



## Early and middle Santonian Cephalopods from the Gosau Group (Upper Cretaceous, Austria) 2. Heteromorph Ammonoidea

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6 Text-Figures, 7 Tables, 11 Plates

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### Abstract

A total number of 24 taxa of heteromorph ammonites are described from the lower and middle Santonian parts of the Gosau Group of Austria: *Eubostrioceras salisburgense* sp. nov.; *Didymoceras* (*Didymoceras*) sp.; *Hyphantoceras plicatum* (D'ORBIGNY, 1842); *Muramotoceras costatum* sp. nov.; *Scalarites cingulatus* (SCHLÜTER, 1872); *Glyptoxoceras crispatum* (MOBERG, 1885); *Glyptoxoceras retrorsum* (SCHLÜTER, 1872); *Glyptoxoceras* sp.; *Neocrioceras* (*Neocrioceras*) *maderi* (IMMEL et al., 1982); *Neocrioceras* (*Neocrioceras*) *gosaviense* sp. nov.; *Neocrioceras* (*Neocrioceras*) sp. indet.; *Schlueterella compressa* KLINGER, 1976; *Pseudoxybeloceras* (*Pseudoxybeloceras*) *quadrinodosum* (JIMBO, 1894); *Pseudoxybeloceras* (*Parasolenoceras*) *splendens* COLLIGNON, 1969; *Polyptychoceras* sp. juv.; *Polyptychoceras* sp., form 1; *Polyptychoceras* sp., form 2; *Polyptychoceras* sp., form 3; *Baculites incurvatus* DUJARDIN, 1837; *Baculites brevicosta* SCHLÜTER, 1876; *Baculites fuchsi* REDTENBACHER, 1873; *Baculites* sp.; *Scaphites leei* REESIDE, 1927, form II (COBBAN, 1969); *Scaphites* sp.

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## Cephalopoden des frühen und mittleren Santoniums der Gosau-Gruppe (Oberkreide, Österreich)

### 2. Heteromorpha Ammonoidea

#### Zusammenfassung

Es werden insgesamt 24 Taxa heteromorpher Ammoniten aus dem unteren und mittleren Santonium der österreichischen Gosau-Gruppe beschrieben: *Eubostrioceras salisburgense* sp. nov.; *Didymoceras* (*Didymoceras*) sp.; *Hyphantoceras plicatum* (P'ORBIGNY, 1842); *Muramotoceras costatum* sp. nov.; *Scalarites cingulatus* (SCHLÜTER, 1872); *Glyptoxoceras crispatum* (MOBERG, 1885); *Glyptoxoceras retrorsum* (SCHLÜTER, 1872); *Glyptoxoceras* sp.; *Neocrioceras* (*Neocrioceras*) *maderi* (IMMEL et al., 1982); *Neocrioceras* (*Neocrioceras*) *gosaviense* sp. nov.; *Neocrioceras* (*Neocrioceras*) sp. indet.; *Schlueterella compressa* KLINGER, 1976; *Pseudoxybeloceras* (*Pseudoxybeloceras*) *quadrinodosum* (JIMBO, 1894); *Pseudoxybeloceras* (*Parasolenoceras*) *splendens* COLLIGNON, 1969; *Polyptychoceras*, sp. juv.; *Polyptychoceras* sp., Form 1; *Polyptychoceras* sp., Form 2; *Polyptychoceras* sp., Form 3; *Baculites incurvatus* DUJARDIN, 1837; *Baculites brevicosta* SCHLÜTER, 1876; *Baculites fuchsi* REDTENBACHER, 1873; *Baculites* sp.; *Scaphites leei* REESIDE, 1927, form II (COBBAN, 1969); *Scaphites* sp.

#### Introduction

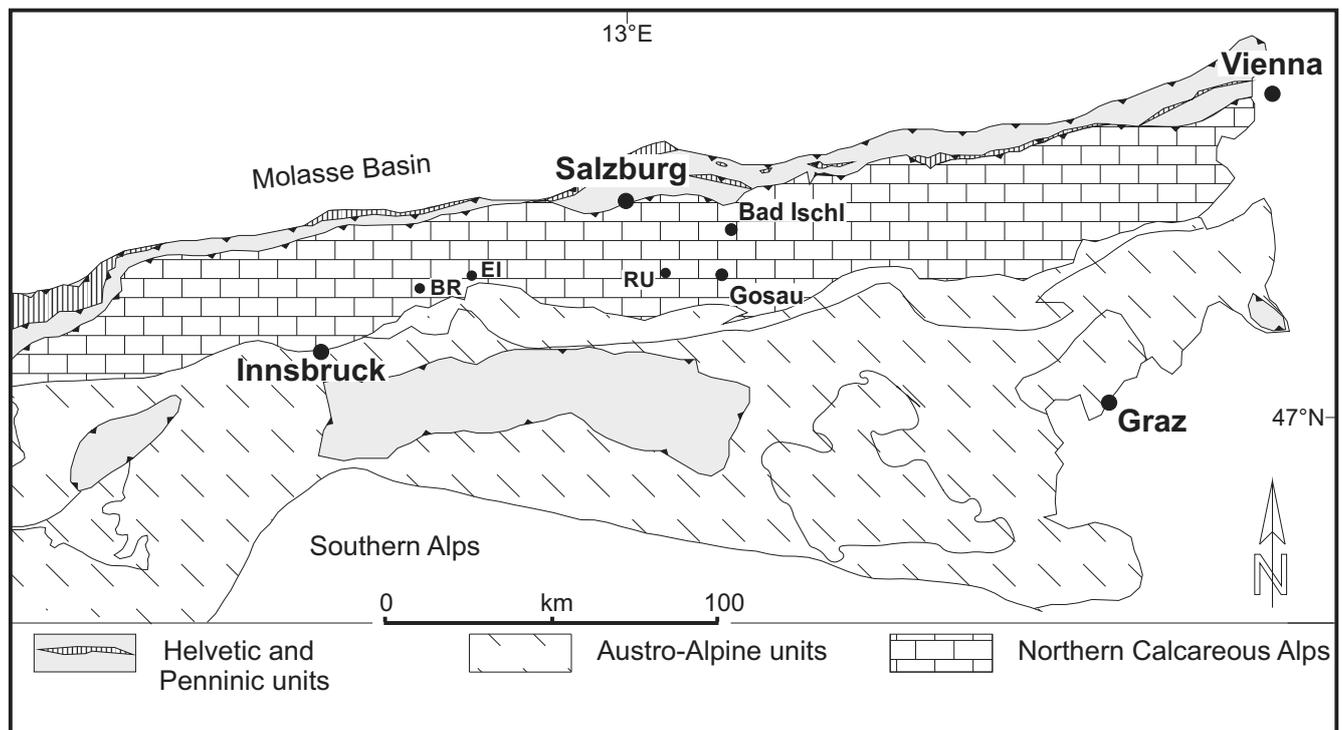
Following the account of the lower and middle Santonian nautiloids and non-heteromorph ammonites of the Gosau Group (SUMMESBERGER et al., 2017a, this volume), the heteromorphs are described below. The revision of the lower Santonian ammonite fauna of Brandenburg (Tyrol; IMMEL et al., 1982) is completed. Previous accounts of the heteromorph ammonites from the early and middle Santonian parts of the Gosau began with that of REDTENBACHER (1873), followed by KATSCHTHALER (1935), BRINKMANN (1935), GERTH (1956, 1961), IMMEL et al. (1982), IMMEL (1987) and KOLLMANN et al. (2000).

Beginning in 1971, H.A. Kollmann (NHMW) and H. Summesberger (NHMW) ran a stratigraphic program, collected numerous lower Santonian fossils, and acquired detailed knowledge of the fossil bearing sites of the Gosau Basin itself and the Gosau Group occurrences of the Northern Calcareous Alps (SUMMESBERGER et al., 2017a:

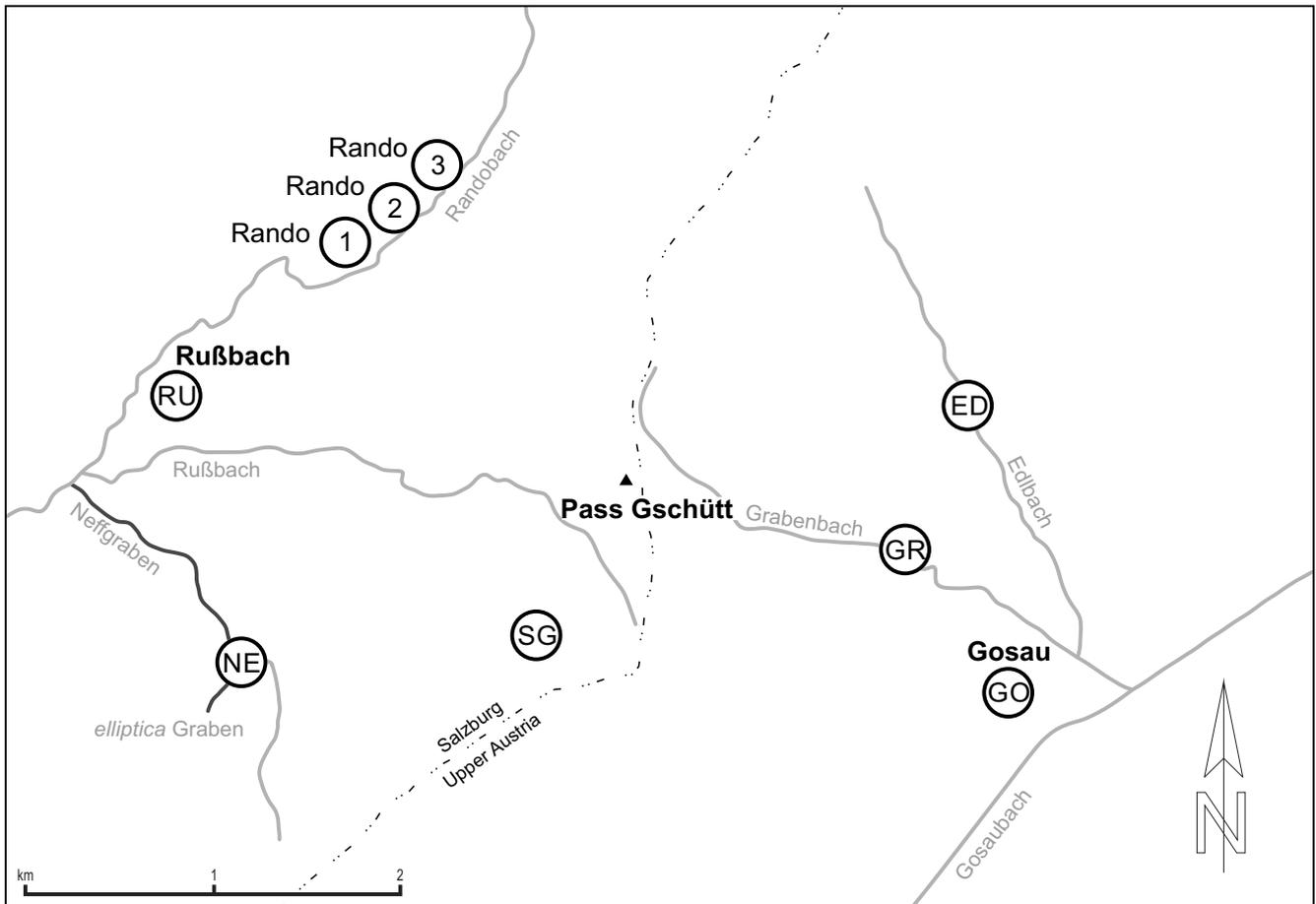
Text-Fig. 1). The most important fossil collection, including heteromorph ammonites, is that of the Skoumal family (Vienna), brought together over a period of 40 years. Additional collections were made by Wolf-Peter Maherndl (Bad Ischl, Upper Austria), Franz Klotz (Rum, Tyrol), Alfred Leiblfinger (Golling, Salzburg), Heinz Seidl (Salzburg), and Michael Wagneich and students (Vienna). Text-Figures 1 and 2 show the position of localities mentioned in the text.

#### Repositories of specimens

NHMW	Museum of Natural History Vienna, Austria.
GBA	Geologische Bundesanstalt (Geological Survey of Austria, former k. k. Geologische Reichsanstalt), Vienna, Austria.
OÖLM	Oberösterreichisches Landesmuseum, Linz, Austria.



Text-Fig. 1.  
Distribution of Gosau Group localities mentioned in the text. BR – Brandenburg, EI – Eiberg, RU – Rußbach.



Text-Fig. 2. Gosau Group localities in the Gosau area (Upper Austria and Salzburg) mentioned in the text: ED – Edlbachgraben, GO – Gosau, GR – Grabenbach, NE – Neffgraben, Rando (= Randograben) 1–3, RU – Rußbach, SG – Schattaugraben.

GPII	Geologisch Paläontologisches Institut der Universität Innsbruck, Austria.
HNS	Haus der Natur, Salzburg.
GPIB	Geologisch-paläontologisches Institut der Universität Bonn, Germany.
BSP	Bayerische Staatssammlung für Paläontologie und historische Geologie, München, Germany.
LE GO	Leibfingler collection, Golling, Salzburg.
KL	Franz Klotz collection, Rum, Tyrol, Austria.
M	Odo Mader collection, Rattenberg, Tyrol, Austria.
MA	Wolf-Peter Maherndl collection, Bad Ischl, Austria.
MM	University Museum, Tokyo, Japan.
SK	Dr. Peter Skoumal collection, Vienna, Austria.
TLMF/SM	Tiroler Landesmuseum Ferdinandeum, Innsbruck, Tyrol, Austria (former Mader collection, Rattenberg).
SEIDL/CE	Heinz Seidl collection, Salzburg.

### Early and middle Santonian heteromorph ammonites of the Gosau Group in the Northern Calcareous Alps

#### Brandenberg (Tyrol, Mühlbach)

- Hyphantoceras plicatum* (D'ORBIGNY, 1842)
- Glyptoxoceras crispatum* (MOBERG, 1885)
- Neocrioceras (Neocrioceras) maderi* IMMEL et al., 1982
- Schlueterella compressa* KLINGER, 1976
- Baculites incurvatus* DUJARDIN, 1837

#### Eiberg (Kufstein, Tyrol), early to middle Santonian

- Neocrioceras (Schlueterella) pseudoarmatum* (SCHLÜTER, 1872)
- Hyphantoceras plicatum* (D'ORBIGNY, 1842)

## **Basin of Gosau (Rußbach, Salzburg), early Santonian**

### **Randobach 3**

*Hyphantoceras plicatum* (D'ORBIGNY, 1842)

*Scaphites* sp.

## **Basin of Gosau (Rußbach, Salzburg), middle Santonian**

### **Randobach 1**

*Polyptychoceras* sp. juv.

*Pseudoxybeloceras* (*Parasolenoceras*) *splendens* COLLIGNON, 1969

### **Randobach 2**

*Ebostrychoceras* (*E.*) *salisburgense* sp. nov.

*Pseudoxybeloceras* (*P.*) *quadrinodosum* (JIMBO, 1894)

*Polyptychoceras* sp. form 2

*Pseudoxybeloceras* (*Parasolenoceras*) *splendens* COLLIGNON, 1969

*Baculites incurvatus* DUJARDIN, 1837

*Baculites fuchsi* REDTENBACHER, 1873

*Baculites brevicosta* SCHLÜTER, 1876

### **Neffgraben**

*Didymoceras* sp.

*Glyptoxoceras retrorsum* (SCHLÜTER, 1872)

*Schlueterella compressa* KLINGER, 1976

*Baculites incurvatus* DUJARDIN, 1837

*Baculites brevicosta* SCHLÜTER, 1876

*Scaphites* sp.

## **Gosau (Upper Austria), early Santonian**

### **Edlbachgraben**

*Hyphantoceras plicatum* (D'ORBIGNY, 1842)

*Scalarites cingulatus* (SCHLÜTER, 1872)

*Neocrioceras* (*N.*) sp. indet.

*Pseudoxybeloceras* (*P.*) *quadrinodosum* (JIMBO, 1894)

*Baculites incurvatus* DUJARDIN, 1837

*Baculites brevicosta* SCHLÜTER, 1876

### **Pass Gschütt (forest road Wegscheidgraben), middle Santonian**

*Glyptoxoceras retrorsum* (SCHLÜTER, 1872)

*Schlueterella compressa* KLINGER, 1976

*Polyptychoceras* sp., form 3

*Baculites incurvatus* DUJARDIN, 1837

## **Grabenbach (p.p. Tiefengraben), middle and early Santonian**

*Muramotoceras costatum* sp. nov.

*Glyptoxoceras* sp.

*Neocrioceras* (*N.*) *gosaviense* sp. nov.

*Schlueterella compressa* KLINGER, 1976

*Polyptychoceras* sp., form 1

*Pseudoxybeloceras* (*Parasolenoceras*) *splendens* COLLIGNON, 1969

*Baculites incurvatus* DUJARDIN, 1837

*Baculites fuchsi* REDTENBACHER, 1873

*Baculites brevicosta* SCHLÜTER, 1876

*Baculites* sp.

*Scaphites leei* REESIDE, 1927, form II (COBBAN, 1969)

## **Systematic Palaeontology**

### **Order Ammonoidea ZITTEL, 1884**

### **Suborder Ancyloceratina WIEDMANN, 1966**

### **Superfamily Turrilitoidea GILL, 1871**

### **Family Nostoceratidae HYATT, 1894**

### **Genus and Subgenus *Ebostrychoceras* (*Ebostrychoceras*) MATSUMOTO, 1967: 332.**

**Type species:** *Ebostrychoceras indopacificum* MATSUMOTO, 1967 (Pl. 18, Fig. 1) by original designation.

### ***Ebostrychoceras* (*Ebostrychoceras*) *salisburgense* sp. nov.**

(Pl. 1, Figs. 1–4)

**Type:** The holotype and only known specimen is SK/RA/2011/159.

**Derivatio nominis:** From Salzburg (Austrian federal state).

**Diagnosis:** Turrilicone, the whorls not in contact, with fine, regular ribs on the outer surface of the whorl and two rows of tubercles at the junction between the outer and lower whorl faces.

**Description:** The holotype is a 36.5 mm long fragment of a composite mould of a helicoid whorl with areas of whitish shell preserved. The whorl height ranges from 14 to 22 mm, the whorl width from 18 to 19 mm; the estimated diameter is about 40 mm. The dimension increases very slowly towards the adapertural end of the fragment. Coiling is sinistral. When complete, the overall shape must have been a tall and narrow whorled turrilicone with a low apical angle and a narrow umbilicus of about 8 mm in the accessible part of the fragment. There are no impressions of the previous whorl on the upper whorl face, indicating that the whorls were not in contact. The ornament consists of about 20 narrow and straight ribs per half whorl parallel to the axis of the helix, separated by narrow interspaces.

Ribs arise and end at the shoulders, some at the external row of tubercles. They never extend around the whole whorl. There are no constrictions, no flared and no looped ribs. Two rows of coarse tubercles are situated at the junction of the outer and lower whorl faces, the upper ones linked to the ribs. The initial coil and the aperture are missing. The sutures are not visible.

