Austrian Journal of Earth Sciences | Vienna | 2017 | Volume 110/1 | 122 - 141 | DOI: 10.17738/ajes.2017.0009

On late Santonian ammonites from the Hofergraben Member (Gosau Group, Upper Cretaceous, Austria)

Herbert SUMMESBERGER[1)*)], William J. KENNEDY[2)] & Peter SKOUMAL[3)]

[1)] Museum of Natural History Vienna, Burgring 7, 1010 Vienna, Austria;

[2)] Oxford University, Museum of Natural History, Oxford OX1 3PW, United Kingdom;

[3)] Bastiengasse 56, 1180 Vienna, Austria;

[*)] Corresponding author, herbert.summesberger@nhm-wien.ac.at

KEYWORDS Ammonites; Late Cretaceous; Northern Calcareous Alps; Gosau Group; Hofergraben Member; Austria

Abstract

11 ammonite taxa are described from the upper Santonian of the Hofergraben site (Gosau Group; Upper Austria): Pachydiscidae gen. et sp. indet. juv., *Placenticeras polyopsis* (Dujardin, 1837), *Placenticeras paraplanum* Wiedmann, 1978, *Placenticeras* aff. *maherndli* Summesberger, 1979, *Texanites quinquenodosus* Redtenbacher, 1873, *Eulophoceras jacobi* Hourcq, 1949, *Jouaniceras hispanicum* Wiedmann, 1994, ? *Jouaniceras* sp., *Eubostrychoceras acuticostatum* (d'Orbigny, 1842), *Glyptoxoceras crispatum* (Moberg, 1885), *Baculites fuchsi* Redtenbacher, 1873. *Jouaniceras hispanicum* Wiedmann, 1994 and *Eubostrychoceras acuticostatum* (d'Orbigny, 1842) are recorded for the first time from the Gosau Group confirming the close connection with the Upper Cretaceous of the Corbières (France: Kennedy in Kennedy et al. 1995).

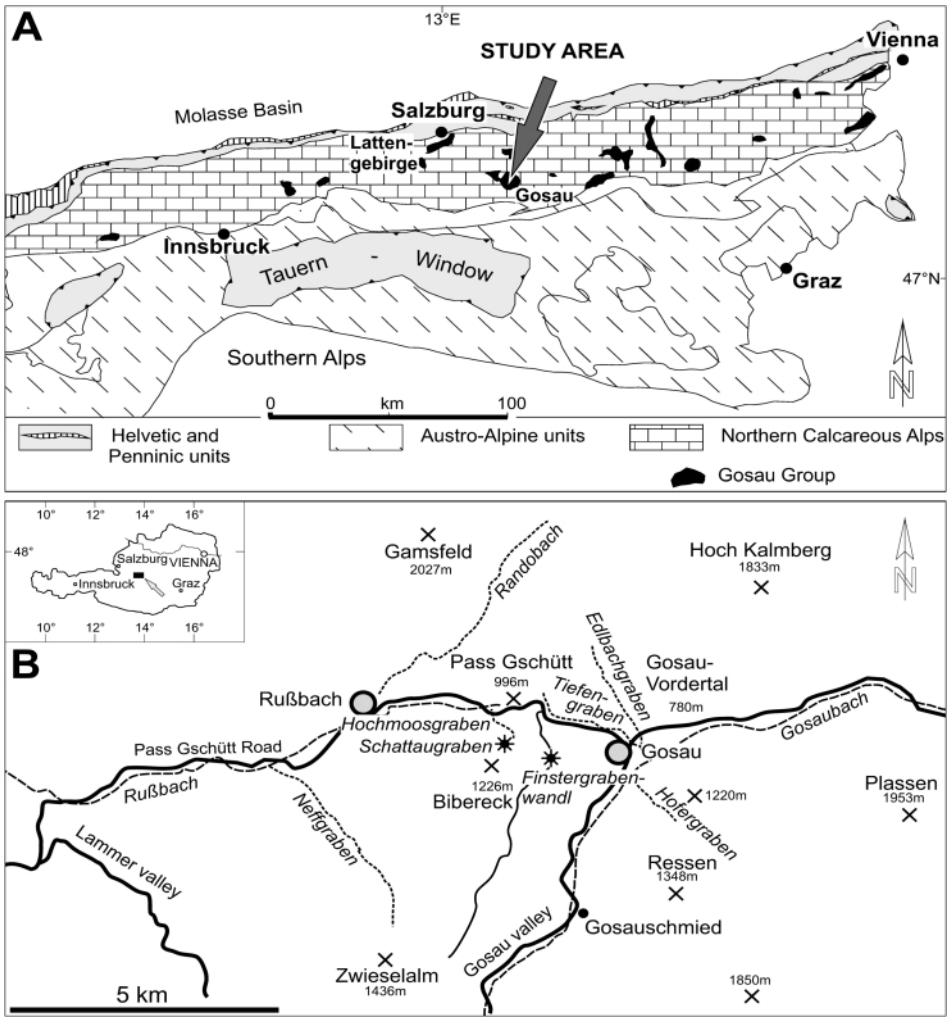


Figure 1: A. Schematic geological map of the Eastern Alps. Occurrences of Gosau Group sediments (black), brick symbol: Northern Calcareous Alps. After Summesberger et al. (2017a). B. Local sketch map of parts of the Gosau Basin, with modifications after Summesberger et al. (2017a) indicating the localities mentioned in the text.

11 Taxa Ammoniten aus dem oberen Santonium des Hofergrabens (Gosau-Gruppe; Oberösterreich) werden beschrieben: Pachydiscidae gen. et sp. indet. juv., *Placenticeras polyopsis* (Dujardin, 1837), *Placenticeras paraplanum* Wiedmann, 1978, *Placenticeras* aff. *maherndli* Summesberger, 1979, *Texanites quinquenodosus* Redtenbacher, 1873, *Eulophoceras jacobi* Hourcq, 1949, *Jouaniceras hispanicum* Wiedmann, 1994, ? *Jouaniceras* sp., *Eubostrychoceras acuticostatum* (d'Orbigny, 1842), *Glyptoxoceras crispatum* (Moberg, 1885), *Baculites fuchsi* Redtenbacher, 1873. *Jouaniceras hispanicum* Wiedmann, 1994 und *Eubostrychoceras acuticostatum* (d'Orbigny, 1842) werden zum ersten Mal aus der Gosau-Gruppe erwähnt und bestätigen die nahe Beziehung zur Oberkreide der Corbières (Frankreich: Kennedy in Kennedy et al., 1995).

