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A Barremian ammonoid association from the Schneeberg Syncline (Early Cretaceous, Northern Calcareous Alps, Upper Austria)

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(With 10 text-figures and 2 plates)

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Abstract

An Early Barremian ammonoid fauna from the Lower Cretaceous Schrambach Formation of the Schneeberg Syncline (Reichraming Nappe, Northern Calcareous Alps) yielded 8 genera, each represented by 1 or 2 species. The exclusively Mediterranean ammonoids are dominated by *Barremites* (54.2%) of the Ammonitina, followed by the Lytoceratina (22.9%), Phylloceratina (12.5%) and *Karsteniceras* (10.4%) from the Ancyloceratina.

Key words: Ammonoids, Lower Cretaceous, Barremian, Schneeberg Syncline, Northern Calcareous Alps

Zusammenfassung

Eine Unter-Barremium Ammonoideen Fauna aus der unterkretazischen Schrambach Formation der Schneeberg Mulde (Reichraming Decke, Nördliche Kalkalpen) erbrachte 8 Gattungen, von welchen jede durch 1 bis 2 Arten vertreten ist. Die ausschließlich mediterranen Ammonoideen werden von *Barremites* (54.2%) aus den Ammonitina dominiert, gefolgt von Lytoceratina (22.9%), den Phylloceratina (12.5%) und *Karsteniceras* (10.4%) aus den Ancyloceratina.

Schlüsselworte: Ammonoideen, Unterkreide, Barremium, Schneeberg Mulde, Nördliche Kalkalpen

1. Introduction

Lower Cretaceous pelagic sediments (Schrambach Formation) form a major element of the northernmost tectonic units of the Northern Calcareous Alps (e.g. Ternberg-, Reichraming-, Frankenfels-, and Lunz Nappes).

In the Reichraming Nappe of the Northern Calcareous Alps, Barremian cephalopod-bearing deposits are rarely recorded due to the soft nature of the sediment and therefore their bad exposure within the Schrambach Formation. Barremian sediments of the Schrambach Formation comprise marls and limestones (LUKENEDER 1997, 1998, 2001; VAŠÍČEK & FAUPL 1996). The stratigraphy of the Lower Cretaceous sediments around the investigated area is based on ammonoids.

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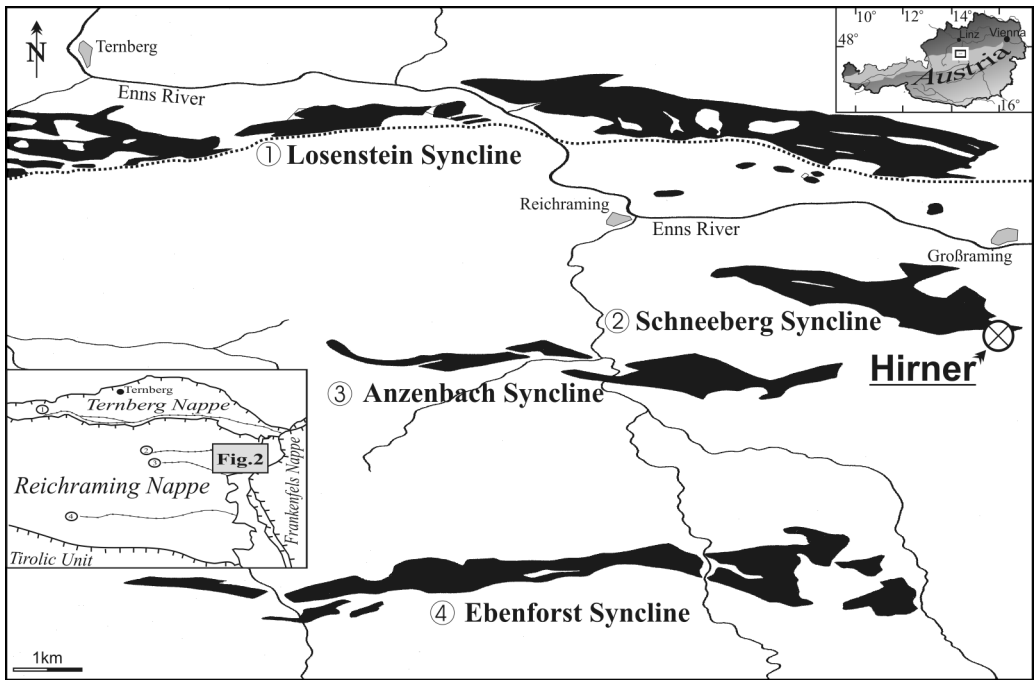


Fig. 1: Locality map of Upper Austria showing distribution of the Schrambach- and Rossfeld Formation (black) around the section investigated within the Northern Calcareous Alps. Positions of the synclines (in black) are given in the tectonic map on the left. With indicated tectonic situation at the area around the Hirner section. Diagram is adapted after LUKENEDER (2003a).

During the 1990s, a rich fauna of cephalopods was described from Lower Cretaceous sediments of the Schneeberg Syncline (VAŠÍČEK & FAUPL 1998, VAŠÍČEK & FAUPL 1999). It comprises faunas from the middle Berriasian (*Subthurmannia occitanica* Zone) up to the latest Hauterivian (*Pseudothurmannia angulicostata* Zone).

The ammonoids discussed here were collected by Herbert SUMMESBERGER in the late 1970s. The detailed study of the well-preserved Barremian ammonoid fauna from the Hirner section, which yields new and important biostratigraphic data, is the main goal of the present paper. The new documentation is a further step towards correlation of Barremian cephalopod faunas between different nappes (e.g. Ternberg- versus Frankenfels Nappe and/or Reichraming- versus Lunz Nappe) in the Northern Calcareous Alps. This will provide greater insight into the problem of regional and interregional Lower Cretaceous palaeogeography. The aim is to give a detailed report on the cephalopod fauna of limestone deposits at the Hirner section, which comprises ammonoids, aptychi and belemnites.

2. Geographic setting

The outcrop is situated in the northeastern part of the Reichraming Nappe (Upper Austria), about 3 km southwest of Großraming (446 m, ÖK 1:50,000, sheet 69 Großraming, Fig. 1).