**Discussion:** *Eubostrychoceras salisburgense* sp. nov. differs from all other representatives of the genus in having tubercles at the junction of the outer and lower whorl faces, and ribs that do not extend around all of the whorl. *E. indopacificum* MATSUMOTO, 1967 (Pl. 18, Fig. 1; see also: KLINGER et al., 2007: 97, Figs. 10A–H) differs in having tight coiling and ribs encircling the shell, as does *E. muramotoi* MATSUMOTO, 1967 (Pl. 19, Figs. 1, 2); both also differ in having flared ribs. *E. japonicum* (YABE, 1904: Pl. 3, Fig. 8) has widely separated whorls with encircling and flared ribs (see MATSUMOTO, 1977: Pls. 48–52, Fig. 3). *E. elongatum* (WHITEAVES, 1903: Pl. 44, Fig. 2) has coarse and distant ribs. *E. densicostatum* MATSUMOTO, 1967 (Pl. 52, Fig. 2) differs in its rapidly increasing whorl section, dense and oblique ribbing, and periodic constrictions. *E. acuticostatum* (D'ORBIGNY, 1842: Pl. 147, Fig. 3) from the Santonian of France differs in its distant ribbing (KENNEDY in KENNEDY et al., 1995: 428, Pl. 28, Figs. 9, 31, 32). *E. saxonicum* (SCHLÜTER, 1875: Pl. 35, Fig. 10) from the Turonian and Coniacian of Germany and France differs in its contiguous whorls and wider apical angle (KAPLAN & SCHMID, 1988: 52). *E. matsumotoi* COBBAN, 1987 (Pl. 1, Figs. 1–26) from the Turonian and early Coniacian of the Western Interior of the United States differs in its larger apical angle and coarse ribbing with several constrictions. *E. otsukai* (YABE, 1904: Pl. 4, Fig. 1) from the Santonian and early Campanian of Japan and Madagascar differs in its coarse ribbing and occasional constrictions. The ribbing effaces around the dorsum (KLINGER & KENNEDY, 2003: 233). *E. woodsi* (KITCHIN, 1922: 49) from the English Chalk Rock differs in having the whorls in contact, a wider apical angle and constrictions. *E. protractum* COLLIGNON, 1969 from the early Campanian of Madagascar differs in having ribs that encircle the dorsum. *E. auriculatum* (COLLIGNON, 1965: Pl. 418, Fig. 1725) from the middle Coniacian of Madagascar has a larger apical angle and collar ribs on the last whorl. *E. nibelae* KLINGER & KENNEDY, 2003 from Campanian III of KwaZulu-Natal in South Africa differs in its tight coiling and large apical angle, whereas *E. zulu* KLINGER & KENNEDY, 2003 from the Coniacian part of the St. Lucia Formation of KwaZulu-Natal differs in its curved ribs, constrictions and its elongated loose helix. None of these species develop tubercles.

**Occurrence:** SK/RA/2011/159 from the Randobach 2 locality (Rußbach, Salzburg) is the only occurrence in the middle Santonian Gosau Group.

## Genus and Subgenus *Didymoceras* HYATT, 1894

**Type species:** *Ancyloceras nebrascense* MEEK & HAYDEN, 1856 (71) by original designation of HYATT (1894: 573).

### *Didymoceras (Didymoceras) sp.*

(Pl. 1, Fig. 14, Pl. 9, Fig. 1, Tab. 1)

**Material:** A single specimen, LE GO/2015/0003 from the middle Santonian of the Neffgraben (Rußbach, Salzburg).

**Description:** LE GO/2015/0003 is an internal mould of a fragment of a single coil of the median part of an individual, with extensive areas of the shell preserved, on a slab of hard calcareous sandstone together with five fragments of *Baculites incurvatus* DUJARDIN, 1837. The general shape appears to have been turrilicone, with a low apical angle and contiguous whorls. The whorl cross section is rounded. The juvenile part is missing, as is the body chamber, which may have been turned upwards (?) close to the adoral end of the fragment. The surface is covered by approximately 50 narrow ribs per whorl, separated by slightly wider interspaces. The rib index is 8. The ribs are coarser on the outer whorl face, weakening on the inner. The ribs are straight, becoming prorsiradiate towards the adapertural end of the fragment, and becoming irregular and developing pointed tubercles at the base of the outer whorl face. There are three irregularly spaced constrictions. Given the fragmentary nature of the specimen, it is left in open nomenclature.

**Discussion:** Comparison with previously described species is difficult as so many are also based on fragments. *Eodidymoceras enigma* KLINGER, KENNEDY & GRULKE, 2007 (102, Figs. 14A–K) from the upper Santonian/lower Campanian of KwaZulu-Natal and the lower Campanian of Madagascar differs from the present species in being larger, with a low helix, wide apical angle, and the whorls in contact. The helical growth stage has about 100 narrow ribs per whorl, every third to fifth one stronger and flared with two rows of pointed tubercles. *Didymoceras (Eodidymoceras) howarthi* KLINGER & KENNEDY, 2003 (295, Figs. 49, 50A, 51) possibly from the uppermost Santonian or lower Campanian part of the St. Lucia Formation of KwaZulu-Natal differs from *Didymoceras (D.) sp.* in its more loosely coiled helix with only 34 ribs per whorl. It has two rows of minute tubercles. *Didymoceras (Eodidymoceras ?) sp.* (KLINGER & KENNEDY, 2003: 300, Figs. 8E, 52A–D) from the Santonian or lower Campanian of KwaZulu-Natal has flared bituberculate major ribs separated by three to four minor ones. It also differs in the smaller diameter of the circular whorl section. *Didymoceras (Eodidymoceras) mitraikyense* (COLLIGNON, 1970: 20, Pl. 614, Fig. 2293) from the Lower Campanian of KwaZulu-Natal and the lower to middle Campanian of Madagascar differs in its extended corkscrew like he-

Inventory No.	D (mm)	Wh (mm)	Wb <sub>1</sub> (mm)	Wb <sub>2</sub> (mm)	U (mm)	U (%)
LE GO/2015/0003	62	26.4	21.8	15.2	22.4	36

Tab. 1.  
*Didymoceras (D.) sp.* (LE GO/2015/0003). Wb<sub>1</sub> and Wb<sub>2</sub> in 180° distance. U % of D.

lix (KLINGER & KENNEDY, 2003: 294, Fig. 48) and the lower number of only 30 ribs per whorl. *Didymoceras subtuberculatum* HOWARTH, 1965 (374, Pl. 7, Figs. 2–6) from the Campanian of Egitto (Angola) differs in its narrower section of the shell which is coiled in a loose helix, ornamented by numerous minor ribs and a few flared major ones often preceded by a constriction. *Didymoceras (D.) australis* KLINGER & KENNEDY, 2003 (282, Figs. 41–44, 50B–C) from Campanian III of KwaZulu-Natal differs in its regular coarse ribbing and coarse bituberculation. *Didymoceras binodosum* (KENNEDY & COBBAN, 1993: 92, Figs. 8.1, 8.2, 8.5, 8.6, 8.13–8.15, 8.22–8.24, 8.28, 8.29, 8.32, 8.33, 8.35–8.39, 9.1–9.5, 12.1) from the Campanian of the Western Interior of the United States (KENNEDY & COBBAN, 1999: 72, Figs. 3, 4) differs in its somewhat irregular ribbing with constrictions. *Didymoceras puebloense* COBBAN, KENNEDY & SCOTT, 1997 (Figs. 1–5) from the upper Campanian of the U.S. Western Interior differs in its weak ribbing with wide interspaces and some ribs bifurcating at the tubercles. The Campanian *Didymoceras cochleatum* (MEEK & HAYDEN, 1858) (see KENNEDY et al., 1999: Figs. 1–4) from the Pierre Shale of the U.S. Western Interior differs in its dense ribbing with small tubercles in two rows and occasional constrictions. The juvenile parts of *Didymoceras (D.)* sp. are not preserved but its adoral parts are very similar to those of *D. cochleatum*. The preserved volution of *Didymoceras* aff. *hornbyense* (WHITEAVES, 1895) from the Campanian of Hornby Island (Vancouver Island, Canada) is similar (JONES, 1963: Pl. 23, Fig. 1) to our specimen. *Didymoceras (D.?) africanum* KLINGER & KENNEDY, 2003 (289, Figs. 46, 47A–C.) from the upper Campanian of KwaZulu-Natal differs in its low spire and very wide umbilicus. The upper Campanian *Didymoceras donezianum* (MIKHAILOV, 1951: Pl. 3, Fig. 23), described from the Donbass region (Ukraine), from the Vistula valley (Poland; BLASZKIEWICZ, 1980) and from Arkansas in the United States (KENNEDY & COBBAN, 1993) differs at the same growth stage as that of the present specimen in having fewer, strong ribs and wide interspaces. One fragment from the upper Campanian of the Gschliefgraben (Austria) (KENNEDY & SUMMESBERGER, 1984: Pl. 12, Figs. 8–10) is too small to be compared with the present specimen. The second one from the Gschliefgraben *Didymoceras binodosum* (KENNEDY & COBBAN, 1993) differs in its regular bituberculation in the adaperatural whorl and in the zigzag tuberculation (KENNEDY & SUMMESBERGER, 1999: Pl. 2, Fig. 13) of the earlier whorl. The upper Campanian *Didymoceras aurarium* KENNEDY et al., 2000a (Pl. 1, Figs. 7–9, Text-Fig. 8) is much smaller and differs in its larger apical angle and its distant rursiradial ribbing with occasional constrictions.

The late Campanian *Didymoceras draconis* STEPHENSON, 1941 (Pl. 82, Figs. 5–9) from the U.S. Western Interior, Delaware and also from Israel differs in its low helical coil and pairs of ribs arising at the tubercles. *Didymoceras nebrascense* (MEEK & HAYDEN, 1856: 71) from the Upper Campanian of the U.S. Western Interior (KENNEDY et al., 2000b: Figs. 3, 4, 6, 7, 8C, D, 9–13, 62) differs in having a densely ribbed and tuberculate middle growth stage, whereas the body chamber is coarsely ribbed with large tubercles. *Didymoceras stevensoni* (WHITFIELD, 1877: 39) (see KENNEDY et al., 2000b: 20, Figs. 8A, B, 14–17, 19D–I, 20–26) is coarsely ribbed in its middle growth stage, with bifurcations and strong tubercles. The loosely coiled spire of *Didymoceras cheyennense* (MEEK & HAYDEN, 1856) also from the late Campanian of the U.S. Western Interior (see KENNEDY et al., 2000b: 36,

Figs. 27–31, 33–38) differs in its distant ribbing with coarse tuberculation. *Didymoceras* cf. *D. draconis* (STEPHENSON, 1941: Pl. 82, Figs. 5–9) from the late Campanian Navesink Formation of New Jersey in the United States (KENNEDY et al., 2000a: 15, Figs. 5I, J) has a wide apical angle in its middle growth stage, and about 85 narrow ribs linking in pairs at relatively coarse tubercles at the junction of outer and lower whorlfaces. *Didymoceras (Didymoceras?) africanum* KLINGER & KENNEDY, 2003 (289, Figs. 46, 47A–C) from Campanian III of KwaZulu-Natal in South Africa differs in its coarse and irregular ribbing.

**Occurrence:** LE GO/2015/0003 is the first representative of the genus *Didymoceras* described from the Austrian Gosau Group. It co-occurs with *Baculites incurvatus* DUJARDIN, 1837 in the middle Santonian Hochmoos Formation of the Neffgraben (Rußbach, Salzburg). Previously described representatives of *Didymoceras (Didymoceras)* sp. are mostly of Campanian age. The specimen from the Gosau Group appears to be the earliest representative of the genus.

### Genus *Hyphantoceras* HYATT, 1900

**Type species:** *Heteroceras roissyanum* SCHLÜTER, error for *reusianum* D'ORBIGNY, 1850 by the original designation of HYATT (1900: 587).

#### *Hyphantoceras plicatum* (D'ORBIGNY, 1842)

(Pl. 1, Figs. 6, 7)

- 1842 *Turrilites plicatus* D'ORBIGNY: 592, Pl. 143, Figs. 7, 8.
- 1876 *Turrilites plicatus* D'ORBIGNY; SCHLÜTER: 137, Pl. 36, Figs. 6, 7.
- 1955 *Turrilites plicatus* D'ORBIGNY; SORNAY (fiche 7, 3 Figs.).
- 1987 *Hyphantoceras (Hyphantoceras) orientiforme* n. sp.; IMMEL: 133, Pl. 14, Fig. 11.
- 1994 *Hyphantoceras plicatum* (D'ORBIGNY, 1842); KAPLAN & KENNEDY: 54, Pl. 37, Figs. 7, 8.
- 1995 *Hyphantoceras plicatum* (D'ORBIGNY, 1842); KENNEDY in KENNEDY et al.: 427, Pl. 28, Figs. 20–23.
- 1995 *Hyphantoceras* aff. *plicatum* (D'ORBIGNY, 1842); KENNEDY in KENNEDY et al.: 427, Pl. 27, Fig. 22.
- 2010 *Hyphantoceras plicatum* (D'ORBIGNY, 1842); REMIN: 177, Fig. 17A.

**Type:** The holotype, by monotypy, is the original of *Turrilites plicatus* D'ORBIGNY, 1842 (Pl. 143, Figs. 7, 8) refigured and redescribed by KENNEDY in KENNEDY et al. (1995: 427, Pl. 28, Figs. 21, 22).

**Material:** BSP-1986 III 31, the holotype of *Hyphantoceras (Hyphantoceras) orientiforme* IMMEL, 1987 from Brandenberg/Mühlbach (Tyrol) and an additional unregistered specimen, SK/RA/1982/67, 68; SEIDL/CE 2015/00004 (Seidl collection) and possibly a fragment NHMW 1982/0033/0001, from the Randobach 3 locality (Rußbach, Salzburg). SK/EB/2008/44, from the Edlbachgraben (Gosau, Upper Austria).

**Description:** Four whorls are preserved in SK/EB/2008/44, and eight whorls in SEIDL/CE.2015/00004. The general shape of the shell is a loose helix with regularly increasing whorl dimensions. The maximum height of the helix is 53 mm,  $Wb_{max}$  is 9.7 mm. The apical angle is 16°. There are about 26 delicate riblets that arise on the internal part of the helix, crossing the external side and returning to the internal part. Transversely elongated tubercles are arranged in three rows. In the earlier growth stage ribs are linked in pairs at tubercles, with a few nontuberculate ribs between. In SK/EB/2008/44, with a height of 44.4 mm, the juvenile part bears two rows of tubercles, the upper ones larger than the lower. 180° from the aperture the ornament changes, and there are three rows of tubercles. As size increases, ribs and tubercles become separated. The whorls are not in contact in any of the specimens.

**Discussion:** For a detailed description of the holotype see KENNEDY in KENNEDY et al., (1995: 427, Pl. 28, Figs. 21, 22). For the first time we are able to describe specimens of *Hyphantoceras plicatum* with four and eight whorls. *Hyphantoceras (Hyphantoceras) orientiforme* IMMEL, 1987 (133, Pl. 14, Fig. 11) conforms closely to the general shape and ornament of *Hyphantoceras plicatum*, and is regarded as a synonym. *Hyphantoceras (Hyphantoceras) orientale* (YABE, 1904: 19, Pl. 3, Fig. 7) differs in having a very elongated helix and a lower rate of increase in whorl dimensions.

**Occurrence:** All of the Austrian specimens (Brandenberg/Mühlbach (Tyrol), Randobach 3 (Rußbach, Salzburg), Edlbachgraben (Gosau, Upper Austria) are of early Santonian age. The holotype (see KENNEDY in KENNEDY et al., 1995: 427) is from an unknown horizon at Soulatgé (France). The species also occurs also in the Coniacian of Westphalia (Dortmund-Mengede: KAPLAN & KENNEDY, 1994: 54, Pl. 37, Figs. 7, 8) and France (Soulatgé).

### Genus *Muramotoceras* MATSUMOTO, 1977

**Type species:** *Muramotoceras yezoense* MATSUMOTO, 1977 (335, Pl. 53, Figs. 1–5, Pl. 54, Fig. 1, Text-Figs. 6, 7) by original designation.

#### *Muramotoceras costatum* sp. nov.

(Pl. 1, Figs. 5, 10)

**Type:** The holotype and only known specimen is NHMW 2017/0136/0001 (Pl. 1, Figs. 5, 10).

**Derivatio nominis:** *costatum* – ribbed.

**Diagnosis:** Nostoceratid with changing orientation of the helical coiling. An initial more or less vertical straight part is encircled by a wide coil leading to the upwards turned body chamber.

**Description:** The holotype is a large fragment of an internal mould with adherent white chalky shell. It consists of a more or less straight juvenile part, surrounded by the adult phragmocone. The embryonic part is missing, the surviving juvenile part is 19 mm long, its width (restored) is 9 mm. The diameter of the circular adult phragmocone is 85 mm, the umbilicus measures 45 mm (= 53 %). The

curved connection to the upwards-directed body chamber is missing. The remaining part of the body chamber (Pl. 1, Fig. 10) including the aperture is 70 mm long. Its section has been compressed by *post mortem* processes but must have been circular, with a (restored) diameter of about 23 mm. The initial juvenile part is closely ribbed, with about nine ribs and interspaces of equal width per 10 mm. Pairs of ribs link at four rows of tiny tubercles. This style of ribbing continues on the planispiral adult phragmocone. The paired ribs and linking tubercles are separated by three narrow, nontuberculate ribs. Looped ribs and tubercles increase in strength as size increases, reaching maximum strength on the body chamber. The aperture is flared, and marked by a slight expansion of the whorl. The sutures are not exposed.

**Discussion:** *Muramotoceras yezoense* MATSUMOTO, 1977 (335, Pl. 53, Figs. 1–5, Pl. 54, Fig. 1, Text-Figs. 6, 7) from the Turonian of Japan, has a comparable overall morphology. It differs from *Muramotoceras costatum* sp. nov. in its much simpler ribbing with coarse ribs separated by wide, smooth interspaces. *Muramotoceras laxum* MATSUMOTO, 1977 (337, Pl. 45, Figs. 1, 2, Pl. 52, Fig. 1, Text-Fig. 8) also from the Turonian of Japan, is smaller than *M. costatum* sp. nov., has similar ribbing to that of *M. yezoense*, and a long, slightly curved body chamber.

**Occurrence:** The holotype of *Muramotoceras costatum* sp. nov. is from the middle to early Santonian of the Grabenbach (Gosau, Upper Austria). The type species, *Muramotoceras yezoense* MATSUMOTO, 1977 was originally described from the Turonian of Japan and is also recorded from the Turonian of Alaska (PASCH & MAY, 1997, 2001).

### Family Diplomoceratidae SPATH, 1926

#### Subfamily Diplomoceratinae SPATH, 1926

#### Genus *Scalarites* WRIGHT & MATSUMOTO, 1954

**Type species:** *Helicoceras scalare* YABE, 1904 (9, Pl. 3, Fig. 2) by original designation.

#### *Scalarites cingulatus* (SCHLÜTER, 1872)

(Pl. 1, Figs. 8, 9)

1872 *Crioceras* (?) *cingulatum* SCHLÜTER: 101, Pl. 30, Fig. 13.

1991 *Exiteloceras cingulatum* (SCHLÜTER, 1872), RIEGRAF & SCHEER: 390.

1995 *Scalarites cingulatum* (SCHLÜTER, 1872); KENNEDY & KAPLAN: 31, Pl. 20, Figs. 1–3 [with synonymy].

2006 *Scalarites cingulatum* (SCHLÜTER, 1872); KAPLAN, KENNEDY & SCHEER: 37, Pl. 8, Figs. 9–12.

**Type:** The holotype by monotypy is the original of SCHLÜTER (1872: Pl. 30, Fig. 13, 14) from the lower Campanian Dülmen Formation, refigured by KENNEDY & KAPLAN (1995: Pl. 20, Figs. 1–3).

**Material:** SK/EB/2009/47 from the early Santonian of the Edlbachgraben (Gosau, Upper Austria).

**Description:** SK/EB/2009/47 is an internal mould of a slightly curved fragment 53.4 mm long with a whorl height of 9.9 mm and a whorl breadth of 6.9–12.4 mm. Most of the original shell has been lost. The specimen is crushed laterally; the original whorl section may have been circular or slightly oval. The rursiradiate ribbing is well preserved, effacing on the dorsum, and strengthening across the flanks. Every third or fourth rib is much strengthened, flared, and bears ventrolateral tubercles close to the median line of the venter. The ribs are rounded in cross section and as wide as the interspaces. The sutures are not exposed.

**Discussion:** The general shape of the fragment suggests an open coil, best compared to that of specimens of *Scalarites sarta* (MÜLLER & WOLLEMAN, 1906: Pl. 10, Figs. 1–3). The rounded rib section and more or less regularly spaced flared and tuberculate ribs separate the fragment the co-occurring *Schlueterella*. *Schlueterella* also differs also having a double row of ventrolateral tubercles, rather than the single ventrolateral row of *Scalarites cingulatus*. *Scalarites sarta* (MÜLLER & WOLLEMAN, 1906: 40, Pl. 9, Fig. 3, Pl. 10, Fig. 1–3) differing in having narrower, sharp ribs.