1. Introduction

The Gosau Group successions of the Northern Calcareous Alps of Austria are well known for

their richness in macrofossils and for their contributions to Upper Cretaceous stratigraphy (e.g. Summesberger, 1985; Wagreich et al., 2009).

The late Santonian Sandkalkbank Member of the Hochmoos Formation is a distinct marker bed of about 20 metres thickness. It extends from the junction of the "*elliptica*" Graben (Gerth, 1961, fig. 3) with the Neffgraben (Russbach, Salzburg), continues along the slope of the Schattau (Russbach, Salzburg) turns around the Bibereck where it appears in the "Finstergrabenwandl". On the opposite side of the Gosau valley it loses its distinct character and terminates in the Hofergraben (Gosau, Upper Austria). The fauna of the Sandkalkbank Member was described by Wiedmann (1978: ammonites), Summesberger (1979, 1980: ammonites), Kollmann (1980: gastropods), Dhondt (1984: bivalves) and Summesberger et al. (2017c: ammonites).

The Hofergraben Member of the Hochmoos Formation, underlying the Sandkalkbank Member, is well-known for the excellent preservation of abundant bivalves (e.g. the type specimen of *Cordiceramus muelleri* (Petrascheck, 1906); fide Dhondt, 1987) and gastropods (Zekeli, 1852; Zittel, 1865–1866; Felix, 1908). In this paper cephalopods from the Hofergraben are described augmenting the previously described late Santonian cephalopod faunas noted above.

2. Geological Setting

The Hofergraben locality is situated in the Upper Austrian part of the Gosau Basin. The Gosau Basin exposes a sedimentary sequence, the Gosau Group, that ranges from Upper Turonian to Eocene. It begins with terrestrial conglomerates (the Kreuzgraben Formation) and coal bearing strata of the Neualm (Salzburg), where the ammonite *Barroisiceras haberfellneri* (Hauer, 1858) indicates a late Turonian age. The early Santonian Grabenbach and Hochmoos formations of the Lower Gosau Subgroup were deposited under shallow marine conditions. The highly fossiliferous Hofergraben Member and the Sandkalkbank Member of the Hochmoos Formation record the end of this shallow marine period, which was followed in the Campanian by increasing subsidence and the deep water deposits of the Upper Gosau Subgroup (Ressen Formation, Nierental Formation). The Maastrichtian to Eocene Zwieselalm Formation marks the end of marine sedimentation

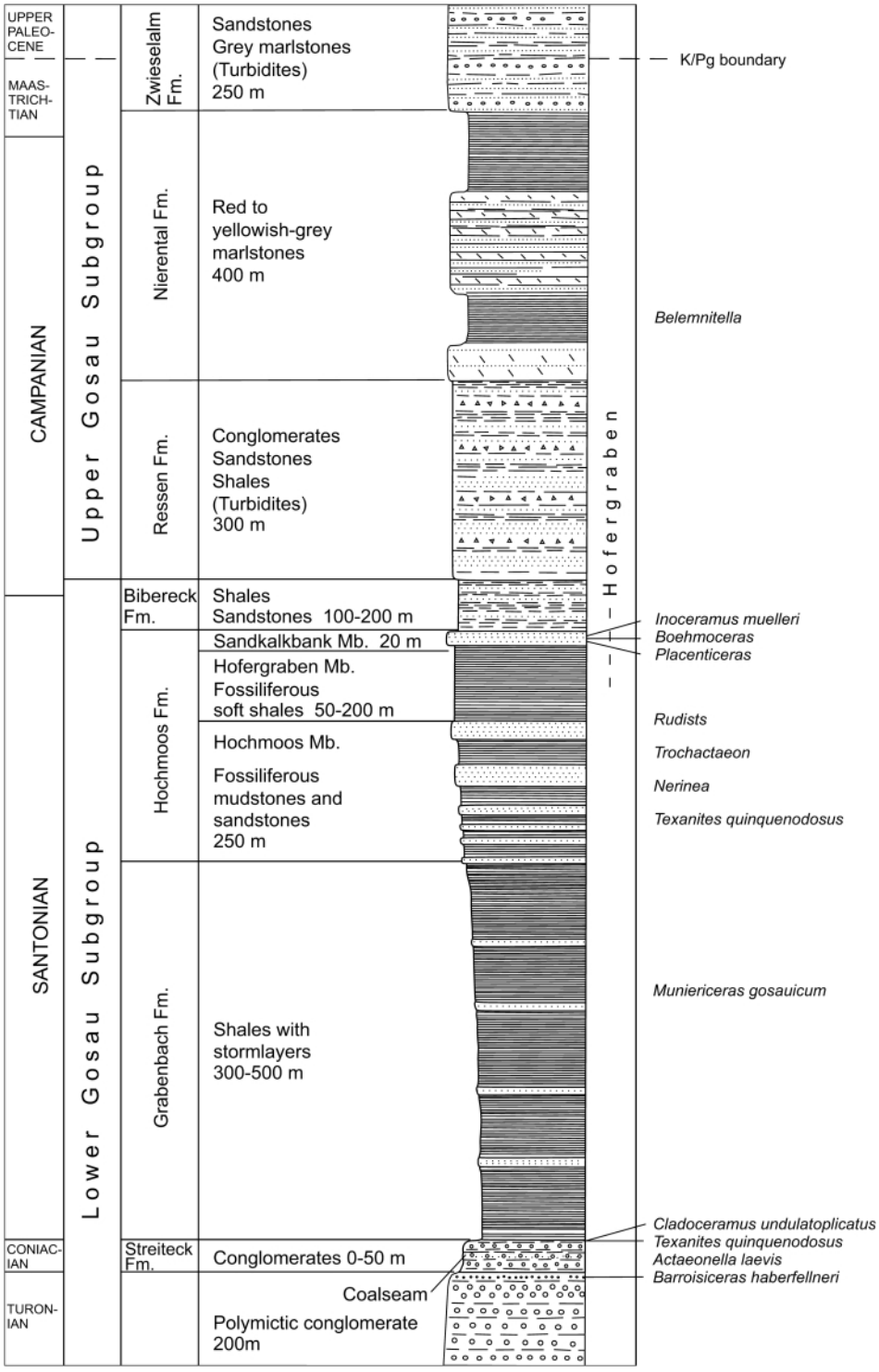


Figure 2: Composite section of the Gosau Group in the Gosau area indicating the position of the Hofergraben Member (with revisions after Summesberger et al. 2017c).

