

Upper Campanian Ammonites from the Gschlifgraben (Ultrahelvetic, Upper Austria)

Obercampane Ammoniten aus dem Ultrahelvetikum des Gschlifgrabens (Oberösterreich).

by

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A b s t r a c t The Upper Campanian shales and limestones of the Gschlifgraben, Upper Austria, contain a rich and diverse fauna including the following species: *Phylloceras* (*Hypophylloceras*) sp., *Saghalinites* sp. cf. *cala* (FORBES, 1846), *Tetragonites* cf. *obscurus* (SCHLÜTER, 1872, *Gaudryceras jukesii* (SHARPE, 1857), *Puzosiinae* indet., *Desmophyllites larteti* (SEUNES, 1891), *Hauericeras fayoli* DE GROSSOUVRE, 1894, *Pachydiscus* (*Pachydiscus*) *haldensis* (SCHLÜTER, 1867), *Pachydiscus* (*Pachydiscus*) *perfidus* DE GROSSOUVRE, 1894, *Pachydiscus* (*Pachydiscus*) cf. *subrobustus* SEUNES, 1891, *Anapachydiscus arrialoorensis* (STOLICZKA, 1865), *Nostoceras* (*Nostoceras*) sp., *Nostoceras* (*Bostrychoceras*) *polyplacum* (ROEMER, 1841), *Nostoceras* (*Didymoceras*) *donezianum* (MICHAILOV, 1951), *Neocrioceras* (*Schlueterella*) sp.?, *Pseudoxybeloceras* (*Parasolenoceras*) *wernickei* (WOLLEMAN, 1902), *Pseudoxybeloceras* (*Parasolenoceras*) *interruptum* (SCHLÜTER, 1872), *Pseudoxybeloceras* (*Parasolenoceras*) cf. *phaleratus* (GRIEPENKERL, 1889), *Neoglyptoxoceras* cf. *retrosum* (SCHLÜTER, 1872), *Polyptychoceras* (*Polyptychoceras*) *obliquecostatum* (SCHLÜTER, 1872), *Polyptychoceras* (*Polyptychoceras*) cf. *pseudogaultinum* (YOKOYAMA, 1890), *Polyptychoceras* (*Polyptychoceras*) sp., and three *Baculites* species.

The bulk of this fauna is also known or has close allies in the Upper Campanian *Bostrychoceras polyplacum* Zone faunas of northern Europe and the USSR, to which stratigraphic horizon it is referred. The *P.* (*Hypophylloceras*) and *S. cala* are exotic elements, but both are known from the Maastrichtian of the same area.

Z u s a m m e n f a s s u n g: Im Gschlifgraben (Ultrahelvetikum, Oberösterreich) konnten in den letzten Jahren beachtliche Aufsammlungen von Ammoniten des Campans gemacht werden. Diese liegen in drei Erhaltungszuständen vor, sodaß auf drei verschiedene Horizonte geschlossen werden kann:

- Relativ wenig deformierte Steinkerne mit Resten der Aragonitschale treten in großen dunklen Kalkkonkretionen auf (*Pachydiscus* ((*P.*)) *perfidus*).
- Aus spröden dunkelgrauen, bioturbaten Kalken stammt ein unbestimmbarer Texanite.
- Die Hauptmasse der hier beschriebenen Fauna ist in Form zusammengedrückter Skulptursteinkerne erhalten. Das Gesteine ist ein hellgrauer, poröser Kalk bis Mergelkalk.

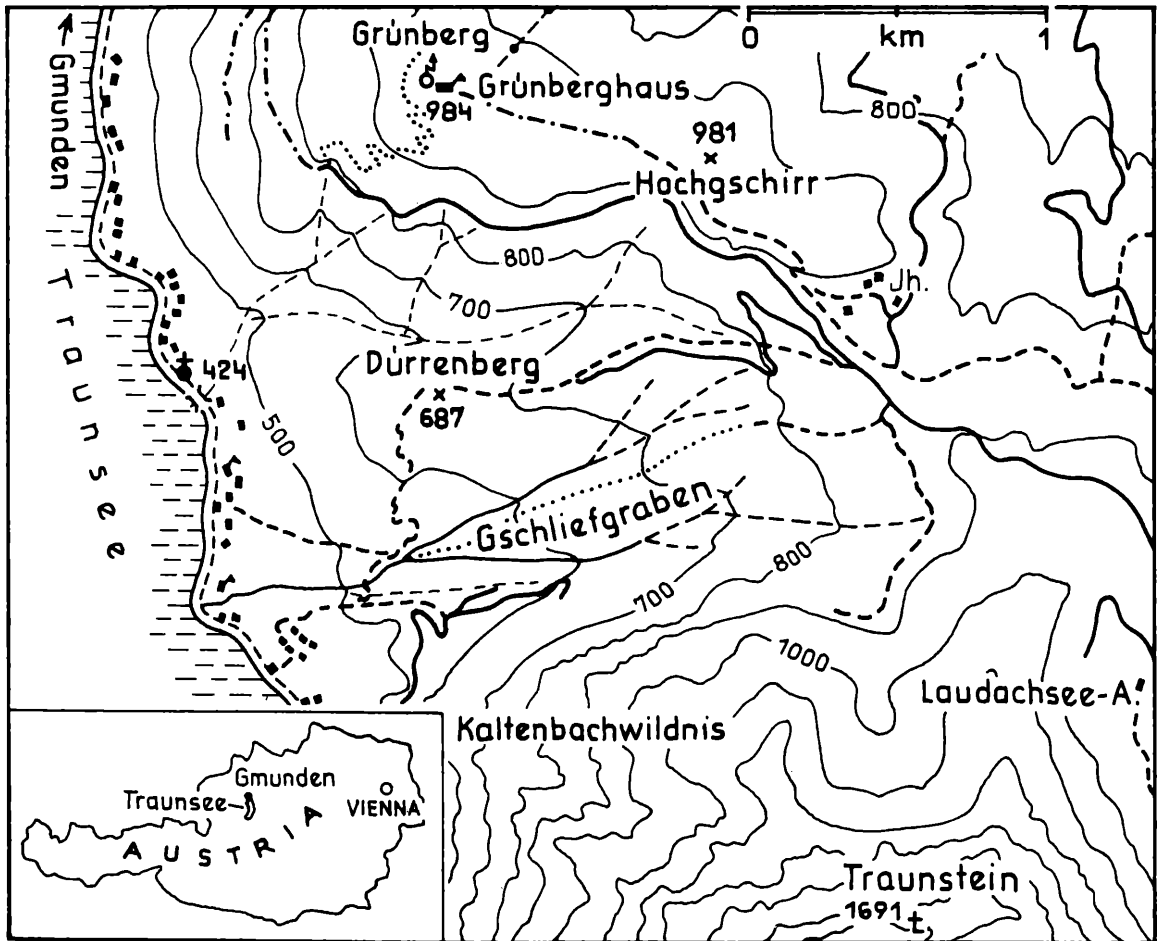
Die Formen der Horizonte a und c sind in das Obercampan zu stellen. Großteils sind es Repräsentanten der traditionellen *Bostrychoceras polyplacum*-Zone, der höchsten Ammonitenzone im nordwesteuropäischen Obercampan. Die meisten Arten sind aus Irland, BRD, DDR, Polen und den USSR bekannt. *Phylloceras* (*Hypophylloceras*), *Saghalinites cala*, *Anapachydiscus arrialoorensis* und *Polyptychoceras* (*Polyptychoceras*) cf. *pseudogaultinum* sind jedoch neu auch für diesen Raum. *Anapachydiscus arrialoorensis* ist ein naher Verwandter des *A. vistulensis* BLASZKIEWICZ, 1980, der in Polen und Deutschland vorkommt. Das Fehlen von *Hoplitoplacenticeras* und *Scaphites spiniger* (SCHLÜTER, 1872) läßt darauf schließen, daß die Gschlifgrabenfauna einem engbegrenzten Horizont des oberen Obercampan entstammt. Nicht einstuftbar ist die Lage mit dem unbestimmbaren Texaniten. Alle Funde stammen aus einem tektonisch stark gestörten Bereich, der durch Erdbebenaktivität jeden Zusammenhang in sich verloren hat.

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Introduction

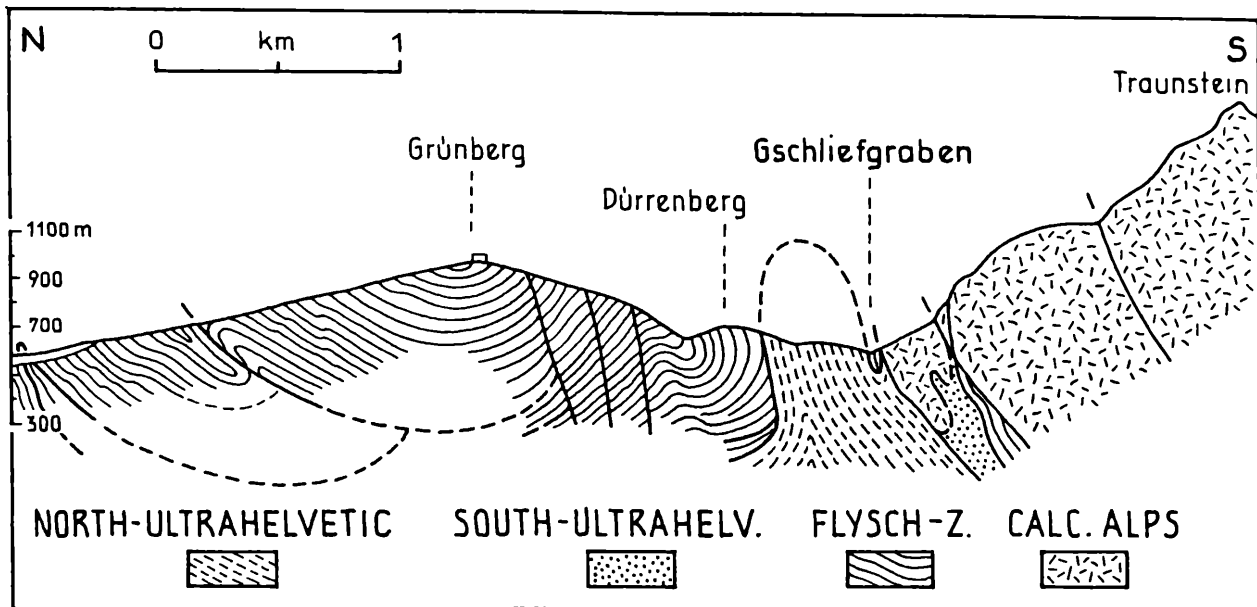
To the east of Salzburg, the Helvetic zone disappears beneath the overthrust Penninic flysch nappe. Helvetic elements reappear in tectonic windows to the east, and are termed Ultrahelvetic by alpine geologists because of their derivation from an originally more southerly position on the outer part of the continental margin on the north side of Tethys. The Gschlifgraben window, situated in the northern part of the Austrian Salzkammergut near the town of Gmunden (Text-fig. 1) is one of these windows. It is framed by Flysch sediments of Cretaceous age, while the northern margin of the Upper Austro-Alpine nappe lies only a few meters to the south (Text-fig. 2). Sediments within the window can be divided into a northern ultrahelvetic "Buntmergelserie" and a southern ultrahelvetic "Klippen" belt. It is the northern series, the succession which has been recently elucidated by PREY (1983) in a masterly unravelling of a highly disturbed, landslipped terrain that yields the ammonite fauna that is the subject of this paper.



Textfig. 1: Location map of the Gschlifgraben area, 1 : 50.000.

HAUER (1866) described, as *Scaphites multinodosus*, a specimen of *Trachyscaphites pulcherrimus* (ROEMER, 1842), while MOJSISOVICS and SCHLOENBACH (1868, p. 213) also noted the presence of ammonites.

In his review of Upper Cretaceous ammonite faunas of the northern Eastern Alps BRINKMANN (1935, p. 5) listed only five specimens from the Gschlifgraben, referring them to five species, his studied specimens being those in the Geologische Bundesanstalt, Vienna.



Textfig. 2: Geological section along the meridian of the Gschlifgraben.

In the present study we have seen nearly two hundred specimens, in the private collections of several local collectors, plus new material housed in the Naturhistorisches Museum, Vienna, and the Oberösterreichisches Landesmuseum, Linz. The ammonite fauna described below is accompanied by a rich microfauna and flora listed in PREY (1983) as well as belemnite, echinoid, poriferan and inoceramid faunas that will be described elsewhere.

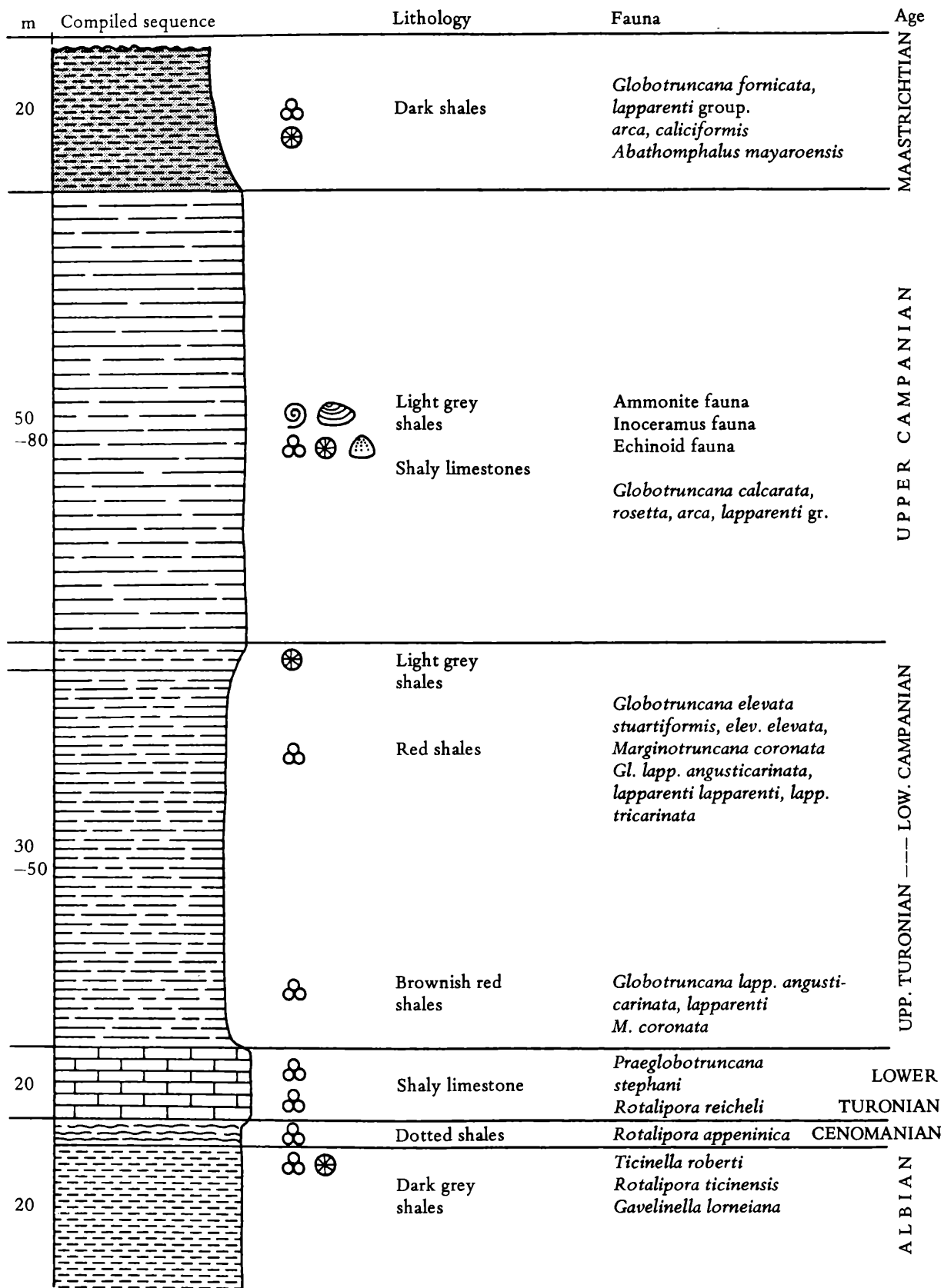
Stratigraphy

Text-figure 3 shows the succession established by PREY (1983). A sequence from Albian to Eocene has been demonstrated on the basis of microfaunas and floras studied by STRADNER (in PREY, 1983). The ammonites described all (with one possible exception) come from a series of light grey shales and shaly limestones with *Globotruncana calcarata*, *G. rosetta*, *G. arca* and members of the *lapparenti* group, while PREY (1983, p. 101) also notes *Belemnitella mucronata* and *Inoceramus salisburgensis*. Together, these suggest an Upper Campanian date. This is supported by the ammonite fauna

Repositories of specimens

These are indicated by the following abbreviations:

- H: Herbert Hütter Collection, Gmunden.
- M: Wolf-Peter Maherndl Collection, Bad Ischl.
- R: Ulrich Roschger Collection, Gmunden/Vienna
- S: Skoumal Collection, Vienna.
- NHMW: Naturhistorisches Museum, Vienna.
- OÖLM: Oberösterreichisches Landesmuseum, Linz.
- GBA: Geologische Bundesanstalt Museum, Vienna.