**Occurrence:** *Scalarites cingulatus* (SCHLÜTER, 1872) is recorded from the early Campanian of Germany and, for the first time, from the early Santonian of the Gosau Group.

## Genus *Glyptoxoceras* SPATH, 1925

**Type species:** *Hamites rugatus* FORBES, 1846 (117, Pl. 11, Fig. 6) by original designation of SPATH (1925: 30).

### *Glyptoxoceras crispatum* (MOBERG, 1885)

(Pl. 1, Figs. 11–13, Pl. 2, Fig. 5)

- 1885 *Anisoceras* (*Hamites*) *crispatus* MOBERG: 32, Pl. 3, Figs. 12, 13.
- 1979 ? *Diplomoceras* (Subgenus?) *tenuisulcatum* (FORBES); SUMMESBERGER: 124, Pl. 3, Fig. 21.
- 1982 *Diplomoceras* (*Glyptoxoceras*) *indicum* (FORBES, 1846); IMMEL et al.: 26, Pl. 10, Figs. 5, 6.
- 1982 *Diplomoceras* (*Glyptoxoceras*) *subcompressum* (FORBES, 1846); IMMEL et al.: 26, Pl. 10, Fig. 7.
- non 1982 *Diplomoceras* (*Glyptoxoceras*) *subcompressum* (FORBES, 1846); IMMEL et al.: 26, Pl. 9, Figs. 4, 5, Pl. 11, Fig. 4 (= ? *Neocrioceras maderi* IMMEL et al., 1982).
- 1987 *Diplomoceras* (*Glyptoxoceras*) *subcompressum* (FORBES, 1846); IMMEL: 136, partim.
- 1995 *Glyptoxoceras crispatum* (MOBERG, 1885), KENNEDY in KENNEDY et al.: 430, Pl. 27, Figs. 16, 24, Pl. 29, Figs. 1, 8, 11, 19, 20 [with synonymy].
- 1997 *Glyptoxoceras crispatum* (MOBERG, 1885); KENNEDY & CHRISTENSEN: 107, Text-Figs. 24a–b.
- 2000 *Glyptoxoceras* cf. *tenuisulcatum* (FORBES); SUMMESBERGER in EGGER et al.: 26.
- 2000 *Glyptoxoceras crispatum* (MOBERG, 1885); KENNEDY & KAPLAN: 96, Pl. 34, Fig. 2.

2010 *Glyptoxoceras crispatum* (MOBERG, 1885); WAGREICH et al.: 185,

2017b *Glyptoxoceras crispatum* (MOBERG, 1885); SUMMESBERGER et al.: 189, Pl. 12, Figs. 6–13.

**Types:** The lectotype, by the subsequent designation of KENNEDY & CHRISTENSEN (1997: 107), is the original of MOBERG (1885: Pl. 3, Fig. 12), Swedish Geological Survey, type series no. 3877; paralectotype 3876 is in the same collection. Both are from the Santonian of Eriksdal, Sweden, and were refigured by KENNEDY & CHRISTENSEN (1997: Text-Figs. 24a–b).

**Material:** M14 (BSP); TLMF /SM/531, GP11 P.8165 (BSP); SK/SG/2002/33, NHMW 2015/0530/0001, NHMW 2010/0081/0006, NHMW 1978/1963/0029, NHMW 2011/0054/0006, M 12, BSP 1963 XXX 30, SK/SG/1992/11, SK/SG/1996/18, SK/SG/2003/33, SK/SG/2006/41, SK/SG/1996/20, 22.

**Description:** The material from Brandenburg was described by IMMEL et al. (1982) as *Diplomoceras* (*Glyptoxoceras*) *indicum* (FORBES, 1846: 116, pars) and *Diplomoceras* (*Glyptoxoceras*) *subcompressum* (FORBES, 1846: 116, Pl. 11, Fig. 6). Detailed information about the shape is based upon SK/SG/2002/33 from the late Santonian of Schattau (SUMMESBERGER et al. (2017c). NHMW 2015/0530/0001 is a 49.5 mm long fragment of the straight shaft, comparable to NHMW 1978/1963/0029 (SUMMESBERGER, 1979: Pl. 3, Fig. 21). M 14 (IMMEL et al., 1982: Pl. 10, Fig. 7) is a fragment about 69 mm long with a whorl height of 16 to 18 mm whorl. TLMF/SM/531 (Pl. 1, Fig. 12) is a fragment 150 mm length. Both are characterized by very fine and dense (rib index 12) rectiradiate to slightly rursiradiate ribs. TLMF/SM/531 shows a few bifurcations. We interpret it as a part of the curved phragmocone, the near-straight shaft broken away.

**Discussion:** *Diplomoceras* (*Glyptoxoceras*) *subcompressum* (FORBES, 1846) is a Maastrichtian species and a synonym of *Glyptoxoceras rugatum* (FORBES, 1846: 116, Pl. 11, Fig. 6) (KENNEDY & HENDERSON (1992: 969). M 14, figured by IMMEL et al. (1982: Pl. 10, Fig. 7) differs from the other heteromorphs from Brandenburg in its much denser ribbing, without bifurcations. Fragments of finely ribbed specimens with rare bifurcations (IMMEL et al., 1982: Pl. 9, Figs. 4, 5, Pl. 11, Fig. 4) are thought to be fragments from juvenile *Neocrioceras maderi*. KENNEDY in KENNEDY et al., (1995: 430) united the Brandenburg specimens under *G. crispatum*. A further discussion of late Santonian *Glyptoxoceras* was given by SUMMESBERGER et al. (2017b) including the lower Santonian representatives. ?*Diplomoceras* (Subgenus?) *tenuisulcatum* (FORBES, 1846) figured by SUMMESBERGER (1979: Pl. 3, Fig. 21) is also referred to *Glyptoxoceras crispatum*.

**Occurrence:** In the Gosau Group *Glyptoxoceras crispatum* occurs in the early Santonian of Brandenburg (IMMEL et al., 1982), and in the late Santonian of the Schattau (Rußbach, Salzburg; SUMMESBERGER et al., 2017b). It is also present in the Middle Santonian *gallicus* Subzone of the Corbières (France; KENNEDY in KENNEDY et al. 1995), and was originally described from the Santonian of Sweden (MOBERG, 1885).

### ***Glyptoxoceras retrorsum* (SCHLÜTER, 1872)**

(Pl. 2, Figs. 1, 7)

- 1872 *Ancyloceras retrorsum* SCHLÜTER: 97, Pl. 30, Figs. 5–10.  
1984 *Neoglyptoxoceras* cf. *retrorsum* (SCHLÜTER, 1872); KENNEDY & SUMMESBERGER: 168, Pl. 6, Fig. 1.  
1986 *Neoglyptoxoceras* (?) *retrorsum* (SCHLÜTER, 1872; KENNEDY: 106, Pl. 16, Figs. 1–4, 6, 7, Pl. 17, Figs. 1, 2, Text-Fig. 38. [with synonymy].  
1997 *Glyptoxoceras retrorsum* (SCHLÜTER, 1872); KENNEDY & KAPLAN: 59, Pl. 5, Fig. 3.  
2005 *Glyptoxoceras retrorsum* (SCHLÜTER, 1872); KAPLAN et al.: 108, Pl. 41, Fig. 1, Pl. 43, Figs. 5, 6, Pl. 45, Figs. 1, 3, 4, Pl. 46, Figs. 1–3, Pl. 48, Fig. 2, Pl. 49, Figs. 1, 2, Pl. 51, Fig. 3.

**Type:** The lectotype, by the subsequent designation of SPATH (1925: 31, footnote), is the original of SCHLÜTER (1872: Pl. 30, Figs. 5–7), refigured by KENNEDY (1986: Text-Figs. 38A–C).

**Material:** LE GO/2015/0002, SK/NE/1989/12.

**Description:** LE GO/2015/0002 is a composite mould with large parts of the brownish shell preserved. The specimen is more or less complete, although parts of the aperture and the earliest juvenile part are restored, and coiled in an ellipse. The whorl section is flattened by *post mortem* compaction, but was probably originally rounded. The total length along the venter is 180 mm; it measures 100 mm diagonally. The apertural part, curved like a hook, is the body chamber in our interpretation. The whorl height of the adapertural part is 5.6 mm, that of the final hook is 11.4 mm. The whorl breadth cannot be established, due to preservation on a slab of matrix. It is regularly ribbed, the ribs and interspaces are narrow and of equal width. The rib index of the juvenile part is 3, that of the final hook it is 7. The ribs are straight to slightly concave, from the curvature to the aperture they are rursiradiate. Next to the aperture the rib interspaces increase in width. SK/NE/1989/12 (Pl. 2, Fig. 2) is a 110.9 mm long curved fragment with comparable ribbing, and a single constriction just before the adapertural end.

**Discussion:** LE GO/2015/0002 and SK/NE/1989/12 are best to be compared with the early Campanian examples from the Münster Basin (KAPLAN et al., 2005: 108, Pl. 41, Fig. 1, Pl. 43, Figs. 5, 6, Pl. 45, Figs. 1, 3, 4, Pl. 46, Figs. 1–3, Pl. 48, Fig. 2, Pl. 49, Figs. 1, 2, Pl. 51, Fig. 3).

**Occurrence:** LE GO/2015/0002 and SK/NE/1989/12 are from the middle Santonian of the Neffgraben (Rußbach, Salzburg). The occurrences in the Münster Basin (KENNEDY & KAPLAN, 1997; KAPLAN et al., 2005) are early Campanian. The single individual from the Gschlifgraben (Austria; KENNEDY & SUMMESBERGER, 1984: Pl. 6, Fig. 1) is of late Campanian age.

### ***Glyptoxoceras* sp.**

(Pl. 3, Fig. 3)

**Material:** A single individual SK/GR/1993/40 from the middle Santonian of Grabenbach (Gosau, Upper Austria).

**Description:** SK/GR/1993/40 is a laterally compressed fragment of a body chamber with yellowish to brownish shell partially preserved. It measures about 120 mm around the terminal curvature. The whorl height, enhanced by deformation ranges from 14 to 24 mm. Ornament consists of narrow sharp ribs with somewhat wider interspaces. Close to and in the curvature the ribbing becomes narrower and widens towards the venter. None of the ribs bifurcate. They are rursiradiate on the straight part of the fragment, becoming rectiradiate on the curved sector. There are three collar ribs at the adapical end of the specimen, marking the adult aperture of the body chamber. There are neither tubercles nor spines.

**Discussion:** *Glyptoxoceras crispatum* (MOBERG, 1885) differs by its finer ribbing. *Glyptoxoceras retrorsum* (SCHLÜTER, 1872) differs by coarser ribbing towards the adapertural end. COLLIGNON (1969) described a similarly densely ribbed *Glyptoxoceras*, *G. subcompressum coarctatum*, from the early Campanian of Madagascar (COLLIGNON, 1969: Pl. 529, Figs. 2084, 2085). As the complete shape of the shell is unknown, we leave the identification open.

**Occurrence:** *Glyptoxoceras* sp. (SK/GR/1993/40) is from the middle Santonian of Grabenbach (Gosau, Upper Austria).

### **Genus and subgenus *Neocrioceras* (*Neocrioceras*) SPATH, 1921**

**Type species:** *Neocrioceras* cf. *spinigerum* JIMBO, 1894 (184 (38), Pl. 8, Figs. 1, 1a, b) by original designation of SPATH (1921a).

**Remarks:** We interpret the subgenus *Neocrioceras* (*Neocrioceras*) SPATH 1921 as criocone without parallel or subparallel shafts. In contrast *Schlueterella* WIEDMANN, 1962 comprises straight shafts linked by curved sectors. Following KLINGER et al. (2007: 109) *Neocrioceras* (*Neocrioceras*) SPATH 1921 is a distinct genus of the Diplomoceratinae. WRIGHT (1996) assigned both genera to two different subfamilies of the Diplomoceratidae SPATH, 1926.

### ***Neocrioceras* (*Neocrioceras*) *maderi* IMMEL, KLINGER & WIEDMANN, 1982**

(Pl. 2, Figs. 4, 6, Pl. 4, Fig. 1, Tab. 2)

- 1982 *Neocrioceras* (*Neocrioceras*) *maderi* IMMEL, KLINGER & WIEDMANN: 24, Pl. 9, Fig. 2, Pl. 11, Figs. 1, 2.  
1982 *Diplomoceras* (*Glyptoxoceras*) *subcompressum* (FORBES 1846); IMMEL, KLINGER & WIEDMANN: 26, Pl. 9, Figs. 4, 5, Pl. 11, Fig. 4 (only), not Pl. 10, Fig. 7 = *Glyptoxoceras crispatum* MOBERG, 1885.  
1986 *Neocrioceras* (*Neocrioceras*) *maderi* IMMEL, KLINGER & WIEDMANN, 1982; MATSUMOTO et al.: 468.

- 1987 *Neocrioceras (Neocrioceras) maderi* IMMEL, KLINGER & WIEDMANN 1982; IMMEL: 134.
- 1991 *Neocrioceras (Schlueterella) cf. maderi* IMMEL, KLINGER & WIEDMANN, 1982; KENNEDY & CHRISTENSEN: 216, Pl. 3, Fig. 6, Pl. 6, Fig. 1, Pl. 7, Fig. 5.
- 1991 *Neocrioceras (Schlueterella) maderi* IMMEL, KLINGER & WIEDMANN, 1982; KENNEDY & COBBAN: 65.
- 1992 *Neocrioceras maderi*; KLOTZ: 237, Text-Fig. 1.

**Type:** The holotype, by original designation, is BSP 1981 I 107, the original of IMMEL et al. (1982: Pl. 11, Figs. 1a, b).

**Material:** Besides the holotype, IMMEL et al. (1982) mentioned seven specimens, all from the early Santonian of Brandenburg/Mühlbach (Tyrol). The almost complete one is from the Klotz collection (KL. 11501) at Rum (Tyrol; KLOTZ, 1992: Text-Fig. 1) also from Brandenburg/Mühlbach and refigured here (Pl. 4).

**Description:** Since the original description by IMMEL et al. (1982: 24, Pl. 9, Fig. 2, Pl. 11, Figs. 1, 2) additional material has been collected. The planispiral criocone shape of the species is demonstrated by the magnificent specimen in the Klotz collection from the early Santonian of Brandenburg (Pl. 4). It is preserved with brownish shell. The criocone spiral is slightly elongated by *post mortem* deformation into an ellipse. The body chamber is partially preserved. The last preserved portion of the body chamber can be removed. The internal whorls are crushed and somewhat restored. The whorls are separated by a distance equal to or wider than the whorl height or irregular as a result of *post mortem* deformation, the terminal part of the body chamber tending to uncoil. In all, five and a half whorls are present. The umbilicus is extremely wide (approximately 86 %). The whorl section is high oval, with feebly rounded umbilical and ventrolateral shoulders. The whorl expansion rate is low.

Ornament consists of narrow, sharp, prorsiradiate (Pl. 2, Figs. 4, 6), ribs and inner and outer ventrolateral spines. Some ribs bifurcate on the body chamber, next to the um-

Inventory No.	Diameter	D <sub>max</sub> (mm)	Wh <sub>max</sub> (mm)	Wb <sub>max</sub> (mm)	U (%)
KL 11501	D1	420	75	40	86
KL 11501	D2	250	--,--	--,--	--,--
KL 11501	D3	280	--,--	--,--	--,--
KL 11501	D4	180	--,--	--,--	--,--
KL 11501	D5	136	--,--	--,--	--,--
KL 11501	D6	95	--,--	--,--	--,--
KL 11501	D7	67	--,--	--,--	--,--
KL 11501	D8	50	--,--	--,--	--,--
KL 11501	D9	30	--,--	--,--	--,--
KL 11501	D10	15	--,--	--,--	--,--

Tab. 2.  
*Neocrioceras (Neocrioceras) maderi* IMMEL KLINGER & WIEDMANN, 1982 (KL 11501). U % of D. --,-- no measurements. D: diameter in several positions.

bilical shoulder. All ribs cross the dorsum without interruption. The ribs flex forwards from the inner ventrolateral tubercles, and cross the venter in a feeble convexity. The rib index is 27 on the adult body chamber. The style of ribbing is more or less the same on the earlier whorls. The ribs do not appear to branch. The most striking feature is the inner and outer ventrolateral spines, which first appear at a diameter of 200 mm. Those in the inner ventrolateral row are closely spaced with 13 spines within 100 mm and about 8 spines in the outer ventral row. The ribs are linked in groups of two or three at the inner ventrolateral spines, with single ribs intercalating between successive groups. On a well-preserved 100 mm sector of the body chamber (Pl. 4) alternate inner and outer ventral spines are linked by groups of ribs. The intercalated ribs cross the venter and link in groups of two or three at the outer ventral spine on the opposite flank. This alternation of rib arrangement produces the difference in the number of inner and outer ventrolateral spines noted above. The body chamber appears to make up more than half of the outer whorl. The spines appear to have been about 20 mm long with more or less rounded bases. The sutures are not exposed.

**Discussion:** *Neocrioceras maderi* was referred to *Neocrioceras* with some doubt by MATSUMOTO et al. (1986: 468). The Brandenburg specimen (KLOTZ, 1992: Text-Fig. 1, Pl. 4) leaves no doubt as to the generic assignation of the species. The new material also demonstrates clearly that there are two successive ontogenetic stages, the inner whorls without spines, the body chamber with long spines. This indicates that fragments without spines described as *Diplomoceras (Glyptoxoceras) subcompressum* by IMMEL et al. (1982: Pl. 9, Figs. 4, 5, Pl. 11, Fig. 4 only, non Pl. 10, Fig. 7) are in fact fragments of the early whorls of *Neocrioceras maderi*. Specimen M 14 of IMMEL et al. (1982: Pl. 10, Fig. 7) was also referred to *Diplomoceras (Glyptoxoceras) subcompressum*. It has much denser and regular ribbing than the specimens referred to *maderi* above, together with narrow constrictions, and is a *Glyptoxoceras*.

The type species of *Neocrioceras*, *N. spinigerum* JIMBO, 1894 (184 (38), Pl. 8, Figs. 1, 1a, b) differs in its depressed, rapidly increasing whorl section, and much tighter coiling. The umbilicus comprises about 50 % of the diameter which is relatively narrow compared to that of *N. maderi*. The tuberculation is coarser even in much smaller individuals (MATSUMOTO et al., 1986: Text-Fig. 1B, Pl. 93).

*Schlueterella compressa* (KLINGER, 1976: 74, Pl. 33, Fig. 5, Text-Figs. 8j, 10g) is distinguished by its more regular style of ribbing with ribs arranged in pairs united by two rows of tubercles on either flank, the inner row situated on the inner third of the flank, the outer one on the ventrolateral shoulder; successive tuberculate rib groups are separated are two or three nontuberculate intercalated ribs.

*Neocrioceras maximum* KENNEDY & COBBAN (1991: 65, Pl. 10, Figs. 5, 8, 12, Pl. 11, Figs. 1, 5, Pl. 12, Figs. 13–16, Text-Fig. 22c) is a close ally which differs in its relatively weak ribbing, the tuberculate ribs wider than the interspaces, with two or three nontuberculate ribs between successive tuberculate groups. There are two rows of tubercles, one in a lateral position, the other on the ventrolateral shoulder, compared to the inner and outer ventrolateral arrangement in *N. maderi*. The holotype (KENNEDY & COBBAN, 1991: Pl. 12, Figs. 13–16) has in general much coarser ornament

at comparable size. Tuberculation of the paratype (KENNEDY & COBBAN, 1991: Pl. 11, Fig. 5) is more irregular, the tubercles are smaller, and often situated upon single ribs, rather than linking groups of ribs.

*Neocrioceras kossmati* (SIMIONESCU, 1899: 257, Pl. 1, Figs. 6, 7) from the Coniacian of Romania (SZÁSZ, 1981: 100) is coiled in a very loose spire, apparently in a single plane, the umbilicus comprising 67 % of the diameter. Relatively narrow primary ribs are separated by two or three very narrow secondaries, with relatively wide interspaces (see PAULIUC, 1968: Pl. 30, Fig. 4). The primary ribs bear two rows of small tubercles, one at mid-flank, the other on the ventrolateral shoulder. The primary ribs are never linked in pairs, and bifurcations are very rare.