(Wagreich and Decker, 2001).

3. Repositories of specimens

NHMW Natural History Museum, Vienna, Austria
GBA Geologische Bundesanstalt (Geological Survey of Austria, former k. k. Geologische Reichsanstalt), Vienna, Austria
MA Wolf-Peter Maherndl collection, Bad Ischl, Austria
SK Dr. Peter Skoumal collection, Vienna, Austria
GPIT Geologisch Paläontologisches Institut der Universität Tübingen
LPMP Laboratoire du Muséum de Paléontologie, Paris

4. Systematic Palaeontology

Class Cephalopoda Cuvier, 1797
Order Ammonoidea Zittel, 1884
Suborder Ammonitina Hyatt, 1889
Superfamily Desmoceratoidea Zittel, 1895
Family Pachydiscidae Spath, 1922
Pachydiscus sp. indet., juv.
Fig. 6/5; Tab. 1

Description: SK/HO/1996/8 (Fig. 6/5) is a small internal mould with large areas of adherent shell preserved. Coiling is involute, the specimen deformed into an ellipse by compaction.The expansion rate is high. Close to the adapertural end the whorl section is almost circular. The umbilicus is deep and narrow, the umbilical shoulder rounded. About ten irregular coarse ribs arise on the umbilical shoulder in the form of elongated bullae, some of which cross the flank and extend over the venter, others end around mid-flank. There are no constrictions or ventral tubercles; the sutures are not visible.
Discussion: The specimen is interpreted as a juvenile pachydiscid, which we are unable to link to adult specimens of the same age. It is not a microconch, as it lacks ventrolateral tubercles.
Occurrence: Known only from the Hofergraben (Gosau, Upper Austria).

	D_{Drest}	Wh	Wb	U	U%
SK/HO/1996/8	25	12	11	5	20%

Table 1: *Pachydiscus* sp. indet., juv.; All measurements are restored.

Superfamily Hoplitoidea H. Douvillé, 1890
Family Placenticeratidae Hyatt, 1900
Genus *Placenticeras* Meek, 1876

Type species: *Ammonites placenta* DeKay, 1828, p. 278, pl. 5, fig. 2 by original designation of Meek, 1876, p. 442.

Placenticeras aff. *maherndli* Summesberger, 1979
Fig. 7/4, 5; Tab. 2

1979 *Placenticeras maherndli* Summesberger, p. 155, pl. 14, fig. 58- 61; pl. 15, figs 62-66.
1995 *Placenticeras maherndli* Summesberger; Kennedy in Kennedy et al., p. 411, pl. 22, fig. 7.

Type: the holotype, by original designation, is MA 77/ 2, form A, the original of Summesberger, 1979 (pl. 14, fig. 58, 59).
Material: SK/HO/1995/7, SK/HO/1989/6, NHMW/2016/0191/0001
Description: SK/HO/1995/7 (Fig. 7/4, 5), SK/HO/1989/6 and NHMW/2016/0191/0001 are fragments of internal moulds with large areas of the original shell preserved. NHMW/2016/0191/0001 is heavily crushed. SK/HO/ 1995/7 is the best preserved individual. All three specimens are deformed into an ellipse. Measurements (Tab. 2) are restored.

	D_{rest}	Wh_{rest}	Wb	U	U%
SK/HO/1995/7	60_{rest}	30_{rest}	14.4	15_{rest}	25%
NHMW/2016/0191/1	60_{rest}	30_{rest}	--	15_{rest}	25%

Table 2: Measurement of *Placenticeras* aff. *maherndli* Summesberger, 1979 from the Hofergraben site. Deformed dimensions are restored ($_{rest}$).

SK/HO/1995/7 and NHMW/2016/0191/0001 are apparently adult individuals with the body chamber preserved. They are laterally flattened to a certain degree. Coiling is moderately involute, the umbilicus comprising about 25% of the diameter. The umbilical depth increases through ontogeny. The umbilical wall is steep and outwards inclined, the umbilical shoulder narrowly rounded. SK/HO/1989/6 is a fragment of an umbilicus, with clearly visible umbilical tubercles; these are less distinct in SK/HO/1995/7. This specimen shows clavate ventrolateral tubercles close to the ventrolateral edge. The flanks are slightly convex, the venter concave between ventrolateral ridges. The flanks are covered with very fine falcoid lirae, increasing in strength towards the aperture. They are prorsiradiate at the umbilical shoulder, sweeping over the flank in a wide convexity before finally flexing back towards the ventrolateral edge in a prorsiradiate concavity. SK/HO/1995/7 shows partially visible, crowded sutures.
Discussion: *Placenticeras* aff. *maherndli* differs from *Placenticeras maherndli* Summesberger, 1979 in its fine lirate ribbing (see MA 1977/3: Summesberger, 1979, pl. 15, fig. 63).
Occurrence: *Placenticeras* aff. *maherndli* occurs in the upper Santonian Gosau Group of the Hofergraben only (Gosau, Upper Austria).