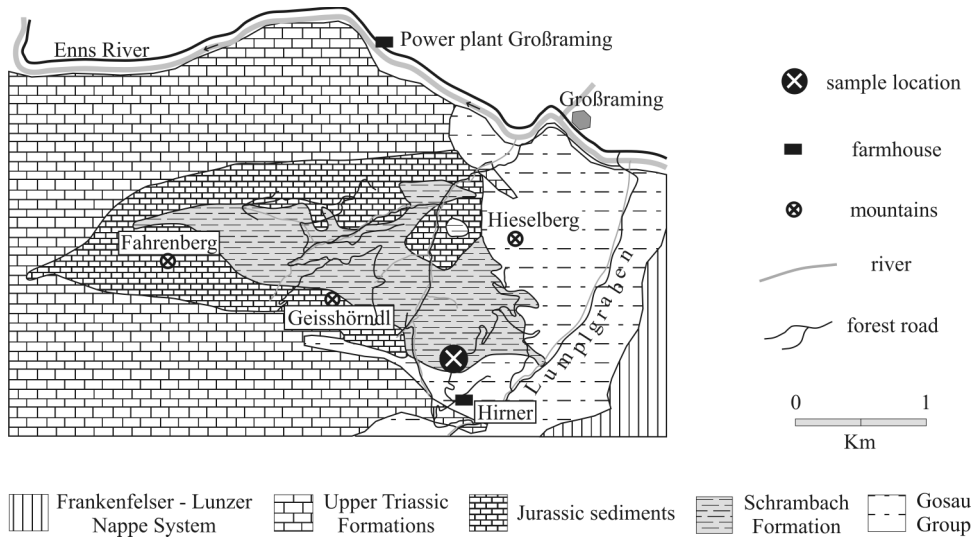


Fig. 2: Sediments of the Schneeberg Syncline with indicated position of the Hirner locality.

The outcrop (640 m) is located in the southeastern-most part of the east-west striking Schneeberg Syncline along a forest road, between the farmhouse Hirner (560 m) to the south and the farmhouse Scharnreitner (580 m) to the north, both situated at the west side of the Lumplgraben (Fig. 2).

The limestone succession on the western side at a forest road comprises the ammonoid-bearing beds (dipping $80^\circ/225^\circ$). The ammonoid occurrence is fixed by GPS data (global positioning system): N $47^\circ 51' 47''$ and E $14^\circ 31' 29''$.

3. Geological setting and lithology

The material derives from a little outcrop of marly limestones and is located at the southeastern margin of the Schneeberg Syncline (Fig. 2). The Schneeberg Syncline is one of the northernmost parts of the Reichraming Nappe (Bajuvaric Unit, Northern Calcareous Alps). It is situated between three more Lower Cretaceous synclines, directly to the north by the Losenstein Syncline of the Ternberg Nappe and to the south the Anzenbach Syncline and the Ebenforst Syncline (Fig. 1). The locality is affiliated with the Upper Cretaceous Gosau Group (20 m to the north and 250 m to the west), which in this area forms of the border of the Weyer Arc Structure.

The ammonoid occurrence in the Schrambach Formation (Lower Barremian) is composed of marls and marly limestones (about 40 m). The succession is intercalated by fossiliferous ammonoid-bearing beds. Light-coloured, grey, fine, marly limestones and limestones are associated with a relatively monotonous benthic macrofauna. The pelagic sediments reflect 'normal' sedimentation rates.

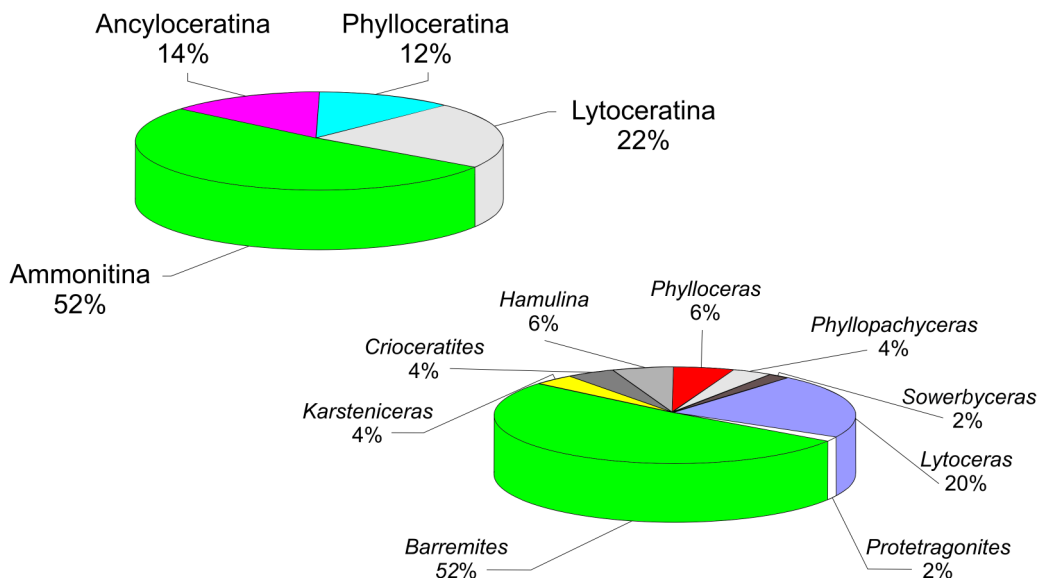


Fig. 3: Ammonoid spectrum from the Hirner locality. Note the dominance of the genus *Barremites*.

4. Material and methods

Bed-by-bed collecting and a systematic-taxonomic study provide the basic data for statistical analysis of the ammonoid fauna. About 48 specimens of ammonoids between 12 and 0.5 cm in diameter were collected. Phylloceratina (6), Lytoceratina (11), Ammonitina (26) and Ancyloceratina (5) were found (Fig. 3).

Most of the specimens are observable on one side only and show minimal fragmentation. Juvenile stages and the ventral area can be observed in just a few specimens. In a few cases suture lines are visible. The specimens are crushed by sediment compaction. Most of the cephalopods show considerable tectonic deformation. Despite the relatively small number of specimens, several important species were detected. Some steinkerns show perfectly preserved sculpture (e.g. *Hamulina*).

5. Fauna of the Barremian section

The Hirner section yielded a rich invertebrate fauna consisting of ammonoids, aptychi, belemnites, echinoderms, bivalves and serpulids. Some parts of these ammonoid-beds contain at least 4 ammonoid specimens per 80 cm² (Pl. 2, Fig. 1). The abundant and generally well-preserved cephalopods are: *Lytoceras subfimbriatum*, *Lytoceras* sp., *Prote-tragonites* aff. *crebrisulcatus*., *Phylloceras serum*, *Phylloceras* sp., *Phyllopachyceras infundibulum*, *Sowerbyceras* cf. *ernesti*, *Barremites difficilis*, *Hamulina lorioli* and *Karsteniceras* cf. *ternbergense* (Fig. 3). The diverse cephalopod fauna is accompanied by rare belemnites.