*Neocrioceras gosaviense* sp. nov. (see below) differs in having only a single row of tubercles on either side of the venter; the shape of the complete shell is unknown.

**Occurrence:** BSP 1981 I 107 (the holotype), GPII P.8166 and M10 (figured by IMMEL et al., 1982) are from the lower Santonian Mühlbach site at Brandenburg (Tyrol), as is the specimen figured by KLOTZ (1992: Fig. 1). *Neocrioceras maderi* co-occurs with *Cladoceramus undulatoaplicatus* and is a basal Santonian species.

#### ***Neocrioceras (Neocrioceras) gosaviense* sp. nov.**

(Pl. 3, Figs. 4, 5)

**Type:** The holotype herewith designated is MA 1973/1, the original of Plate 3, Figures 4, 5, from the Santonian of the Tiefengraben (= Grabenbach of authors), Gosau, Upper Austria.

**Derivatio nominis:** After the community of Gosau, where it was collected.

**Material:** Besides MA 1973/1, the holotype, MA 1976/17 from the Late Santonian of the Schattau (SUMMESBERGER et al., 2017b).

**Diagnosis:** Coiling is open, and in a single plane. Ornament is of regular, even ribs; there is a single row of ventrolateral tubercles on some of the ribs, with two to four nontuberculate ribs between successive tuberculate ones.

**Description:** The holotype is an internal mould, crushed to wafer thickness, retaining traces of original aragonitic shell. Total length measured along the venter is about 200 mm. The whorl height ranges from 19 to 27 mm. The original whorl section appears to have been high oval as is seen in MA 1976/17, which is less crushed than the holotype. Ornament consists of crowded, narrow, sharp, straight ribs, changing from prorsiradiate on the adapical shaft to rursiradiate around the curved sector and on the adapertural shaft. They are periodically linked to pairs by prominent ventrolateral spines and looped between the spines across the venter. The interspaces are somewhat wider than the ribs. Rib density at mid-flank is about 6 to 7 ribs per 10 mm. There are from two to four non-tuberculate ribs between the looped pairs. Ribbing strengthens markedly on the adapertural part the holotype, indicating the proximity of the adult aperture. Ribs coarsen, and interspaces widen, with three constrictions succeeded by collar ribs (Pl. 3, Figs. 4, 5). The specimen from the

Schattau (MA 1976/17) has two constrictions followed by stronger, sharp and narrow ribs. Both specimens seem to be body chamber fragments. The spines are about 4 mm long. We are not able to reconstruct the general shape of the shell, but it was probably a loosely coiled criocone.

**Discussion:** General style of ribbing and tuberculation together with the loose coiling of the body chamber leads us to place the species in *Neocrioceras*. It differs from all previously described species of both *Neocrioceras* and *Schlueteria* in having only a single row of ventrolateral tubercles. *Neocrioceras maderi* IMMEL, KLINGER & WIEDMANN, 1982, *N. compressum* (KLINGER, 1976), *N. maximum* KENNEDY & COBBAN, 1991 and the type species *N. spinigerum* (JIMBO, 1894) have two rows of ventrolateral tubercles; this is also the case in *Neocrioceras kossmati* (SIMIONESCU, 1899) which in all other characteristics is very similar.

**Occurrence:** *Neocrioceras gosaviense* sp. nov. occurs at Gosau (Upper Austria), in the middle to lower Santonian Grabenbach Formation of the Tiefengraben (= Grabenbach of authors) to the upper Santonian part of the Hochmoos Formation.

#### ***Neocrioceras (Neocrioceras) sp. indet.***

(Pl. 3, Figs. 1, 2)

1894 *Crioceras spinigerum* JIMBO: 184, Pl. 24, Figs. 1, 1a, 1b, 1c.

1985 *Neocrioceras spinigerum* (Jimbo, 1894); MATSUMOTO: 56, Text-Figs. 1, 2.

1986 *Neocrioceras spinigerum* (JIMBO); MATSUMOTO et al.: 463–474, Pl. 93–94, with synonymy.

**Material:** SK/EB/2002/27a, b, c; three fragments of a single individual.

**Description:** SK/EB/2002/27a is half a whorl of an internal mould with adherent white, chalky shell, possibly part of the body chamber, and some fragments of the inner whorls. Details of morphology are best shown by SK/EB/2002/27b, an external mould with an estimated diameter of about 80 mm, and a maximum whorl height of about 30 mm. The umbilicus measures about 30 mm, about 37 % of the diameter. Ornament of the last whorl consists of about 100 slightly prorsiradiate narrow and sharp ribs separated by equal interspaces. Only a few bifurcate. There is a single row of very strong tubercles, linked to two or three ribs. These are separated by two or three non-tuberculate ribs. Groups of ribs link the tubercles over the venter.

**Discussion:** The poor preservation hinders specific identification of this interesting specimen; nevertheless, assignment to *Neocrioceras* seems to be justified. *Neocrioceras spinigerum* (JIMBO, 1894) differs in having coarser ribbing, and two rows of ventrolateral tubercles.

**Occurrence:** Early Santonian of Edlbachgraben (Gosau, Upper Austria).

**Genus *Schlueterella* WIEDMANN, 1962**

**Type species:** *Ancyloceras pseudoarmatum* SCHLÜTER, 1872 (99, Pl. 31, Figs. 1–3) by original designation by WIEDMANN (1962: 205). MATSUMOTO & MIYAUCHI (1984: 60) treated *Schlueterella* as a genus separate from *Neocrioceras* (see also the discussion of KLINGER & KENNEDY, 2003: 312).

***Schlueterella compressa* KLINGER, 1976**

(Pl. 2, Figs. 2, 3, Pl. 5, Figs. 1, 3, 5, Pl. 6, Figs. 1–10, Tab. 3)

- 1921b *Neocrioceras* cf. *spinigerum*, JIMBO sp.; SPATH: 52, Pl. 7, Figs. 6a–c.
- 1961 *Bostrychoceras* sp.; GERTH: 123, Pl. 24, Figs. 8, 9.
- 1976 *Neocrioceras* (*Schlueterella*) *compressus* KLINGER: 74, Pl. 33, Fig. 5, Text-Figs. 8j, 10g.
- 1982 *Neocrioceras* (*Schlueterella*) *compressum* KLINGER 1976; IMMEL, KLINGER & WIEDMANN: 25, Pl. 9, Fig. 3, Pl. 10, Figs. 1–4, Pl. 11, Fig. 3.
- 1986 *Neocrioceras* (*Schlueterella*) *compressum* KLINGER (1976); MATSUMOTO in MATSUMOTO et al.: 468.
- 1987 *Neocrioceras* (*Schlueterella*) *compressum* KLINGER 1976; IMMEL: 134.
- 1991 *Neocrioceras* (*Schlueterella*) *compressum* KLINGER 1976; KENNEDY & COBBAN: 65, Pl. 10, Figs. 1, 2, Pl. 12, Figs. 4–7, Text-Fig. 25c.
- ? 1995 *Neocrioceras* (*Neocrioceras*) sp. juv. ? KENNEDY in KENNEDY et al.: 430, Pl. 28, Fig. 33.
- 1995 *Neocrioceras* (*Schlueterella*) *compressum* KLINGER 1976; KENNEDY in KENNEDY et al.: 430, Pl. 27, Figs. 13–15, 17, Pl. 29, Figs. 4–7.
- 2003 *Neocrioceras* (*Schlueterella*) *compressum* KLINGER, 1976; KLINGER & KENNEDY: 315, Text-Figs. 59, 60A–C, 61.
- 2005 *Neocrioceras* (*Schlueterella*) *compressum* KLINGER, 1976; KAPLAN et al.: 114, Pl. 52, Fig. 4.
- 2007 *Schlueterella compressum* KLINGER, 1976; KLINGER et al.: 109, Text-Figs. 9C, 18C–D.

**Type:** The holotype, by original designation, is the original of *Neocrioceras* (*Schlueterella*) *compressus* KLINGER (1976: 74, Pl. 33, Fig. 5, Text-Figs. 8j, 10g).

**Material:** The originals of IMMEL et al. (1982: M 2, Pl. 9, Fig. 3, M 60, Pl. 10, Figs. 1a, b, BSP 1959 VI 49, Pl. 10, Fig. 2, GP II P. 8167, Pl. 10, Fig. 3, GP II P. 8168, Pl. 11, Fig. 3, M 1, Pl. 10, Fig. 4), all from the early Santonian of Brandenberg/Mühlbach (Tyrol, Austria). SK/GR/1981/2, SK/GR/1981/9, SK/GR/1993/41, SK/GR/2015/51 are from the Santonian Gosau Group of Grabenbach; NHMW 2015/0402/0001 from the middle Santonian of Neffgraben, LE GO/2015/0001 from the Santonian of the Pass Gschütt area; one unregistered specimen from the parking place of the cable car (Schwaighofer collection, Rußbach, Salzburg); GPIB 31 255 and GPIB 31 339 described by GERTH (1961: Pl. 24, Figs. 8, 9) under *Bostrychoceras* sp. from the Santonian of the Gosau Group of Neffgraben (Rußbach, Salzburg) and Grabenbach (Gosau, Upper Austria).

**Description:** SK/GR/1981/2 (Pl. 6, Fig. 6) is an internal mould with partially preserved light brownish shell. It consists of a loosely coiled helix with a wide apical angle and a separate curved fragment. Due to compaction along the axis of coiling the apical angle cannot be determined. The smallest measurable diameter of the helix is 6 mm, the next measurable ones are 24 and 47.8 mm. At this size the umbilicus is 39.7 mm across (U = 83 %). The slightly curved fragment close by and apparently broken off during or after the fossilisation process might be the body chamber. It measures 78.8 mm in length and 18 mm in width. The whorl section appears to have been rounded. Ornament consists of straight fine ribs with narrow interspaces of more or less the same width around the whole shell; the rib index is about eight. On the helix, pairs of ribs are joined and loop between lateral and ventrolateral spines, with three nontuberculate ribs between successive tuberculate ones. Only two spines, 7.6 mm long, are preserved on the body chamber. Well preserved spines are present on SK/GR/1981/9 from the Grabenbach area (Pl. 6, Fig. 3) with completely preserved spines on LE GO/2015/0001 (Pl. 5, Fig. 1).

M 60 (IMMEL et al., 1982: Pl. 10, Fig. 1), refigured here (Pl. 5, Fig. 5), is a large fragment of a loosely coiled, elliptically deformed spire. Deformation vertical to the spire cannot be excluded. The whorl section is expanding slowly, and is high oval to almost circular. Wh<sub>max</sub> is 26.8 mm at the apertural end, Wb<sub>max</sub> is 25 mm, and D<sub>max</sub> is about 150 mm. Successive whorls are rather closely spaced, but this may be due, to a certain degree, to *post mortem* deformation. U % has an estimated value of 54–55 %. Due to deformation it is uncertain if the early whorls might have been helically coiled. The ornament of this specimen is characterised by regularly looped pairs of straight and closely spaced ribs in the adult stage with strong tubercles connecting the ribs on either side of the shell in two rows, the one ventrolateral, the other below mid-flank. In the adult stage the ribs and tubercles are arranged in zigzag pattern (Pl. 5, Fig. 3), as described by IMMEL et al. (1982: Pl. 10, Figs. 2, 3a). Ribs and interspaces increase in size towards the adult aperture. One or two intercalated ribs efface near the ventrolateral tubercles on one flank, and reappear on the other flank. Juvenile tuberculation seems to start with a single ventrolateral row, the lateral row appearing at a whorl height of approximately 15 mm.

SK/GR/1981/9 (Pl. 6, Figs. 3–5) and SK/GR/1993/41 (Pl. 6, Figs. 7, 8), from the Santonian of Grabenbach (Gosau, Upper Austria), may be body chamber fragments; they show the same arrangement of ribs and tubercles. In LE GO/2015/0001 the rib junctions at mid-flank are marked by a distinct tubercle, the ventrolateral ones by several millimeters long spines. None of the specimens show the sutures.

Inventory No.	D (mm)	Wh (mm)	WB (mm)	U (mm)	U %
LE GO/2015/0001	80	23.7	14.2	48.9	61.1

Tab. 3. Measurements of *Schlueterella compressa* KLINGER, 1976 (LE GO/2015/0001). U % of D.

**Discussion:** MATSUMOTO et al. (1986: 469) treated *Schlueterella* as a separate genus, rather than as a subgenus of *Neocrioceras*. WRIGHT (1996: 253) treated it as a subgenus of *Pseudoxybeloceras*. Despite differences, the Brandenburg specimens and those from the Gosau area are thought to be conspecific, or at least closely related. Fragmentary and deformed preservation in both areas of occurrence make absolute certainty impossible.

The Japanese *Schlueterella kawadai* MATSUMOTO & MIYAUCHI, 1984 (61, Pl. 26, Fig. 1, Pl. 27, Figs. 3, 4, Pl. 28, Fig. 2, Pl. 29, Fig. 1, Pl. 30, Figs. 1–2, Pl. 31, Fig. 3, Text-Fig. 9) differs in its long and slightly arcuate shaft followed by a hook at the end, and in its coarser ornamentation. *Neocrioceras* (*Schlueterella*) *pseudoarmatum* (SCHLÜTER, 1872: 99, Pl. 31, Figs. 1–3) from the Early Campanian of Westphalia (Germany) differs in having straight shafts (KENNEDY & KAPLAN, 1997: Pl. 64). *Neocrioceras maderi* IMMEL, KLINGER & WIEDMANN, 1982 (24, Pl. 9, Fig. 2, Pl. 11, Figs. 1, 2) differs in the distinct change of ornament with increasing diameter, the slightly more irregular ornament on the adult body chamber, and in having inner and outer ventrolateral, rather than the ventrolateral and lateral tubercles of the present species. *Neocrioceras spinigerum* (JIMBO, 1894) has a more depressed and more rapidly expanding whorl section, the whorls much tighter coiled, the relatively narrow umbilicus comprising about 50 % of the diameter. *Neocrioceras maximum* KENNEDY & COBBAN, 1991 is a close ally which differs in its narrow delicate ribs with generally two or three non-tuberculate ribs between successive tuberculated ones. Tuberculation of the paratype (KENNEDY & COBBAN, 1991: Pl. 11, Fig. 5) is more irregular, tubercles are smaller, and often positioned upon single, not looped ribs, whereas the holotype (KENNEDY & COBBAN, 1991: Pl. 12, Figs. 13–16) is similar with generally much coarser ornament at comparable size. *Neocrioceras kossmati* (SIMIONESCU, 1899), is coiled in a very loose spire ( $U = 67\%$ ) apparently in a single plane. The style of ribbing is characterised by relatively narrow primaries, separated by two or three very narrow secondaries and relatively wide interspaces. The primary ribs bear two rows of small tubercles, one at mid-flank, the other in a ventrolateral position. The primaries are never linked in pairs, and bifurcation is very rare. *Neocrioceras gosaviense* sp. nov. (see above) differs in having only a single row of ventrolateral tubercles.

**Occurrence:** GPIB 255 is from the middle Santonian of the Neffgraben (Rußbach, Salzburg), GPIB 339 from the early to middle Santonian of the Grabenbach (Gosau, Upper Austria; GERTH, 1961). The Brandenburg (Tyrol, Austria) occurrence is early Santonian. The species also occurs in the middle Santonian *gallicus* Subzone of the Corbières, France, the early Santonian St. Lucia Formation in KwaZulu-Natal (South Africa), and the Middle Coniacian *Volviceramus involutus* Zone of Wyoming in the US Western Interior.

## Subfamily Polytychoceratinae MATSUMOTO, 1938

### Genus and Subgenus *Pseudoxybeloceras* WRIGHT & MATSUMOTO, 1954

**Type species:** *Hamites quadrinodosus* JIMBO, 1894 (39, Pl. 7, Figs. 3, 4) by original designation.

#### *Pseudoxybeloceras* (*Pseudoxybeloceras*) *quadrinodosum* (JIMBO, 1894)

(Pl. 5, Figs. 2, 4, Pl. 6, Fig. 11, Pl. 7, Fig. 12)

- 1894 *Hamites quadrinodosus* JIMBO: 39, Pl. 7, Figs. 3, 4.  
 1954 *Pseudoxybeloceras quadrinodosum* (JIMBO); WRIGHT & MATSUMOTO: 120, Pl. 7, Fig. 6, Text-Figs. 6, 9–12.  
 1974 *Pseudoxybeloceras quadrinodosum* (JIMBO); SZÁSZ: 193, Pl. 1, Figs. 1–4, Pl. 2, Figs. 1–3, Pl. 3, Fig. 1, Text-Fig. 2.  
 1977 *Pseudoxybeloceras quadrinodosum* (JIMBO); MATSUMOTO: 345, Pl. 57, Fig. 2, Pl. 61, Fig. 4.  
 2003 *Pseudoxybeloceras* (*Pseudoxybeloceras*) *quadrinodosum* (JIMBO, 1894); KLINGER & KENNEDY: 319, Figs. 60D, 62 [with synonymy].

**Type:** The lectotype, by subsequent designation of WRIGHT & MATSUMOTO (1954: 120), is the specimen from the ?Santonian–Campanian of Hokkaido figured by JIMBO (1894: Pl. 7, Fig. 3) in the collections of the University Museum, Tokyo n° MM7524-1.

**Material:** Two fragments SK/RA/1981/32 from the middle Santonian of the Randograben 2 site (Rußbach, Salzburg) and SK/EB/2015/75 from the lower Santonian of the Edlbachgraben.

**Description:** SK/RA/1981/32 (Pl. 5, Figs. 2, 4, Pl. 7, Fig. 12) is a 59.6 mm long fragment of a straight shaft with part of a U-bend preserved at the adapertural end. It is an internal mould with extensive areas of the shell preserved, and has been deformed by *post mortem* crushing; the original whorl section was probably circular. The diameter increases rapidly towards the adapertural end of the fragment. The surface is covered with regular narrow and sharp ribs separated by somewhat wider interspaces. The rib index is about 7 to 8 at the adapical end, and 11 at the adapertural end. The ribs are straight, do not branch, and extend over the dorsum (where they narrow slightly), flanks and venter. Tiny inner and outer ventrolateral tubercles, perched on slightly flared ribs are aligned parallel to the venter. Ribbing appears to be somewhat irregular in the area of tuberculation. Occasional non-tuberculated ribs are intercalated. SK/EB/2015/75 (Pl. 6, Fig. 11) is a curved fragment approximately 33 mm long, with an estimated original whorl height of about 7 mm. The ribs are feebly prorsiradiate, concave and narrow, and separated by narrow interspaces; the rib index is about 7. There are worn lateral and ventrolateral tubercles on every fourth, slightly stronger rib.

**Discussion:** Co-occurring *Pseudoxybeloceras* (*Parasolenoceras*) *splendens* COLLIGNON, 1969, described below, appears to be more regular in its general shape, the whorl section ex-

panding more slowly. *Pseudoxybeloceras* (*Pseudoxybeloceras*) *matsumotoi* COLLIGNON, 1965 (12, Pl. 419, Fig. 1731) differs in its spatulate spines.

**Occurrence:** *Pseudoxybeloceras* (*Pseudoxybeloceras*) *quadrinodosum* (JIMBO, 1894) occurs from the Santonian to Campanian of Japan (MATSUMOTO, 1977). It is also recorded from the Campanian of Romania (SZÁSZ, 1974, 1982).

### Subgenus *Parasolenoceras* COLLIGNON, 1969

**Type species:** *Parasolenoceras splendens* COLLIGNON, 1969 (44, Pl. 530, Figs. 2087, 2088) by original designation.

#### *Pseudoxybeloceras* (*Parasolenoceras*) *splendens* COLLIGNON, 1969

(Pl. 6, Figs. 12–15)

- 1969 *Parasolenoceras splendens* COLLIGNON, nov. gen., nov. sp.: 44, Pl. 530, Fig. 2087.
- ? 1995 *Pseudoxybeloceras* (*Parasolenoceras*) aff. *splendens* COLLIGNON, 1969; KENNEDY in KENNEDY et al.: 431, Pl. 29, Figs. 2, 3.
- 1996 *Pseudoxybeloceras* (*Parasolenoceras*) *splendens* COLLIGNON, 1969; WRIGHT: 253, Figs. 196/4a, b.
- 2005 *Pseudoxybeloceras* (*Parasolenoceras*) *splendens* COLLIGNON, 1969; KAPLAN et al.: 122, Pl. 52, Figs. 3, 5, Pl. 53, Figs. 1–3, Pl. 54, Figs. 1, 2 [with synonymy].
- 2014 *Parasolenoceras splendens* COLLIGNON, 1969; KENNEDY in WALASZCZYK et al.: 122, Figs. 32 D, E.