Placenticeras polyopsis (Dujardin, 1837), juv.
Fig. 6/6, 7

1837 *Ammonites polyopsis* Dujardin, p. 232, pl. 17, fig. 12.
1903 *Placenticeras depressum* Hyatt, p. 237.
1935 *Placenticeras depressum*; Brinkmann, p. 5.
1978 *Stantonoceras depressum* (Hyatt); Wiedmann, p. 665; pl. 1, figs 1, 2.
1979 *Stantonoceras depressum* (Hyatt), Summesberger, p. 145; pl. 10, figs 42, 43; pl. 11, figs 44-47; pl. 12, figs 48-52, text-figs

31-37 (with synonymy).
1983 *Placenticeras polyopsis* (Dujardin, 1837); Kennedy and Wright, p. 156, pls. 85, 86, text-figs 1-4 (with synonymy).
1995 *Placenticeras polyopsis* (Dujardin, 1837); Kennedy in Kennedy et al. (p. 410, pl. 17, figs. 2-7, 9, 10; pl. 18, fig. 7.12; fig. 21. (with additional synonymy).
2017c *Placenticeras polyopsis* (Dujardin, 1837); Summesberger et al.,in press, pl. 10, figs 6a-b.

Lectotype: the original of Dujardin (1837: pl. 17, fig. 12a) designated by Kennedy and Wright (1983: p. 856).
Material: SK/HO/1989/4 a single juvenile individual.
Description: The single specimen SK/HO/1989/4 (Fig. 6/6, 7) is a well preserved juvenile of about 30 mm diameter. The umbilicus measures 4.4 mm. The whorl height is about 10 mm. There are 10 prorsiradiate umbilical bullae. They efface on the lower third of the flank, and may or may not link to the strong ventrolateral clavi. The flanks are irregular and very flat; there are narrow ventrolateral ridges, the venter is flat. The sutures are not visible. The aperture is not preserved.
Discussion: *Placenticeras* aff. *maherndli* Summesberger, 1979 differs from *Placenticeras polyopsis* (Dujardin, 1837) in the lirate ornament of the flanks.
Occurrence: *Placenticeras polyopsis* (Dujardin, 1837) is common in the upper Santonian of the Finstergrabenwandl Member (Summesberger, 1979, Summesberger et al., 2017c. In the Corbières it ranges through the whole Santonian (Grossouvre, 1894; Kennedy in Kennedy et al., 1995). It seems to be limited to the upper Santonian in the Gosau Group.

Superfamily Acanthoceratoidea de Grossouvre, 1894
Family Collignoniceratidae Wright and Wright, 1951
Subfamily Texanitinae Collignon, 1948
Genus and Subgenus *Texanites* Spath, 1932

Type species: *Texanites texanus* F. Roemer, 1852 by original designation of Spath, 1932

Texanites (Texanites) quinquenodosus (Redtenbacher, 1873)
not figured

1854 *Ammonites texanus* ?; Reuss, p. 24, 41.
1858 *Ammonites texanus* von Hauer (non Römer, 1852); p. 10, pl. 2, fig. 4–6.
1873 *Ammonites quinquenodosus* Redtenbacher; p. 108; pl. 24, fig. 3.
1948 *Texanites quinquenodosus* (Redtenbacher); Collignon, p. 69.
1981 *Texanites quinquenodosus* (Redtenbacher); Kennedy, Klinger and Summesberger, p. 126, fig. 8–16 (with synonymy).
2012 *Texanites quinquenodosus* (Redtenbacher, 1873); Summesberger and Zorn, pp. 6, 7; pl. 15, fig. 1; pl. 16, fig. 1.
2017a *Texanites (Texanites) quinquenodosus* (Redtenbacher, 1873); Summesberger et al., in press, pl. 19, figs. 3-7 (with synonymy).

Lectotype: is GBA 1873/01/13, the original of Redtenbacher (1873, pl. 24, Fig. 3a, b) from the Santonian Gosau Group of St. Wolfgang, refigured by Kennedy et al. (1981: p. 128, fig. 8).
Material: NHMW 1864/0001/0730, a single specimen from the collection of the Natural History Museum Vienna.
Description and Discussion: NHMW 1864/0001/0730 is a large fragment of originally about 120 mm in diameter, broken into pieces but nevertheless identifiable by the preserved characteristics. A larger part of the fragment was figured by Kennedy et al. (1981, Fig. 9 C).
Occurrence: *Texanites quinquenodosus* Redtenbacher, 1873 is one of the more common ammonites occurring in the Gosau Group. Its stratigraphic range extends from basal Santonian through lower and middle Santonian. Stratigraphically lowest occurrences are at the Randobach of Russbach (Salzburg), the Stöcklwaldgraben (a side creek of the Randobach), at the Schneiderwirtsbrücke, often co-occurring with *Cladoceramus undulatoplicatus*. Its stratigraphically highest position is below the Sandkalkbank Member in the Neffgraben (Russbach, Salzburg). Its occurrence at the Hofergraben is therefore older than the recently collected upper Santonian fauna described herein.

Family Sphenodiscidae Hyatt, 1900
Subfamily Lenticeratinae Hyatt, 1900
Genus *Eulophoceras* Hyatt, 1903

Type species: *Eulophoceras natalense* Hyatt, 1903, p. 86, pl. 11, figs 2-6, by original designation.

Eulophoceras jacobi Hourcq, 1949
Fig. 4/1-8; Tab. 3

1949 *Eulophoceras Jacobi* Hourcq; p. 95, pl. 1, fig. 2.
1969 *Eulophoceras Jacobi* Hourcq; Collignon, p. 204, pl. 600, fig. 2253.
1979 *Skoumalia austriaca* Summesberger 1979, form B; p. 143, pl. 9, fig. 39-41, text-fig. 29, 30.
non 1979 *Skoumalia austriaca* Summesberger, form A, p. 141, pl. 9, fig. 37-38, text-fig. 26, 27, 28 (= *Diaziceras austriacum* (Summesberger, 1979)).
1980 *Skoumalia austriaca* Summesberger, form B; Summesberger, p. 280, pl. 2, fig. 5–6; pl. 3, fig. 7-8; text-fig. 5, 6. 1982 *Skoumalia austriaca* Summesberger; Kollmann and Summesberger, p. 49, partim.
1985 *Eulophoceras austriacum*, "forme B" (Summesberger); Amédro and Hancock, p. 23–24; fig. 11 d, e.
1987 ? *Eulophoceras austriacum* (Summesberger 1979); Immel, p. 113, partim.
1987 *Eulophoceras austriacum* (Summesberger, 1979); Kennedy, p. 776, pl. 82, fig. 1–3.
1995 *Eulophoceras austriacum* (Summesberger, 1979); Kennedy in Kennedy et al., p. 426; pl. 26, fig. 8; text-fig. 33.
non 1995 *Eulophoceras austriacum* (Summesberger, 1979); Kennedy in Kennedy et al., Pl. 25, Fig 3–5; text-fig. 34 (= *Dia-*