6. Systematic palaeontology

Conventions: NHMW = Naturhistorisches Museum Wien. The author follows the classification of the Cretaceous Ammonoidea by WRIGHT et al. (1996). D = maximum diameter; Wh = whorl-height, Wb = whorl-breadth; C = Wb/Wh (compression of whorl). L = maximum length in heteromorphs; pro shaft = proversum; retro shaft = retroversum; sp = space between shafts. All values are given in cm. Only measurements for photographed specimens are given below.

Order Ammonoidea ZITTEL, 1884

Suborder Phylloceratina ARKELL, 1950

Superfamily Phylloceratoidea ZITTEL, 1884

Family Phylloceratidae ZITTEL, 1884

Subfamily Phylloceratinae ZITTEL, 1884

Genus *Phylloceras* SUESS, 1865

Type species. *Ammonites heterophyllus* SOWERBY, 1820.

Whitby, Yorkshire, original designation by SUESS, 1865: 76.

Subgenus *Hypophylloceras* SALFELD, 1924

Type species. *Phylloceras onoense* STANTON, 1896.

Lower Aptian, California, original designation by SALFELD, 1924: 6.

Phylloceras (Hypophylloceras) serum (OPPEL, 1865)

(Pl. 1, Fig. 1)

1865 *Ammonites serum* OPPEL – p. 550, N 63.

1868 *Phylloceras serum* OPPEL sp. – ZITTEL: 66, pl. 7, fig. 5.

1907 *Phylloceras serum* OPPEL – PERVINQUIÈRE: 12, pl. 1, fig. 3.

1960 *Phylloceras serum* OPPEL – COLLIGNON: pl. 134, figs. 506 & 507.

1976 *Phylloceras (Hypophylloceras) thetys* (OPPEL) – AVRAM: 16, pl. 1, fig. 1.

1976 *Phylloceras (Hypophylloceras) thetys* (OPPEL) – PATRULIUS & AVRAM: 160, pl. 1, fig. 1.

1976 *Phylloceras serum* (OPPEL) – JOLY: 147, figs. 1, 2 & 5; pl. 8., fig. 8; pl. 41, figs. 10, 12 & 14; pl. 42, fig. 1.

1977 *Phylloceras (Phylloceras) thetys* (OPPEL) – KENNEDY & KLINGER: 352, pls. 1, 2 & 3, figs. 1 & 2; textfig. 1.

1987 *Phylloceras (Hypophylloceras) thetys* (D'ORBIGNY) – IMMEL: 56, pl. 1, fig. 2.

1989 *Phylloceras serum* (OPPEL) – AUTRAN: pl. 1, fig. 8.

1994 *Phylloceras serum* (OPPEL) – HOEDEMAEKER: 245, pl. 12, fig. 5 (cum syn.).

T y p e s : Lectotype is the original of ZITTEL (1868: 66, pl. 7, fig. 5a-c) designated by KENNEDY & KLINGER 1977: 352; housed in the former Hohenegger collection of the 'Bayerische Staatssammlung für Paläontologie und historische Geologie', Munich.

M a t e r i a l : 2 flattened specimens (Pl. 1, Fig.1; 2003z0045/0001).

D e s c r i p t i o n : Discocone and very involute shell; highly ovate whorl section; narrow but prominent umbilicus; sculpture made of fine, weakly falcoidal striae; internal

moulds bear closely spaced ribs attaining a uniform size starting from the mid-flank; ribs are almost radially directed to slightly prosiradiate; specimen is coated by a thin limonitic (yellow) patina.

M e a s u r e m e n t s : D = 10.7; Wh = 6.0; Wb = 1.5; U = 0.4; C = 0.25

R e m a r k s : As noted by HOEDEMAEKER (1994), *P. serum* has often been confounded with *P. thetys*. Apart from the difference in suture lines there is also a clear morphological difference: the umbilicus of *P. serum* is situated far out of the middle and close to two thirds of the diameter (HOEDEMAEKER 1994). The umbilicus of *P. thetys* lies in central position. The length of the radially directed part of the striae near the venter is longer in *P. serum* than in *P. thetys*. The whorl section of *P. serum* is more compressed than that of *H. thetys* (the latter feature is difficult to see in diagenetically compressed specimens, and the flanks are flattened (HOEDEMAEKER 1994). *P. thetys* is clearly distinguished by forming smooth, uniform S-shaped ribbing, the involute shell and the position of the umbilicus.

O c c u r r e n c e : Lower Barremian of the Schrambach Formation, at the Hirner section.

D i s t r i b u t i o n : It has been found in SE-France, Bulgaria, Romania, Czech Republic, Switzerland, Spain, Tunisia, Algeria and Austria. At the Caravaca section (Spain), HOEDEMAEKER (1994) was unable to find *P. serum* above the *Pseudothurmannia ohmi* Zone. Nevertheless, BUSNARDO & DAVID (1957) and KENNEDY & KLINGER (1977) found *P. serum* in the Barremian.

Genus *Phyllopachyceras* SPATH, 1925

Type species. *Ammonites infundibulum* d'ORBIGNY, 1841.

Barremian, SE France, original designation by SPATH, 1925: 101.

Phyllopachyceras infundibulum (d'ORBIGNY, 1841)

(Pl. 1, Fig. 2)