**Type:** The lectotype by the subsequent designation of KAPLAN et al. (2005: 122) is the original of COLLIGNON (1969: 44, Pl. 530, Fig. 2087), refigured by KAPLAN et al. (2005: Pl. 54, Figs. 1, 2).

**Material:** Three specimens: SK/GR/1983/31 from Grabenbach, SK/RA/1997/135, SK/RA/2005/153a from the site Randograben 2 (Rußbach, Salzburg), and an additional one in the Seidl collection: SEIDL/CE 00014.01.

**Description:** SK/RA/2005/153a (Pl. 6, Figs. 12, 13) is a compressed fragment of a straight shaft, with white shell material preserved, 44.6 mm long, with an estimated whorl width of 5.15 mm. There are six to seven regular fine ribs per 10 mm length that extend across the dorsum, flanks and venter. Each rib bears a small ventrolateral tubercle.

SK/RA/1997/135 (Pl. 6, Fig. 14) is a fragment of a shaft of 42.5 mm length with a small curved part preserved. The phragmocone ends at the curvature; the body chamber is more or less straight. Ornament consists of about 4.8 sharp ribs/cm. Ribs are more or less straight and separated by somewhat wider interspaces. They coarsen towards the aperture and the interspaces increase in width. SK/GR/1983/31 (Pl. 6, Fig. 15) is the most complete specimen with two parallel shafts and the linking curved sector preserved. The fragment is about 60 mm long. The total length of both shafts including the curvature is about 120 mm. The estimated diameter of the smaller shaft must have been around 6 mm, the diameter at the restored end of the body chamber about 9 mm.

**Discussion:** Narrow straight fine ribs and a single row of tiny tubercles on each ventrolateral shoulder indicate that all three specimens belong to *Pseudoxybeloceras* (*Parasolenoceras*) *splendens*. COLLIGNON's original specimen (1969: 44, Pl. 530, Fig. 2087) is larger, but differs in no significant details from the Gosau specimens. *Pseudoxybeloceras* (*Parasolenoceras*) *wernickei* (WOLLEMAN, 1902: Pl. 4, Fig. 4, Pl. 5, Figs. 1, 2) is larger, with coarser, widely separated ribs. *Parasolenoceras periodicum* (MATSUMOTO & MIYAUCHI, 1984: 64, Pl. 28, Fig. 1, Pl. 31, Fig. 1) has major ribs with coarse tubercles that are linked across the venter by two or three ribs developed at irregular intervals, and separated by several ribs with weaker tubercles, linked across the venter by a single rib.

**Occurrence:** *Pseudoxybeloceras* (*Parasolenoceras*) *splendens* COLLIGNON, 1969 was first described from the early Campanian of Madagascar (COLLIGNON, 1969: 44, Pl. 530, Fig. 2087). It occurs also in the early Campanian of Westphalia (Germany; KAPLAN et al., 2005). A single specimen from the Corbières (KENNEDY in KENNEDY et al., 1995: Pl. 29, Figs. 2, 3) is from the Late Santonian *paraplanum* Zone. The Austrian specimens are from the middle Santonian.

### Genus *Polyptychoceras* YABE, 1927

**Type species:** *Ptychoceras pseudo-gaultinum* YOKOYAMA, 1890 (181, Pl. 20, Figs. 1–3) by original designation. The species is based on three syntypes, the originals of YOKOYAMA (1890: 29, Pl. 46, Figs. 1–3). No lectotype has been designated according to MATSUMOTO (1984: 29), who pointed out that YOKOYAMA's Plate 20, Figures 1 and 2 are conspecific (and correspond to the prevailing interpretation of the species), while the original of YOKOYAMA's Plate 20, Figure 3 belongs to some other species.

#### *Polyptychoceras* sp., juv.

(Pl. 7, Fig. 5)

**Material:** A single specimen SK/RA/1988/117a, b from Randobach 1 site (Rußbach, Salzburg).

**Description:** SK/RA/1988/117 consists of external moulds of the left and right sides of the same specimen with only a small, 18.6 mm long fragment of the internal mould preserved. The specimen consists of three parallel shafts, linked by curved sectors, and a 6 mm long final shaft. The specimen is ornamented by single delicate feebly rursiradiate ribs. The index is nine approximately, decreasing to six on the final short shaft, which appears to be part of the body chamber. There are no constrictions or ribs, and the ribs neither branch nor loop.

**Discussion:** None of the previously described species of *Polyptychoceras* have such a high density of feebly rursiradiate ribs. The closest is the late Campanian *Polyptychoceras rectecostatum* (SCHLÜTER, 1872: 107, Pl. 29, Fig. 7; KAPLAN et al., 2005: 126, Pl. 48, Fig. 3) but here the rib index is 5, rather than up to 9, as in the present specimen.

**Occurrence:** Middle Santonian of Randobach.

### ***Polyptychoceras* sp., form 1**

(Pl. 7, Figs. 1, 2, 4)

**Material:** SK/GR/1981/7, SK/GR/1983/32 and NHMW 2015/0530/0002 are all from the Grabenbach area (Gosau).

**Description:** SK/GR/1981/7 is a relatively large crushed internal mould with at least three parallel shafts and large areas of the shell preserved. The juvenile parts and the aperture are missing. The internal shaft is broken and dislocated and its connection with the following median shaft is not preserved. The connection between the median and the third shaft is a well preserved U-curve. The internal shaft as far as observable is approximately 70 mm long, the median shaft about 105 mm, the last one is 120 mm long including the U-bend. The whorl height close to the adapertural end is 13.6 mm, at the internal shaft it measures 5.8 mm. The original whorl section was probably circular. The ribs are narrow, sharp and rursiradiate. The rib index is 6 from close to the aperture to the initial shaft. The interspaces are somewhat wider than the ribs. There are few irregularly spaced, inconspicuous constrictions. There are neither tubercles, nor flared ribs. NHMW 2015/0530/0002 and SK/RA/1983/32 are fragments with short parts of the shaft and the curved sector preserved.

**Discussion:** SK/GR/1981/7 differs from *Polyptychoceras pseudogaultinum* (YOKOYAMA, 1890: 29, Pl. 46, Figs. 1–3) in its slightly rursiradiate ribs. *Polyptychoceras obstrictum* (JIMBO, 1894: 184, Pl. 23, Fig. 2) differs in its straight and crowded ribs (rib index 10). The specimen figured by WHITEAVES, 1903 (Pl. 44, Fig. 3) has slightly rursiradiate ribs with occasional bifurcations. *Polyptychoceras haradanum* (YOKOYAMA, 1890: 182, Pl. 20, Fig. 5) from the Santonian of Hokkaido is similar but has coarser ribbing.

**Occurrence:** All three specimens of *Polyptychoceras* sp. form 1 occur in the lower and middle Santonian of the Gosau Group (Gosau, Upper Austria) only.

### ***Polyptychoceras* sp., form 2**

(Pl. 7, Fig. 3)

**Material:** SK/RA/1997/136 from the middle Santonian of Randobach 2.

**Description:** SK/RA/1997/136 is a curved fragment of an individual with at least two shafts, the longer one – in part possibly body chamber – measures 40 mm, the shorter one 34 mm. The curvature is more than 180°. The diameter of the terminal shaft is about 7 to 8 mm (reconstructed), that of the penultimate shaft is 6 to 7 mm (reconstructed). The straight ribs are narrow and sharp and separated by somewhat wider interspaces. Ribbing is regular, about 6 ribs per 10 mm on the terminal part and about 8 per 10 mm on the adapical part. Ribs are undivided. There are no tubercles. The sutures are not exposed.

**Discussion:** SK/RA/1997/136 differs from *Polyptychoceras* sp. form 1, above, by the almost circular course of the U-shaped part of the shell. This could, however, be the result of *post mortem* deformation. It is left in open nomenclature.

**Occurrence:** Middle Santonian of the Randobach 2 site (Rußbach, Salzburg)

### ***Polyptychoceras* sp., form 3**

(Pl. 7, Fig. 6)

**Material:** SK/GR/2014/49.

**Description:** SK/GR/2014/49 is a fragment of a crushed internal mould with the whitish shell completely preserved, consisting of a straight shaft and part of a curved sector, suggesting an individual with at least two parallel shafts. The length of the specimen is 26.4 mm. The whorl height is 6.2 mm, exaggerated by lateral compaction. The original whorl section was probably circular or oval. There are approximately six narrow, sharp, oblique prorsiradiate ribs per 10 mm that extend across the dorsum (where they are slightly effaced), flanks and venter. The interspaces are somewhat wider than the ribs. There are no tubercles. The suture is not exposed.

**Discussion:** *Polyptychoceras* sp. form 3 differs from *P. pseudogaultinum* in its oblique ribbing.

**Occurrence:** SK/GR/2014/49 is from the middle Santonian of Pass Gschütt (Gosau, Upper Austria).

## **Family Baculitidae GILL, 1871**

### **Genus *Baculites* LAMARCK, 1799**

**Type species:** *Baculites vertebralis* LAMARCK, 1801 (103), by the subsequent designation of MEEK (1876: 391).

### ***Baculites incurvatus* DUJARDIN, 1837**

(Pl. 8, Figs. 1–2, 4–13, Pl. 9, Figs. 1–10, Text-Figs. 3, 4, Tab. 4)

- 1837 *Baculites incurvatus* DUJARDIN: 232, Pl. 17, Figs. 13a–d.
- 1876 *Baculites incurvatus*, DUJ.; SCHLÜTER: 142, Pl. 39, Figs. 6, 7, Pl. 40, Fig. 3 [with synonymy].
- 1906 *Baculites incurvatus* DUJARDIN; MÜLLER & WOLLEMAN: 4, Pl. 2, Figs. 2–5.
- 1961 *Baculites incurvatus* DUJARD. 1837; GERTH: 121, Pl. 24, Fig. 6.
- 1982 *Baculites incurvatus* DUJARDIN 1837; IMMEL et al.: 27, Pl. 11, Figs. 5–7 [with synonymy].
- 1984 *Baculites incurvatus* DUJARDIN, 1837; KENNEDY: 143, Pl. 32, Figs. 12, 15–19, Pl. 33, Figs. 1–22, Text-Figs. 41, 42.
- 1987 *Baculites incurvatus* DUJARDIN 1837; IMMEL: 128.
- 1991 *Baculites* cf. *incurvatus* DUJARDIN, 1837; KENNEDY & CHRISTENSEN: 217, Pl. 1, Figs. 2a, b.
- 1996 *Baculites incurvatus* DUJARDIN, 1837; WRIGHT: 256, Figs. 199, 3 d, e.
- 1997 *Baculites incurvatus* DUJARDIN, 1837; KLINGER & KENNEDY: 92, Fig. 56.

- 2000 *Baculites incurvatus* DUJARDIN, 1837; KENNEDY & KAPLAN: 106, Pl. 35, Fig. 6, Pl. 38, Figs. 1–3.
- 2001 *Baculites incurvatus* DUJARDIN, 1837; KLINGER & KENNEDY: 169, Figs. 128 A–P [with synonymy].

**Type:** The lectotype, by the subsequent designation of IMMEL et al. (1982: 127) is the original of DUJARDIN (1837: Pl. 17, Fig. 13a), refigured by KENNEDY (1984: Pl. 33, Figs. 4–6) and KLINGER & KENNEDY (1997: Fig. 56).

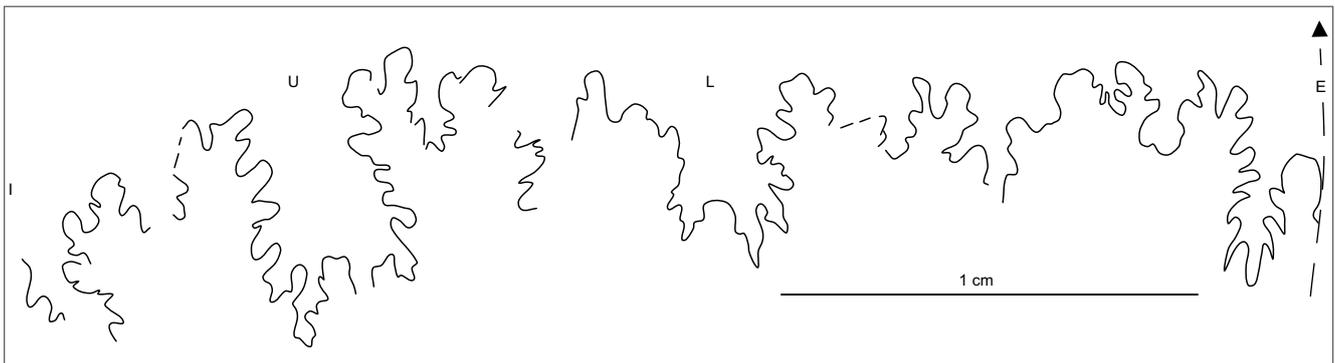
**Material:**

- a) Skoumal collection:  
 From Randobach (Rußbach, Salzburg) 14 specimens: SK/RA/1981/37a; SK/RA/1982/70a, b, c, e; SK/RA/1982/71d, e; SK/RA/1983/92a, b; SK/RA/1983/93c; SK/RA/1984/105; SK/RA/2003/50c; SK/RA/2003/150a, c.  
 From Neffgraben (Rußbach, Salzburg) five specimens: SK/NE/1989/2, SK/NE/1989/11b, d, e; SK/NE/2013/21e.  
 From Edlbachgraben (Gosau, Upper Austria) one specimen: SK/EB/2003/30.
- b) NHMW collection: about 50 specimens, and fragments.
- c) Mader collection (IMMEL et al., 1982): three specimens.
- d) Gerth collection: GPIB 212 from Neffgraben (Rußbach, Salzburg); the original of GERTH (1961: Pl. 24, Fig. 6).

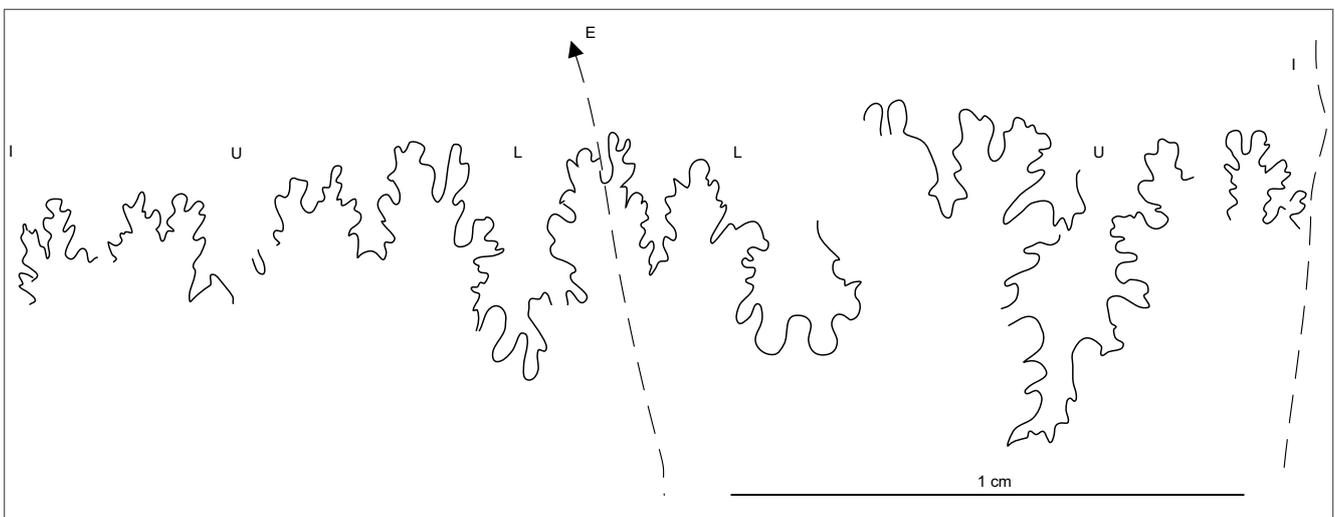
- e) Leibfingler Prömer collection: LPG: five specimens on a slab (LE GO/2015/0003) from the Neffgraben (Rußbach, Salzburg).
- f) Seidl collection: SEIDL/CE 00003.

**Description:** *Baculites incurvatus* DUJARDIN, 1837, is a highly variable species, both in the form of the shell and the ornament. The material recently collected by Peter Skoumal demonstrates the occurrence of different types of shell form and sculpture at the same locality.

GERTH (1961: 121, Pl. 24, Fig. 6) was the first to figure a specimen of *B. incurvatus* from the Gosau Group (Neffgraben, Rußbach, Salzburg), a slightly curved fragment of the body chamber and a part of the phragmocone (length: 84 mm,  $Wb_{max}$ : 12 mm). It is preserved as an internal mould with adherent white shell, and is more or less flattened by compaction. The majority of the recently collected specimens from the Gosau area are also slightly curved, the venter convex in profile, the dorsum concave. Many of the specimens are also straight (e.g. Brandenburg: IMMEL et al., 1982: Pl. 11, Figs. 9–11). The venter is in many cases bordered by parallel shallow sulci. The adult apertural margin (which follows the course of the growth lines) is concave on the flanks, projecting forwards as a long ventral rostrum and a short dorsal rostrum (Pl. 8, Figs. 8, 12, 13, Pl. 9, Figs. 10, 11). The most prominent feature is the variable



Text-Fig. 3.  
 Suture of *Baculites incurvatus* DUJARDIN, 1837 (SK/EB/2003/30).



Text-Fig. 4.  
 Suture of *Baculites incurvatus* DUJARDIN, 1837 (SK/RA/1982/70a).

Inventory No.	Length (mm)	Wh (mm)	Wb (mm)
SEIDL/CE 00003	250 <sub>rest.</sub>	23 <sub>rest.</sub>	15 <sub>rest.</sub>
SK/NE/ 1989/2	250 <sub>rest.</sub>	15 <sub>rest.</sub>	15 <sub>rest.</sub>
SK/RA/1982/70a	160 <sub>rest.</sub>	12 <sub>rest.</sub>	10 <sub>rest.</sub>
SK/RA/2003/150a	160 <sub>rest.</sub>	13 <sub>rest.</sub>	12 <sub>rest.</sub>

Tab. 4.  
*Baculites incurvatus* DUJARDIN, 1837 (all specimens are fragments with tentatively restored data; rest. = restored). Measurements from the apertural end of the fragment.

ornament. There are strong, distant, irregularly spaced prorsiradiate dorsolateral bullae. The growth lines project strongly forwards on the outer flanks and strengthen into well-developed ribs that cross the venter in a broad convexity. The suture was illustrated by GERTH (1961: Fig. 1).

**Discussion:** The closest relative of *Baculites incurvatus* appears to be the highly variable South African *Baculites capensis* WOODS, 1906 (342, Pl. 44, Figs. 6, 7). KLINGER & KENNEDY (1997) distinguished 12 morphotypes on the basis of differences in sculpture. They also discussed the possibility of *B. capensis* being a subspecies or junior synonym of *B. incurvatus*. However, there are no curved individuals in the South African populations (KLINGER & KENNEDY, 1997: Figs. 27–33, 34A–L, ?34M–R, 35–54) and we keep the species separate here. *Baculites brevicosta* SCHLÜTER, 1876 (Pl. 11, Figs. 1–21), which co-occurs with *Baculites incurvatus* in the Gosau Group of Gosau and Rußbach differs in its distinctive crescentic and closely spaced dorsolateral bullae. Co-occurring *Baculites fuchsi* REDTENBACHER, 1873 (Pl. 10, Figs. 1–15) is smooth, apart from strengthened growth lines in some individuals. Species of *Boehmericeras* have a much more strongly curved shell (KENNEDY & KLINGER, 1997: 121).