ziceras austriacum (Summesberger, 1979).
non 1995 *Eulophoceras austriacum* (Summesberger, 1979); Lommerzheim, p. 61, Pl. 5, Fig. 2.
2000 *Eulophoceras austriacum* (Summesberger, 1979); Summesberger in: Egger et al., p. 26, partim.
2012a *Eulophoceras jacobi* Hourcq; Kennedy and Klinger, p. 32, 35; fig. 4, 12 A-C.
2017c *Eulophoceras jacobi* Hourcq, 1949; Summesberger et al., in press, pl. 10, Figs. 2-5, Text-fig. 17.

Lectotype: is the original of Hourcq (1949: pl. 11, fig. 2, text-fig. 7) subsequently designated and refigured by Kennedy and Klinger (2012a, p. 35; text-fig. 12 A-C).
Material: 11 specimens: SK 1979/3; SK/HO/1989/5a,b; SK/HO/2003/9, 10, 11, 12; SK/HO/2004/14, 15, 16, 20; (+ 9 specimens from Hofergraben, collection Skoumal).

	D	Wh	Wb	U	U%
SK/HO/1989/5a	37.3	20.2	5.5	2.7	7.2 %
SK/HO/1989/5b	25.8_{rest}	16.0	7.8	2.7	10.4 %
SK/HO/2003/9	53.3	31.3		2.9	5.4 %
SK/HO/2003/10	39.5_{rest}	30.0	8.0_{rest}	2.2	5.7 %
SK/HO/2003/11	36.5_{rest}	21.4	9.88	2.7	7.4 %
SK/HO/2003/12	23.3_{rest}	13.4_{rest}	--	1.8	7.8 %
SK/HO/2004/14	25.5_{rest}	18.4_{rest}	3.9	1.6	6.3 %
SK/HO/2004/15	27.5	14.3	4.9	3.7	5.8 %
SK/HO/2004/16	24.0	30.05	--	1.5	6.25 %
SK/HO/2004/20	30.0_{rest}	15.7		2.1	7.0 %
Orig. Hourcq	119.0	70.0	25.0	2.7	2.3 %
SK 1979/3	122.2	69.7	29.0	--	--

Table 3: Measurements of *Eulophoceras jacobi* Hourcq, 1949 from the upper Santonian of the Hofergraben (Gosau, Upper Austria); rest = restored value. Orig. Hourcq (measurement after Kennedy and Klinger 2012a, p. 35); SK 1979/3 (from Finstergrabenwandl; measurement after Summesberger, 1980).

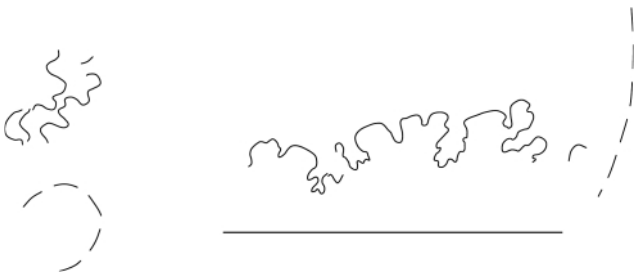


Figure 3: External suture of Eulophoceras jacobi Hourcq, 1949; SK/HO 2004/20.

Description: All individuals from the Hofergraben site are relatively small and preserved as internal moulds with large areas of adherent shell. They are flattened by lateral compaction and deformed into an ellipse. The measurements are tentatively restored in tab. 3. Prorsiradiate umbilical bullae give rise to pairs or single flexuous ribs that cross the flanks in a broad, shallow convexity. They efface or strengthen again close to the venter, where they terminate in a ventrolateral swelling. The entire and sharp keel is flanked by shallow sulci. The umbilicus is very small. The contemporaneous individual SK 1979/3 from the Finstergrabenwandl (Summesberger, 1980) is much larger. The entire and sharp keel of the phragmocone disappears on the body chamber, a feebly convex venter extending to the adult aperture. Its surface is smooth but for bullate swellings in a marginal position. The well-preserved suture was figured by Summesberger (1980, text-fig. 6). For further description of *Eulophoceras jacobi* Hourcq, 1949 see Kennedy and Klinger 2012a (p. 35, figs 12 A-C, the lectotype) and Summesberger et al. (2017c).
Discussion: *Eulophoceras jacobi* Hourcq, 1949 from the upper Santonian of the Gosau Group was described originally as form B of *Skoumalia austriaca* Summesberger 1979, 1980. After Amédro and Hancock (1985, p. 23, fig. 11 d, e) form B fell into synonymy of *Eulophoceras austriacum* (Summesberger). Kennedy and Klinger (2012a, p. 32) separated both "forms" generically, form A being *Diaziceras* and form B being *Eulophoceras*. They (2012a, p. 32) compared *Skoumalia austriaca* form B (Summesberger, 1979) with *Eulophoceras jacobi* Hourcq, 1949 and *Skoumalia austriaca* form A (Summesberger, 1979) with *Diaziceras* resembling closely *D. guillantoni* Hourcq, 1949. We follow their suggestion and assume that *Skoumalia austriaca* form B is conspecific with *Eulophoceras jacobi* Hourcq, 1949. The closest relative in our opinion and probably the ancestor of *E. jacobi* is *Eulophoceras natalense* Hyatt, 1903.
There is remarkable parallel evolution in the ontogenetic changes of ornament in *Eulophoceras jacobi* Hourcq, 1949 and *Eulophoceras natalense* Hyatt, 1903: a flank ornament of falcoid ribs in immature individuals is succeeded by a stage with smooth flanks, with very feeble ribs or growth lines only in adults.
Diaziceras austriacum (Summesberger, 1979) differs in its larger umbilicus (13%), distinct umbilical tubercles and irregular and very flat ribbing. The type species is *Diaziceras tissotiaeforme* Spath 1921, the holotype by monotypy refigured by Kennedy and Klinger (2012 b, text-fig. 1 C, D, E).
Occurrence: *Eulophoceras jacobi* Hourcq, 1949 occurs in the upper Santonian Hofergraben Member of the Upper Gosau Subgroup of the Hofergraben (Gosau, Upper Austria) and in the stratigraphically very close Finstergrabenwandl. It was described originally by Hourcq, 1949 from the top Santonian of Madagascar. It was furthermore described under *Eulophoceras austriacum* (Summesberger) "forme B" by Amédro and Hancock 1985 (p. 23, 25; figs 11 d, e. from the autoroute "L'Aquitaine" (Charentes, France). Collignon (1969, p. 204) established a lower Campanian Zone of *Anapachydiscus wittekindi* and *Eulophoceras jacobi* in Madagascar.