- 1841 *Ammonites infundibulum* – d'ORBIGNY: 131, pl. 39. figs. 4-5.
- 1882 *Phylloceras infundibulum* D'ORBIGNY – UHLIG: 379.
- 1910 *Phylloceras infundibulum* D'ORBIGNY – KILAN: 254, pl. 6. fig. 1.
- 1925 *Phyllopachyceras infundibulum* D'ORBIGNY – SPATH: 101.
- 1964 *Partschiceras infundibulum* D'ORBIGNY – WIEDMANN: 239, pl. 16, figs. 3-4.
- 1972 *Partschiceras infundibulum* D'ORBIGNY – VAŠÍČEK: 27, pl. 1, fig. 2 (cum syn.).
- 1976 *Phyllopachyceras infundibulum* d'ORBIGNY – AVRAM: 17, pl. 1., fig. 2 (cum syn.).
- 1981 *Partschiceras infundibulum* D'ORBIGNY – NAGY: 70, pl. 1, fig. 2.
- 1987 *Partschiceras infundibulum* D'ORBIGNY – IMMEL: 57, pl. 1, fig. 5.
- 1994 *Phyllopachyceras infundibulum* (D'ORBIGNY) – CECCA et al.: 560, text-fig. 5, fig. 5b.
- 1994 *Phyllopachyceras infundibulum* (D'ORBIGNY) – HOEDEMAEKER: 247, pl. 12, fig. 1.
- 1996 *Phyllopachyceras infundibulum* (D'ORBIGNY) – REBOULET: 184, pl. 36, figs. 1-5.
- 1996 *Phyllopachyceras infundibulum* (D'ORBIGNY) – FARAONI et al.: pl. 4, fig. 17.
- 1998 *Phyllopachyceras infundibulum* (D'ORBIGNY) – CECCA et al.: 65, pl. 1, figs. 1-7.
- 2001b *Phyllopachyceras infundibulum* (D'ORBIGNY) – LUKENEDER: 20, pl. 1, fig. 2.

T y p e s : Lectotype (designated by JOLY, in press) is *Ammonites infundibulum* d'ORBIGNY, 1841: 131, pl. 39. figs. 4-5; housed in the collection d'ORBIGNY in Paris; Muséum National D'Histoire Naturelle, Nr. 5365-1. (JOLY in FISCHER: "Revision Critique" de la Paléontologie française).

M a t e r i a l : 2 flattened, entire specimens and 1 negative (2003z0045/0002).

Description: Extremely evolute shells; whorls higher than wide; rounded flanks and maximum whorl breadth above umbilical edge; ventral area rounded on the phragmocone and flat on the body chamber of the adult specimens; whorl section changes with growth, from ovate in the young stage to sub-trapezoidal in the mature stage; umbilicus is deep, narrow, funnel-shaped with a smooth, steep, oblique, umbilical wall; primary ribs are prorsiradiate and weak to very weak on the umbilical wall, where they originate, then they strengthen and become rectiradiate from the umbilical edge; primaries adorally convex on the venter; one intercalatory rib between two primaries; secondaries originating at different heights to the flank.

Measurements: $D = 5.8$; $Wh = 3.4$; $Wb = 0.9$; $U = 0.3$; $C = 0.26$

Remarks: *P. infundibulum* displays a slight intraspecific variability of both whorl section and ornamentation. It can be distinguished from *P. bulgaricum* DIMITROVA, which shows characteristic whorls that are wider than high. *P. ladinum* (UHLIG) bears intercalatory ribs strengthened on the venter, whereas in *P. infundibulum* the primaries are strengthened. However, one of CECCA et al.'s (1998) specimens shows primary and intercalatory ribs alternately strengthened on the venter. Therefore *P. ladinum* and *P. infundibulum* could be conspecific as already considered by SARASIN & SCHÖNDELMAYER (1901).

Occurrence: Lower Barremian of the Schrambach Formation, at the Hirner section.

Distribution: *P. infundibulum* was reported from Hauterivian to Barremian sediments from SE-France, Spain (Mallorca), Italy, Austria, Switzerland, Czech Republic, Hungary, Croatia, Romania and Russia.

Genus *Sowerbyceras* PARONA & BONARELLI, 1895

Type species. *Ammonites tortisulcatus* d'ORBIGNY, 1841,
original designation by PARONA & BONARELLI, 1895: 119.

Subgenus *Holcophylloceras* SPATH, 1927

Type species. *Phylloceras mediterraneum* NEUMAYR, 1871.
Callovian, northeastern Alps, original designation by SPATH, 1927: 56.

Sowerbyceras (Holcophylloceras) cf. ernesti (UHLIG, 1883) (Pl. 1, Fig. 3)

- 1883 *Phylloceras Ernesti* n. sp. – UHLIG: 183, pl. 4, fig. 6.
- 1889 *Phylloceras Ernesti* UHLIG – KILIAN: 226.
- 1898 *Phylloceras Ernesti* UHLIG – SIMIONESCU: 115.
- 1960 *Salfediella ernesti* (UHLIG) – DRUSHCHITS & KUDRYAVITSEV: 255, pl. 4, fig. 4.
- 1972 *Sowerbyceras (Holcophylloceras) ernesti* (UHLIG) – VAŠIČEK: 32, pl. 1, fig. 5 (cum syn.).
- 1976 *Holcophylloceras ernesti* (UHLIG) – MANOLOV: 142, pl. 2, figs. 1-5.
- 1987 *Sowerbyceras (Holcophylloceras) ernesti* (UHLIG) – IMMEL: 60, pl. 1, fig. 11.

Type s: Holotype (designated by VAŠIČEK, 1972) is *Phylloceras Ernesti* UHLIG, 1883: 183, pl. 4, fig. 6; housed in the former collection Hohenegger of the 'Bayerische Staatssammlung für Paläontologie und historische Geologie', Munich.

Material: 1 flattened, fragmented specimen (partly negative) (2003z0045/0003).

Description: Involute shell; narrow umbilicus; sculpture is formed by closely spaced fine ribs; ribs diverge moderately from the umbilicus forwards and are conspicuously bent downwards mid-way along the whorl height; prorsiradiately, biconvex curved on outer half of the whorl and cross the outer side; ribs most conspicuous on the outer side; about six weak constrictions on last half whorl following apparently the course of the ribs.

Measurements: D = 3.7; Wh = 2.3; Wb = 0.8; U = 0.3; C = 0.35

Remarks: *S. (H.) ernesti* differs from a number of closely comparable species, such as *S. (H.) guettardi* (RASPAIL, 1831) and *S. (H.) pseudoernesti* (COLLIGNON, 1937), especially in having a greater number of constrictions. *S. (H.) guettardi* shows 6-7 constrictions on the last whorl. Note, however, that phylloceratids show variable fluctuation in numbers of constrictions.

Occurrence: Lower Barremian of the Schrambach Formation, at the Hirner section.

Distribution: *S. (H.) ernesti* is known from the Barremian of Romania, the Czech Republic, Russia, northern Caucasus, Austria, and from the Aptian of France.

Suborder Lytoceratina HYATT, 1889

Superfamily Lytoceratoidea NEUMAYR, 1875

Family Lytoceratidae NEUMAYR, 1875

Subfamily Lytoceratinae NEUMAYR, 1875

Genus *Lytoceras* SUESS, 1865

Type species. *Ammonites fimbriatus* SOWERBY, 1871.