**Occurrence:** The Austrian representatives of *Baculites incurvatus* DUJARDIN, 1837 appear in the early Santonian, with an acme in the middle Santonian. They disappear together with *Texanites quinquenodosus* and *Muniericeras gosauicum* below the Sandkalkbank Member in the late Santonian. In France (Touraine, Aquitaine) they appear in the middle Coniacian and extend into the late Coniacian in Germany. In Denmark they possibly occur in the Santonian.

### *Baculites brevicosta* SCHLÜTER, 1876

(Pl. 8, Fig. 3, Pl. 11, Figs. 1–7, 9–20, Text-Fig. 5, Tab. 5)

- 1876 *Baculites brevicosta* SCHLÜTER: 141, Pl. 39, Figs. 9, 10.  
non 1931 *Baculites* cf. *brevicosta* SCHLÜTER; COLLIGNON: 34, Pl. 5, Figs. 1, 1a, Pl. 9, Fig. 13 (= *B. capensis* WOODS, 1906; teste KLINGER & KENNEDY, 1997: 53).  
1959 *Baculites brevicosta* SCHLÜTER (1876); MATSUMOTO: 117, 121, 128.  
1984 *Baculites* cf. *brevicosta* SCHLÜTER, 1876; KENNEDY: 146, Pl. 33, Figs. 23–25 [with synonymy].  
1994 *Baculites brevicosta* SCHLÜTER, 1876; KAPLAN & KENNEDY: 59, Pl. 40, Figs. 15–19.  
1997 *Baculites brevicosta* SCHLÜTER, 1876; KLINGER & KENNEDY: 106.

2001 *Baculites* cf. *brevicosta* SCHLÜTER, 1876; KLINGER & KENNEDY: 136, Figs. 128 Q, R, S, ?Figs. 103 R, S.

**Type:** The lectotype, by the subsequent designation of KENNEDY (1984: 146), is the original of SCHLÜTER (1876: 141, Pl. 39, Figs. 9, 10).

**Material:** Altogether we have about 25 specimens from the Gosau Group of the Gosau Basin (Austria). From Germany SCHLÜTER (1876: 141) mentioned only a few specimens of apparently Coniacian age (KENNEDY, 1984: 146; KLINGER & KENNEDY, 2001: 106).

### Skoumal collection

SK/RA/1981/37b; SK/RA/1981/38a, b, c; SK/RA/1982/69a; SK/RA/1982/71a; SK/RA/1983/90; SK/RA/1983/92c, d, e; SK/RA/1983/93a, b; SK/RA/1983/100a; SK/RA/2003/150b, d; SK/NE/1989/11a, c; SK/NE/2001/19; SK/NE/2013/21a, b, c, d; SK/EB/2011/54a, b, c.

### Seidl collection

SEIDL/CE 00009.

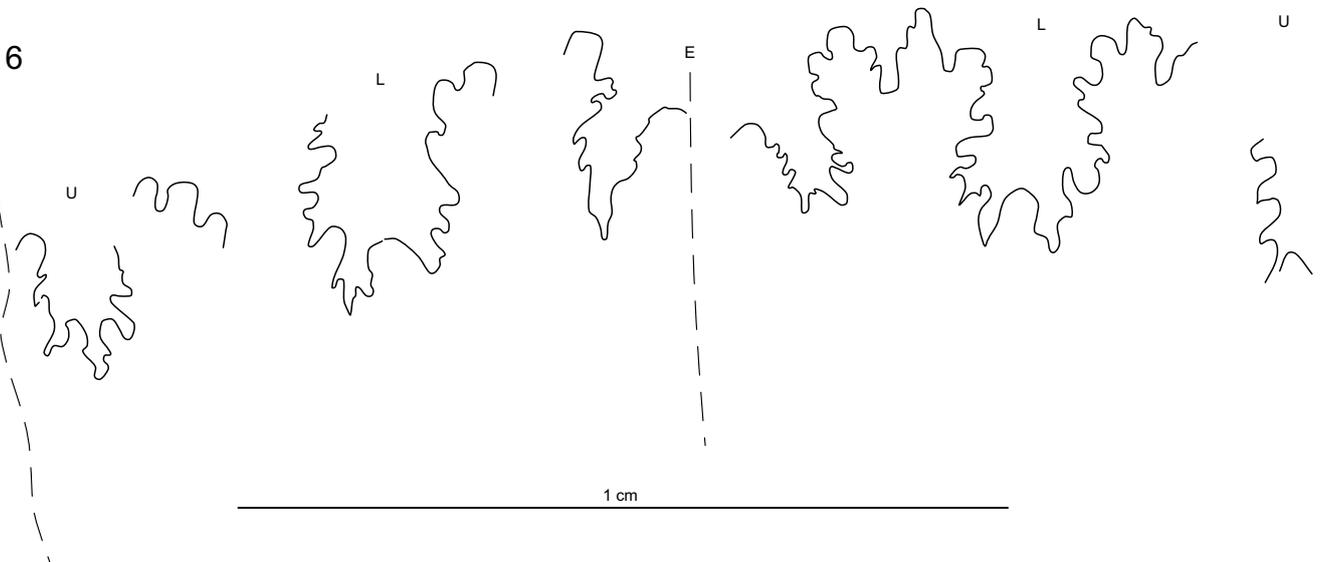
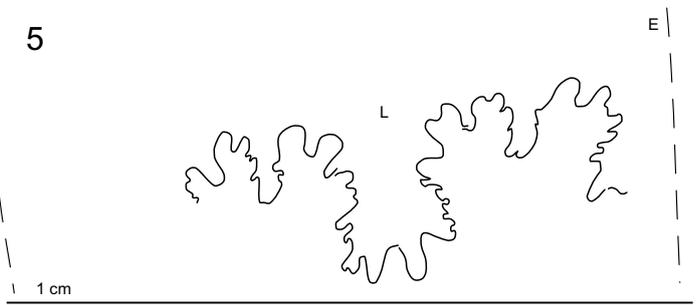
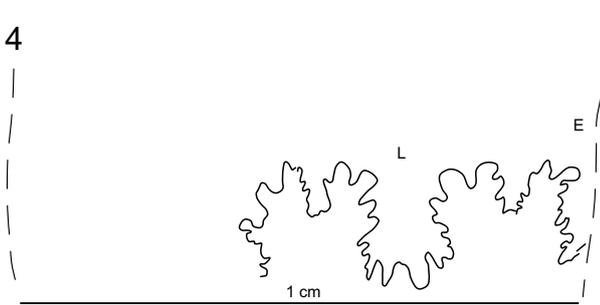
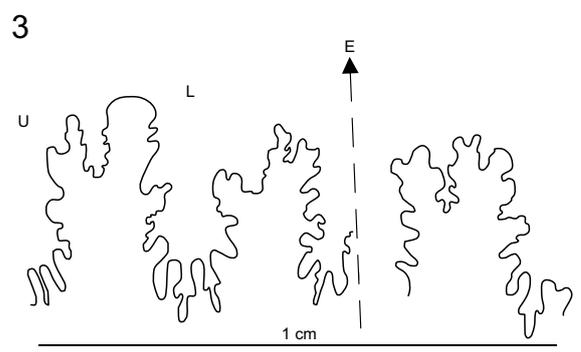
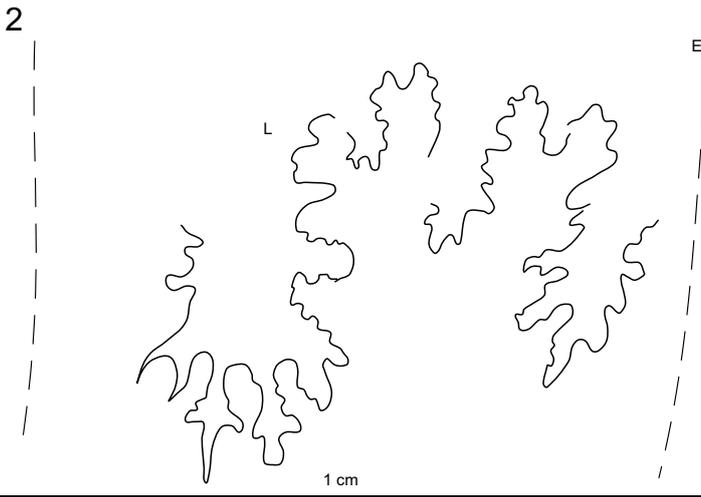
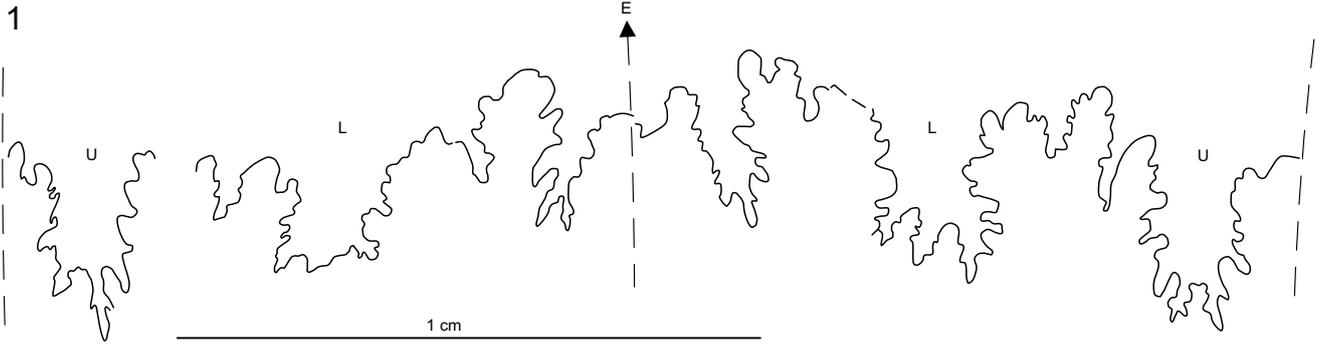
**Description:** *Baculites brevicosta* SCHLÜTER, 1876 is a rare species, described here for the first time from the Gosau Group. SCHLÜTER (1876: 141) described the lectotype as follows: “kleiner Bakulit [...], welcher auf den Flanken in der Nähe des Rückens gekrümmte, halbmondförmige kurze Rippen trägt.“ The crescentic (= halbmondförmig) ribs are also visible in SCHLÜTER’s figure (1876: Pl. 39, Figs. 9, 10).

The general shape of the shell is slightly curved or straight. All Gosau specimens are preserved as internal moulds with adherent yellowish shell remains. All are crushed to a certain degree. Longitudinal measurements are still meaningful; the whorl section cannot be restored with accuracy.

SK/NE/2001/19 (Pl. 11, Fig. 4) is a body chamber fragment of 64 mm long, the venter gently rounded and bordered by ventrolateral sulci. It is elongated into a distinct rostrum with a rounded end forming part of the well preserved aperture with a short and broad dorsal protuberance, the rostra connected by a deep sinus on the flanks. The shell – in this case originally nacre – is decorated by closely spaced weak crescentic ribs, of which there are about six per centimeter. In SK/RA/1981/38a (Pl. 11, Fig. 3) the growth lines are strengthened into characteristic dorsolateral crescentic ribs, effaced on the mid-flank region, and reappearing on the outermost flank; close-spaced fine ribs extend across the venter. SEIDL/CE 00009 (Pl. 11, Fig. 1) is a 65 mm long fragment with closely spaced crescentic dorsolateral ribs of variable strength.

Inventory No.	Length (mm)	Wh (mm)	Wb (mm)
SK/NE/1989/11a	87	15 <sub>rest.</sub>	13 <sub>rest.</sub>
SK/RA/1981/38a	81	11 <sub>rest.</sub>	9 <sub>rest.</sub>
SK/RA/2003/150b	80	6.5 <sub>rest.</sub>	5.5 <sub>rest.</sub>
SEIDL/CE 00009	75	12 <sub>rest.</sub>	10 <sub>rest.</sub>

Tab. 5.  
Measurements of *Baculites brevicosta* SCHLÜTER, 1876 (all specimens are fragments with tentatively restored data; rest. = restored). Measurements from the apertural end of the fragment.



◀ Text-Fig. 5.

Sutures of *Baculites brevicosta* SCHLÜTER, 1876.

1. SK/RA/1983/92d; 2. SK/NE/1989/11a; 3. SK/RA/2003/150b; 4. SK/RA/1983/93b juv.; 5. SK/RA/1983/93b juv.2; 6. SK/RA/1983/93b adult.

**Discussion:** The slight curvature of the shell and the shape of the aperture indicate a close relationship with *Baculites incurvatus*. The coarse dorsolateral tuberculation of the latter is, however, quite distinct. *Baculites fuchsi* is ornamented by delicate growth lines, and weak ventrolateral and ventral ribs in some individuals.

**Occurrence:** *B. brevicosta* SCHLÜTER, 1876 is a rare species in the Coniacian of Germany (see KAPLAN & KENNEDY, 1994: 59, Pl. 40, Figs. 15–19). It also occurs in the Upper Coniacian of the Corbières (KENNEDY, 1984: *B. cf. brevicosta* SCHLÜTER). The Austrian occurrences are the youngest, in the lower to middle Santonian.

***Baculites fuchsi* REDTENBACHER, 1873**

(Pl. 10, Figs. 1–15, Text-Fig. 6, Tab. 6)

- 1873 *Baculites fuchsi* REDTENBACHER: 134, Pl. 30, Fig. 15.
- 1979 *Baculites fuchsi* REDTENBACHER, 1873; SUMMESBERGER: 113, Pl. 1, Figs. 2, 3; Text-Figs. 2, 3 [with synonymy].
- 1979 *Baculites* sp.; SUMMESBERGER: 116, Pl. 1, Figs. 8, 9, Text-Fig. 5.
- 1982 *Baculites fuchsi* REDTENBACHER, 1873; IMMEL et al.: 28, Pl. 11, Fig. 8.
- 1991 *Baculites cf. fuchsi* REDTENBACHER, 1873; KENNEDY & CHRISTENSEN: 217, Pl. 7, Figs. 1a, b.
- ? 1995 *Baculites* sp.; KENNEDY in KENNEDY et al.: 431, Pl. 27, Figs. 1–3.
- 2017b *Baculites fuchsi* REDTENBACHER, 1873; SUMMESBERGER et al.: 193, Pl. 15, Fig. 4.
- 2017c *Baculites fuchsi* REDTENBACHER, 1873; SUMMESBERGER et al.: 129, Fig. 7/2, 3.

**Type:** The holotype, by monotypy, is the original of REDTENBACHER (1873: 134, Pl. 30, Fig. 15).

**Material:** SK/1977/5, the original of SUMMESBERGER (1979: Pl. 1, Figs. 2–4), SK/1977/7, the original of SUMMESBERGER (1979: Pl. 1, Figs. 8, 9); GPII P. 8170, the original of

Inventory No.	Length (mm)	Wh (mm)	Wb (mm)
NHMW 1865/0001/0138	72 <sub>est</sub>	15 <sub>est</sub>	12 <sub>est</sub>
NHMW 2016/0047/0001	64	15 <sub>est</sub>	12 <sub>est</sub>
OÖLM 2016/2	--	16.8	13.9
SK/RA/1983/99	129.2	15 <sub>est</sub>	14 <sub>est</sub>

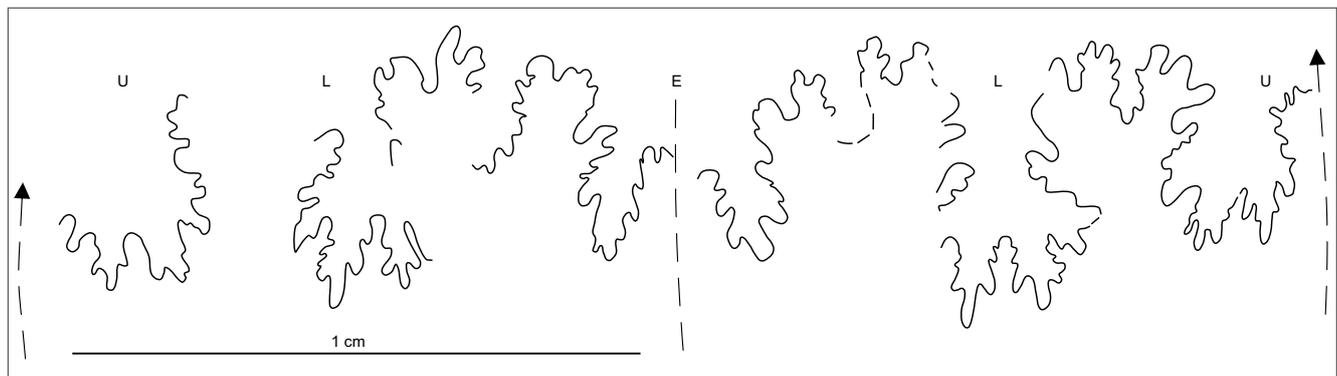
Tab. 6. Measurements of *Baculites fuchsi* REDTENBACHER, 1873 (all fragments). <sub>est</sub> = estimated. Measurements from the apertural end of the fragment.

IMMEL et al. (1982: Pl. 11, Fig. 8); NHMW 1865/0001/0138 (the holotype and original of REDTENBACHER, 1873: Pl. 30, Fig. 15), NHMW 1926/0002/2468 (ex coll. Heinrich); NHMW 2016/0047/0001; OÖLM/2016/1, OÖLM/2016/2; SK/RA/1982/69b, c; SK/RA/1982/70d, SK/RA/1982/71b, c; SK/RA/1983/92f, SK/RA/1983/99, SK/RA/1983/100b; SK/GR/1981/17b; HNS 6404.

**Description:** All specimens of *B. fuchsi* are straight fragments. Detailed descriptions were given by SUMMESBERGER (1979: 113, Pl. 1, Figs. 2, 3, Text-Figs. 2, 3) and by IMMEL et al. (1982: 28, Pl. 11, Fig. 8). The surface is smooth in most cases apart from weak undulations of the venter (SUMMESBERGER, 1979: 114) and faint growth lines parallel to the aperture.

**Discussion:** *Baculites fuchsi* REDTENBACHER, 1873 differs from co-occurring *B. incurvatus* and *B. brevicosta* in its very weakly ornamented to smooth surface. KLINGER & KENNEDY (1997: 46), stated that *B. bailyi* (WOODS, 1906) from South Africa, Madagascar, Antarctica, Hokkaido and British Columbia and *B. fuchsi* REDTENBACHER, 1873 are virtually indistinguishable, suggesting that *bailyi* might be a junior synonym. KLINGER & KENNEDY (1997: 46) also noted the parallelism of co-occurrence of the European near-smooth *B. fuchsi* and tuberculate *B. incurvatus* and the co-occurrence of tuberculate *B. bailyi* and near smooth *B. capensis* WOODS in the classic Mzamba section in northeastern Eastern Cape Province in South Africa.

**Occurrence:** The holotype is from the Tiefengraben (= Grabenbach, Gosau, Upper Austria). This and the majority of recently collected specimens are from the lower and middle Santonian. The Brandenburg specimen is from the



Text-Fig. 6. Suture of *Baculites fuchsi* REDTENBACHER, 1873 (SK/RA/1982/69c).

Lower Santonian. The specimens described by SUMMESBERGER (1979) are from the Upper Santonian. *Baculites fuchsi* REDTENBACHER, 1873 is a typical Santonian species, occurring in the limited area of the Gosau Group. It is also described under *Baculites* cf. *fuchsi* REDTENBACHER, 1873 from the Coniacian/Santonian of Denmark (KENNEDY & CHRISTENSEN, 1991: 217) and Spain (SANTAMARIA, 1991; SANTAMARIA ZABALA, 1992).

***Baculites* sp.**

(Pl. 11, Fig. 8)

**Material:** SK/GR/1981/17a is a single individual from the Grabenbach locality (Gosau, Upper Austria).

**Description:** SK/GR/1981/17a is an internal mould with large parts of the shell preserved. L is 88 mm, Wb is 17–21 mm. The single straight fragment is sculptured by four very coarse ribs crossing the flank in somewhat irregular distances.

**Discussion:** SK/GR/1981/17a is described in open nomenclature as it differs from the baculitids described above in its very coarse ornament. The sculpture recalls similarity to the Campanian *Baculites vanhoepeni* VENZO, 1936 (see KLINGER & KENNEDY, 1997).

**Occurrence:** SK/GR/1981/17a is single specimen from the middle Santonian of the Grabenbach locality (Gosau, Upper Austria).