Suborder Ancyloceratina Wiedmann, 1966
Superfamily Turrilitoidea Gill, 1871
Family Nostoceratidae Hyatt, 1894
Genus *Jouaniceras* Basse, 1939

Type species: *Heteroceras* ? *sicardi* DE GROSSOUVRE, 1894, pl

37, fig. 6, 11), by original designation by Basse, 1939.

Jouaniceras hispanicum Wiedmann, 1994
Fig. 5/1-6, 8, 9, 11, 12; Tab. 4

1994 *Jouaniceras hispanicum* n. sp., Wiedmann, p. 232, pl. 43, fig. 1, 2; text-fig. 16 a.
1995 *Jouaniceras hispanicum*, Wiedmann; Kennedy in Kennedy et al., p. 429.
1998 *Jouaniceras hispanicum*, Wiedmann; Küchler, p. 223.

Type: The holotype by original designation of Wiedmann (1994, p. 232, pl. 43, fig. 2; text-fig.16 A) is GPIT 1755/1 from the middle Santonian of Puerto de Vitoria (Alava), paratype is IGD Ce0121 (Wiedmann, 1994, p. 232, pl. 43, fig. 1).
Material: SK/HO/1989/1a, b, c, d, e, f; SK/HO/1989/2a, b, c, d; NHMW 2017/0050/0001, 2.
Description: SK/HO/1989/2a is a slightly deformed internal mould with adherent shell fragments. Three inner whorls of the individual are coiled in a plane. The body chamber uncoils from the last quarter of the fourth whorl. The three inner whorls measure 25 mm (restored) in diameter. Including the uncoiled body chamber the diameter would be (restored) about 45 mm. Whorl height increases from 2 mm on the innermost whorl to 7 mm, and up to 8 mm close to the aperture. The very shallow umbilicus measures 3 mm in diameter. The whorl section is rounded, with a dorsal depression that housed the dorsum of the previous whorl (Wiedmann, 1994, fig. 16 A). Approximately 35 sharp and narrow ribs per whorl are straight, single and encircle the whorl. The interspaces are much wider than the ribs. Rib density increases markedly towards the aperture (Fig. 5/5). SK/HO/1989/1c (Fig. 5/12) is a crushed fragment. It also shows the uncoiled body chamber and the increase in rib density at the aperture. All specimens available have neither constrictions nor tubercles nor flared ribs. The sutures are not exposed. Uncoiling of the body chamber of *Jouaniceras hispanicum* Wiedmann, 1994 (pl. 43, fig. 2) can be observed in Fig. 5/5.

	D	Wh	Wb	U	U%
SK/HO/1989/1a$_{rest}$	28.7	5.9$_{intercos}$	5.1$_{intercos}$	--	--
SK/HO/1989/1b	28.3	6.8	--	3.3	11.6 %
SK/HO/1989/2a$_{rest}$	45	8.8	6	3.0	6.6 %
SK/HO/1989/2a	25	4.9	4.3	3.0	12%
SK/HO/1989/2b$_{rest}$	26.5	8.7	4.5	--	--
SK/HO/1989/2c	20.3	4.8	5.5	--	--
SK/HO/1989/2d$_{rest}$	21.0	6.5	6.5	3.3	15%

Table 4: Measurements of *Jouaniceras hispanicum* from the upper Santonian of the Hofergraben (Gosau, Upper Austria). Intercost. = intercostal

Discussion: *Jouaniceras sicardi* (de Grossouvre, 1894) differs from *J. hispanicum* in its helical early whorls (see Kennedy in Kennedy et al. 1995, pl. 28, fig. 2-7; Basse 1939, pl. 3, fig. 4- 6) which are perpendicular to the succeeding planispiral whorls. Grossouvre (1894) established *Heteroceras* (?) *Sicardi* already in a footnote (p. 224) contradicting his own assignment (p. 223) of "*Lytoceras Sicardi* n.sp." for reasons of an early developmental stage with different orientation of the whorls. Basse (1939, p. 43, pl. 3, fig. 3-7, p. 42, text-fig. 1) and Kennedy in Kennedy et al. (1995. p. 429, pl. 28, fig. 1-8) followed this argument and figured the early helical stage. A further difference is the lack of uncoiling of the body chamber in *J. sicardi*. The different ribbing of holotype and paratype of *Jouaniceras hispanicum* should be mentioned, the holotype (GPIT 1755/1; pl. 43, fig. 2) has narrow ribs (rib index 5) and distinct uncoiling, whereas the paratype IGD Ce 0121 (pl. 43, fig.1) has widely separated straight ribs (rib index 3). In both specimens of *J. hispanicum* figured and described by Wiedmann (1994) the early growth stage is not preserved.
Jouaniceras ? sp. described by Klinger et al. (2007) differs in its larger size and in its flared main ribs, with much finer secondary ribs between.
SK/HO/1989/1e and SK/HO/1989/1f are straight fragments of *Jouaniceras* sp. both with a slight curvature at the (?) adapical end. The section is round, in tab. 5 somewhat restored. They are possibly body chamber fragments.
Heteroceras (?) cfr. *Sicardi* de Grossouvre described from the Upper Cretaceous of Florence, Italy (Desio, 1920, p. 233, pl. 5, fig. 3.) was noted by Wiedmann (1994, p. 232) as "quite different to both species ('*sicardi*' and '*hispanicum*') and may represent a third one". Kennedy in Kennedy et al. (1995, p. 429) quoted *Heteroceras* (?) cfr. *Sicardi* de Grossouvre, Desio, 1920 with a question mark in the synonymy. Given its rapidly increasing whorl height (Desio, 1920, pl. 5, fig. 3) and accompanying Coniacian ammonites (e.g. *Peroniceras* sp.) it seems even questionable that the specimen is a *Jouaniceras*. ? *Jouaniceras* sp. described below differs in its straight shafts with an indication of a curved continuation.
Occurrence: The occurrence of *Jouaniceras hispanicum* Wiedmann, 1994 at the Hofergraben site is the only one so far in the Austrian Gosau Group. Fide Wiedmann (1994, p. 232) it occurs in Burgos, Alava and San Pantaleón and in Barranca (Spain) fide Küchler (1998, p. 223) and Kannenberg (1995, text-fig. 28B).