Middle Lias, France, ICZN opinion.

***Lytoceras subfimbriatum* (d'ORBIGNY, 1841)**

(Pl. 1, Fig. 4)

- 1841 *Ammonites subfimbriatus* d'ORBIGNY – p. 121, pl. 35, figs. 1-4.
- 1858 *Ammonites subfimbriatus* D'ORBIGNY – PICTET & LORIOU: 13, pl. 11, figs. 1-4.
- 1868 *Ammonites subfimbriatus* d'ORBIGNY – pl. 12, fig. 2; pl. 37, fig. 4.
- 1883 *Lytoceras subfimbriatum* D'ORBIGNY – UHLIG: 189, pl. 5, fig. 11.
- 1898 *Lytoceras subfimbriatum* D'ORBIGNY – SIMIONESCU: 56.
- 1901 *Lytoceras subfimbriatum* D'ORBIGNY – SARASIN & SCHÖNDELMAYER: 16, pl. 2, fig. 3.
- 1919 *Lytoceras subfimbriatum* D'ORBIGNY – RODIGHIERO: 75, pl. 8, fig. 7.
- 1972 *Lytoceras subfimbriatum* (D'ORBIGNY) – VAŠÍČEK: 34, pl. 1, fig. 7.
- 1976 *Lytoceras subfimbriatum* (D'ORBIGNY) – AVRAM: 53, pl. 2, figs. 1 & 3.
- 1967 *Eulytoceras subfimbriatum* (D'ORBIGNY) – DIMITROVA: 27, pl. 10, fig. 1.
- 1987 *Lytoceras subfimbriatum* (D'ORBIGNY) – IMMEL: 61, pl. 1, fig. 1.
- 1993 *Lytoceras subfimbriatum* (D'ORBIGNY) – AUTRAN: 60, pl. 10, fig. 6.
- 1993 *Lytoceras subfimbriatum* D'ORBIGNY – AVRAM & GRADINARU: 672, pl. 3, figs. 5, 6a, b.
- 1994 *Lytoceras subfimbriatum* (D'ORBIGNY) – AVRAM: 118, pl. 3, fig. 4.
- 1994 *Lytoceras subfimbriatum* (D'ORBIGNY) – HOEDEMAEKER: 247, pl. 11, fig. 1.
- 1996 *Lytoceras* cf. *subfimbriatum* (D'ORBIGNY) – VAŠÍČEK: 105, pl. 1, fig. 5.
- 1996 *Lytoceras subfimbriatum* (D'ORBIGNY) – REBOULET: 193, pl. 37, figs. 6-7; pl. 38, figs. 5-7.
- 1998 *Lytoceras subfimbriatum* (D'ORBIGNY) – CECCA: 68, pl. 1, fig. 16.
- 2001a *Lytoceras subfimbriatum* (D'ORBIGNY) – LUKENEDER: 130, pl. 2, fig. 1 (cum syn.).
- 2001b *Lytoceras subfimbriatum* (D'ORBIGNY) – LUKENEDER: 20, pl. 2, fig. 1.

T y p e s : Holotype is *Ammonites subfimbriatus* d'ORBIGNY, 1841: 121, pl. 35, figs. 1-4; housed in the collection d'Orbigny in Paris; Muséum National D'Histoire Naturelle.

M a t e r i a l : 1 flattened, fragmented specimens without body chamber (2003z0045/0004).

D e s c r i p t i o n : Shell is strongly evolute; umbilical wall is relatively steep; umbilicus is wide and rather deep; subcircular whorls with rounded venter; sculpture on the internal mould formed by thin, relatively closely spaced, simple, fine ribs, probably slightly prorsiradiate at the umbilicus; irregularly spaced flares; ribs become conspicuously crinkled and more closely spaced with increasing diameter;

M e a s u r e m e n t s : D = 7.3; Wh = 2.7; Wb = 0.9; U = 4.5; C = 0.33

R e m a r k s : The unique dense and fine ribbing and the more or less rounded whorl section relates the specimens to *L. subfimbriatum*. *L. subfimbriatum* is distinguished from *L. densifimbriatum* by its smaller umbilicus, the compressed whorl section (rounder), and the higher density of ribbing in *L. densifimbriatum*. The different flare type distinguishes it from *L. textum* (see also IMMEL 1987 and VAŠÍČEK 1972).

O c c u r r e n c e : Lower Barremian of the Schrambach Formation, at the Hirner section.

D i s t r i b u t i o n : *L. subfimbriatum* is a common Hauterivian to Barremian species but occurs also in the Upper Valanginian. It is recorded along the Northern Tethyan margin from France, Switzerland, Italy, Austria, Romania, Bulgaria, Hungary, Croatia, Czech Republic and Italy.

Genus *Protetragonites* HYATT, 1900

Type species. *Ammonites quadrisulcatus* d'ORBIGNY, 1841.
Valanginian, France, original designation by HYATT, 1900: 569.

***Protetragonites* aff. *crebrisulcatus* (UHLIG, 1883)** (Pl. 1, Fig. 5)

1871 *Ammonites quadrisulcatus* D'ORBIGNY – TIETZE: 138, pl. 9, fig. 12.

1883 *Lytoceras crebrisulcatus* n. sp. – UHLIG: 191, pl. 5, figs. 8-10.

1920 *Lytoceras crebrisulcatus* UHLIG – GIGNOUX: 110.

1938 *Protetragonites crebrisulcatus* UHLIG – ROMAN: 42.

1972 *Protetragonites crebrisulcatus* (UHLIG) – VAŠÍČEK: 40, pl. 3, fig. 5; pl. 15, figs. 1-2 (cum syn.).

1981 *Protetragonites* aff. *crebrisulcatus* UHLIG – NAGY: 71, pl. 1, fig. 3.

1987 *Protetragonites* cf. *crebrisulcatus* (UHLIG) – IMMEL: 63, pl. 2, fig. 4.

1994 *Protetragonites crebrisulcatus* (UHLIG) – HOEDEMAEKER: 248, pl. 11, fig. 3.

T y p e s : Holotype is *Lytoceras crebrisulcatus* UHLIG, 1883, p. 191, pl. 5, figs. 8-10; housed in the collection Hohenegger of the 'Bayerische Staatssammlung für Paläontologie und historische Geologie', Munich.

M a t e r i a l : 2 flattened specimens (2003z0045/0005), one of them a juvenile.