Textfig. 3: Compiled sequence of the Cretaceous sediments in the North-ultrahelvetic series of the Gschlifgraben window (after PREY, 1983).

Systematic Description

Phylum MOLLUSCA – CLASS CEPHALOPODA CUVIER, 1797

Order AMMONOIDEA ZITTEL, 1884, pp. 335, 392

Suborder PHYLLOCERATINA ARKELL, 1950, p. 355

Superfamily PHYLLOCERATAEAE ZITTEL, 1884, p. 434

Family PHYLLOCERATIDAE ZITTEL, 1884, p. 434

Subfamily PHYLLOCERATINAE ZITTEL, 1884, p. 434

(= Hypophylloceratinae SPATH, 1927, p. 38; Calliphylloceratinae SPATH, 1927, p. 38)

Genus *PHYLLOCERAS* SUESS, 1865, p. 76

Types species. By monotypy, *Ammonites heterophyllus* J. SOWERBY, 1820, p. 119, pl. 226.

Subgenus *HYPOPHYLLOCERAS* SALFELD, 1924, p. 6

(= *Neophylloceras* SHIMIZU, 1934, p. 16; *Paraphylloceras* SHIMIZU, 1935, p. 180 (nom. nud.; non SALFELD, 1919, p. 11); *Hyporbulites* BREISTROFFER, 1947, p. 82; *Goretophylloceras* COLLIGNON, 1949, p. 68; *Epiphyllloceras* COLLIGNON, 1956, p. 24; *Euphylloceras* DRUSHCHITZ, 1953, p. 141; *Aphroditiceras* MAHMOUD, 1956, p. 72 (MAHMOUD in BREISTROFFER, 1952, p. 2635, nom. nud.)).

Type species. By monotypy, *Phylloceras onoense* STANTON, 1895, p. 74.

Phylloceras (Hypophylloceras) sp.

Plate 1, fig. 5.

Material One specimen only, R1.

Description The specimen is crushed. Coiling is very involute, with a crater-like umbilicus that has an outwards sloping umbilical wall and markedly angular umbilical shoulder, in part perhaps an artefact of crushing. The whorl section is compressed, but beyond this the original form cannot be determined. Ornament is not preserved on the inner flank, being perhaps mere striae, but on the outer flank there are dense prorsiradiate and apparently concave riblets that coarsen markedly over the venter.

Discussion *Phylloceras (Hypophylloceras)* are very rare in the Campanian of north-west Europe. *P. (H.) pergensi* DE GROSSOUVRE, 1894 (p. 216; = *Ammonites velledae* SHARPE non MICHELIN, p. 39, pl. 17, fig. 7) is known from the Upper Campanian of Norwich, England and northern Ireland, while *P. (H.) velledaeformis* (SCHLÜTER, 1872) (p. 60, pl. 18, figs. 4–7), a species often regarded as Campanian (e. g. COLLIGNON, 1956) appears, rather, to be Maastrichtian (e. g. WIEDMANN, 1979, table 6; BIRKELUND, 1979, p. 53). Both differ from the present form in having flexuous riblets that are concave rather than convex, in which respect the specimen recalls the Lower Maastrichtian *P. (H.) nera* (FORBES, 1846) (p. 106, pl. 8, fig. 7) (see also KOSSMAT, 1895, p. 160(64), pl. 16(2), figs. 2, 3).

Occurrence Upper Campanian of the Gschliefgraben.

Suborder LYTOCERATINA HYATT, 1889, p. 7

Superfamily TETRAGONITACEA HYATT, 1900, p. 568

Family TETRAGONITIDAE HYATT, 1900, p. 568

Genus *TETRAGONITES* KOSSMAT, 1895, p. 131 (35)

Type species. *Ammonites timotheanus* PICTET, 1848, p. 295, pl. 2, fig. 6; pl. 3, fig. 1 by original designation.

Tetragonites cf. obscurus (SCHLÜTER, 1872)

Plate 2, figs. 10–12

compare:

1872 *Ammonites obscurus* SCHLÜTER, p. 70, pl. 22, fig. 9.

M a t e r i a l. One specimen only, H4.

D e s c r i p t i o n The specimen is crushed. Coiling is very involute, with a small umbilicus, outwards-sloping, flattened umbilical wall, parallel inner flanks, broadly rounded ventrolateral shoulders and venter with a marked siphonal ridge. Shell surface otherwise smooth.

D i s c u s s i o n This specimen closely resembles SCHLÜTER's *Ammonites obscurus* from the Campanian of Coesfeld, German Federal Republic. COLLIGNON (1961, p. 95) suggested this might be a *Damesites*, but the proportions of the surviving syntypes plus the presence of a constriction in one shows the species to be a *Tetragonites*.

O c c u r r e n c e Upper Campanian of the Gschliefgraben.

Genus *SAGHALINITES* WRIGHT and MATSUMOTO, 1954, p. 110.

Type species: *Ammonites cala* FORBES, 1846, p. 104, pl. 8, fig. 4, by original designation.

Saghalinites sp. cf. *cala* (FORBES, 1846)

Plate 1, figs. 2–4, 11.

1846 *Ammonites cala* FORBES, p. 104, pl. 8, fig. 4.

1977 *Saghalinites cala* (FORBES, 1846); KENNEDY and KLINGER, p. 168, text-figs. 10A, B; 11A, B; 12D–G, 13A, B, E–K; 14A–F; 15A–F (with full synonymy).

M a t e r i a l Fifteen specimens are referred to the species, several of the juveniles with some hesitation: R8, 10–13, 15, 17, 22; OÖLM 58/1975/1; NHMW 1979/2076/2–4, 6, 9; S3.

D e s c r i p t i o n All the material is badly preserved. Coiling is very evolute, serpentine, with a broad shallow umbilicus. When uncrushed, the whorl section appears to have been depressed and trapezoidal. A few specimens show constrictions at diameters of 10–50 mm (e.g. Plate 1, figs. 2–4). They are not visible in others (e. g. Plate 1, fig. 11). They number seven per whorl in the best-preserved specimen, are strongly prorsiradiate, straight on the inner flank but curved back and are convex on the middle to outer flank, passing over the venter with a shallow concavity. A few specimens show longitudinal ridges and grooves on the venter.

D i s c u s s i o n. The material is poor, but shows sufficient features to indicate it to be a *Saghalinites*, best compared with *S. cala* (FORBES, 1846), a species reviewed at length by KENNEDY and KLINGER (1977). *Saghalinites* is rare in Europe. BIRKELUND (1979) has recorded *Saghalinites wrighti* (BIRKELUND, 1965) from the Lower/Upper Maastrichtian boundary in Denmark and the Lower Maastrichtian of Hemmoor, north Germany (BIRKELUND, 1982). This species differs from *S. cala* is lacking constrictions on the early whorls and having 6–7 straight rather than flexuous constrictions per whorl. Other species are discussed by KENNEDY and KLINGER (1977).

O c c u r r e n c e *S. cala* ranges from Upper Campanian to Lower Maastrichtian and is known from southern India, Zululand, Antarctica, Tunisia (?) and perhaps the Gschliefgraben.

Family GAUDRYCERATIDAE SPATH, 1927, p. 66.

Genus GAUDRYCERAS DE GROSSOUVRE, 1894, p. 225.

(= *Epigaudryceras* SHIMIZU, 1934, p. 67; *Hemigaudryceras* SHIMIZU, 1934, p. 67; *Neogaudryceras* SHIMIZU, 1935, p. 164).

Type species. *Ammonites mitis* VON HAUER, 1866, p. 305, pl. 2, figs. 3, 4 by the subsequent designation of BOULE, LEMOINE and THÉVENIN, 1906, p. 183 (11).

Gaudryceras jukesii (SHARPE, 1857)

Plate 1, figs. 1, 7, 9, 10; Plate 10, fig. 7

1857 *Ammonites jukesii* SHARPE, p. 53, pl. 23, fig. 11.

non 1879 *Ammonites jukesii* ? SHARPE; WHITEAVES, p. 111, pl. 13, fig. 3.

1895 *Lytoceras (Gaudryceras) jukesii* SHARPE; KOSSMAT, p. 116 (10).

- non 1895 *Lytoceras jukesii* (SHARPE); WHITEAVES, p. 129, pl. 2, figs. 1, 2.
 1901 *Gaudryceras jukesii* SHARPE; DE GROSSOUVRE, p. 281.
 ? 1902 *Gaudryceras mite* VON HAUER; WOLLEMAN, p. 93, pl. 4, fig. 6.
 1925 *Gaudryceras jukesii* SHARPE; DIENER, p. 48.
 1951 *Gaudryceras ? jukesii* (SHARPE); WRIGHT and WRIGHT, p. 12.
 ? 1980 *Gaudryceras cf. mite* (HAUER, 1866); BLASZKIEWICZ, p. 10, pl. 54, fig. 1.

Type. The holotype, by monotypy, is no. 26788–9 (parts of one specimen) from the Upper Campanian White Limestone of 'Londonderry', northern Ireland, the original of SHARPE, 1857, p. 23, fig. 11, in the British Geological Survey Collections, London.

M a t e r i a l . Eight specimens: H1; R2–7; S1a–b.

D e s c r i p t i o n Inner whorls poorly preserved (Plate 1, fig. 10), very evolute, slowly expanding, with 4–5 constrictions per whorl on the mould, each of which is preceded by a strong collar rib. No other ornament is preserved on the specimens. At somewhat larger diameters (Plate 1, figs. 1, 7), the coiling remains serpentine, the umbilicus comprising 52 % of the diameter. The whorl section appears to have been subcircular, but all specimens are deformed to varying degrees. Internal moulds (Plate 1, fig. 10) are smooth except for 4–5 constrictions per whorl, each of which is preceded by a strong collar-rib. The constrictions and ribs are markedly prorsiradiate on the umbilical wall and shoulder, convex and prorsiradiate across the inner flank, but flex back and are concave on the outer flank before sweeping forwards over the ventrolateral shoulder. Composite moulds (Plate 1, figs. 1, 7) preserve delicate flexuous lirae which parallel the course of the constrictions. Ornament coarsens markedly in later growth stages (S 1 provides a link) and the two adult fragments (Plate 1, fig. 9; Plate 10, fig. 7) are coarsely liriate, the lirae convex on the umbilical wall and shoulder, sweeping back on the outer flank and becoming recti- to feebly rursiradiate and then transverse over the venter.

D i s c u s s i o n . The *Vertebrites*-like inner whorls and coarsely ornamented outer whorls closely recall the poorly known *Gaudryceras jukesii* (SHARPE, 1857) (p. 53, pl. 23, fig. 11) previously recorded only from the Upper Campanian of northern Ireland and Norwich, England. The *Gaudryceras cf. mite* of BLASZKIEWICZ (1980, p. 19, pl. 54, fig. 1) may belong here, as may WOLLEMAN's specimen (1902, pl. 4, fig. 6) while the Madagascan Lower Maastrichtian species *G. mokotibense* COLLIGNON, 1971, p. 4, pl. 641, fig. 2365 is obviously a close ally. A full discussion of *G. jukesii* is deferred, however, until the extensive faunas of the Campanian White Limestone of northern Ireland are properly illustrated.

O c c u r r e n c e . Upper Campanian of northern Ireland, ? Norwich, England, ? Poland and North Germany and the Gschliefgraben.

Suborder AMMONITINA HYATT, 1889, p. 7.

Superfamily DESMOCERATAEAE ZITTEL, 1895, p. 426.

(nom. transl. WRIGHT and WRIGHT, 1951, p. 18 ex Desmoceratidae ZITTEL, 1895)

Subfamily PUZOSIINAE SPATH, 1922, p. 126.

(= Silesitoidinae BREISTROFFER, 1953, p. 74; Melchioritinae BRESKOVSKI, 1977, p. 892 (nom. correct. WRIGHT and KENNEDY, 1984, p. 54; ex MELCIORITINAE BRESKOVSKI); Abrytusitinae BRESKOVSKI, 1977, p. 893 (nom. correct. WRIGHT and KENNEDY, 1984, p. 54 ex Abrytusitinae BRESKOVSKI)).

Genus UNCERTAIN

'Puzosiinae indet'

Plate 2, figs. 7–9.

M a t e r i a l . One specimen only, OÖLM 58/1975/2.

D e s c r i p t i o n Evolute, the umbilicus comprising 39 % of the diameter. The whorl section is compressed, with a whorl breadth to height ratio of 0.87. The umbilical shoulder is narrowly rounded, the flanks parallel and the venter narrowly arched. The surface of the mould is smooth except for six strong constrictions per whorl. These are strongly prorsiradiate on the inner flank, convex at

mid-flank, concave on the outer flank and strongly projected over the ventrolateral shoulder, forming an obtuse chevron over the siphonal line.

D i s c u s s i o n The shell is puzosiine in morphology, and as only two members of the subfamily, *Parapuzosia* (*Parapuzosia*) NOWAK, 1913 and *Kitchinites* SPATH, 1922 are known from the Campanian it presumably belongs to one or other of these genera. It could conceivably be an inflated *Haue-riceras*, but there is no trace of a siphonal keel.

O c c u r r e n c e Upper Campanian of the Gschlifgraben.

Subfamily DESMOCERATINAE ZITTEL, 1895, p. 426.

Genus *DESMOPHYLLITES* SPATH, 1929, p. 270.

(nom. nov. pro. *Schlüteria* DE GROSSOUVRE, 1894, p. 216 (non FRITSCH in FRITSCH and KAFKA, 1887, p. 33); *Schlütericeras* COLLIGNON, 1938, p. 92 (objective synonym non HYATT, 1903, p. 92)).

Type species. *Desmoceras larteti* SEUNES, 1891, p. 19, pl. 12(2), fig. 2; pl. 13(3), figs. 2, 3.

***Desmophyllites larteti* (SEUNES, 1891)**

Plate 1, fig. 6; Plate 2, figs. 1–3, 5–6.

1891 *Desmoceras larteti* SEUNES, p. 19, pl. 12(3), fig. 2; pl. 13(4), figs. 2, 3.

1894 *Schlüteria larteti* SEUNES, sp.; DE GROSSOUVRE, p. 218, pl. 24, figs. 2, 3.

1895 *Schlüteria Larteti* (SEUNES); KOSSMAT, p. 105(9).

1925 *Schlüteria Larteti* SEUNES; DIENER, p. 132.

1938 *Schlüteria Larteti* (SEUNES); COLLIGNON, p. 92, pl. 7, fig. 3, text-figs. K, L on p. 92.

? 1961 *Desmophyllites larteti* SEUNES; COLLIGNON, p. 66, pl. 26, fig. 2; text-fig. 6.

? 1971 *Desmophyllites larteti* SEUNES; COLLIGNON, p. 38, pl. 655, fig. 2416.

T y p e; Lectotype, here designated, the original of SEUNES 1891, pl. 13(4), fig. 2; paralectotype: SEUNES, 1891, pl. 12(3), fig. 1, pl. 13(4), fig. 3. Both are unregistered specimens in the collections of the Sorbonne, now in the Université Pierre et Marie Curie, Paris. The types are from the Campanian–Maastrichtian of Tercis, Landes, France.

M a t e r i a l. Eight specimens are firmly attributed to the species: H5, 6; R19, 21, 25, 26; NHMW 1979/2076/15; S2. R16 and 20 and OÖLM 58/1975/1 may also belong here.

