur. Figs A–E are × 2; Figs E–H, K, L are ×1; Fig. J is × 0.67

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