D e s c r i p t i o n : Shell very evolute; umbilicus is shallow and wide; circular to oval whorl section; rounded lateral side; steeply inclined umbilical wall; shell without sculpture; almost smooth; straight to slightly curved constrictions are poorly visible on the internal moulds; on the last third of the whorl, 3 constrictions, initial whorl poorly preserved.

M e a s u r e m e n t s : D = 4.0; Wh = 1.4; Wb = 0.8; U = 1.9; C = 0.57

R e m a r k s : *P. crebrisulcatus* shows 7 or 8 constrictions per whorl and can therefore readily be distinguished from its ancestor *P. quadrisulcatus*, which has at least four constrictions per whorl (HOEDEMAEKER 1994). As noted by HOEDEMAEKER (1994), Upper Valanginian *P. quadrisulcatus* is in most cases smaller (max. D. = 6 cm) than comparable specimens of *L. honnoratianus* (max. D. = 20 cm). *P. quadrisulcatus* (d'ORBIGNY) is apparently replaced by *P. crebrisulcatus* (UHLIG) at the beginning of the *Pseudothurmannia cattulloi* Zone (uppermost Hauterivian; see HOEDEMAEKER 1994). For a more detailed comparison see VAŠÍČEK (1972).

O c c u r r e n c e : Lower Barremian of the Schrambach Formation, at the Hirner section.

D i s t r i b u t i o n : *P. crebrisulcatus* is known from Barremian to Lower Aptian beds in the Mediterranean region. It was found in the Czech Republic, Romania, Algeria, Bulgaria, Spain (Mallorca), Italy, Madagascar and Austria.

Suborder Ammonitina HYATT, 1889

Superfamily Desmoceratoidea ZITTEL, 1895

Family Desmoceratidae ZITTEL, 1895

Subfamily Barremitinae BRESKOVSKI, 1977

Genus *Barremites* KILIAN, 1913

Type species: *Ammonites difficilis* d'ORBIGNY, 1841.
Barremian, France, original designation KILIAN, 1913: 333.

***Barremites* cf. *difficilis* (d'ORBIGNY, 1841)**
(Pl. 2, Fig. 1)

1841 *Ammonites difficilis* d'ORBIGNY – p. 135, pl. 41, figs. 1-2.

1967 *Barremites (Barremites) difficilis difficilis* (D'ORBIGNY) – DIMITROVA: 129, pls. 60, figs. 1-2.

1976 *Barremites (Barremites) difficilis* (D'ORBIGNY) – AVRAM: 44; pl. 4, fig. 4 (cum syn.).

1987 *Barremites (Barremites) difficilis* (D'ORBIGNY) – IMMEL: 83; pl. 8, fig. 1.

2001a *Barremites (Barremites) cf. difficilis* (D'ORBIGNY) – LUKENEDER: 72, pl. 1, figs. 1-4; pl. 2, figs. 1-3.

2001b *Barremites (Barremites) cf. difficilis* (D'ORBIGNY) – LUKENEDER: 223, pl. 1, fig. 8; pl. 2., figs. 1 & 2.

T y p e s : Holotype is *Ammonites difficilis* d'ORBIGNY, 1841, p. 135, pl. 41, figs. 1-2; is housed in the collection d'ORBIGNY in Paris; Muséum National d'Histoire naturelle.

M a t e r i a l : 26 flattened and compressed, imperfectly preserved specimens (2003z0045/0006).

D e s c r i p t i o n : Shell is involute; The whorls are moderately involute with flat flanks; sharp umbilical margins; narrow umbilicus; shell is smooth: weakly S-shaped, comparatively broad constrictions, sharply defined anteriorly and passing the outer side prorsiradiately; they are visible on the internal moulds of the incomplete body chamber (only visible as coloured striae).

M e a s u r e m e n t s : D = 5.6; Wh = 3.0; Wb = 0.7; U = 0.9; C = 0.23

R e m a r k s : *B. (B.) difficilis* (d'ORBIGNY) is clearly distinguished from other species of the genus *Barremites* by showing more constrictions (5-7) on the body chamber and

no ribs. *B. strettostoma* (UHLIG) has strongly S-shaped ribs, *B. psilotatus* (UHLIG) has relatively broad and fewer constrictions (1-2) on the body chamber and more rounded flanks.

Occurrence: Lower Barremian of the Schrambach Formation, at the Hirner section.

Distribution: *B. (B.) difficilis* (d'ORBIGNY) is known from the Barremian of SE-France, Bulgaria, Romania, Czech Republic, Switzerland, S. Russia and Austria.

Suborder Ancyloceratina WIEDMANN, 1966

Superfamily Ancyloceratoidea GILL, 1871

Family Hamulinidae GILL, 1871

Genus *Hamulina* d'ORBIGNY, 1850

Type species. *Hamulina astieriana* d'ORBIGNY, 1852.

Barremian, France, subsequent designation by ROMAN, 1938: 47.

***Hamulina lorioli* UHLIG, 1883**

(Pl. 2, Fig. 2)

1883 *Hamites (Hamulina) Lorioli* n. sp. – UHLIG: 212, pl. 12, figs. 2-5.

1960 *Anahamulina lorioli* UHLIG – DRUSHCHITS: 265, pl. 10, fig. 3.

1987 *Hamulina lorioli* UHLIG – IMMEL: 125, pl. 14, fig. 3.

1994 *Hamulina lorioli* UHLIG – VAŠÍČEK: 68, pl. 20, figs. 7-8.

Type s: Holotype is *Hamites lorioli*, UHLIG, 1883: 212, pl. 12, figs. 2-5; housed in the former collection PICTET in Genf; 'Museum der Genfer Akademie'.

Material: 3 flattened specimens. One is well preserved (2003z0045/0007). One specimen is a negative.

Description: Heteromorph shells of medium size; two subparallel shafts; pro-versum shows fine, dense, oblique, single ribs; they pass from the dorsal part of the shaft prorsiradiately on to the ventral side; ribs sharp and distinct on the hook; ribs are horizontal (perpendicular to the shaft); main shaft (retroversum) with dense, fine, prorsiradiate minor ribs and distant, periodic weakly trituberculate major ribs; rib-branching on the first rib with a tubercle (on hook); following ribs with a tubercle do not branch; between tuberculated ribs, 3-4 simple ribs occur.

Remarks: Whilst SARASIN & SCHÖNDELMAYER (1901) consider *H. lorioli* as the synonym of *H. davidsoni* COQUAND in MATHERON 1879, VAŠÍČEK (1994) assumed *H. lorioli* to be an independent species (see also IMMEL 1987).