**Superfamily Scaphitoidea GILL, 1871**

**Family Scaphitidae GILL, 1871**

**Subfamily Scaphitinae GILL, 1871**

**Genus and subgenus *Scaphites* PARKINSON, 1811**

**Type species:** *Scaphites equalis* J. SOWERBY, 1813, by subsequent designation by MEEK (1876).

**Remarks:** In general, Scaphitinae are quite common in the Coniacian and again in the Campanian of the Gosau Group but very rare in the Santonian. Doubtful *Scaphites* are mentioned from Brandenburg by KATSCHTHALER (1935) followed by BRINKMANN (1935) and FISCHER (1964). A single individual was described as "*Scaphites* cf. *meslei* GROSSOUVRE" by GERTH (1956: 433, Text-Fig. 1), and was from the middle Santonian of the Neffgraben (Rußbach, Salzburg). Gerth believed to have it collected in the Coniacian (GERTH, 1961: 134/135, Text-Fig. 4). We have not seen the original specimen, and place it in the synonymy of *Scaphites leei* (see below).

***Scaphites leei* REESIDE, 1927, form II (COBBAN, 1969)**

(Pl. 7, Figs. 7, 8)

**Type:** The holotype is USNM 73354 (REESIDE, 1927: Pl. 1, Figs. 17–22) by original designation. It was refigured by COBBAN (1969: Pl. 1, Figs. 8, 9).

1927 *Scaphites leei* REESIDE: 26, Pl. 20, Figs. 17–22.

? 1935 *Scaphites lamberti* var. *meslei* GROSSOUVRE; BRINKMANN: 4.

? 1956 *Scaphites* cf. *meslei* GROSSOUVRE; GERTH: 433, Text-Fig. 1.

? 1961 *Scaphites* cf. *meslei* GROSSOUVRE; GERTH: 134, Text-Fig. 4.

1969 *Scaphites leei* REESIDE II; COBBAN: 15, Pl. 1, Figs. 8–18.

1987 *Scaphites* (*Scaphites*) *meslei* DE GROSSOUVRE 1894; IMMEL: 137, Pl. 14, Figs. 13, 14.

1995 *Scaphites leei* REESIDE, 1927, form II, COBBAN 1969; KENNEDY in KENNEDY et al.: 433, Pl. 30, Figs. 2–5, 6, 7–17, 20–21, 26–27.

**Material:** A single specimen, NHMW 1982/0034/0001 (Santonian, Grabenbach, Gosau, Upper Austria).

**Description:** NHMW 1982/0034/0001 is a fragment of an internal mould of a body chamber with adherent shell remaining, 23.7 mm long, 10.8 mm wide, the umbilicus 4.9 mm in diameter. Sharp and narrow strong ribs arise on the umbilical shoulder, some with an elongated bulla, some without. Some primary ribs terminate a bullate or triangular strong and acute ventrolateral tubercle. Narrow secondary ribs, some of them bifurcating, arise on the ventrolateral shoulder, cross the venter in a very feeble convexity, and are separated by wide interspaces.

**Discussion:** The closest relative of the present specimen seems to be the questionable *Scaphites* cf. *meslei* GROSSOUVRE of GERTH (1956: Text-Fig. 1), which was already excluded from synonymy of the typically Coniacian *meslei* by KENNEDY (1984: 148).

**Occurrence:** *Scaphites leei* REESIDE, 1927, originally described from the U.S. Western Interior, occurs in the Middle and Upper Santonian of the Corbières (France). It is recorded from the Gosau for the first time.

***Scaphites* sp.**

(Pl. 7, Figs. 9–11, Tab. 7)

**Material:** SK/RA/1996/130, SK/EB/1985/7.

**Description:** Both specimens are undeformed fragments of phragmocones with some original shell material preserved. They are thought to be conspecific. The whorl breadth and height increase rapidly in SK/RA/1996/130 (Pl. 7, Figs. 9, 10). There are seven primary ribs on a 120° whorl sector. They arise on the umbilical shoulder and are straight on the inner third of the flank, then slightly prorsiradiate and falcid, sweeping back again in a shallow convexity, and passing straight across the venter. Most of the ribs bifurcate around the middle of the flank, and additional ribs intercalate, to give a total of about 21 ribs on the venter. The ornament of SK/EB/1985/7 (Pl. 7, Fig. 11) is comparable.

**Discussion:** These two phragmocones are specifically indeterminate.

Inventory No.	D (mm)	Wh (mm)	Wb (mm)	U (mm)	U (%)
SK/RA/1996/130	16.8	10.2	7.3	1.9	8.8
SK/EB/1985/7	20.1	13.8	5.6	2.3	8.7

Tab. 7.  
Measurements of *Scaphites* sp. from the Santonian of the Gosau Group.

**Occurrence:** Both specimens occur in the early Santonian, in the Edlbachgraben (Gosau, Upper Austria) and Randedobachgraben (Rußbach, Salzburg).

### Biostratigraphical conclusions on the Santonian Gosau Group

In the Gosau Group the Zone of *Placenticerias polyopsis* can be divided by ammonites into three subzones which are defined by the appearance of the dominant ammonite.

### List of the late Santonian Zone of *Placenticerias paraplanum*

*Gaudryceras mite* (HAUER, 1866)  
*Pseudophyllites loryi* (KILIAN & REBOUL, 1909)  
*Parapuzosia seppenradensis* (LANDOIS, 1895)  
*Parapuzosia corbarica* (DE GROSSOUVRE, 1894)  
*Kitchinites stenomphalus* SUMMESBERGER, 1979  
*Hauericeras (Gardeniceras) welschi* DE GROSSOUVRE, 1894  
*Hauericeras (Gardeniceras) lagarum* (REDTENBACHER, 1873)  
*Eupachydiscus isculensis* (REDTENBACHER, 1873)  
*Damesites sugata* (FORBES, 1846)  
*Nowakites draschei* (REDTENBACHER, 1873)  
*Nowakites savini* (DE GROSSOUVRE, 1894)  
*Texasia dentatocarinata* (ROEMER, 1852)  
*Placenticerias polyopsis* (DUJARDIN, 1837)  
*Placenticerias paraplanum* WIEDMANN, 1978  
*Placenticerias maherndli* SUMMESBERGER, 1979  
*Diaziceras austriacum* (SUMMESBERGER, 1979)  
*Eulophoceras jacobi* HOURCQ, 1949  
*Reginaites gappi* WIEDMANN, 1978  
*Amapondella amapondense* (VAN HOEPEN, 1921)  
*Scalarites sarta* (MÜLLER & WOLLEMANN, 1906)  
*Glyptoxoceras souqueti* COLLIGNON, 1969  
*Glyptoxoceras crispatum* (MOBERG, 1885)  
*Neocrioceras (Neocrioceras) gosaviense* sp. nov.  
*Polyptychoceras* sp.  
*Baculites fuchsi* REDTENBACHER, 1873  
*Baculites sulcatus* BAILY, 1855  
*Boehmoceras krekeleri* (WEGNER, 1905)  
*Boehmoceras arculus* (MORTON, 1834)

### List of the middle Santonian Zone of *Muniericeras gosauicum*

*Angulithes westphalicus* (SCHLÜTER, 1872)  
*Cymatoceras* sp.  
*Cymatoceras* cf. *huxleyanum* (BLANFORD, 1861)  
*Gaudryceras mite* (HAUER, 1866)  
*Saghalinites nuperus* (VAN HOEPEN, 1921)  
*Parapuzosia corbarica* (DE GROSSOUVRE, 1894)  
*Nowakites carezi* (DE GROSSOUVRE, 1894)  
*Nowakites draschei* (REDTENBACHER, 1873)  
*Eupachydiscus isculensis* (REDTENBACHER, 1873)  
*Tragodesmoceras aff. clypeale* (SCHLÜTER, 1872)  
*Muniericeras gosauicum* (HAUER, 1858)  
*Pseudoschloenbachia inconstans* (DE GROSSOUVRE, 1894)  
*Texanites quinquenodosus* (REDTENBACHER, 1873)  
*Damesites sugata* (FORBES, 1846)  
*Eubostriochoceras (E.) salisburgense* sp. nov.  
*Didymoceras (Didymoceras) sp.*  
*Muramotoceras costatum* sp. nov.  
*Glyptoxoceras retrorsum* (SCHLÜTER, 1872)  
*Glyptoxoceras sp.*  
*Neocrioceras (Neocrioceras) gosaviense* sp. nov.  
*Schlueterella (Schlueterella) compressa* KLINGER, 1976  
*Pseudoxybeloceras (P) quadrinodosum* (JIMBO, 1894)  
*Pseudoxybeloceras (Parasolenoceras) splendens* COLLIGNON, 1969  
*Polyptychoceras sp., juv.*  
*Polyptychoceras sp., form 1*  
*Polyptychoceras sp., form 2*  
*Polyptychoceras sp., form 3*  
*Baculites incurvatus* DUJARDIN, 1837  
*Baculites fuchsi* REDTENBACHER, 1873  
*Baculites brevicosta* SCHLÜTER, 1876  
*Baculites sp.*

### List of the early Santonian Zone of *Eulophoceras natalense* HYATT, 1903

*Cimomia* cf. *gosavica* (REDTENBACHER, 1873)  
*Cymatoceras* sp.  
*Angulithes westphalicus* (SCHLÜTER, 1872)  
*Hyporbulites woodsi* (VAN HOEPEN, 1921)  
*Anagaudryceras redtenbacheri* (IMMEL et al., 1982)  
? *Anagaudryceras* cf. *subtililineatum* (KOSSMAT, 1895)  
*Gaudryceras mite* (REDTENBACHER, 1873)  
*Saghalinites nuperus* (VAN HOEPEN, 1921)  
*Parapuzosia daubreei* (DE GROSSOUVRE, 1894)  
*Parapuzosia corbarica* (DE GROSSOUVRE, 1894)  
*Hauericeras (Gardeniceras) aff. gardeni* (BAILY, 1855)  
*Nowakites carezi* (DE GROSSOUVRE, 1894)  
*Nowakites savini* (DE GROSSOUVRE, 1894)

*Eupachydiscus isculensis* (REDTENBACHER, 1873), microconch  
*Texanites quinuenodosus* (REDTENBACHER, 1873)  
*Texasia cricki* (SPATH, 1921)  
*Eulophoceras natalense* HYATT, 1903  
*Hauericeras* (*Hauericeras*) *pseudogardeni* (SCHLÜTER, 1872)  
*Kossmaticeras* (*Kossmaticeras*) cf. *sparsicostatum* (KOSSMAT, 1897)  
*Patagiosites?* sp.  
 ? *Paratexanites serratomarginatus* (REDTENBACHER, 1873)  
*Hyphantoceras plicatum* (D'ORBIGNY, 1842)  
*Scalarites cingulatus* (SCHLÜTER, 1872)  
*Neocrioceras* (*N.*) sp. indet.  
*Neocrioceras* (*Neocrioceras*) *maderi* IMMEL et al., 1982  
*Schlueterella* (*Schlueterella*) *compressa* KLINGER, 1976  
*Pseudoxybeloceras* (*P.*) *quadrinodosum* (JIMBO, 1894)  
*Baculites incurvatus* DUJARDIN, 1837  
*Baculites brevicosta* SCHLÜTER, 1876  
*Scaphites leei* REESIDE, 1927, form II, COBBAN, 1969  
*Scaphites* sp.  
*Cladoceramus undulatoplicatus* (F. ROEMER, 1852)

The early Santonian Zone of *Eulophoceras natalense* is present at the following localities: Brandenburg/Mühlbach, Edlbachgraben/Gosau, Randograben 3/Stöcklwaldgraben/Rußbach, lower part of the Grabenbach (= Tiefengraben), Gosau. *Texanites quinuenodosus* appears together with *C. undulatoplicatus* and *E. natalense* in the lowest parts of the Gosau Group and co-occurs with *M. gosauicum* through the middle Santonian part of the section. Both disappear about 20 m below the base of the Sandkalkbank Member in the Neffgraben.

The basal middle Santonian is defined in the Gosau Group at the Randobach 2/Rußbach, Salzburg site with a mass occurrence of *Muniericeras gosauicum*. The middle Santonian is also indicated by the occurrence of *Muniericeras gosauicum* in the Neffgraben up to the confluence with the *elliptica*-Graben (GERTH, 1961), and in the middle and upper part of the Grabenbach (= Tiefengraben/Gosau).

Late Santonian biomarkers are limited to the Schattaugraben exposure (Rußbach, Salzburg) which is in lithostratigraphical contact with the Finstergrabenwandl (Gosau, Upper Austria; SUMMESBERGER, 1979, 1980) and to the Hofergraben exposures (SUMMESBERGER et al., 2017c). The characteristic ammonite fauna is listed above.

### Revised list of heteromorph Ammonites described by IMMEL et al. (1982) and IMMEL (1987)

*Neocrioceras* (*Neocrioceras*) *maderi* IMMEL, KLINGER & WIEDMANN, 1982 → *Neocrioceras* (*Neocrioceras*) *maderi* IMMEL et al., 1982  
*Neocrioceras* (*Schlueterella*) *compressum* KLINGER, 1976 → *Schlueterella compressa* KLINGER, 1976  
*Diplomoceras* (*Glyptoxoceras*) *subcompressum* (FORBES, 1846) → *Glyptoxoceras crispatum* (MOBERG, 1885)  
*Diplomoceras* (*Glyptoxoceras*) *indicum* (FORBES, 1846) → *Glyptoxoceras crispatum* MOBERG, 1885  
*Baculites incurvatus* DUJARDIN, 1837 → *Baculites incurvatus* DUJARDIN, 1837  
*Baculites fuchsi* REDTENBACHER, 1873 → *Baculites fuchsi* REDTENBACHER, 1873  
*Hyphantoceras* (*Hyphantoceras*) *orientaliforme* IMMEL, 1987 → *Hyphantoceras plicatum* (D'ORBIGNY, 1842)

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<i>Hyphantoceras plicatum</i> (D'ORBIGNY, 1842)	106	Pl. 1, Figs. 6, 7
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## Plate 1

Figs. 1–4: *Eubosstrychoceras* (*Eubosstrychoceras*) *salisburgense* sp. nov.; SK/RA/2011/159; holotype; Randobach, Rußbach, Salzburg.

Figs. 5, 10: *Muramotoceras costatum* sp. nov.; Fig. 5 is NHMW 2017/0136/0001; holotype; Fig. 10: dorsal view of the body chamber; Grabenbach, Gosau.

Figs. 6, 7: *Hyphantoceras plicatum* (D'ORBIGNY, 1842); SK/EB/2008/44; Edlbachgraben, Gosau.

Figs. 8, 9: *Scalarites cingulatus* (SCHLÜTER, 1872); SK/EB/2009/47; Edlbachgraben, Gosau.

Figs. 11–13: *Glyptoxoceras crispatum* (MOBERG, 1885); GP II P. 8165 (Fig. 11), TLMF/SM/531 (Fig. 12), M 14 (BSP; Fig. 13); Brandenburg.

Fig. 14: *Didymoceras* (*D.*) sp.; LE GO/2015/0003; Neffgraben, Rußbach.

Figs. 1–4, 14 are middle Santonian, Edlbachgraben and Brandenburg are lower Santonian. All but Fig. 14 are coated with ammonium chloride. Fig. 12 is a silicone cast; enlargements are indicated by 20 mm scale bars.



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## Plate 2

Figs. 1, 7: *Glyptoxoceras retrorsum* (SCHLÜTER, 1872); Fig. 1: LE GO/2015/0002, Fig 7: SK/NE/1989/12; Neffgraben, Rußbach.

Figs. 2, 3: *Schlueterella compressa* KLINGER, 1976; GPII P. 8167; Brandenburg.

Figs. 4, 6: *Neocioceras (Neocioceras) maderi* IMMEL et al., 1982; Fig. 4 is BSP 1981 I 107, the holotype; Fig. 6 is GPII, P. 8166; both from Brandenburg, Tyrol.

Fig. 5: *Glyptoxoceras crispatum* (MOBERG, 1885); NHMW 2015/0539/0001; Grabenbach, Gosau.

Figs. 1, 2, 5 are middle Santonian, Figs. 3, 4, 6, 7 are lower Santonian. All are coated with ammonium chloride. Fig. 1 is x 0.9, Figs. 2–7 are natural size.



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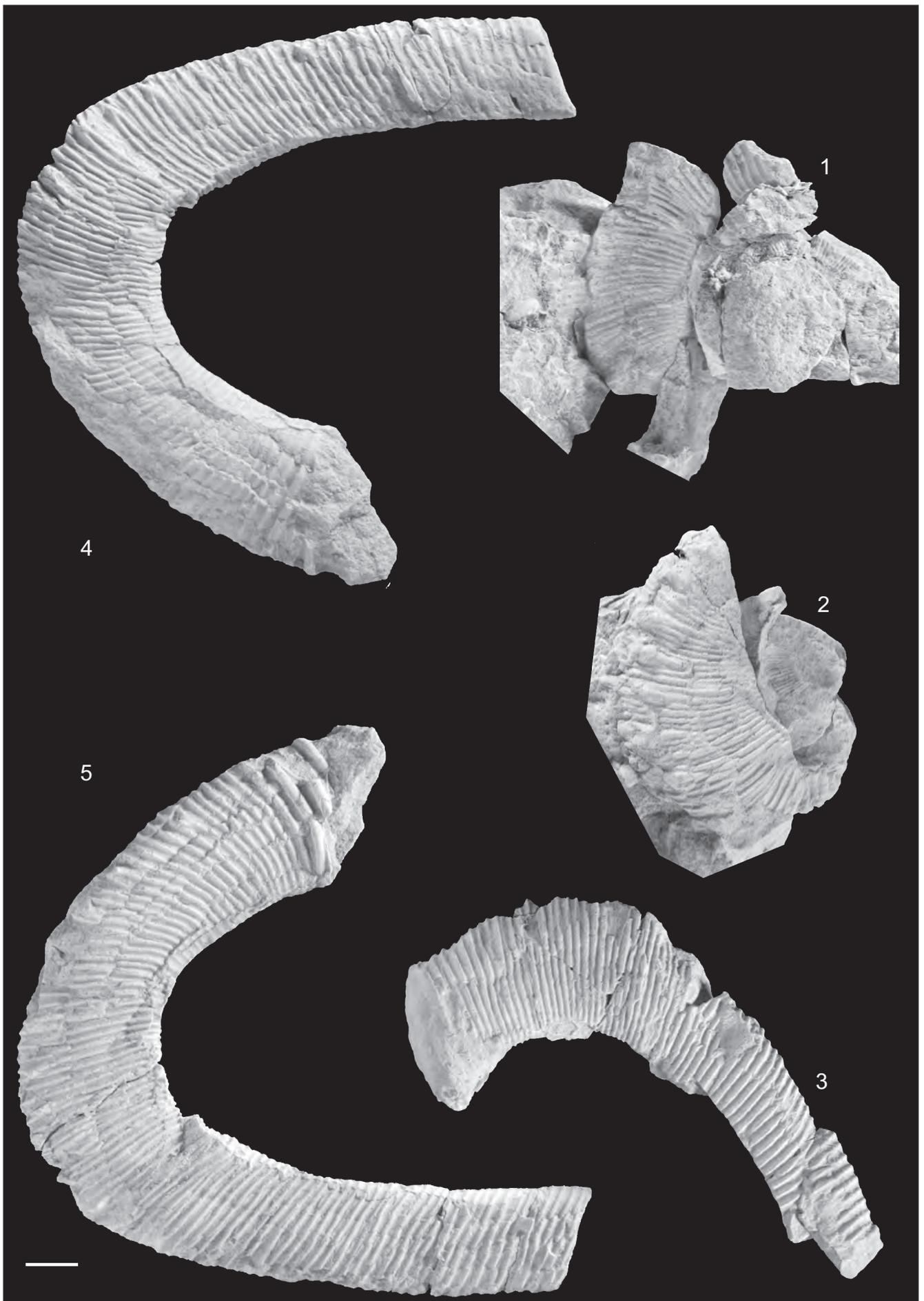
## Plate 3

Figs. 1, 2: *Neocrioceras* (*Neocrioceras*) sp. indet. 1; SK/EB/2002/27a, b; Edlbach, Gosau; lower Santonian.