D e s c r i p t i o n Very involute with a tiny crater-like umbilicus. Whorl section compressed with parallel flanks and a narrowly rounded venter. Shell surface smooth except for weak to prominent flexuous, prorsiradiate constrictions; there are an estimated nine per whorl.

D i s c u s s i o n. Although poor, these specimens resemble the types in both degree of compression, form, number and course of constrictions. *Desmophyllites diphylloides* (FORBES, 1846) (p. 105, pl. 8, fig. 8; see detailed synonymies in MATSUMOTO and OBATA, 1955, p. 12; MATSUMOTO, 1959, p. 9 and COLLIGNON, 1961) a widely occurring, largely Indo-Pacific form is stouter, with less prominent, less flexuous constrictions, although whether these differences merit specific separation is questionable.

O c c u r r e n c e Upper Campanian of the Gschlifgraben, Campanian–Maastrichtian of Tercis, Landes, France, and possibly Lower Maastrichtian of Madagascar.

Subfamily HAUERICERATINAE MATSUMOTO, 1938, p. 193.

Genus *HAUERICERAS* DE GROSSOUVRE, 1894, p. 219.

(= *Schlüteria* ROLLIER, 1922, p. 359, non FRITSCH in FRITSCH and KAFKA, 1887, p. 33; *Pseudogardenia* TOMLIN, 1939, p. 23; *Gardeniceras* MATSUMOTO and OBATA, 1955, p. 134).

Type species. *Ammonites gardeni* BAILY, 1855, p. 450, pl. 11, fig. 3, by original designation.

Hauericeras fayoli DE GROSSOUVRE, 1894

Plate 1, figs. 8, 12; Plate 2, figs. 4, 13–15.

1894 *Hauericeras fayoli* DE GROSSOUVRE, p. 220, pl. 27, fig. 3.1925 *Hauericeras fayoli* DE GROSSOUVRE; DIENER, p. 95.1935 *Hauericeras gardeni* BAILY; BRINKMANN, p. 5.? 1949 *Hauericeras remda* (FORBES); COLLIGNON, p. 132.? 1961 *Hauericeras* sp. aff. *fayoli* DE GROSS.; COLLIGNON, p. 85, pl. 32, fig. 2.1961 *Hauericeras fayoli* DE GROSSOUVRE; COLLIGNON, p. 85.

T y p e The holotype, by monotypy, is an unregistered specimen in the Sorbonne Collections, now in the Université Pierre et Marie Curie, Paris. It is from Assize Q of ARNAUD at Montmoreau (Charente-Maritime, France) according to DE GROSSOUVRE (1894, p. 220, pl. 27, fig. 3), but the preservation of the specimen shows it to be from the Campanian–Maastrichtian sequence of Tercis, Landes, France. It is refigured here as Plate 2, figs. 13–14.

M a t e r i a l Eleven specimens: H7; S3, 4; R27, 28; NHMW 1984/70; GBA 1935.01.29; NHMW 1979/2076/11, 16, OÖLM 30/1984; S7.

D e s c r i p t i o n Evolute, with wide, shallow umbilicus (45 % of diameter). Umbilical wall low, umbilical shoulder sharp. Whorl section compressed, lanceolate, with shallow impressed dorsal zone, flattened inner and convergent outer flanks. Venter narrowly arched on mould.

There are four constrictions per whorl on nuclei (Plate 1, figs. 8, 12), these are narrow, first appear on the umbilical wall, and are strongly prorsiradiate, straight or concave on the inner flank, with a marked geniculation and narrow convexity at mid-flank, sweep back on the outer flank and are strongly projected forwards on the ventrolateral shoulder to form an elongate acute chevron over the venter.

In the largest specimen (Plate 2, fig. 15) the constrictions are less flexuous and, at the largest diameter preserved, appear more closely spaced.

D i s c u s s i o n The coiling, whorl proportions, form and number of constrictions of the poorly preserved holotype closely resemble those of the Gschlifgraben material, while topotypes in the Oxford University Museum Collections show the species to occur at a similar horizon at Tercis. *H. fayoli* is easily separated from the other European *Hauericeras*. *H. sulcatum* (KNER, 1849), a Maastrichtian species recently reviewed by BLASZKIEWICZ (1980, p. 41, pl. 54, fig. 3) and known from Poland, the USSR and Bulgaria (see TZANKOV, 1964 for synonymy) is more involute ($U = 31\%$), higher-whorled, with more numerous constrictions, 6–7 per whorl, that are prorsiradiate and concave rather than flexuous. *H. pseudogardeni* (SCHLÜTER, 1871) (p. 54, pl. 16, figs. 3–6) from the Lower Campanian and the Santonian *H. welschi* DE GROSSOUVRE, 1894 (p. 222, pl. 35, fig. 9) also have higher whorls, are more involute and have more numerous concave, rather than flexuous constrictions.

The Santonian–Campanian *H. gardeni* (BAILY, 1855) (p. 450, pl. 9, fig. 3), recently reviewed by SUMMESBERGER (1979, p. 133) is a closer ally; the constrictions are more numerous (5 in juveniles, 6–7 in adults according to COLLIGNON, 1961, p. 78) and are concave, without the marked sinuosity and geniculation of the present form.

The Maastrichtian *H. remda* (FORBES, 1846) (p. 111, pl. 7, fig. 3) from southern India is much more compressed. The umbilicus is smaller and juveniles have less markedly flexuous constrictions; STOLICZKA's larger fragment (1865, p. 63, pl. 33, fig. 5) shows a biconcave constriction which is thus distinct from that of adults of the present species.

O c c u r r e n c e Upper Campanian of Tercis (Landes), France and the Gschlifgraben. Records from the Lower Maastrichtian of Madagascar are doubtful.

Family PACHYDISCIDAE SPATH, 1922, p. 132.

(nom. transl. SPATH, 1923, p. 39 for Pachydiscinae SPATH, 1922, p. 132).

Genus PACHYDISCUS ZITTEL, 1884, p. 466.

Type species. *Ammonites neubergicus* HAUER, 1858, p. 12, pl. 2, figs. 1–4, by the subsequent designation of DE GROSSOUVRE, 1894, p. 177.

D i s c u s s i o n We review the type material of the type species and the genus elsewhere, in our account of the Neuberg fauna (KENNEDY and SUMMESBERGER in press). Two subgenera are recognised: *P. (Pachydiscus)* and *P. (Neodesmoceras)* MATSUMOTO, 1947. The latter is restricted to the Maastrichtian and chiefly Indo–Pacific in distribution, with a single record from the Calcaire a *Baculites* of the Cotentin Peninsula (KENNEDY in press).

***Pachydiscus (Pachydiscus) haldemisis* (SCHLÜTER, 1867)**

Plate 4, figs. 1–5; Plate 5, fig. 1; Plate 6, fig. 2; Plate 7, figs. 1–11; Plate 13, fig. 1.

- 1867 *Ammonites haldemisis* SCHLÜTER, p. 19, pl. 3, fig. 1.
 1872 *Ammonites haldemensis* SCHLÜTER, p. 70.
 1872 *Ammonites Galicianus* FAVRE; SCHLÜTER, p. 63, pl. 19, figs. 3–5.
 1885 *Ammonites Oldhami* SHARPE; MOBERG, p. 23, pl. 3, fig. 1.
 1889 *Pachydiscus galicianus* FAVRE; GRIEPENKERL, p. 101(403).
 1894 *Pachydiscus koeneni* A. DE GROSSOUVRE n. sp., p. 178.
 1902 *Pachydiscus galicianus* (SCHLÜTER); WOLLEMANN, p. 103.
 ? 1914 *Pachydiscus kaliszanensis* NOWAK, p. 359, pl. 40, fig. 8.
 1914 *Pachydiscus oldhami* SHARPE sp.; NOWAK, p. 362, pl. 41, fig. 16; pl. 43, fig. 31; pl. 45, fig. 43.
 1914 *Pachydiscus haldemisis* SCHLÜTER; NOWAK, p. 349.
 1925 *Pachydiscus koeneni* GROSSOUVRE; DIENER, p. 106.
 1925 *Parapachydiscus haldemensis* SCHLÜTER; DIENER, p. 116.
 1935 *Pachydiscus* ex. aff. *galicianum* FAVRE; BRINKMANN, p. 5.
 1951 *Pachydiscus* cf. *koeneni* GROSSOUVRE; MICHAÏLOV, p. 60, pl. 10, fig. 47.
 1952 *Pachydiscus haldemensis* SCHLÜTER; COLLIGNON, p. 90.
 1952 *Pachydiscus koeneni* DE GROSSOUVRE; COLLIGNON, p. 90.
 1955 *Pachydiscus haldemensis* SCHLÜTER; COLLIGNON, p. 81.
 1955 *Pachydiscus koeneni* DE GROSSOUVRE; COLLIGNON, p. 82.
 1955 *Ammonites haldemensis* SCHLÜTER; MATSUMOTO, p. 168.
 1959 *Pachydiscus koeneni* GROSSOUVRE; NAIDIN, p. 185, pl. 9, fig. 1.
 1964 *Pachydiscus koeneni* GROSSOUVRE; GIERS, p. 263, pl. 5, figs. 1, 2; text-fig. 5.
 1966 *Pachydiscus koeneni* GROSSOUVRE; BLASZKIEWICZ, table.
 1974 *Menuites ambiguus* (GROSSOUVRE); NAIDIN, p. 183, pl. 62, fig. 2.
 1974 *Pachydiscus koeneni* GROSSOUVRE, 1894; NAIDIN, p. 186, pl. 65, figs. 2, 3; text-fig. 34.
 1979 *Pachydiscus koeneni* GROSSOUVRE; BLASZKIEWICZ, p. 478 et. seq.
 1980 *Pachydiscus koeneni* GROSSOUVRE, 1894; BLASZKIEWICZ, p. 42, pl. 26, figs. 1–2; pl. 27, figs. 1–4; pl. 28, figs. 1–4; pl. 34, figs. 3–4.

T y p e s The lectotype of *Ammonites haldemisis*, here designated, is the original of SCHLÜTER, 1867, pl. 3, fig. 1, from the Upper Campanian of Haldem, Westphalia, refigured here as Plate 7, figs. 3, 4. The lectotype of *Pachydiscus koeneni*, here designated, is the original of SCHLÜTER 1876, p. 63, pl. 19, fig. 3, from the Upper Campanian of Haldem, Westphalia (Schlüter Collection, Geologisches Institut, Bonn), refigured here as Plate 14, figure 2.

M a t e r i a l 28 specimens: H9–15; R33–51; NHMW 1979/2076/22, OÖLM 58/1975/4.

D e s c r i p t i o n The species is strongly dimorphic. The innermost whorls (Plate 7, figs. 1, 6) are moderately evolutely with a compressed whorl section (although all specimens are crushed) with, apparently, the greatest breadth on the inner flanks, which are rounded, convergent outer flanks and a rounded venter. The umbilicus comprises approximately 30 % of the diameter. There are sixteen narrow umbilical bullae per whorl at 35 mm diameter. These give rise to narrow, distant prorsiradiate concave primary ribs that decline and disappear on the outer flank. In microconchs (Plate 4, fig. 1; Plate 5, fig. 1; Plate 6, fig. 1; Plate 7, figs. 2, 5, 7–11) the bullae strengthen as size increase, but remain narrow, extending progressively across the flanks. At a diameter of 40 mm small, sharp ventral clavi appear at the end of the ribs (Pl. 7, figs. 5–8), which are now linked across the venter by a feeble transverse rib. Intercalated ribs, arising low on the flank, appear at 40–60 mm

diameter (Plate 5, fig. 1; Plate 7, figs. 2, 8, 9, 11). There is at first only one intercalatory between the primaries, thereafter a second intercalatory appears, at which point the ventral tubercles disappear abruptly and the last part of the body chamber shows a marked increase in rib density so that there are 34–5 ribs of which 16–19 are primaries.

In some cases the secondary ribs at the end of the body chamber are linked to the umbilical bullae by feeble striae. The adult specimens (Plate 4, fig. 1; Plate 5, fig. 1; Plate 7, figs. 2, 5, 7–11) show what appears to be a flared apertural rib at a terminal diameter of 95–100 mm.

Macroconchs (Plate 4, figs. 2–5; Plate 6, fig. 2) show the same distant primary ribs as microconchs at the smallest diameters visible, but lack the tuberculate stage. Instead, flank ornament, first visible in the present material at a whorl height of 22 mm, resembles that of the end of the body chamber of the adult microconch (compare Plate 4, figs. 1, 2). In the best preserved specimen there are thus 20–23 primary ribs, arising from variably developed umbilical bullae or not. They are prorsiradial, straight on the inner flank, and markedly convex on the outer flank and sometimes feebly flexuous (Plate 4, figs. 4), crossing the venter in a broad convexity. In a few cases the ribs arise in pairs from bullae (although the connection of one of the pair is tenuous), while one or two shorter, intercalated ribs of variable length are inserted between the primaries to give a total of nearly sixty ribs per whorl in the best-preserved specimens. The largest well-preserved specimen, shown in Plate 6, fig. 2, is 150 mm in diameter, and this shows distant primaries separated by pairs of short secondaries. Our largest specimen, 330 mm in diameter, is poorly preserved, but shows persistent primary ribs throughout on the flank; the venter is poorly preserved, but the intercalated ribs appear to have declined in strength or disappeared.

All macroconchs are crushed to varying degrees, but the whorl section appears to have been a compressed oval.

D i s c u s s i o n *Ammonites haldemisi* SCHLÜTER, 1867, p. 19, pl. 3, fig. 1, based on a microconch, is the earliest name applied to this species; the lectotype, here designated (Plate 7, figs. 3, 4), being the figured specimen from Haldem. It is identical with the specimen from the Gschliefsgraben shown in Plate 7, fig. 8, and is preserved in the Bonn Collections. The species *haldemisi* has been referred to in lists by DIENER (1925) and COLLIGNON (1952, 1955) has been discussed by NOWAK (1913, p. 349) and MATSUMOTO (1955, p. 168) and must stand as the prior name for the more familiar *koeneni*. A topotype macroconch of the species is shown in Plate 13, fig. 1. The linking of small bituberculate specimens that would normally be referred to *Menuites* SPATH, 1922 or *Pseudomenuites* MATSUMOTO, 1955 with large, non-tuberculated specimens referred to *Pachydiscus* and the proposal that they are micro- and macroconch of the same species is the first example of dimorphism proven in the Pachydiscidae. The basis for the link is the identical early development of the two forms and the similar ornament of the end of the body chamber of microconchs with that of the middle growth stages of macroconchs. Microconchs are up to 103 mm in diameter; incomplete macroconchs reach 330 mm, while we have 7 undoubted microconchs and 15 undoubted macroconchs, the remaining specimens being juveniles.

Pachydiscus koeneni the macroconch of this species, is based upon the original of SCHLÜTER's (1872, pl. 19, figs. 3–5) *Ammonites galicianus*. The figures are of two specimens; according to SCHLÜTER's explanation (pl. 19, Fig. 3, 4) the completely septate lectotype is reduced $\times 0.8$ and is thus 138 mm in diameter, while the adult specimen (pl. 19, fig. 5) is reduced by 0.5 and thus 200 mm in diameter. GIERS' statement, that his figure (pl. 5, fig. 1) is reduced $\times 0.7$ is obviously an error.

Microconchs of the present species are easily differentiated from other bituberculate pachydiscid microconchs described from the European Campanian. Thus *Ammonites auritocostatus* SCHLÜTER, 1872 (nom. nov. pro *Ammonites proteus* SCHLÜTER, 1867, p. 20, pl. 3, fig. 2), lectotype, by the subsequent designation of MATSUMOTO, 1955 (p. 169, footnote) the original of SCHLÜTER's pl. 13, fig. 2, is a larger, more inflated, coarsely ribbed form which has coarse umbilical in addition to ventral tubercles. It has been referred to the genus *Urakawites* MATSUMOTO, 1955. *Menuites portlocki* (SHARPE, 1855) (p. 30, pl. 13, figs. 2, 3), lectotype, the original of SHARPE's

pl. 13, fig. 2, by the subsequent designation of WRIGHT and WRIGHT, 1951 (p. 36) and the various forms recognised by BLASZKIEWICZ (1980) are all readily separated by their inflated form, coarse umbilical and ventral tubercles, the former giving rise to pairs of ribs.