? *Jouaniceras* sp.
Fig. 5/7, 10; Tab. 5

Material: two specimens, SK/HO/1989/1e, SK/HO/1989/1f
Description: Both specimens are straight shafts (33 mm, 47.5 mm length) with a suggestion of a curved continuation. The whorl section is circular, the diameter is about 4.5 mm. SK/HO/1989/1f (fig. 5/7) has even, regular, oblique rursiradiate ribs that encircle the whorl. The ribs are narrow and sharp, the interspaces narrow. There are no flared ribs, bifurcations, nor tubercles. SK/ HO/1989/1e (fig. 5/10) is partially embedded in matrix. This specimen is curved at one of the ends (? adapertural). Ribbing is similar to, but somewhat wider spaced than in SK/HO/1989/1f.

Discussion: Co-occurrence and similar ribbing leads to the assumption that both specimens are related to *Jouaniceras*.

	L	Wh	Wb
SK/HO/1989/1e	47.5	5.8_{ador}	4.3_{ador}
SK/HO/1989/1e	--	3.7_{adap}	3.5_{adap}
SK/HO/1989/1f	33.0	5.0_{rest}	5.0_{rest}

Table 5: Measurements of questionable fragments of body chambers of ? *Jouaniceras* sp. from the upper Santonian of the Hofergraben (Gosau, Upper Austria). $_{adap}$ = adapical; $_{ador}$ = adoral; $_{rest}$ = restored; L= length.

Occurrence: The occurrence of ? *Jouaniceras* sp. at the Hofergraben site is the only record so far from the Austrian Gosau Group.

Genus *Eubostrychoceras* Matsumoto, 1967

Type species: *Eubostrychoceras indopacificum* Matsumoto, 1967, p. 33, pl. 18, fig. 1, by original designation.

Eubostrychoceras acuticostatum (d'Orbigny, 1842)
Fig. 6/8-11

1842 *Turrilites acuticostatus* d'Orbigny, p. 605; pl. 147, fig. 3, 4.
1955 *Turrilites (Bostrychoceras) acuticostatus* d'Orbigny, 1942; Sornay, Palaeontologia Universalis; Paris, nouvelle series, fiche n°6, 2 9. Paris.
1995 *Eubostrychoceras acuticostatum* (d'Orbigny, 1842); Kennedy in Kennedy et al., p. 428, pl. 28, fig, 9, 31, 32 (with synonymy).
2006 *Eubostrychoceras acuticostatum* (d'Orbigny, 1842); Sornay et al., p. 174, pl. 64, fig. 3.

Type: The holotype by monotypy is the original of d'Orbigny, 1842, pl. 147, fig. 3, 4, (d'Orbigny collection, N° 7210; LPMP -R 1193) recently refigured by Kennedy in Kennedy et. al. (1995, pl. 28, fig. 9) and by Sornay et al. (in: Gauthier, 2006, p. 174, pl. 64, fig. 3).
Material: SK/HO/1998/6 a, b, two fragments.
Description: SK/HO/1998/6 a, b are two fragments of internal moulds of a crushed loosely coiled spire possibly from the same individual. The whitish shell is partially preserved. The estimated diameter of the spire is about 36 mm, the umbilicus approximately 18 mm. The originally apparently circular diameter of the whorl must have been about 10 mm, now deformed by crushing. The surface is ornamented by about 45 S-shaped and sharp-crested ribs per whorl, separated by wider interspaces. The rib index is about 4. There are no constrictions, no flared ribs, no bifurcations and no tubercles. The sutures are not exposed.
Discussion: In our opinion *Eubostrychoceras acuticostatum* (d'Orbigny, 1842) is closely related to *Eubostrychoceras otsukai* (Yabe, 1904).
Occurrence: In Europe *Eubostrychoceras acuticostatum* (d'Orbigny, 1842) is a rare species occurring in the middle Santonian of the Corbières (France). It is recorded for the first time from the upper Santonian of the Gosau Group.

Family Diplomoceratidae Spath, 1926
Subfamily Diplomoceratinae Spath, 1926
Genus *Glyptoxoceras* Spath, 1925

Type species: Hamites rugatus Forbes, 1846, p. 117, pl. 11, fig. 6, by the original designation of Spath (1925, p. 30).

Glyptoxoceras crispatum (Moberg, 1885)
Fig. 6/1, 2, 3, 4

1885 *Anisoceras* (*Hamites* ?) *crispatum* Moberg, p. 32; pl. 3, figs 12, 13.
1979 ? *Diplomoceras* (Subgenus ?) *tenuisulcatum* (Forbes); Summesberger, p. 124, pl. 3, fig. 21.
1982 *Diplomoceras (Glyptoxoceras) indicum* (Forbes, 1846); Immel et al., p. 26; pl. 10, fig. 5, 6.
1982 *Diplomoceras (Glyptoxoceras) subcompressum* (Forbes, 1846); Immel et al., p. 26; pl. 10, fig. 7.
non 1982 *Diplomoceras (Glyptoxoceras) subcompressum* (Forbes, 1846); Immel et al., p. 26; pl. 9, figs 4, 5; pl. 11, fig. 4 (= ? *Neocrioceras maderi* Immel et al., 1982).
1987 *Diplomoceras (Glyptoxoceras) subcompressum* (Forbes, 1846); Immel, p. 136, partim.
1995 *Glyptoxoceras crispatum* (Moberg, 1885), Kennedy in: Kennedy et al., p. 430, pl. 27, figs 16, 24; pl. 29, figs 1, 8, 11, 19, 20 (with synonymy).
2000 *Glyptoxoceras* cf. *tenuisulcatum* (Forbes); Summesberger in Egger et al., p. 26.
2000 *Glyptoxoceras crispatum* (Moberg, 1885); Kennedy and Kaplan, p. 96; pl. 34, fig. 2.
2010 *Glyptoxoceras crispatum* (Moberg, 1885); Wagreich et al. p. 185.
2017b *Glyptoxoceras crispatum* (Moberg, 1885); Summesberger et al., pl. 1, figs 11, 12, 13.
2017c *Glyptoxoceras crispatum* (Moberg, 1885); Summesberger et al., pl. 12, figs 6-13.