Measurements: L = 6.1; pro-shaft Wh = 0.8; retro-shaft Wh = 1.6; Wb = 0.8; sp = 0.2 at 0.5 cm from flexus

Occurrence: Lower Barremian of the Schrambach Formation, at the Hirner section.

Distribution: *H. lorioli* is known from the Lower Barremian of France (Angles), Austria (Northern Calcareous Alps), Switzerland, from the Silesian Unit of the Outer Carpathians (Poland and Czech Republic), and from Crimea.

Family Ancyloceratidae GILL, 1871

Subfamily Leptoceratoidinae THIEULOY, 1966

Genus *Karsteniceras* ROYO Y GOMEZ, 1945

Type species. *Ancyloceras Beyrichii* KARSTEN, 1858. Barremian, Colombia, original designation by ROYO Y GOMEZ, 1945: 460. KARSTEN 1858: 103, pl. 1, figs. 4a-d.

According to the more recent findings in the Lower Barremian of the Silesian Unit (VAŠÍČEK & KLAJMON 1998), the genus *Karsteniceras* includes only trochospirally-coiled shells with irregular tubercles. The planspiral shells without tubercles or with the regular marginal tubercles on each rib should be included in the genus *Leptoceratoides*.

A spatial coiling of shells of the genus *Karsteniceras* is usually hidden in clayey sediments by frequent shell deformations in the bedding plane, secondarily yielding planispiral coiling. This considerably complicates distinguishing between the two genera.

***Karsteniceras* cf. *ternbergense* LUKENEDER, 2002**

(Pl. 2, Fig. 3)

2002 *Karsteniceras ternbergense* LUKENEDER – LUKENEDER & TANABE: 18, figs. 3A-C, 5-6.

2003 *Karsteniceras ternbergense* LUKENEDER – LUKENEDER: 96, pl. 10, figs. 1-13.

T y p e s : Holotype is *Karsteniceras ternbergense* LUKENEDER, 2002 (NHMW 2001z0170/0002); from the Schrambach Formation, Northern Calcareous Alps, Upper Austria, *Moutoniceras moutonianum* Zone; housed in the collection of the Museum of Natural History Vienna.

M a t e r i a l : 2 crushed specimens with well-preserved sculpture (2003z0045/0008).

D e s c r i p t i o n : Small, criocone shells; whorls with probably weak torsions (trochospiral coiling); spire becomes criocone after an advolute embryonal and juvenile stage; sculpture comprises relatively dense, sharp and simple ribs; sharp, uniform ribs cross the venter without a ventral depression or furrow; up to 23 single ribs are present on the last half whorl; no tubercles occur; no bifurcation of ribs.

M e a s u r e m e n t s : D = 1.9; Wh = 0.4; Wb = 0.15; U = 1.25; C = 0.37

R e m a r k s : *K. ternbergense* differs from all other related species of the genus *Karsteniceras* by the clear and distinct main ribs on the body chamber of adult specimens, different maximum size and number of ribs per whorl. Main ribbing is missing at the described specimens but all other morphologies fit best with the latter species. A detailed discussion of the genus *Karsteniceras* and morphological details of its members is given in VAŠÍČEK & WIEDMANN (1994).

O c c u r r e n c e : Lower Barremian of the Schrambach Formation, at the Hirner section.

D i s t r i b u t i o n : *K. ternbergense* was described by LUKENEDER (2002, 2003a) from one level (two layers), of Early Barremian age, in the KB1-B section of the Ternberg Nappe (Upper Austria, Northern Calcareous Alps). Its stratigraphic range is assumed to be the *Moutoniceras moutonianum* Zone (LUKENEDER & TANABE 2002, LUKENEDER 2003a). Probably the same level is observable about 150 km east in the Lunz Nappe (Sparbach, Northern Calcareous Alps).

BARREMIAN	Upper	<i>P. waagenoides</i>	
		<i>C. sarasini</i>	
		<i>I. giraudi</i>	
		<i>H. feraudianus</i>	
		<i>G. sartousiana</i>	
	Lower		<i>G. provincialis</i>
			<i>G. sartousiana</i>
		<i>A. vandenheckii</i>	
		<i>C. darsi</i>	
		<i>K. compressissima</i>	
		<i>N. pulchella</i>	
		<i>K. nicklesi</i>	
		<i>T. hugii</i> auct.	

Fig. 4: Stratigraphic position within the Lower Barremian (*C. darsi* Zone) of the Hirner fauna (in grey). Table modified after HOEDEMAEKER et al. (2003).

7. Biostratigraphy

The association indicates that the cephalopod-bearing beds in the Schrambach Formation belong to the latest Early Barremian (probably to the *Moutoniceras moutonianum* ammonoid Zone; according to the results of the Vienna meeting of the Lower Cretaceous Ammonite Working Group of the IUGS; HOEDEMAEKER & RAWSON 2000). The *M moutonianum* Zone was recently replaced (according to the results of the Lyon meeting of the Lower Cretaceous Ammonite Working Group of the IUGS) by the *Coronites darsi* Zone (HOEDEMAEKER et al. 2003) (Fig. 4).

The occurring cephalopods are: *Lytoceras subfimbriatum*, *Protetragonites* aff. *crebrisulcatus*, *Phylloceras serum*, *Phyllopachyceras infundibulum*, *Sowerbyceras ernesti*, *Barremits* (*Barremites*) cf. *difficilis*, *Hamulina lorioli* and *Karsteniceras* cf. *ternbergense*. Although *Moutoniceras moutonianum* and *Coronites darsi* are missing, the typical association hints to the latest Early Barremian.

8. Results and Conclusions

The macrofauna is represented especially by ammonoids. The whole section yielded about 48 ammonoids. Due to the preservation (moulds) of the cephalopods and the lithologic character of the Schrambach Formation, collecting and preparing ammonoids is difficult. Probably one ammonoid zone defined by HOEDEMAEKER & RAWSON (2000) and HOEDEMAEKER et al. (2003) can be recognized.

The stratigraphic investigation of the ammonoid fauna revealed that the Hirner section comprises uppermost Lower Barremian sediments (probably *M. moutonianum* Zone or *C. darsi* Zone) and belongs exclusively to the Mediterranean Province.

Sorting and packing due to sedimentological or biological effects, and alignments or concentration due to transport or bottom currents, cannot be observed. The analysis of the macrofauna and the sedimentological data support the interpretation of a palaeoenvironment on the outer shelf to slope.