Pachydiscus ambiguus DE GROSSOUVRE, 1894 (p. 198, pl. 29, fig. 3), lectotype, by the subsequent designation of MATSUMOTO, 1955 (p. 169, footnote), DE GROSSOUVRE's figured specimen from Assize P3 of ARNAUD at Tauillard (Charente, France) is poorly preserved and crushed, but has more and finer ribs than the present material; it is a possible synonym, and is the type species of *Pseudomenuites* MATSUMOTO, 1955. The specimen referred to *Menuites ambiguus* by NAI-DIN (1974, p. 182, pl. 63, fig. 2) appears to belong here. Macroconchs of *P. haldemsi* closely resemble *Pachydiscus oldhami* (SHARPE, 1855) (p. 32, pl. 14, fig. 2). SCHLÜTER (1872, p. 65) noted the resemblance of his specimen to SHARPE's figure. However, as SHARPE noted, the surface of the specimen is heavily corroded and the ribs are bolder on the figure than on the actual specimen (GSM 37244). Study of a series of *Pachydiscus* from the Upper Campanian White Limestone of Northern Ireland reveals some specimens that are very close indeed to macroconch *P. haldemsi* and others, corresponding to the type of *P. oldhami* that differ in having a much more subdued ornament. The differences are slight, however, and further work may even show *haldemsi* to be a synonym of *oldhami*. *Pachydiscus kaliszanensis* NOWAK, 1914 (p. 359, pl. 40, fig. 8) is based on a large fragment with strong primaries that are separated by 2–4 secondaries of variable length; it is probably no more than a variant of the present form. *Pachydiscus bystrzycae* NOWAK, 1914 (p. 353, pl. 40, fig. 9) shows superficial similarities, but most of the ribs are long.

Of other species occurring in the Gschlieffgraben, the tabulate venter and coarse ornament of the outer whorls of *P. perfidus* DE GROSSOUVRE, 1894 (p. 213, pl. 34, fig. 1) are utterly distinctive (see Plate 3, fig. 1; Plate 6, fig. 6). *Pachydiscus subrobustus* SEUNES, 1871 (p. 15, pl. 13(4), fig. 1) is coarsely and distantly ribbed, the ribs strongly projected and concave on the outer flank, with secondaries lost in middle growth. *Anapachydiscus arrialoorensis* (STOLICZKA, 1865) (p. 126, pl. 63, figs. 2–4; pl. 64, fig. 1) is more involute with massive whorls and coarse, alternately long and short ribs, the nuclei having umbilical bullae.

O c c u r r e n c e Upper Campanian of the Gschlieffgraben, north Germany, Poland, Sweden, Donbas, Kopet Dag and elsewhere in the USSR.

Pachydiscus (Pachydiscus) perfidus DE GROSSOUVRE, 1894

Plate 3; Plate 6, fig. 6.

- 1894 *Pachydiscus perfidus* A. DE GROSSOUVRE n. sp., p. 213, pl. 34, fig. 1.
 1911 *Pachydiscus perfidus* GROSSOUVRE; LOPUSKI, p. 107, pl. 1, figs. 1–3; pl. 2, fig. 1.
 1921 *Parapach. perfidus* GROSSOUVRE; SPATH, p. 122.
 1925 *Parapachydiscus perfidus* GROSSOUVRE; DIENER, p. 118.
 1952 *Pachydiscus perfidus* DE GROSSOUVRE; COLLIGNON, p. 91.
 1955 *Pachydiscus perfidus* DE GROSSOUVRE; COLLIGNON, p. 82.
 1966 *Pachydiscus perfidus* GROSSOUVRE; BLASZKIEWICZ, table.
 1979 *Pachydiscus perfidus* GROSSOUVRE; BLASZKIEWICZ, p. 478 et seq.
 1980 *Pachydiscus perfidus* GROSSOUVRE, 1984; BLASZKIEWICZ, p. 43, pl. 29, figs. 1–4; pl. 30, figs. 1, 3, 4; pl. 31, figs. 1–3; pl. 32, figs. 1–3; pl. 33, figs. 3, 4; pl. 37, figs. 1–2.

T y p e The lectotype, here designated in the original of DE GROSSOUVRE, 1894, pl. 34, fig. 1, an unregistered specimen in the ARNAUD Collection, in the Collections of the Sorbonne, now in the Universite Pierre et Marie Curie, Paris. It is from the Upper Campanian of Tercis (Landes), France.

M a t e r i a l Three specimens: NHMW 1979/2077/1; NHMW 1984/71/; OÖLM 58/1975/3.

D e s c r i p t i o n . The material occurs in a distinctive preservation in calcareous concretions, retain shell and are little-deformed. Large, moderately involute, whorl section compressed, with greatest breadth at umbilical shoulder; inner flanks rounded, outer flanks convergent, ventrolateral shoulders rounded, venter distinctly flattened. At the smallest diameter visible (Plate 6, fig. 6) there are 12–14 strong primary ribs. These are feebly concave on the umbilical wall, strengthen into elongate

bullae on the umbilical shoulder and inner flank and giving rise to strong single prorsiradiate straight ribs. These strengthen markedly at the ventrolateral shoulder and pass straight across the flattened venter, weakening a little over the median zone. There are two short intercalated ribs at the smallest diameter visible, and one or two such ribs persist to the end of the phragmocone, with only a single intercalatory on the body chamber (Plate 3).

Suture typical for genus.

D i s c u s s i o n The pronounced changes in ornament shown by the inner whorls and described in detail by DE GROSSOUVRE cannot be fully confirmed on our much larger specimens, but they match the last part of the lectotype and are identical with the series of large individuals figured by BLASZKIEWICZ (1980).

The changes in ornament, and especially the coarse adult ornament and flattened venter readily separate this species from all others described from the European Campanian.

O c c u r r e n c e Upper Campanian of Tercis (Landes), France, Poland and the Gschlieffgraben, Austria.

Pachydiscus cf. subrobustus SEUNES, 1891.

Plate 8, fig. 4.

compare:

- 1891 *Pachydiscus subrobustus* SEUNES, p. 15, pl. 13(4), figs. 1.
- 1894 *Pachydiscus subrobustus* SEUNES; DE GROSSOUVRE, p. 200, pl. 36, fig. 2.
- 1910 *Pachydiscus subrobustus* SEUNES; FRECH, p. 4, pl. 1, fig. 1; text-figs. 2, 3.
- 1914 *Pachydiscus subrobustus* SEUNES; NOWAK, p. 357, pl. 41, fig. 15.
- 1925 *Pachydiscus subrobustus* SEUNES; DIENER, p. 108.
- 1951 *Pachydiscus subrobustus* SEUNES; MICHAILOV, p. 70, pl. 9, figs. 43–44.
- 1952 *Pachydiscus subrobustus* SEUNES; COLLIGNON, p. 92.
- 1955 *Pachydiscus subrobustus* SEUNES; COLLIGNON, p. 83.
- 1964 *Pachydiscus subrobustus* SEUNES; GIERS, p. 265, pl. 5, fig. 3.
- non 1971 *Pachydiscus subrobustus* SEUNES; COLLIGNON, p. 34, pl. 454, fig. 2411.
- 1974 *Pachydiscus subrobustus* SEUNES, 1891; NAIDIN, p. 185, pl. 65, fig. 1; text-fig. 33.

T y p e Lectotype, here designated, the original of SEUNES, 1891, pl. 13(4), fig. 1, from the Upper Campanian of Tercis (Landes), France; the specimen is in the Collections of the Sorbonne, now in the Université Pierre et Marie Curie, Paris.

M a t e r i a l. Two specimens, H16 and R32.

D e s c r i p t i o n. Both specimens are badly crushed. Coiling appears to have been fairly evolute, with rather slowly expanding whorls. 17/18 primary ribs are visible on the inner whorl of the best-preserved specimen, H16 (Plate 8, fig. 4) and there are a somewhat greater number on the outer whorl. The primaries arise at the umbilical seam, are concave across the umbilical wall, strengthen markedly on the shoulder, and sometimes develop into an incipient bulla. The ribs are prorsiradiate, straight on the inner flank, feebly flexed and concave on the outer flank, projected on the ventrolateral shoulder and cross the venter in a distinct convexity. The primaries are separated by one or two secondaries, which arise at variable positions on the flank and strengthen to match the primary ribs from outer flank to venter. At the largest diameter visible (120 mm) long ribs dominate, and there is a total of perhaps 40 ribs per whorl.

D i s c u s s i o n. Although poorly preserved, the specimens are very close to the lectotype in style, strength and number of ribs, and appear to have had similar whorl proportions.

When compared with other Gschlieffgraben material, the ribbing is much coarser than in *P. haldemisis*. *Pachydiscus perfidus* has even coarser and more distant ribs in middle growth, while the whorl section, with sub-tabulate venter, is immediately distinctive. *Anapachydiscus arrialoorensis* (STOLICZKA, 1865) is more involute, rapidly expanding, with massive whorls, umbilical bullae when small and regularly alternately long and short ribs.

The *Pachydiscus subrobustus* of NAIDIN (1974, p. 185, pl. 65, fig. 1) has rather short intercalato-

ries, but similar specimens occur at Tercis, the type locality (Ecole des Mines Collections, now at Lyon).

The Maastrichtian specimen from Madagascar figured by COLLIGNON (1971, pl. 454, fig. 2411) seems to be a different species, with a smaller umbilicus, higher expansion rate and umbilical bullae. *O c c u r r e n c e* Upper Campanian of Tercis (Landes), France, Poland, Galicia, the Donbas region and the southern USSR and the Gschliefgraben.

Genus *ANAPACHYDISCUS* YABE and SHIMIZU, 1926, p. 172

Type species. *Pachydiscus (Parapachydiscus) fascicostatum* YABE, 1921, p. 57(5), pl. 8(1), fig. 5; pl. 9(2), figs. 2–5, by original designation.

Anapachydiscus arrialoorensis (STOLICZKA, 1865)

Plate 5, figs. 3–4; Plate 8, figs. 1–3.

- 1865 *Ammonites arrialoorensis* STOLICZKA, p. 126, pl. 63, figs. 2–4; pl. 64, fig. 1 (*Ammonites deccanensis* in the plate explanation, manifestly an error).
 1890 *Pachydiscus arrialoorensis* STOLICZKA; YOKOYAMA, p. 186, pl. 21, fig. 1.
 1898 *Pachydiscus ariyalurensis* STOL.; KOSSMAT, p. 168(103).
 non 1920 *Pachydiscus arrialoorensis* (STOLICZKA); TAUBENHAUS, p. 21, pl. 6, fig. 6.
 1925 *Pachydiscus ariyalurensis* STOLICZKA; DIENER, p. 114.
 1932 *Parapachydiscus arrialoorensis* STOLICZKA; COLLIGNON, p. 22, pl. 6, fig. 4; text-figs. 9, 10.
 non 1936 *Parapachydiscus arrialoorensis* (STOLICZKA); VENZO, p. 77(19), pl. 12(8), fig. 4.
 1938 *Parapachydiscus arrialoorensis* STOL.; COLLIGNON, p. 79.
 1952 *Anapachydiscus arrialoorensis* STOLICZKA; COLLIGNON, p. 49, pl. 13, fig. 2.
 1952 *Anapachydiscus arrialoorensis* STOL.; var *bererensis* COLLIGNON, p. 51, pl. 13, fig. 3.
 1955 *Anapachydiscus arrialoorensis* STOLICZKA; COLLIGNON, p. 49, pl. 13, fig. 2.
 1955 *Anapachydiscus arrialoorensis* STOL. var *bererensis* COLLIGNON, p. 50, pl. 13, fig. 3.
 ? 1973 *Eupachydiscus arrialoorensis* (STOLICZKA); TODIRIȚĂ-MIHAILESCU, p. 102(4), pl. 1, figs. 1–3; pl. 2, fig. 1.
 ? 1976 *Anapachydiscus arrialoorensis* (STOLICZKA); SZASZ, p. 206, pl. 1; pl. 2; pl. 3, fig. 1; pl. 4, fig. 1.

T y p e The lectotype, here designated, is the original of STOLICZKA, 1865, pl. 64, fig. 1, from the Arrialoor Group of Karapandy, southern India.

M a t e r i a l. Six specimens, R29–31, 50; XX and M1.

D e s c r i p t i o n. All the specimens are highly distorted, but the coiling is very involute, the whorls massive, and probably originally depressed. The smallest specimen shows strong umbilical bullae, four (?) per half whorl, giving rise to one or two strong ribs, with shorter ribs intercalated. R39, a somewhat larger specimen (Plate 8, fig. 2) has 10–12 umbilical bullae at a diameter of 80 mm. These give rise to one, rarely two primary ribs. These are coarse, distant and prorsiradiate, straight on the inner flank but markedly concave on the outer flank, strongly projected on the ventrolateral shoulder, crossing the venter with a marked forwards convexity. One or two shorter intercalated ribs are inserted between the primaries, arising at a variable position on the flank to give a total of 17 ribs per half whorl. Our largest specimens (Plate 5, figs. 3–4; Plate 8, fig. 1) show a decline and loss of umbilical bullae and a stabilisation of long ribs separated by a single short intercalatory so that, at 150 mm diameter there is a total of 36 ribs, of which 16 are primaries. They are coarse, distant, prorsiradiate and distinctly concave, especially on the outer flank.

D i s c u s s i o n. Prominent umbilical bullae on the inner whorls show these specimens to be *Anapachydiscus*. Although poorly preserved, our specimens show such a close similarity in ribbing and tuberculation, as well as in the ontogenetic changes in both these features as to merit firm reference to *A. arrialoorensis*. COLLIGNON's var *bererensis* is more finely ribbed, as is the type species, *A. fascicostatus* YABE, 1921 (p. 57(5), pl. 8(1), fig. 5; pl. 9(2), figs. 2–5), where there are many more secondaries between the primary ribs. *Anapachydiscus wittekindi* (SCHLÜTER, 1876) (p. 160, nom. nov. pro *Ammonites robustus* SCHLÜTER, 1872, p. 67, pl. 31, figs. 1–8, pl. 22, figs. 1–3), lectotype by the subsequent designation of BLASZKIEWICZ, 1980, p. 50 the original of SCHLÜTER's

pl. 22, figs. 1–3 is easily separated from the present species; the inner whorls having very coarse ribs that commonly arise in pairs from bullae, a smooth middle stage when *arrialoorensis* retains ribs and an adult stage with distant, bar-like ribs. COLLIGNON (1952, 1955) misidentified this species, correctly interpreted by BLASZKIEWICZ, (1980, p. 50, pl. 42, figs. 1–2; pl. 43, fig. 2; pls. 44–47; pl. 48, figs. 3–4; pl. 49, figs. 1–3; pl. 50, figs. 2–3; pls. 51–53). *Anapachydiscus vistulensis* BLASZKIEWICZ, 1980 (p. 49, pl. 42, figs. 3–4; pl. 43, figs. 1–3; pl. 48, figs. 1–2) is much more coarsely ribbed on the inner whorls and has strong bullae at a point where they are weak or lost in our material. It differs in detail only from the lectotype of *arrialoorensis*, and, given additional material might fall within the range of variation of the species.

We doubt that the material from the Coniacian of Roumania (SZASZ, 1976, p. 206, pls. 1, 2; pl. 3, fig. 1; pl. 4, fig. 1) belongs here as it is much older than all other material referred to the species.

O c c u r r e n c e . Campanian of southern India, Madagascar and the Gschliefgraben.

Superfamily ACANTHOCERATAE DE GROSSOUVRE, 1894, p. 22

Family COLLIGNONICERATIDAE WRIGHT and WRIGHT, 1951, p. 50.

Subfamily TEXANITINAE COLLIGNON, 1948, p. 54.

(nom. transl. WRIGHT, 1957, p. L429, ex Texanitidae COLLIGNON, 1948, p. 54)

Indeterminate Texanitine

Plate 5, fig. 2

M a t e r i a l . One specimen only, OÖLM 39/1938.

D e s c r i p t i o n . Plate 5, fig. 2 shows a photographically reversed print of an external mould in grey brittle limestone quite distinct from all other Gschliefgraben specimens described here. There are 22 straight, prorsiradiate ribs per whorl, bearing umbilical, ventrolateral and possibly lateral tubercles.