Fig. 3: *Glyptoxoceras* sp.; SK/GR/1993/40; Grabenbach.

Figs. 4, 5: *Neocrioceras* (*Neocrioceras*) *gosaviense* sp. nov.; MA 1973/1; holotype; Grabenbach.

All are natural size. Figs. 1, 2 are lower Santonian, Figs. 3–5 are lower to middle Santonian. All are coated with ammonium chloride.



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Plate 4

Fig. 1: *Neocrioceras (Neocrioceras) maderi* IMMEL et al., 1982; KL 11501; Brandenberg (Tyrol); lower Santonian.

Uncoated, 55 % of natural size.

10 cm



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## Plate 5

Figs. 1, 3, 5: *Schlueteria compressa* KLINGER, 1976; Fig. 1 is LE GO/2015/0001, Pass Gschütt, Gosau, Fig. 3 is BSP 1959/VI/49, the original of IMMEL et al. (1982: Pl. 10, Fig. 2), Fig. 5 is a cast of M 60, the original of IMMEL et al. (1982: Pl. 10, Figs. 1a, b), Figs. 3 and 5 are from the lower Santonian of Brandenburg.

Figs. 2, 4: *Pseudoxybeloceras (Pseudoxybeloceras) quadrinodosum* (JIMBO, 1894); SK/RA/1981/32 from the middle Santonian of the Rando-  
bach 2 site.

Figs. 1, 3, 5 are natural size, Figs. 2, 4 are enlarged x 1,15. All but Fig. 1 are coated with ammonium chloride.



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## Plate 6

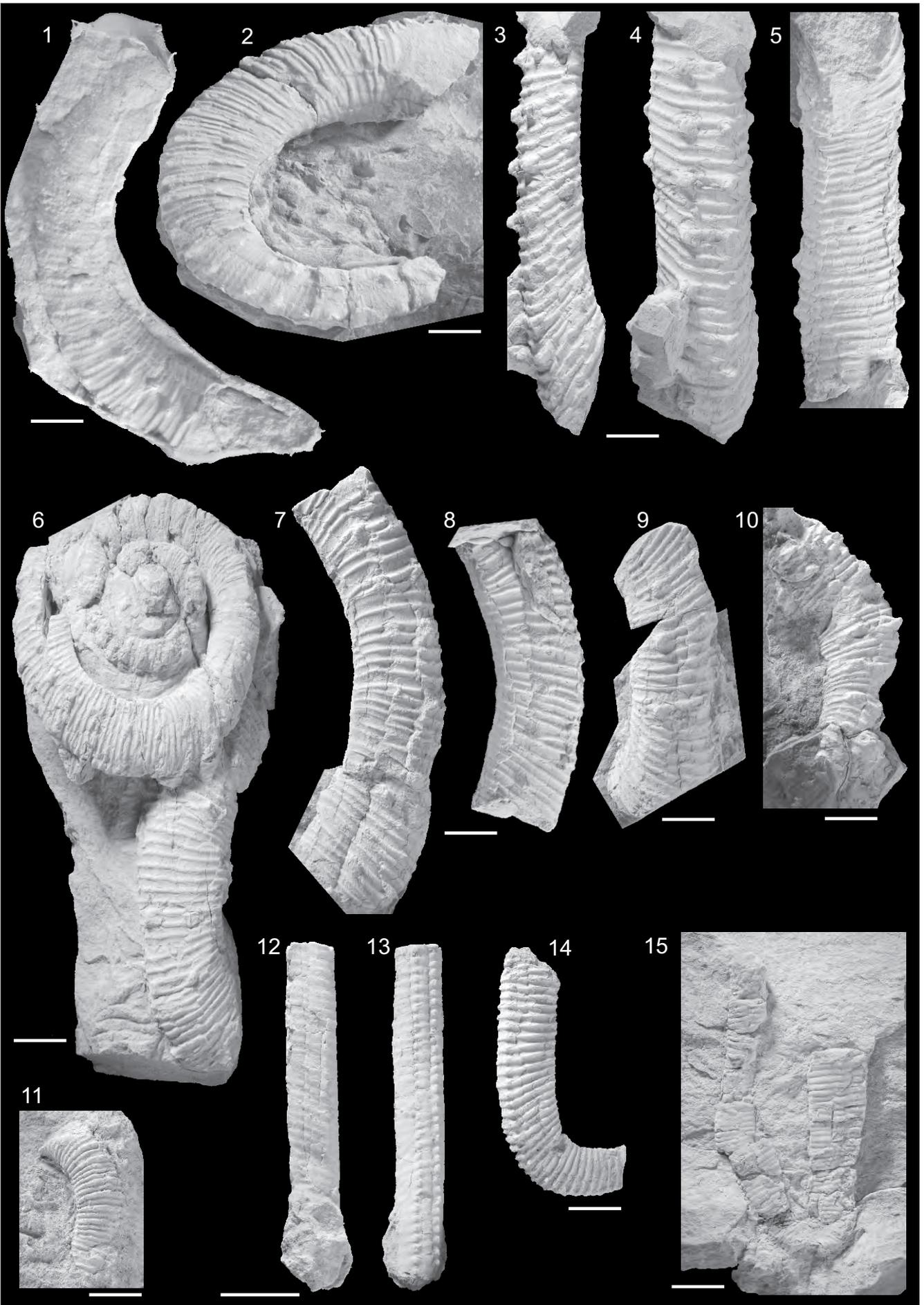
Figs. 1–10: *Schlueteria compressa* KLINGER, 1976; Fig. 1 is GPII P. 8168 (BSP) from Brandenberg, Fig. 2 is from the Santonian of the cable car parking place, Rußbach, Schwaighofer collection, unregistered. Figs. 3–5 are SK/GR/1981/9 from Grabenbach, Gosau, Figs. 6–8 are also from Grabenbach, Fig. 6 is SK/GR/1981/2, Figs. 7, 8 are SK/GR/1993/41, Fig. 9 is NHMW 2015/0402/0001 from Neffgraben, Rußbach, Fig. 10 is SK/GR/2015/51 from the Grabenbach, Gosau.

Fig. 11: *Pseudoxybeloceras (Pseudoxybeloceras) quadrinodosum* (JIMBO, 1894); SK/EB/2015/75 is from Edlbachgraben, Gosau.

Figs. 12–15: *Pseudoxybeloceras (Parasolenoceras) splendens* COLLIGNON, 1969; Figs. 12, 13 are SK/RA/2005/153a, Fig. 14 is SK/RA/1997/135 from Randobach, Rußbach, Fig. 15 is SK/GR/1983/31 from Grabenbach, Gosau.

All but Fig. 2 are coated with ammonium chloride, all but Figs. 12, 13 are natural size, enlargement is indicated by 20 mm scale bars.

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## Plate 7

Figs. 1, 2, 4: *Polyptychoceras* sp., form 1; Fig. 1 is SK/GR/1981/7, Fig. 2 is NHMW 2013/0530/0002, Fig. 4 is SK/GR/1983/32; all are from Grabenbach, Gosau.

Fig. 3: *Polyptychoceras* sp., form 2; SK/RA/1997/136; Randobach, Rußbach 2 site.

Fig. 5: *Polyptychoceras* sp., juv.; SK/RA/1988/117a, b from the Randobach 1 site, Rußbach.

Fig. 6: *Polyptychoceras* sp., form 3; SK/GR/2014/49 from Grabenbach, Gosau.

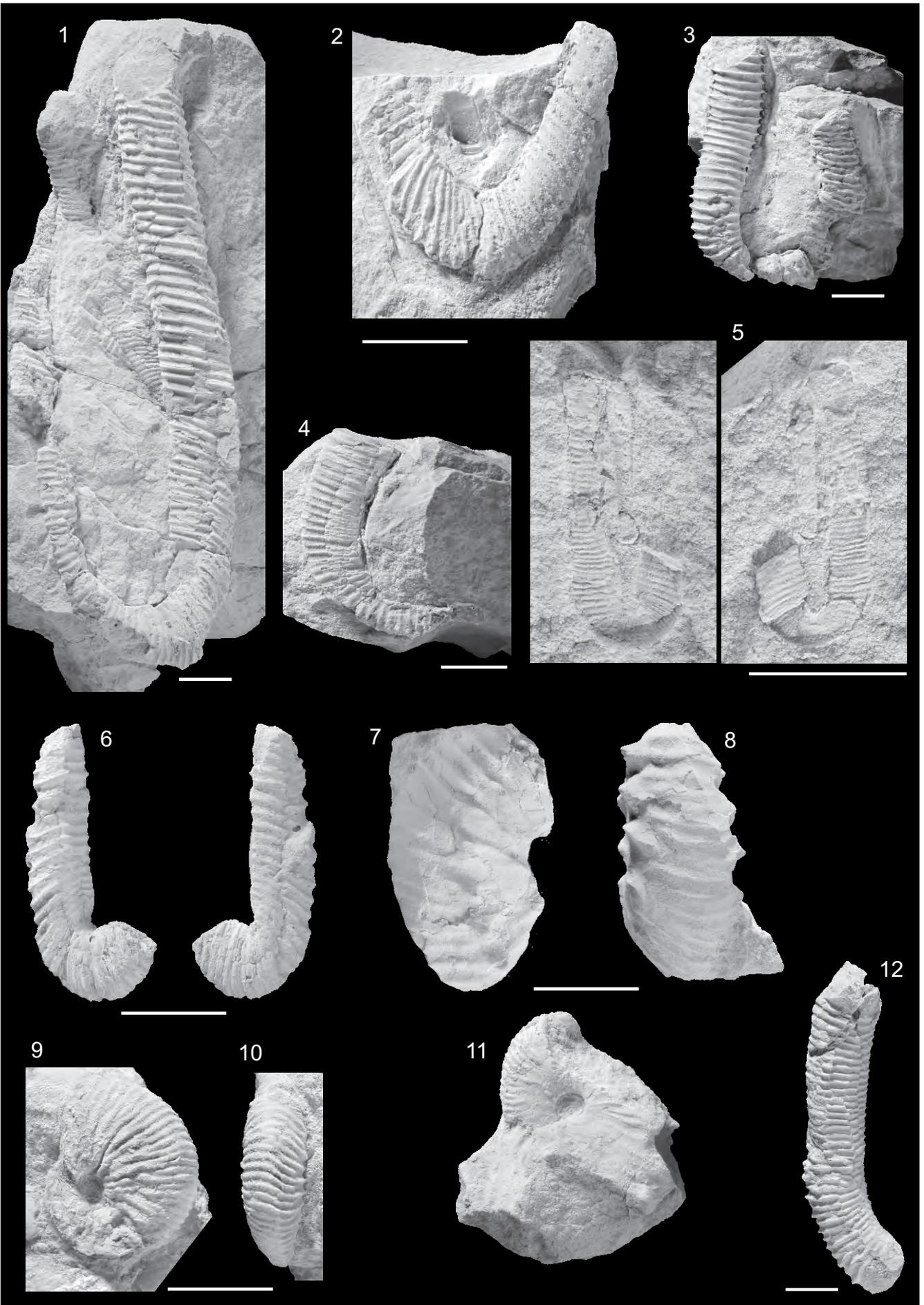
Figs. 7, 8: *Scaphites leei* REESIDE, 1927, form II (COBBAN, 1969); NHMW 1982/0034/0001 from Grabenbach, Gosau.

Figs. 9–11: *Scaphites* sp.; Figs. 9, 10 are SK/RA/1996/130 (Randobach, Rußbach), Fig. 11 is SK/EB 1985/7 (Edlbach, Gosau).

Fig. 12: *Pseudoxybeloceras* (*Pseudoxybeloceras*) *quadrinodosum* (JIMBO, 1894); SK/RA/1981/32 from the middle Santonian of the Randobach 2 site.

Figs. 1, 3 are natural size, Fig. 2 is enlarged x 2, Fig. 4 is enlarged x 1,25, Fig. 5 is enlarged x 3, Figs. 6–11 are enlarged x 2, Fig. 12 is enlarged x 1.15. All are coated with ammonium chloride, Fig. 5 is enhanced by pencil. Scale bars are 10 mm.

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## Plate 8

- Fig. 1: SK/RA/1982/70a.  
Fig. 2: SK/RA/1981/37a.  
Fig. 3: SK/RA/1981/37b *B. brevicosta*.  
Fig. 4: SK/RA/1982/70c.  
Fig. 5: SK/RA/1983/92b.  
Fig. 6: SK/RA/1982/70b.  
Figs. 7, 8: SK/RA/1983/93c.  
Fig. 9: SK/RA/2003/150c.  
Figs. 10, 11: SK/EB/2003/30.  
Fig. 12: SEIDL/CE 00003.  
Fig. 13: SK/NE/1989/2.

Figs. 1, 2, 4–13: *Baculites incurvatus* DUJARDIN, 1837, Fig. 3 is *B. brevicosta* SCHLÜTER, 1876.

All are natural size, all are coated with ammonium chloride. Figs. 1–9 are from Randobach, Figs. 10, 11 are from Edlbachgraben, Figs. 12, 13 from Neffgraben, Rußbach. Figs. 1–9, 12, 13 are middle Santonian, Figs. 10, 11 are lower Santonian. Scale bar is 10 mm.

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## Plate 9

### *Baculites incurvatus* DUJARDIN, 1837

- Fig. 1: LE GO/2015/0003; mass occurrence of *Baculites incurvatus* together with *Didymoceras (D.)* sp.  
Figs. 2, 3: SK/RA/2003/150a.  
Fig. 4: SK/NE/2013/21e.  
Figs. 5, 6: SK/NE/1989/11b.  
Fig. 7: SK/RA/1982/70e.  
Figs. 8, 9: SK/RA/1982/71d.  
Fig. 10: SK/NE/1989/11d.

All but Figs. 8, 9 (= x 2) are natural size, all are coated with ammonium chloride. Figs. 2, 3, 7, 8, 9 are from Randobach, Rußbach, Figs. 1, 4, 5, 6, 10 are from Neffgraben, Rußbach; all are middle Santonian. Scale bars are 10 mm.



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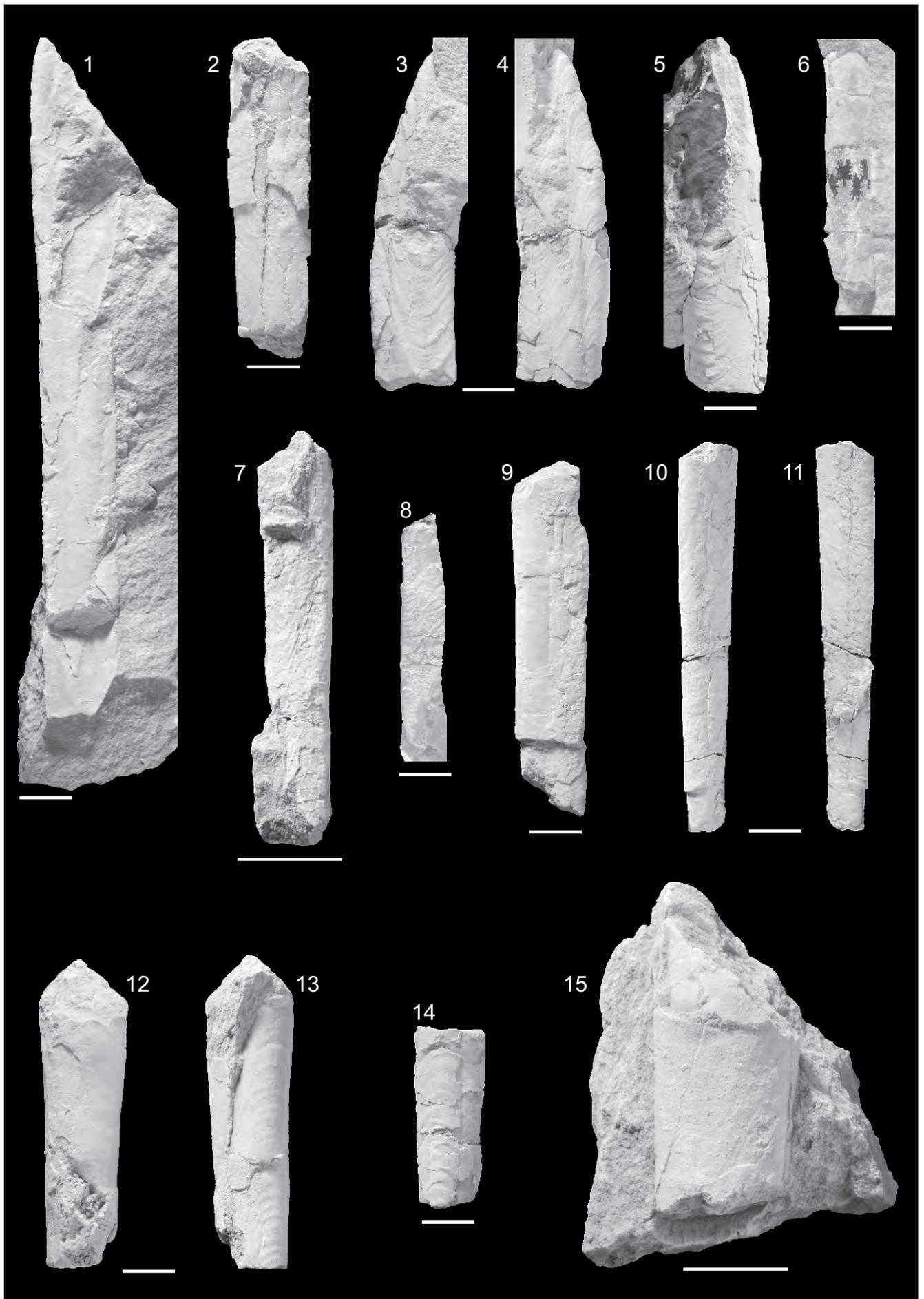
## Plate 10

### *Baculites fuchsi* REDTENBACHER, 1873

- Fig. 1: SK/RA/1983/99.  
Fig. 2: SK/RA/1982/69c.  
Figs. 3, 4: NHMW 2016/0047/0001.  
Fig. 5: NHMW 1865/0001/0138 (holotype), Tiefengraben, Gosau.  
Fig. 6: NHMW 1926/0002/2468 (ex coll. Heinrich).  
Fig. 7: SK/RA/1982/71b.  
Fig. 8: SK/RA/1982/70d.  
Fig. 9: SK/GR/1981/17b.  
Figs. 10, 11: OÖLM/2016/1.  
Figs. 12, 13: OÖLM/2016/2.  
Fig. 14: SK/RA/1983/100b.  
Fig. 15: HNS 6404.

All but Figs. 7, 15 (= x 2) are natural size, all but Fig. 6 are coated with ammonium chloride. Figs. 1, 2, 7, 8, 14 are from Randobach, Figs. 5, 9 are from Tiefengraben (= Grabenbach), Gosau. Scale bars are 10 mm.

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## Plate 11

- Fig. 1: SEIDL/CE 00009.  
Fig. 2: SK/NE/1989/11a.  
Fig. 3: SK/RA/1981/38a.  
Fig. 4: SK/NE/2001/19.  
Fig. 5: SK/NE/2013/21c.  
Fig. 6: SK/NE/2013/21b.  
Fig. 7: SK/NE/1989/11c.  
Fig. 8: SK/GR/1981/17a *Baculites* sp.  
Fig. 9: SK/NE/2013/21d.  
Fig. 10: SK/RA/1981/38c.  
Fig. 11: SK/RA/2003/150b.  
Fig. 12: SK/RA/1981/38a.  
Fig. 13: SK/RA/1982/71a.  
Figs. 14, 15: SK/RA/1983/90.  
Fig. 16: SK/RA/1983/93b.  
Figs. 17, 18: SK/RA/1983/92c.  
Fig. 19: SK/RA/1983/93a.  
Fig. 20: SK/RA/2003/150d.

Figs. 1–7, 9–20: *Baculites brevicosta* SCHLÜTER, 1876. Fig. 8 is *Baculites* sp.

All are natural size, all are coated with ammonium chloride, all are middle Santonian. Figs. 1–2, 4–6, 7, 9 are from Neffgraben, Rußbach, Figs. 3, 10–20 are from Randobach, Rußbach, Fig. 8 is from Grabenbach, Gosau.

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