The presented paper is a further step toward correlating rare Barremian faunas (e.g. layers of ammonoid occurrences) in Lower Cretaceous sediments within the Northern Cal-

careous Alps. Most of the ammonoids found at the Hirner section were apparently abundant or accumulated in few beds over the whole section (e.g. *Barremites*-abundance zone). Such beds show extraordinary abundance of more or less one species (see LUKENEDER 2003a). This was investigated on bedding planes from the Hirner section (Pl. 2, Fig. 1).

The main future investigation topics concerning these ammonoid abundance zones and biohorizons within the above-described framework will be the palaeoecological, palaeobiogeographic and biostratigraphic development of Lower Cretaceous ammonoid beds within the Northern Calcareous Alps.

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Plate 1

Lower Barremian Phylloceratina and Lytoceratina from the Schneeberg Syncline. Typical representatives of the Hirner assemblage.

Fig. 1: *Phylloceras (Hypophylloceras) serum* (OPPEL 1865); Schrambach Formation, NHMW 2003z0045/0001, x1.

Fig. 2: *Phyllopachyceras infundibulum* (d'ORBIGNY 1841); Schrambach Formation, NHMW 2003z0045/0002, x1.

Fig. 3: *Sowerbyceras (Holcophylloceras) cf. ernesti* (UHLIG 1883); Schrambach Formation, NHMW 2003z0045/0003, x1.

Fig. 4: *Lytoceras subfimbriatum* (d'ORBIGNY 1841); Schrambach Formation, NHMW 2003z0045/0004, x1.

Fig. 5: *Protetragonites aff. crebrisulcatus* (UHLIG 1883); Schrambach Formation, NHMW 2003z0045/0005, x1.



Plate 2

Lower Barremian Ammonitina, Ancyloceratina, belemnites and echioderms from the Schneeberg Syncline. Typical representatives of the Hirner assemblage.

Fig. 1: *Barremites (Barremites) cf. difficilis* (d'ORBIGNY 1841); Schrambach Formation, NHMW 2003z0045/0006, x1.

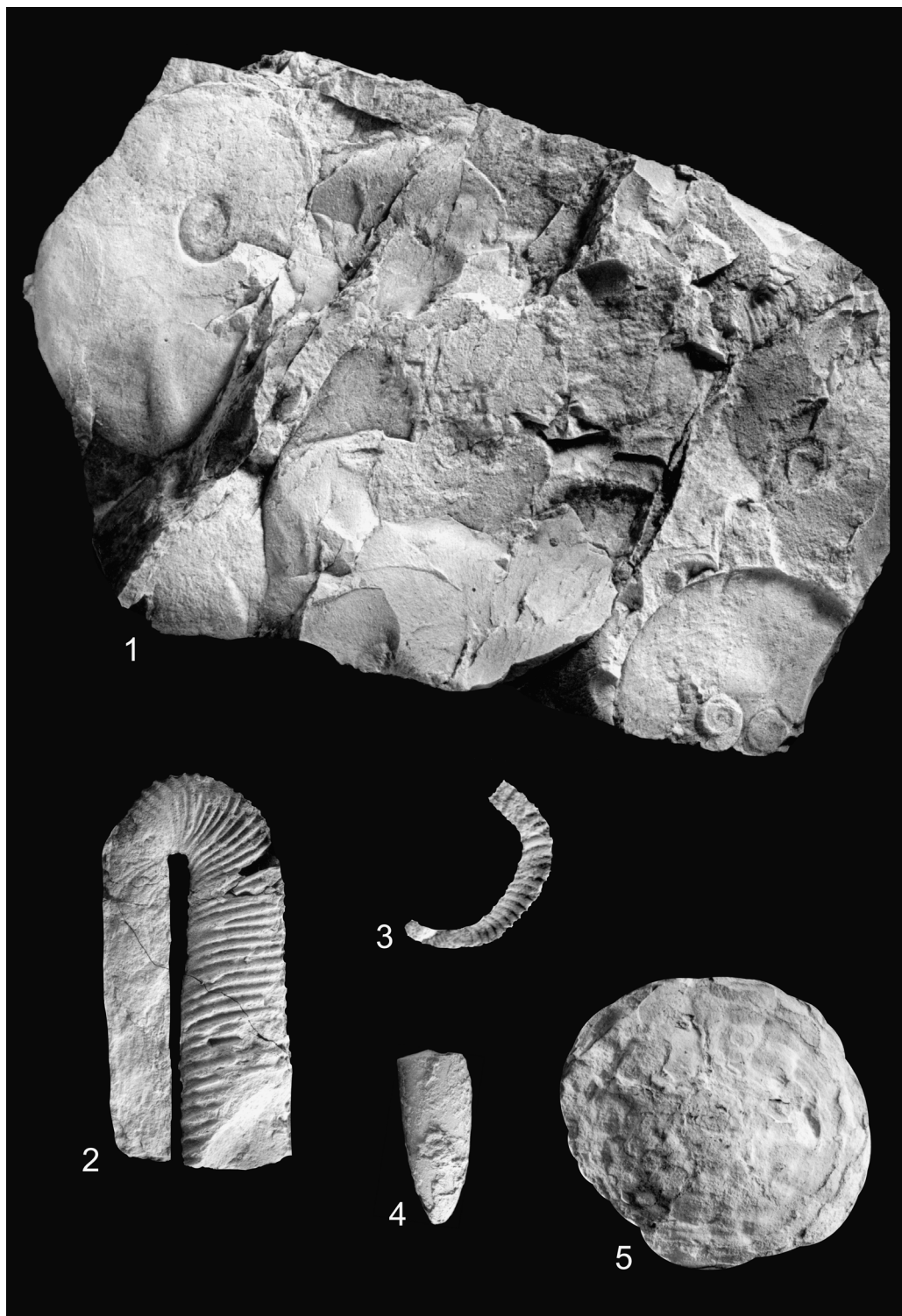
Fig. 2: *Hamulina lorioli* UHLIG, 1883; Schrambach Formation, NHMW 2003z0045/0007, x1.

Fig. 3: *Karsteniceras cf. ternbergense* LUKENEDER, 2002; Schrambach Formation, NHMW 2003z0045/0008, x1.5.

Fig. 4: Belemnite; Schrambach Formation, NHMW 2003z0045/0009, x1.

Fig. 5: Echinoid; Schrambach Formation, negative, NHMW 2003z0045/0010, x1.

All specimens in Plate 1 and 2 were coated with ammonium chloride before photographing.



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