D i s c u s s i o n . The evolute coiling, simple ribs and presence of several rows of tubercles suggest this to be a texanitine of some sort, but it is generically indeterminate. It is of interest because the Texanitinae die out in the middle of the Campanian.

O c c u r r e n c e . Gschliefgraben, age unknown.

Suborder ANCYLOCERATINA WIEDMANN, 1966, p. 54

Superfamily TURRILITACEAE GILL, 1871, p. 3.

Family NOSTOCERATIDAE HYATT, 1894, p. 568.

(= Jouaniceratidae WRIGHT, 1952, p. 16; Emperoceratinae SPATH, 1953, p. 17; Bostrychoceratinae SPATH, 1953, p. 16; Hyphantoceratinae SPATH, 1953, p. 16).

Genus *NOSTOCERAS* HYATT, 1894, p. 569

Subgenus *NOSTOCERAS* HYATT, 1894, p. 569

Type species. *Nostoceras stantoni* HYATT, 1894, p. 570, by original designation.

Nostoceras (Nostoceras) sp.

Plate 9, figs. 1, 2, 3, 9.

M a t e r i a l . 5 specimens, H29; R58, 59, 65, 67, plus two doubtful fragments, H20 and H21.

D e s c r i p t i o n . Small, apical angle narrow, loosely coiled, whorls barely in contact. Upper whorl face bears feeble concave prorsiradiate ribs that strengthen on the outer face into coarse oblique ribs, varying from 23 (Plate 9, fig. 1) to 33 per whorl (Plate 9, fig. 3), the number increasing throughout ontogeny. The ribs are simple and unbranched, and all bear two rows of prominent equal tubercles. The ribs continue over the lower whorl face (Plate 9, fig. 9) although weakened. The body chamber uncoils; the two fragments tentatively referred to the species suggest it was recurved into a U, the tubercles persisting, and with an apertural constriction.

D i s c u s s i o n . These specimens agree with Campanian material referred by previous authors to

the Maastrichtian *N. (N.) schloenbachi* (FAVRE, 1869) (pl. 7, fig. 5) the holotype of which is a body chamber fragment which shows single primary ribs on the outer whorl face, all of which bear tubercles, as in our material. But there are also traces of intercalated ribs on the upper part of the flank and upper whorl surface, not shown by our material, which more closely resembles specimens referred to *schloenbachi* by NAIDIN (1974, pl. 55, figs. 6, 7), who also refers specimens in which pairs of ribs extend from the upper whorl suture to the upper tubercle to the species, as does NOWAK (1913, pl. 41, fig. 14). All these specimens are tightly coiled, as is our material, while other specimens referred to *schloenbachi* by WIEDMANN (1962, p. 204) and KLINGER (1976, p. 67, pl. 29, fig. 4, pl. 30, fig. 4) are loose helices without whorls in contact, perhaps better placed in *N. (Didymoceras)*. We are thus inclined to agree with BLASZKIEWICZ (1980, p. 27) that Campanian specimens referred to *schloenbachi* belong to other species, and leave our material in open nomenclature.

O c c u r r e n c e . The Gschliefraben, the Donbas and southern USSR.

Subgenus *BOSTRYCHOCERAS* HYATT, 1900, p. 588
(= *Mobergoceras* SCHMIDT and ERNST, 1975, p. 342)

Type species. *Turrilites polyplocus* ROEMER, 1841, p. 92, pl. 14, figs. 1, 2, by original designation.

Nostoceras (Bostrychoceras) polyplocus (ROEMER, 1841)

Plate 9, figs. 4, 8, 12–14.

- 1841 *Turrilites polyplocus* ROEMER, p. 67, pl. 3, fig. 1 only.
 1925 *Turrilites polyplocus* A. ROEMER; DIENER, p. 87 (pars) (with extensive synonymy).
 1962 *Cirroceras (Cirroceras) polyplocus* (A. ROEMER); WIEDMANN, p. 198 (with synonymy).
 1962 *Cirroceras (Cirroceras) polyplocus polyplocus* (A. ROEMER); WIEDMANN, p. 200, pl. 11, fig. 4.
 1974 *Bostrychoceras polyplocus* (ROEMER, 1841); NAIDIN, p. 165, pl. 54, figs. 1–3; pl. 55, fig. 1.
 1975 *Bostrychoceras (Bostrychoceras) polyplocus* (F. A. ROEMER, 1841); SCHMIDT and ERNST, p. 339, pl. 4, figs. 2, 3.
 1980 *Bostrychoceras polyplocus polyplocus* (ROEMER, 1841); BLASZKIEWICZ, p. 20, pl. 1, figs. 1–9; pl. 11, figs. 2–3, 5–6.
 1980 *Bostrychoceras polyplocus schlueteri* BLASZKIEWICZ, p. 20, pl. 2, figs. 1, 4, 9–11.
 ? 1980 *Bostrychoceras unituberculatum* BLASZKIEWICZ, p. 21, pl. 3, figs. 1–8; pl. 4, figs. 3–6.
 1982 *Bostrychoceras polyplocus* (ROEMER, 1841); TZANKOV, p. 18, pl. 3, fig. 5.

T y p e s The original of ROEMER, 1841, pl. 14, fig. 1, from the Upper Campanian of north Germany (the actual locality is in doubt according to SCHLÜTER (1872, p. 114)) is said by WIEDMANN (1962, p. 198) to have been designated lectotype by SCHLÜTER, but this is not the case. Until ROEMER's material is reillustrated, lectotype designation is unwise.

M a t e r i a l . Ten specimens H18, 19; R52, 53, 55, 56; M2, M3; OÖLM 58/1975/5, OÖLM 58/1975/6.

D e s c r i p t i o n . Whorls loosely in contact, dextral or sinistral, ornamented by dense, flexuous, oblique ribs, most of which are simple. On early whorls, from one to three ribs are linked by a lateral tubercle, while periodic ribs are flared and may be associated with narrow constrictions. On later whorls the tubercles may persist or not. One specimen (Plate 9, figs. 14) shows a recurved, pendant hook at the end of the adult body chamber.

D i s c u s s i o n . The nomenclature of European Campanian *N. (Bostrychoceras) polyplocus* has been discussed at length by WIEDMANN (1962) and BLASZKIEWICZ (1980) with very different results and interpretations of previous figures, while the latter, curiously, makes no reference to the work of the former. The type material has never been adequately redescribed or figured photographically, nor has the beautiful material described by SCHLÜTER (1872) which WIEDMANN referred to no less than four species, *indicum*, *schloenbachi*, *polyplocus* and *depressum*, to which can be added BLASZKIEWICZ's *polyplocus schlueteri* for specimens regarded as both *indicum* and *polyplocus* by WIEDMANN. Preliminary observations on abundant material from Haldem, Westphalia, suggest a widely variable species in which tuberculation varies with ontogeny (e. g. Plate 9, figs. 4, 14) and which is also strongly dimorphic such that whorl fragments of the same size but at diffe-

rent ontogenetic stages may have quite different styles of tuberculation. Until this material and the types are adequately illustrated, we refer our specimens to the traditional concept of a variable species in terms of both ribbing and tuberculation as it is insufficient to resolve the problems outlined above. We would note, however, that our specimens are all unituberculate when small and may lose all tubercles when large. As such they correspond at one stage to *unituberculatum* of BLASZKIEWICZ at another to *polyplocum schlueteri* of BLASZKIEWICZ and *indicum* as interpreted by WIEDMANN.

O c c u r r e n c e . *B. polyplocum* in the sense used here is restricted to the Upper Campanian and occurs widely in Europe: northern Ireland, England, the Aquitaine Basin in France, Belgium, Germany, Poland, Bulgaria, the USSR, in Iran and north Africa. Subspecies *zumayaense* from the Lower Maastrichtian of Zumaya, Spain (WIEDMANN, 1962, pl. 9, fig. 5) is some other nostoceratid and is probably specifically indeterminate.

Subgenus *DIDYMOCERAS* HYATT, 1894, p. 573.

(= *Emperoceras* HYATT, 1894, p. 575)

Type species. *Ancyloceras ? nebrascense* MEEK and HAYDEN, 1856, p. 71, by original designation.

Nostoceras (Didymoceras) donezianum (MICHAILOV, 1951)

Plate 12, figs. 8–10.

1951 *Bostrychoceras polyplocum* ROEMER (?) var. *doneziana* MICHAILOV, p. 53, pl. 4, figs. 23, 24.

1980 *Didymoceras donezianum donezianum* (MICHAILOV, 1951); BLASZKIEWICZ, p. 24, pl. 5, fig. 1; pl. 7, figs. 9–15, 18 (with synonymy).

H o l o t y p e . The original of MICHAILOV, 1951, pl. 4, figs. 23, 24, from the Upper Campanian of the Donets Basin.

One specimen only, H27.

D e s c r i p t i o n The fragment appears to be part of a low helix. What we take to be the upper surface (Plate 12, fig. 8) shows strong, distantly ribs, at first straight but strongly flexed on the outer part of the whorl face. On the outer whorl face (Plate 12, fig. 9) there appears to be a tubercle on every rib, while on the lower part of the face is a second tubercle, at one of which two ribs are linked.

D i s c u s s i o n . Although badly distorted, the helicoid coiling of the fragment shows this to be a nostoceratid. It agrees closely with the holotype of *Nostoceras (Didymoceras) donezianum* (MICHAILOV, 1951) (p. 53, pl. 4, figs. 23, 24) and Polish specimens figured by BLASZKIEWICZ (1980, p. 24, pl. 5, fig. 1; pl. 7, figs. 9–15, 18).

BLASZKIEWICZ suggested that *Bostrychoceras polyplocum* var. *renngarteni* MICHAILOV, (p. 54, pl. 3, figs. 17, 18) was a subspecies of *donezianum*, but the coiling is quite different, with whorls in contact, showing it to be a *Nostoceras (Nostoceras)*.

O c c u r r e n c e . Upper Campanian of the Donets Basin, Poland and the Gschliefgraben.

Family DIPLOMOCERATIDAE SPATH, 1926, p. 81

(= Neocrioceratinae SPATH, 1953, p. 17)

Subfamily DIPLOMOCERATINAE SPATH, 1926, p. 81.

(= Proavitoceratinae SPATH, 1953, p. 17; Scalaritinae WARD, 1976, p. 455)

Genus *NEOCRIOCERAS* SPATH, 1921, p. 51.

Type species. *Crioceras spinigerum* JIMBO, 1894, p. 185 (39), pl. 23(8), fig. 3, 4, by original designation.

Subgenus *SCHLUETERELLA* WIEDMANN, 1962, p. 205

Type species. *Ancyloceras pseudarmatum* SCHLÜTER, 1872, p. 99, pl. 31, figs. 1, 2, by original designation.

Neocrioceras (Schlueterella) sp. ?

Plate 10, fig. 4.

M a t e r i a l . Two specimens, R 66 and 70.**D e s c r i p t i o n .** R66 is a small curved fragment with a maximum whorl height of 6 mm. There are four sharp, narrow, widely separated ribs in a distance equal to the whorl height, all of which bear small lateral and ventral tubercles. R70 is crushed, but shows a similar ornament at the beginning of an open curved fragment that appears to correspond to part of a straight shaft and hook. The ribbing differentiates at a whorl height of 19 mm, when periodic ribs are strengthened, their being 6 normal ribs between (Plate 10, fig. 4).**D i s c u s s i o n .** The presence of lateral and ventral tubercles on all ribs suggest this to be a *Pseudoxybeloceras*. The periodic flared ribs are, however, a feature of *Neocrioceras (Schlueterella)* while the coiling, which appears to be criocone rather than polyptychoceratid is reminiscent of *Neocrioceras* rather than *Pseudoxybeloceras*. The specimen is, in consequence, referred to as *Neocrioceras (Schlueterella) sp.?***O c c u r r e n c e .** Upper Campanian of the Gschliefgraben.Genus *PSEUDOXYBELOCERAS* WRIGHT and MATSUMOTO, 1954, p. 119Type species. *Hamites quadrispinosus* JIMBO, 1894, p. 185(39), pl. 23(7), figs. 3, 4, by original designation.Subgenus *PARASOLENOCERAS* COLLIGNON, 1969, p. 44Type species. *Parasolenoceras splendens* COLLIGNON, 1969, p. 44, pl. 530, figs. 2087–2088.*Pseudoxybeloceras (Parasolenoceras) wernickei* (WOLLEMAN, 1902)

Plate 6, fig. 3; plate 9, figs. 6, 7; Plate 10, figs. 1, 8, 9.

- 1902 *Hamites wernickei* WOLLEMAN, p. 95, pl. 4, fig. 4 (? not 5); pl. 5, figs. 1, 2.
 1903 *Hamites (Anisoceras) sp. indet.* PERVINQUIÈRE p. 133.
 1907 *Hamites (Anisoceras) wernickei* WOLLEMAN; PERVINQUIÈRE, p. 86, pl. 3, fig. 33.
 1925 *Anisoceras wernickei* WOLLEMAN; DIENER, p. 74.
 1951 *Anisoceras wernickei* (WOLLEMAN); MICHAÏLOV, p. 40, pl. 1, fig. 1.
 1960 *Neancyloceras wernickei* (WOLLEMAN); WIEDMANN, p. 716.
 1962 *Neancyloceras wernickei* (WOLLEMAN); WIEDMANN, p. 209, pl. 12, fig. 5.
 1964 *Neancyloceras wernickei* (WOLLEMAN); WIEDMANN, p. 113.
 1974 *Neancyloceras wernickei* (WOLLEMAN); NAIDIN, p. 169, pl. 57, fig. 4.
 ? 1976 *Neancyloceras sp. cf. Neancyloceras wernickei* (WOLLEMAN), 1902; KLINGER, p. 73, pl. 33, fig. 4; text-fig. 8i, 10f.
 1982 *Hamites wernickei* WOLLEMAN, 1902; KLINGER, p. 237.
 1982 *Neancyloceras wernickei* (WOLLEMAN, 1902); TZANKOV, p. 20, pl. 5, fig. 5.

T y p e s . WOLLEMAN figured three specimens, the original of his plate 4, fig. 1 is herein designated lectotype.**M a t e r i a l .** Seven specimens: H23–24; R62, 64, 96; S11–13. H26 may also belong here.**D e s c r i p t i o n .** The material falls into two size categories, both including curved portions and parallel shafts, close together in the small specimens (Plate 9, figs. 6–7), but well-separated in the larger (Plate 10, figs. 1, 9), suggesting the coiling to have been polyptychoceratid with at least four shafts. The small specimens bear strong ribs, narrower than the interspaces. They are prorsiradiate and straight on the straight portion, but change to curved to rectiradiate around the hook. Each bears a small, sharp ventral tubercle, linked across the venter by a narrow high rib. S12 although badly crushed, shows a 105 mm long straight shaft with a whorl height (restored) of an estimated 12 mm maximum, ornament being as described above. S11 (Plate 10, fig. 9) is a much larger shaft some 200 mm long. The ornament continues unchanged, apart from a change in direction and curvature around the book. The tubercles are markedly clavate at this stage. R62 (Plate 10, fig. 1) a somewhat

larger hook shows the clavi well, while H26 (Plate 10, fig. 8) a relatively uncrushed specimen, apparently body chamber, shows an oval whorl section, with strong prorsiradiate ribs, which do not weaken over the venter and all of which bear prominent ventral clavi. The rib index is 6–7.

S13 (Plate 6, fig. 3) appears to be from close to the adult aperture, and has lost its ventral tubercles, shows weakened ribbing and a collared constriction.

D i s c u s s i o n . The present material closely resembles the lectotype (WOLLEMAN, 1902, pl. 4, fig. 4) in every respect. It differs from the large paralectotypes (WOLLEMAN, 1902, pl. 5, figs. 1, 2) in that these both show irregularities of ventral ribbing. The smaller figured paralectotype (WOLLEMAN, 1902, pl. 4, fig. 5) is coarser ribbed than the comparably sized material figured here (Plate 9, figs. 6, 7) and may be better referred to '*Hamites*' *interruptus* SCHLÜTER, 1872, discussed further below. '*Hamites*' *phaleratus* GRIEPENKERL (1889, p. 406 (104), pl. 45 (11), figs. 3; pl. 45 (12) figs. 3–4) referred to *Pseudoxybeloceras* (*Parasolenoceras*) by KLINGER (1982, p. 237) has tubercles on alternate ribs only in the original illustrations, and a pair of ribs linking the tubercles across the venter; this is confirmed by NAIDIN's photograph (e. g. 1974, pl. 56, fig. 6). These features readily separate it from the present form. *P.* (*Parasolenoceras*) *splendens* COLLIGNON, 1969 (p. 44, pl. 53, fig. 2087, 2088) has a near circular section and much finer ribbing; it is from the Lower Campanian of Madagascar.

O c c u r r e n c e . Upper Campanian of north Germany, the Gschlifgraben, the Donbas and southern USSR, central Tunisia and northern Spain. The South Africa (Zululand) record is doubtful.

***Pseudoxybeloceras* (*Parasolenoceras*) *interruptum* (SCHLÜTER, 1872)**

Plate 9, figs. 5, 10–11

- 1872 *Hamites interruptus* SCHLÜTER, p. 105, pl. 32, figs. 8, 9.
 1902 *Hamites wernickei* WOLLEMAN, p. 95 (pars), pl. 4, fig. 5 only.
 1925 *Hamites interruptus* SCHLÜTER; DIENER, p. 68.
 ? 1936 *Hamites interruptus* SCHLÜTER; NALIVAJKO, p. 36, pl. 14, fig. 42 (fide NAIDIN 1974).
 1951 *Hamites* (?) *interruptus* SCHLÜTER; MICHAÏLOV, p. 38, pl. 1, figs. 2, 3.
 1953 *Hamites interruptus* SCHLÜTER; SPATH, p. 16.
 1959 "*Neancyloceras*" *interruptum* (SCHLÜTER); NAIDIN, p. 182, pl. 3, figs. 4, 5.
 1974 *Solenoceras interruptum* (SCHLÜTER, 1872); NAIDIN, p. 167, pl. 56, fig. 5.
 1982 *Pseudoxybeloceras* (*Parasolenoceras*) *interruptus* (SCHLÜTER, 1872); KLINGER, p. 237, text-fig. 8F, G.

T y p e Holotype by monotypy is the original of SCHLÜTER, 1872, p. 32, figs. 8, 9, Göttingen University Collection no. 65–13 from the Upper Campanian of Ahlten, German Federal Republic (see KLINGER, 1982, text-fig. 8F, G for photographs of this specimen).

M a t e r i a l . Two specimens: H25, R63.

D e s c r i p t i o n . The two specimens show part of two parallel shafts and the connecting hook of a small form with a depressed whorl section. The shell is ornamented by coarse ribs, four in a distance equal to the whorl height. They are weak on the dorsum, which they pass straight across, but strengthen markedly and are prorsiradiate and straight on the flank of the shafts and are separated by somewhat wider interspaces. They crowd on the hook, where they swing from prorsiradiate to rursiradiate before reassuming their prorsiradiate course (Plate 9, fig. 11). All ribs bear a small ventral clavus on either side of a broad venter. The ribs weaken and efface markedly on the venter between these tubercles.

D i s c u s s i o n . Our specimens are identical with the holotype. The coarseness of ribbing and effacement of ventral ribs distinguishes this species from all others discussed above under *Ps.* (*Parasolenoceras*) *wernickei* and also from that species.

The small paralectotype of *Ps.* (*Parasolenoceras*) *wernickei* figured by WOLLEMAN as his pl. 4, fig. 5 may belong here, having a very low rib density.

The type and the other figured specimens listed in the synonymy are all small fragments. A series of fine specimens from the Upper Campanian part of the White Limestone of Northern Ireland (Ulster Museum) confirm the polyptychoceratid coiling of the species.

O c c u r r e n c e . Upper Campanian of north Germany, the Gschliefgraben, Donbas and southern USSR, northern Ireland.

***Pseudoxybeloceras (Parasolenoceras) cf. phaleratus* (GRIEPENKERL, 1889)**

Plate 6, figs. 4, 5; Plate 10, figs. 5, 6.

compare:

1889 *Hamites phaleratus* GRIEPENKERL, p. 406, pl. 44, fig. 3; pl. 45, figs. 3, 4.

1980 *Neancyloceras phaleratum* (GRIEPENKERL, 1889); BLASZKIEWICZ, p. 28, pl. 11, figs. 1, 2, 4–8; pl. 12, figs. 1–4, 6–9 (with synonymy).

M a t e r i a l Two specimens: R71, S9.

D e s c r i p t i o n . The material consists of one short, slightly curved fragment 42 mm long and a larger fragment, again curved. The whorl section appears to have been a compressed oval. Ornament consists of strong, rounded ribs that weaken slightly on the dorsum, six in a distance equal to the whorl height. They are straight to slightly curved, and vary from prorsi- to recti- to rursiradiate, depending on position on the curved fragments. Alternate ribs bear small ventral clavi, linked across the venter by a broad rib subdivided into looped riblets or by riblets that link irregularly. In some cases the non-tuberculate rib on one flank links across the venter to the tubercle of the preceding or succeeding rib on the opposite flank, producing a characteristic zig-zag pattern on the venter.

D i s c u s s i o n The pattern of ribs and tubercles on flank and venter recall GRIEPENKERL's species, although neither shows the looped dorsal ribbing shown in his pl. 12, fig. 4.

O c c u r r e n c e Upper Campanian of the Gschliefgraben. The species occurs at the same horizon in north Germany, Poland and possibly Sweden.

Genus *NEOGLYPTOXOCERAS* COLLIGNON, 1969, p. 35.

(? = *Epiglyptoxoceras* COLLIGNON, 1969, p. 35).

Type species. *Neoglyptoxoceras magnificum* COLLIGNON, 1969, p. 35, pl. 526, figs. 2074–6.

***Neoglyptoxoceras ? cf. retrorsum* (SCHLÜTER, 1872)**

Plate 6, fig. 1.

compare:

1872 *Anyloceras retrorsum* SCHLÜTER, p. 97, pl. 30, figs. 5–10.

M a t e r i a l . One specimen only, M4.

D e s c r i p t i o n . The specimen consists of an external mould of an open spire 55 mm in diameter and a fragment of composite internal mould, the latter shown in Plate 9, fig. 1. Ornament consists of sharp, distant, annular, rursiradiate ribs. The external mould shows them to have been high and sharp.

D i s c u s s i o n This poor fragment recalls the smaller specimens figured by SCHLÜTER (1872, pl. 30, figs. 9, 10, but is at best a doubtful record.

O c c u r r e n c e Upper Campanian of the Gschliefgraben; the species occurs widely in the Upper Campanian in Germany, Poland and the USSR.

Subfamily POLYPTYCHOCERATINAE MATSUMOTO, 1938, p. 193.

(nom. transl. WIEDMANN, 1962, p. 185, ex Polyptychoceratidae MATSUMOTO)

Genus *POLYPTYCHOCERAS* YABE, 1927, p. 44.

Subgenus *POLYPTYCHOCERAS* YABE, 1927, p. 44.

Type species. *Ptychoceras pseudogaultinum* YOKOYAMA, 1890, p. 181, pl. 20, figs. 1–3, by original designation.

Polyptychoceras (Polyptychoceras) obliquecostatum (SCHLÜTER, 1872)

compare:

- 1872 *Hamites obliquecostatus* SCHLÜTER, p. 187, pl. 29, fig. 6.
 1876 *Hamites Berkelis* SCHLÜTER, p. 45.
 ? 1890 *Ptychoceras pseudogaultinum* YOKOYAMA, pl. 20, fig. 3 only.
 1953 *Polyptychoceras* sp. juv. ind. SPATH, p. 18, pl. 7, fig. 5.
 ? 1962 *P. (Polyptychoceras) obliquecostatum* (SCHLÜTER); WIEDMANN, p. 185, pl. 10, fig. 6.
 1965 *P. (?) obliquecostatum* (SCHLÜTER); HOWARTH, p. 385.

T y p e Lectotype, here designated, the original of SCHLÜTER 1872, pl. 29, fig. 6, from the Upper Campanian of Coesfeld, Westphalia.

M a t e r i a l . H22.

D e s c r i p t i o n The single available specimen consists of a straight shaft 27.5 mm long with a maximum diameter of 4.5 mm and part of a hook. The shaft is ornamented by weak, dense, feebly prorsiradiate ribs, six in a distance equal to the whorl height.

D i s c u s s i o n Rib density and strength correspond closely with that shown by the lectotype if a little less prorsiradiate. The very delicate ribbing distinguishes this species from all others. The paralectotype of *P. (Polyptychoceras) pseudogaultinum* (YOKOYAMA, 1890) (pl. 20, fig. 3) from the Santonian of Japan referred to this species by WIEDMANN has much more markedly prorsiradiate ribs, while the example from the Santonian of northern Spain figured by WIEDMANN (1962, pl. 10, fig. 6) shows variable, sharper ribbing. The Antarctic example figured by SPATH (1953, p. 18, pl. 7, fig. 5), also placed in *obliquecostatum* by WIEDMANN is Lower Maastrichtian in age.

O c c u r r e n c e . Upper Campanian of the Gschlieffgraben and north Germany. Other records are doubtful.

Polyptychoceras (Polyptychoceras) cf. pseudogaultinum (YOKOYAMA, 1890)

Plate 11, fig. 9.

compare

- 1890 *Polyptychoceras pseudogaultinum* YOKOYAMA, p. 181, pl. 20, figs. 1, 2, non 3.
 1925 *Ptychoceras pseudogaultinum* YOKOYAMA; DIENER, p. 78.
 1952 *Polyptychoceras pseudogaultinum* YOKOYAMA sp.; SPATH, p. 16.
 1965 *Polyptychoceras pseudogaultinum* (YOKOYAMA); HOWARTH, p. 385, pl. 11, fig. 2.

M a t e r i a l . 1 specimen only, R60.

D e s c r i p t i o n The specimen is crushed, and consists of a straight shaft 120 mm long followed by a complete hook and a short length of the final shaft with an adult aperture preserved. The shaft is slowly expanding and ornamented by low, broad ribs. These are effaced on the dorsum, and well-developed on flank and venter. They decline around the hook, while the final shaft is smooth with a marked constriction and succeeding flare marking the adult aperture.

D i s c u s s i o n The low, blunt ribbing of the specimen is sparser and more subdued than that shown by YOKOYAMA, more closely resembling that of the Angola specimens figured by HOWARTH (1965, pl. 11, fig. 2). It recalls that of *Phylloptychoceras siphon* (FORBES, 1846) to a degree (see photograph of lectotype, HOWARTH, 1965, pl. 11, fig. 1) but is better differentiated into ribs rather than broad bulges. If differences from the undeformed Japanese and Angola material are attributed to crushing then reference to *pseudogaultinum* seems reasonable.

O c c u r r e n c e . Upper Campanian of the Gschlieffgraben.

Polyptychoceras (Polyptychoceras) sp.

Plate 10, figs. 2, 3.

M a t e r i a l S10.

D e s c r i p t i o n . The single specimen available is part of the hook and one limb with a maximum whorl height of 11 mm. The whorl height appears to have been subcircular or slightly depressed. Or-

nament consists of rounded ribs, six in a distance equal to the whorl height and separated by narrow interspaces. The ribs vary in direction around the hook, and too little of the shaft survives to show their predominant direction there. The ribs appear to have been weak or absent on the dorsum, and are narrow and weak on the dorsolateral shoulder, straight on the flank, which they strengthen across, and transverse over the venter. They are invariably single, never branch and there are no intercalatories.

D i s c u s s i o n . The tightness of curvature of the specimen, style and simplicity of ribbing show this to be a fragmentary *Polyptychoceras*. With so little material it cannot be identified specifically with any confidence, but there are similarities to the Santonian *P. (P.) obstrictum* (JIMBO, 1894; p. 184 (38), pl. 23 (7)).

O c c u r r e n c e Upper Campanian of the Gschlifgraben.

Family BACULITIDAE GILL, 1871, p. 3.
(= Eubaculitinae Brunnschweiler, 1966, p. 4)

Genus BACULITES LAMARCK, 1799, p. 80.

(= *Homaloceratites* HÜBSCH, 1768, p. 110 (non binom.); *Euhomaloceras* SPATH, 1926, p. 80).

Type species. *Baculites vertebralis* LAMARCK, 1801, p. 103, by subsequent designation by MEEK, 1876, p. 391.

***Baculites* sp. 1.**

Plate 11, figs. 3, 5–8, 10.

M a t e r i a l Seventeen specimens: H29, 32–34; R85–94; S14; NHMW 1979/2076/12–13.

D e s c r i p t i o n . Large, whorl height up to 50 mm. Shell slowly expanding, whorl section compressed (whorl breadth to height ratio 0.63 in the single undeformed specimen) with broadly rounded dorsum, swollen inner to mid-flanks, convergent outer flanks and narrowly rounded venter. The shell surface is smooth, generally poorly preserved and lacks growth lines.

The suture, partially visible in R 85, is simple, with rectangular bifid elements.

D i s c u s s i o n . These specimens correspond to the large *Baculites* from the 'Mucronaten-Kreide' of north Germany described by SCHLÜTER (1876, p. 145, pl. 39, figs. 16–20) as *Baculites knorrianus* DESMAREST in that they are large and featureless with piriform whorl section; a lengthy synonymy is given by DIENER (1925). Virtually all material referred to this species is poorly preserved and KNORR's original (KNORR and WELSCH 1775, p. 202, pl. 12) is from a boulder in superficial deposits near Danzig. Many records are Campanian, but there are others from the Maastrichtian (e. g. FAVRE, 1869); BIRKELUND (1979, p. 53) who gives the most precise records of European Upper Cretaceous *Baculites* places *knorrianus* in the Lower Maastrichtian, with a very limited range at the top of the *Belemnella occidentalis* Zone in Denmark. Study of Maastrichtian material from Nagorzany (Galicia) suggests true *knorrianus* to be a distinct, exclusively Maastrichtian form.

O c c u r r e n c e . Upper Campanian, Gschlifgraben.

***Baculites* sp. 2**

not figured

M a t e r i a l . One specimen only, H31.

D e s c r i p t i o n . The specimen is crushed, with a maximum whorl height of 17 mm. Whorl section compressed, with narrowly rounded venter and broad dorsum. Flanks ornamented by concave crescentric ribs, three in a distance equal to the whorl height, well-developed on the dorsolateral to mid-lateral area, strongly projected on the ventrolateral area where they decline into striae that intersect the line of the venter at an acute angle.

D i s c u s s i o n . This may be no more than a ribbed form of *Baculites* sp. 1, described above.

O c c u r r e n c e . Upper Campanian, Gschlifgraben.

***Baculites* sp. 3**

Plate 11, fig. 4.

Material. One specimen only, H30.**Description.** This poorly preserved specimen bears a single rib only in a total length of 80 mm, and recalls a similarly paucicostate species present in the Upper Campanian of the Aquitaine Basin to be described in a future publication. The present specimen is so poor that discussion of the species is deferred to that occasion.**Occurrence** Upper Campanian of the Gschliefgraben and northern Aquitaine, France.

Superfamily SCAPHITACEAE GILL, 1871, p. 3

(nom. transl. WRIGHT and WRIGHT, 1951, p. 13, ex Scaphitidae GILL)

Family SCAPHITIDAE GILL, 1871, p. 3

Subfamily SCAPHITINAE GILL, 1871, p. 3

Genus TRACHYSCAPHITES COBBAN and SCOTT, 1964, p. E7

Type species. *Trachyscaphites redbirdensis* COBBAN and SCOTT, p. E7, pl. 1, figs. 1–7, text-fig. 3, by original designation.***Trachyscaphites pulcherrimus* (ROEMER, 1841)**

Plate 11, figs. 1, 2; Plate 12, figs. 1–7, 10–22; Plate 13, figs. 2–6.

1841 *Scaphites pulcherrimus* ROEMER, p. 91 (pars) not pl. 14, fig. 4.1866 *Scaphites multinodosus* VON HAUER, p. 306, pl. 1, figs. 7, 8.1872 *Scaphites pulcherrimus* ROEMER; SCHLÜTER, p. 85, pl. 26, figs. 1–5.1894 *Scaphites pulcherrimus* ROEMER sp.; DE GROSSOUVRE, p. 250, pl. 32, figs. 6, 9.1915 *Scaphites spinosissimus* FRECH, p. 564, text-fig. 12.1916 *Acanthoscaphites pulcherrimus* (ROEMER); NOWAK, p. 63.1925 *Scaphites (Acanthoscaphites) pulcherrimus* ROEMER; DIENER, p. 206.1927 *Acanthoscaphites pulcherrimus* (ROEMER); REESIDE, p. 33.1951 *Acanthoscaphites pulcherrimus* (ROEMER); MICHAÏLOV, p. 96, pl. 18, figs. 83, 84.1959 *Acanthoscaphites pulcherrimus* (ROEMER); NAIDIN, p. 195, pl. 6, fig. 14.1964 *Trachyscaphites pulcherrimus* (ROEMER); COBBAN and SCOTT, p. 1.1968 *Scaphites pulcherrimus* ROEMER; ARNOLD, p. 314, text-fig. 36.1972 *Trachyscaphites pulcherrimus* (ROEMER); KHAKHIMOV, p. 160, pl. 1, fig. 3.1973 *Trachyscaphites pulcherrimus* (ROEMER); COBBAN, p. 695, figs. 1a–g, k–l; 2a–o.1974 *Trachyscaphites pulcherrimus* (ROEMER, 1841); NAIDIN, p. 171, pl. 58, fig. 5.1976 *Trachyscaphites pulcherrimus* (ROEMER); ATABEKYAN and KHAKHIMOV, p. 68, pl. 8, fig. 3; pl. 12, fig. 1.1980 *Trachyscaphites pulcherrimus* (ROEMER, 1841); BLASZKIEWICZ, p. 33, pl. 15, figs. 1, 4–11.1982 *Trachyscaphites pulcherrimus* ROEMER; MARTINEZ, p. 173, pl. 30, fig. 7.**Type s.** ROEMER based this species on several specimens, which he described as having five rows of tubercles on each side. He figured a specimen with only four rows on the phragmocone, however, and SCHLÜTER (1872, p. 86) referred this to his new species *Scaphites spiniger*. ROEMER's specimens are presumably in the Roemer–Pelizaeus Museum, Hildesheim, and lectotype designation in agreement with current interpretation of the species must await a reexamination of this material. COBBAN (1973, explanation of fig. 1 k, l speaks of the original of SCHLÜTER 1872, pl. 26, figs. 1–3 as the 'holotype' of *T. pulcherrimus*; this is an error.**Material.** 21 specimens: the original of *Scaphites multinodosus* HAUER, 1866, GBA 1866/01/4; R73–83; H34, 36; OÖLM 78/1975; NHMW 1979/2076/49a–c; NHMW 1979/2076/55; S16, M7.**Description.** The material shows marked size dimorphism, with microconchs (Plate 12, figs. 1–5, 11, 12, 17–22) 30–50 mm long and macroconchs (Plate 11, figs. 1–2; Plate 12, figs. 15–16) 64 to 68 mm long; the former are much commoner than the latter.

The coiled phragmocone is very involute, compressed and parallel-sided, with rounded ventrolateral shoulders and a narrow tabulate venter (Plate 12, figs. 7, 13, 20, 21). Elongate umbilical bullae perch on the umbilical shoulder and give rise to flexuous prorsidariate primary ribs, concave on the inner

flank, convex across the mid-flank and straight to the ventrolateral shoulder. These ribs branch irregularly, while intercalated ribs, inserted low on the flanks also subdivide once or twice, so that there are many more ribs crowded on the outer flank and ventrolateral shoulder than at the umbilicus. Umbilical bullae are accompanied by a variably developed lateral tubercle on all but the earliest visible part of the spire, with well-developed inner and outer ventrolateral tubercles.

As size increases the pattern of rib division becomes more complex as does the tuberculation, such that there are more lateral than umbilical tubercles, with not all ribs bearing laterals, more inner ventrolaterals than laterals and more outer than inner ventrolaterals. In some cases ribs arise in pairs from the laterals while, on the outer whorl of the phragmocone, an additional row of lateral tubercles appears, with ribs branching at what are inner and outer lateral tubercles and looping irregularly between the outer and inner lateral and ventrolateral tubercles (Plate 11, fig. 1; Plate 12, fig. 15). Body chamber ornament is variable. In microconchs (Plate 12, figs. 1, 3, 4, 5, 11, 17, 19, 22) umbilical bullae persist to the mature aperture. They give rise to pairs of ribs, which, with long intercalatories bear inner and outer lateral tubercles that decline and disappear on the initial bend of the final hook. Short intercalatories arise on the outer flank and all ribs bear persistent inner and outer ventrolateral tubercles. These alternate on the early part of the body chamber and are not linked by ventral ribs. Ribbing generally coarsens at the expense of tubercles on the final hook and become markedly prorsiradiate and distinctly convex on the outer flank, while on the venter the outer ventrolaterals, now approximately opposite, are linked by a slightly oblique rib. Feeble siphonal tubercles may or may not be present.

In macroconchs (e. g. Plate 11, figs. 1–2; Plate 12, figs. 15–16) tubercles are coarser, the lateral tubercles and ribs declining markedly on the flank region of the early part of the body chamber. On the final hook the ribbing coarsens markedly and there is a comparable change in ventral ornament to that seen in microconchs. Some specimens develop a siphonal tubercle (Plate 2, fig. 18).

Some macroconchs show an umbilical bulge (Plate 12, fig. 15), and the larger microconchs can also be differentiated from the macroconchs by the persistent umbilical bullae, non-effacement of flank ornament at the beginning of the body chamber, concave rather than convex umbilical wall and slender body chamber.

D i s c u s s i o n COBBAN (1973) provides a lucid account of this species to which the reader is referred; our material conforms to his careful description and discussion. Of European *Trachyscaphtes* this species is only liable to confused with *T. spiniger* (SCHLÜTER, 1872) (p. 32, pl. 25, figs. 1–8). This is easily separated because it has only four rows of tubercles and never develops siphonal tubercles on the body chamber. In addition, the lateral rib pattern is distinctive. COBBAN and SCOTT (1964, p. E9) provide a valuable account of this species and its subspecies. *Trachyscaphtes praespiniger* COBBAN and SCOTT, 1964 (p. E11, pl. 4, figs. 1–13; text-fig. 5) is equally distinctive, having even fewer tubercles. *Scaphites multinodosus* HAUER, 1866 (p. 306, pl. 1, figs. 7, 8) is no more than a microconch *pulcherrimus* (Pl. 12, figs. 1–3). It is of interest to note that both macro- and microconchs from the Gschliefgraben are significantly smaller than the German material of this species, specimens of which are shown in Plate 13, figs. 2–6.

O c c u r r e n c e Upper Campanian of Germany, France, northern Spain (Lleida) the Gschliefgraben, Poland, the USSR, and New Jersey and Texas in the U.S.A.

Discussion

The extensive faunas from the Gschliefgraben occur in three distinctive preservations:

(a) As relatively undeformed specimens with traces of aragonitic shell, from black septarian limestones: *Pachydiscus* (*Pachydiscus*) *perfidus* DE GROSSOUVRE, 1894. Only three specimens are known.

(b) In brittle, dark grey, bioturbated limestone: one specimen of an indeterminate texanite.

(c) The bulk of the fauna which occurs as crushed composite moulds in light grey shales and limestones: *Phylloceras* (*Hypophylloceras*) sp., *Saghalinites* cf. *cala* (FORBES, 1846), *Tetragonites* cf. *obscurus* (SCHLÜTER, 1872), *Gaudryceras jukesii* (SHARPE, 1857), Puzosiinae indet., *Desmophyl-*

lites larteti (SEUNES, 1891), *Hauericeras fayoli* DE GROSSOUVRE, 1894, *Pachydiscus* (*Pachydiscus*) *haldemsi* (SCHLÜTER, 1867), *Pachydiscus* (*Pachydiscus*) cf. *subrobustus* SEUNES, 1891, *Anapachydiscus arrialoorensis* (STOLICZKA, 1865). *Nostoceras* (*Nostoceras*) sp., *Nostoceras* (*Bostrychoceras*) *polyplocum* (ROEMER, 1841), *Nostoceras* (*Didymoceras*) *donezianum* (MICHAILOV, 1951), *Neocrioceras* (*Schlueterella*) sp.?, *Pseudoxybeloceras* (*Parasolenoceras*) *wernickei* (WOLLE-MANN, 1902), *Pseudoxybeloceras* (*Parasolenoceras*) *interruptum* (SCHLÜTER, 1872), *Pseudoxybeloceras* (*Parasolenoceras*) cf. *phaleratus* (GRIEPENKERL, 1889), *Neoglyptoxoceras* cf. *retrorsum* (SCHLÜTER, 1872), *Polyptychoceras* (*Polyptychoceras*) *obliquecostatum* (SCHLÜTER, 1872), *Polyptychoceras* (*Polyptychoceras*) cf. *pseudogaultinum* (YOKOYAMA, 1890), *Polyptychoceras* (*Polyptychoceras*) sp., and three *Baculites* species.

(a) and (c) are entirely Upper Campanian in age, with the great majority of the species well-known from faunas referred to the traditional *Bostrychoceras polyplocum* Zone, the highest zone recognised in the north-west European Campanian. Most species are known from this level in northern Ireland, the Germanies, Poland or the USSR, only *Phylloceras* (*Hypophylloceras*), *Saghalinites cala*, *Anapachydiscus arrialoorensis* and *Polyptychoceras* (*Polyptychoceras*) cf. *pseudogaultinum* have not been previously recorded from northern European Campanian faunas. Of these, *A. arrialoorensis* is a close ally of *A. vistulensis* BLASZKIEWICZ, 1980, known from Poland and Germany.

If the Gschlifgraben assemblage is compared with the zonation of BLASZKIEWICZ, 1980, it will be seen to include elements of his *phaleratum*, *polyplocum*, *donezianum* and *pozaryskii* Zones, that is to say all of the Upper Campanian as conceived by that author. The total absence of species of *Hoplitoplacentoceras*, *Scaphites spiniger* (SCHLÜTER, 1872) and other species suggest, however, that the Gschlifgraben fauna is from a more restricted, Upper Upper Campanian level.

The solitary texanite cannot be dated precisely.

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Explanation of Plates

Plate 1

- Figs. 1, 7, 9, 10 *Gaudryceras jukesii* (SHARPE, 1857). 1 is R4; 7 is R3; 9 is R5; 10 is H1.
 Figs. 2–4, 11 *Saghalinites cf. cala* (FORBES, 1846). 2–4, S3; 11 is OÖLM 58/1975/1.
 Fig. 5 *Phylloceras (Hypophylloceras) sp.* R1.
 Fig. 6 *Desmophyllites larteti* (SEUNES, 1891). R19.
 Figs. 8, 12 *Hauericeras fayoli* DE GROSSOUVRE, 1894. 8 is GBA 1935/01/29; 12 is S7.
 All figures are natural size.

Plate 2

- Figs. 1–3, 5–6 *Desmophyllites larteti* (SEUNES, 1891). 1–3 are R25; 5–6 are NHMW 1979/2076/15.
 Figs. 4, 13–15 *Hauericeras fayoli* DE GROSSOUVRE, 1894. 4 is OÖLM 30/1984; 13–14, the holotype, an unregistered specimen in the Collections of the Sorbonne, now in the Université Pierre et Marie Curie, Paris; 15 is R28.
 Figs. 7–9 *Puzosiinae* indet. OÖLM 58/1975/2.
 Figs. 10–12 *Tetragonites cf. obscurus* (SCHLÜTER, 1872). H4.
 All figures are natural size.

Plate 3

Pachydiscus (Pachydiscus) perfidus DE GROSSOUVRE, 1894. OÖLM 58/1975/3; Reduced x 0.75.

Plate 4

- Figs. 1–5 *Pachydiscus (Pachydiscus) haldemsi* (SCHLÜTER, 1867). 1 is a microconch, H9; 2 a juvenile macroconch, H12; 3–5, R44 a macroconch.
 All figures are natural size.

Plate 5

- Fig. 1 *Pachydiscus (Pachydiscus) haldemsi* (SCHLÜTER, 1867). A complete microconch, H10.
 Fig. 2 Unidentified texanitine, OÖLM 39/1938.
 Fig. 3, 4 *Anapachydiscus arrialoorensis* (STOLICZKA, 1865) R31.
 All figures are natural size.

Plate 6

- Fig. 1 *Neoglyptoxoceras cf. retrorsum* (SCHLÜTER, 1872) M4.
 Fig. 2 *Pachydiscus (Pachydiscus) haldemsi* (SCHLÜTER, 1867). OÖLM 58/1975/4.
 Fig. 3 *Pseudoxybeloceras (Parasolenoceras) wernickei* (WOLLEMANN, 1902) S13.
 Figs. 4, 5 *Pseudoxybeloceras (Parasolenoceras) cf. phaleratus* (GRIEPENKERL, 1889) R71.
 Fig. 6 *Pachydiscus (Pachydiscus) perfidus* DE GROSSOUVRE, 1894. NHMW 1979/2077/1.
 Fig. 1 is magnified X 2; the remainder are natural size.

Plate 7

- Figs. 1–11 *Pachydiscus (Pachydiscus) haldemsi* (SCHLÜTER, 1867). 1 is R37, a juvenile; 2 is H10, a microconch; 3–4 are the lectotype, a microconch from Haldem, Westphalia (Bonn Collections); 5, 7, 8 is R46, a microconch; 6 is R36, a juvenile; 9 is R34, a microconch; 10, 11, H9, a microconch.
 All figures are natural size.

Plate 8

- Figs. 1–3 *Anapachydiscus arrialoorensis* (STOLICZKA, 1865) 1 is R30; 2 is R29; 3 is M1.
 Fig. 4 *Pachydiscus (Pachydiscus) cf. subrobustus* (SEUNES, 1891). R48.
 All figures are natural size.

Plate 9

- Figs. 1–3, 9 *Nostoceras (Nostoceras) sp.* 1 is R59; 2, 3 R58; 9 is H28.
 Figs. 4, 8, 12–14 *Nostoceras (Bostrychoceras) polyplocum* (ROEMER), 1841. 4 is R56; 8 is OÖLM 58/1975/5; 12 is OÖLM 58/1975/6; 3 is M3; 14 is M2.

- Figs. 5, 10, 11 *Pseudoxybeloceras (Parasolenoceras) interruptum* (SCHLÜTER, 1872). 5 is H25; 10, 11, R63.
 Figs. 6, 7 *Pseudoxybeloceras (Parasolenoceras) wernickei* (WOLLEMAN, 1902). H24.
 All figures are natural size.

Plate 10

- Figs. 1, 8, 9 *Pseudoxybeloceras (Parasolenoceras) wernickei* (WOLLEMAN, 1902). 1 is R62; 8 is H23; 9 is S11.
 Figs. 2, 3 *Polyptychoceras (Polyptychoceras) sp.* S10.
 Fig. 4 *Neocrioceras (Schlueterella) sp. ?* R70.
 Figs. 5, 6 *Pseudoxybeloceras (Parasolenoceras) cf. phaleratus* (GRIEPENKERL, 1889). S9.
 Fig. 7 *Gaudryceras jukesii* (SHARPE, 1857). OÖLM 31/1984.
 All figures are natural size.

Plate 11

- Figs. 1, 2 *Trachyscaphites pulcherrimus* (ROEMER, 1842). OÖLM 78/1975.
 Figs. 3, 5–8, 10 *Baculites* sp. 1. 3 is R88; 5 is NHMW 1979/2076/12; 6–8 R85; 10 is NHMW 1979/2076/13.
 Fig. 4 *Baculites* sp. 3. H30.
 Fig. 9 *Polyptychoceras (Polyptychoceras) cf. pseudogaultinum* (YOKOYAMA, 1890) R60.
 All figures are natural size.

Plate 12

- Figs. 1–7, 11–22 *Trachyscaphites pulcherrimus* (ROEMER, 1841). 1–3, GBA 1866/01/4, the original of *Scaphites multinodosus* HAUER (1866, pl. 1, fig. 7, 8), a microconch; 4 is S16, a microconch; 5, NHMW 1979/2076/55 is a microconch; 6, 7, NHMW 1979/2076/49 a, a juvenile; 11, 18 R76 a microconch; 12, 13, NHMW 1979/2076/49 a and 14, R77 are juveniles; 15, 16 is H34, a macroconch; 17 is R75 a microconch; 19–22 is H36, a microconch.
 Figs. 8–10 *Nostoceras (Didymoceras) donezianum* (MICHAILOV, 1951). H 27.
 All figures are natural size.

Plate 13

- Fig. 1 *Pachydiscus (Pachydiscus) haldemsi* (SCHLÜTER, 1867). Museum für Naturkunde Collection, East Berlin. An unregistered macroconch from Haldem, Westphalia.
 Figs. 2–6 *Trachyscaphites pulcherrimus* (ROEMER, 1842). 2–4 a microconch; 5, 6 a macroconch in the Museum für Naturkunde Collections, East Berlin, unregistered, also from Haldem.
 All figures are natural size.

Plate 14

- Fig. 1, 2 *Pachydiscus (Pachydiscus) haldemsi* (SCHLÜTER, 1867). Two macroconchs from Haldem (Westphalia); unregistered specimens from the Schlüter Collection, Bonn. Syntypes of *Pachydiscus koeneni* DE GROSSOUVRE, 1894 (= *Ammonites galicianus* SCHLÜTER, 1876, non FAVRE, 1869), fig. 2 being the lectotype. Fig. 1 is the original of SCHLÜTER 1872: pl. 19, fig. 5; fig. 2 of pl. 19, fig. 3,4.

Both figures are natural size.



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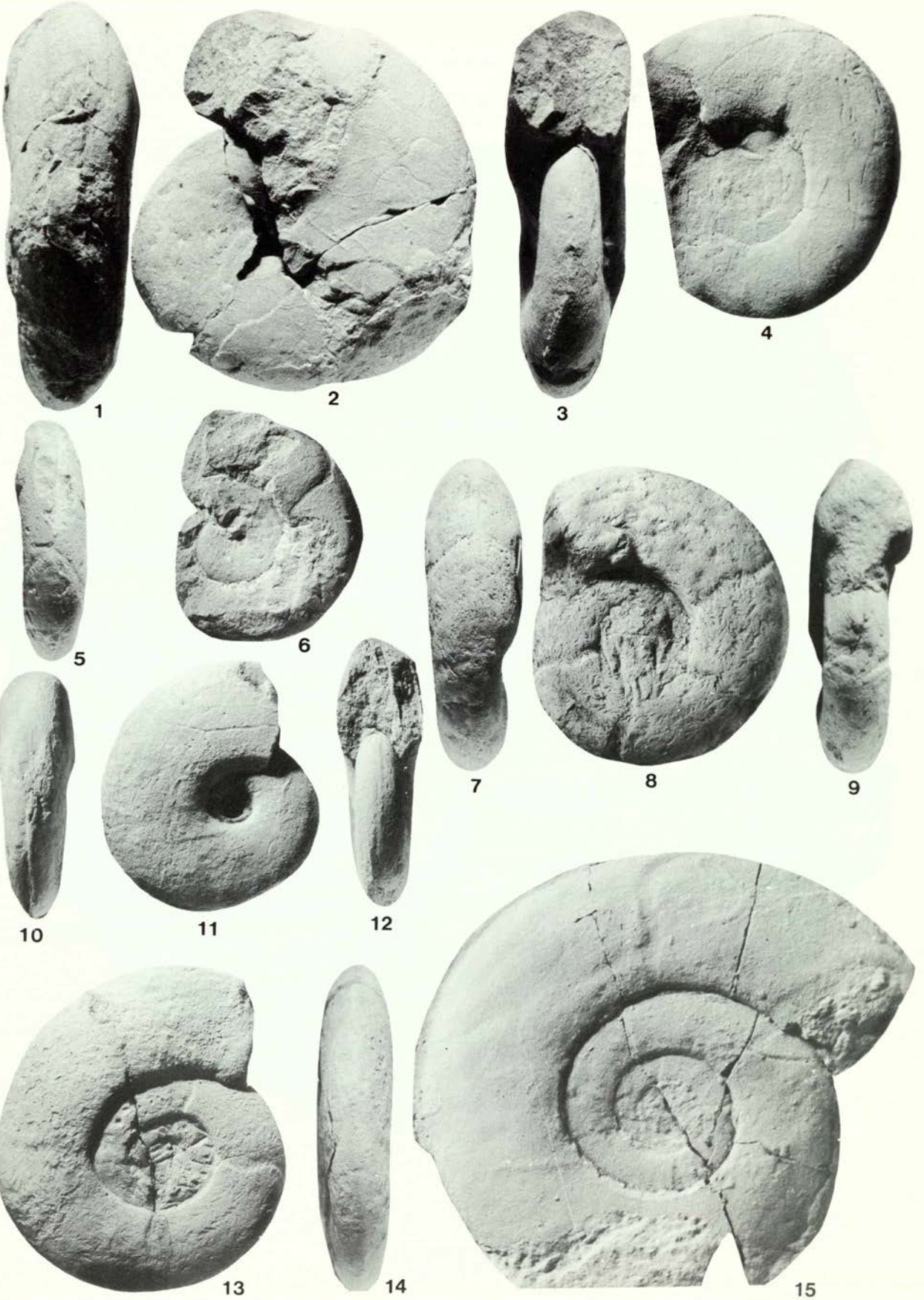
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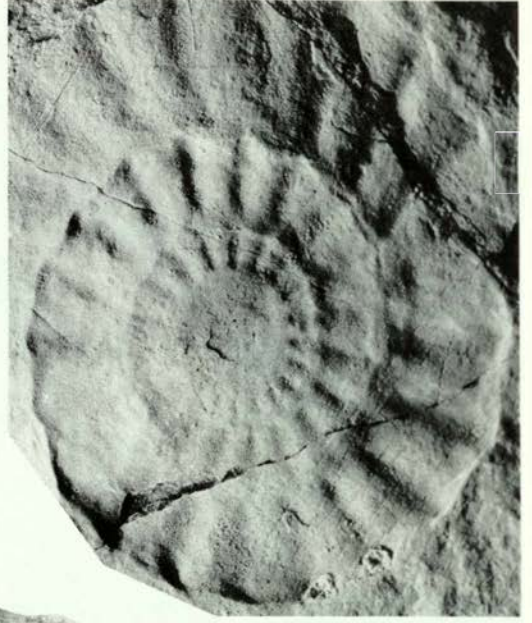
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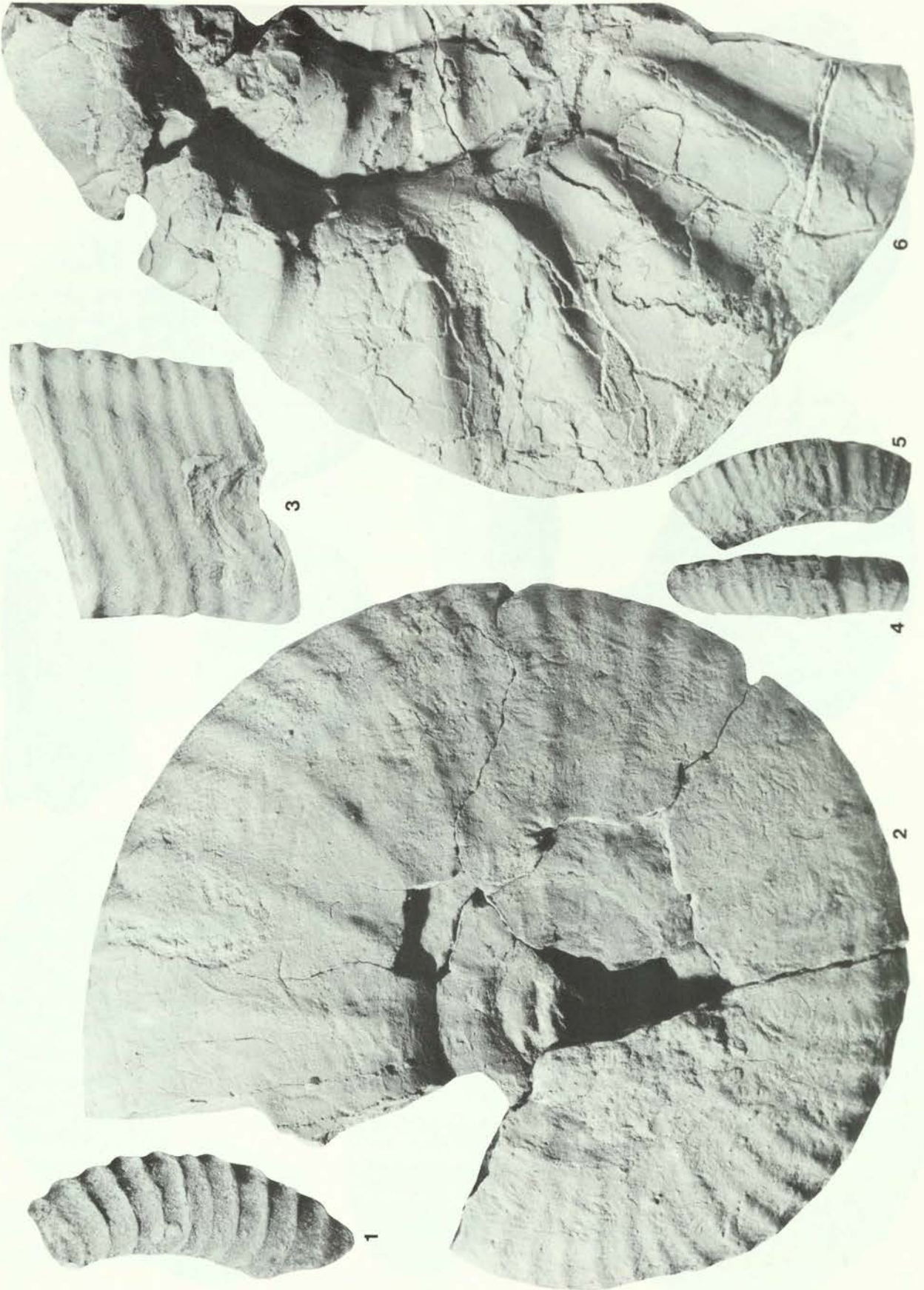
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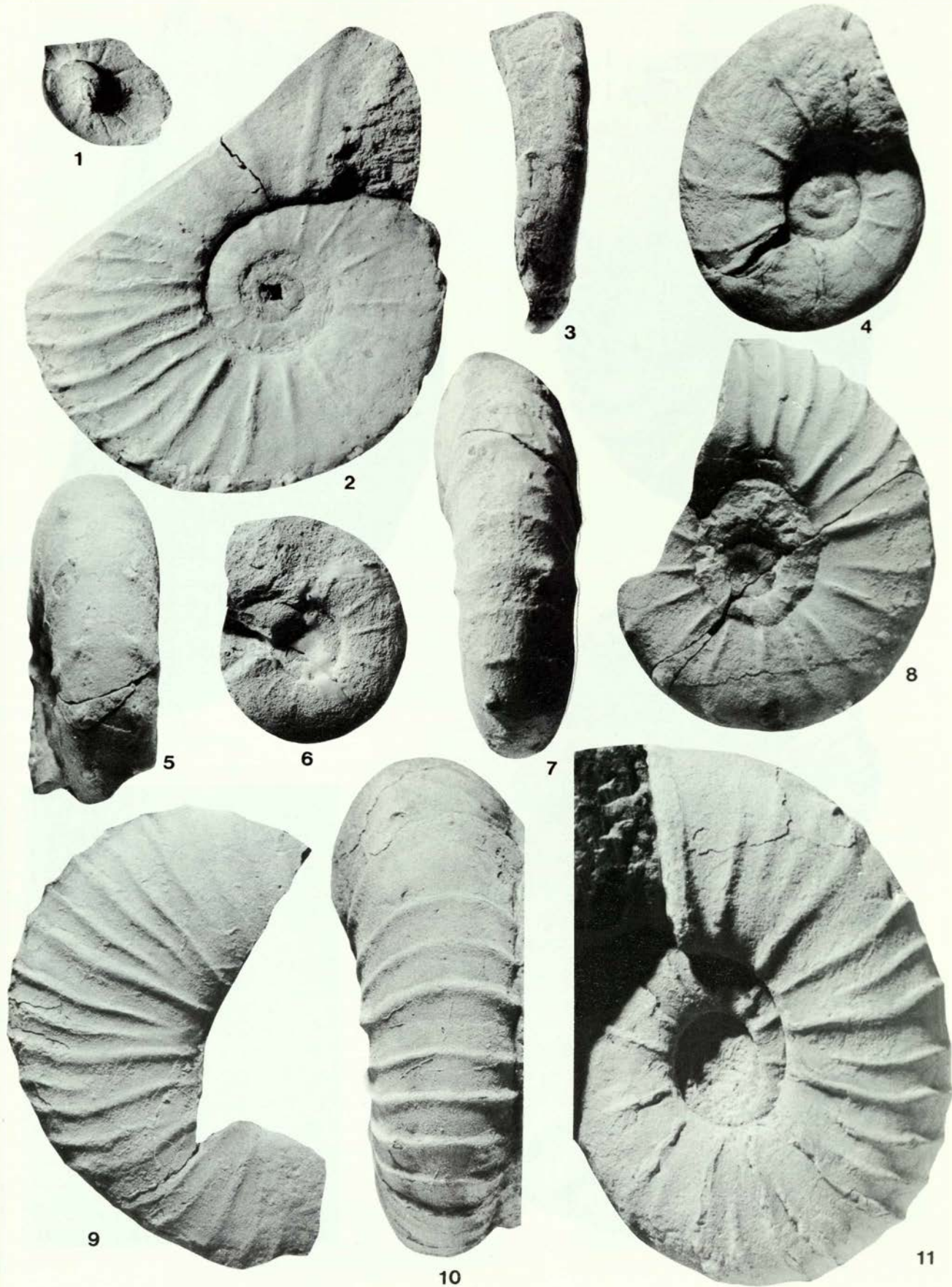


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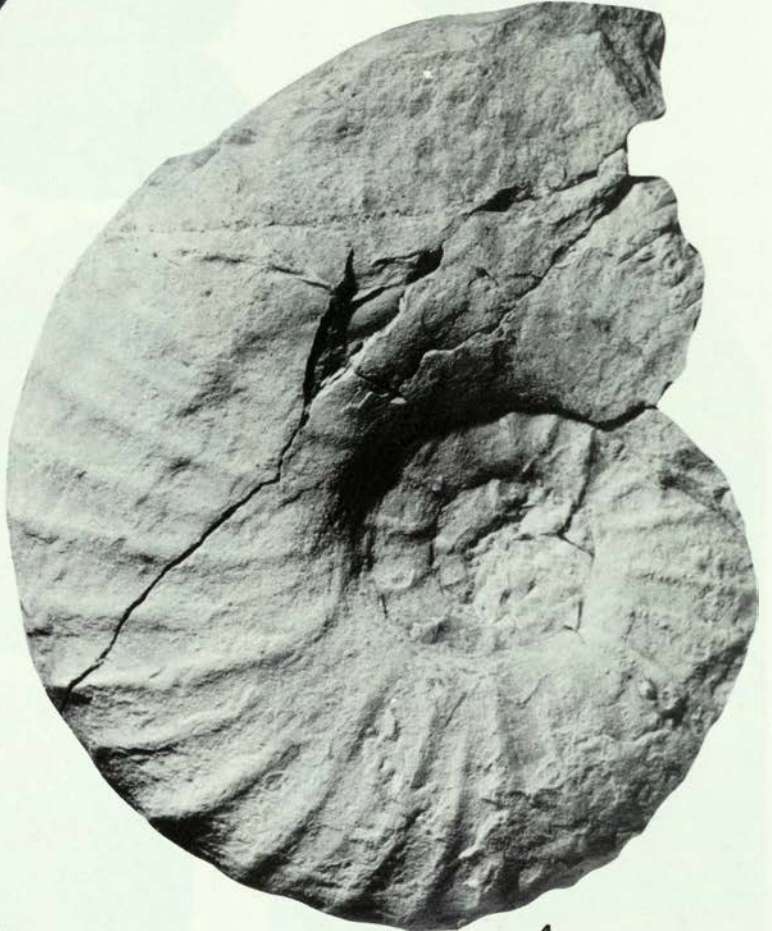
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