Types: The lectotype, by the subsequent designation of Kennedy and Christensen (1997, p. 107), is no. 3877 in the collections of the Sveriges geologiska Untersökning, Uppsala, Sweden, the original of Moberg (1885, p. 32, pl. 3, figs 12-13). The paralectotype is no. 3876 in the same collection. Both are from the Santonian of Eriksdal, Sweden.
Material: 6 fragments: SK/HO /1989/3a, b, c, d; SK/HO/2004/17, 18.
Description: The general shape is demonstrated by SK SG/2002/33 (Summesberger et al., 2017c; pl. 12, fig. 13) from the Schattaugraben (Russbach, Salzburg): an initial wide criocone whorl, followed by a straight section and a terminal body chamber hook. SK/HO/1989/3a, b and SK/HO/2004/17 are fragments of the body chamber, SK/HO/1989/3c, d and SK/

HO/2004/18 are straight parts. The surface is ornamented by narrow, sharp, straight to rursiradiate ribs.

Discussion: *Glyptoxoceras crispatum* (Moberg, 1885) was discussed by Kennedy and Christensen (1991), Kennedy in Kennedy et al. (1995), Kennedy and Kaplan (2000), and Summesberger et al. (2017 b, c). The straight fragments from the Sandkalkbank Member were misidentified by Summesberger (1979, p. 124, pl. 3, fig. 21) as ? *Diplomoceras* (Subgenus ?) *tenuisulcatum* (Forbes).

Occurrence: *Glyptoxoceras crispatum* (Moberg, 1885) occurs in the lower and middle Santonian of the Corbières and Sweden, in the middle Santonian of the Münster Basin (Germany). In the Gosau Group it occurs in the lower Santonian (Brandenberg, Tyrol) and the lower to upper Santonian in the Gosau Group of Upper Austria and Salzburg.

Family Baculitidae Gill, 1871
Genus *Baculites* Lamarck, 1799

Type species: *Baculites vertebralis* Lamarck, 1801 by subsequent designation of Meek, 1876.

Baculites fuchsi Redtenbacher, 1873
Fig. 7/2, 3

1937 *Baculites* cf. *vertebralis* Lamarck; Brinkmann, 1937, p. 4.
1991 *Baculites* cf. *fuchsi* Redtenbacher, 1873; Kennedy and Christensen, p. 217
2017b *Baculites fuchsi* Redtenbacher, 1873, Summesberger et al., p. 121, pl. 10, figs. 1-15, text-fig. 6.
2017c *Baculites fuchsi* Redtenbacher, 1873, Summesberger et al., in press, pl. 15, fig. 4a-c.

Description: GBA 1935/001/0026 is a laterally flattened individual of 111 mm length and (exaggerated) 15 mm width. The asymmetrically U-shaped aperture is preserved.

Discussion: Brinkmann (1937, p. 4) was the first to describe the specimen GBA 1935/001/0026 from the Hofergraben. His identification "*Baculites* cf. *vertebralis* Lamarck" is limited to the Maastrichtian. In our opinion *Baculites fuchsi* Redtenbacher, 1873 is today the adequate interpretation. It differs from *Baculites incurvatus* DUJARDIN, 1837 and *Baculites brevicosta* SCHLÜTER, 1876 by its smooth surface without ornamentation.

Occurrence: *Baculites fuchsi* Redtenbacher, 1873 is common in the Santonian (Summesberger et al., 2017b, c). 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 Brandenberg specimen is from the 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. Unfortunately it cannot be localised exactly within the Hofergraben. It is also described under *Baculites* cf. *fuchsi* Redtenbacher, 1873 from the Coniacian/Santonian of Denmark (Kennedy and Christensen, 1991: 217) and Spain (Santamaria, 1991; Santamaria Zabala, 1992).

5. Conclusions

The sequence exposed in the Hofergraben belongs to the Hofergraben Member, which is very close stratigraphically to the Finstergrabenwandl (Sandkalkbank Member) and to the Bibereck Formation of the Schattau section (Summesberger et al., 2017c). The cephalopod fauna of the Hofergraben site differs in several aspects: The most conspicuous difference is the occurrence of *Jouaniceras hispanicum* Wiedmann 1979 in a remarkable sample (Fig. 6). Also present is *Eulophoceras jacobi* Hourcq, 1949, whereas *Diaziceras austriacum*, co-occurring in the neighbouring Finstergrabenwandl, is absent. Also of note is the absence of several other taxa, including Nautiloidea, and the ammonites *Hauericeras* and *Boehmoceras*.

Acknowledgements

We are deeply indebted to private collectors for access to their collections, and valuable information on the provenance of specimens: Kurt Skoumal (†,Vienna) and Elisabeth Skoumal (†,Vienna).

For cooperation and support in the field we thank Heinz A. Kollmann (NHMW), Michael Wagreich (GIUW), Andreas Kroh (NHMW) and Wolfgang Summesberger (Gablitz. Lower Austria). We thank Alice Schumacher (NHMW) for photography, and the staff of the NHMW, who assisted with technical work. The support of the staff on the Oxford University Museum of Natural History and the Department of Earth Sciences, Oxford, is gratefully acknowledged. Financial support was given by the International Geological Correlation Program (IGCP) and by the Friends of the Natural History Museum Vienna. Finally, we thank Andreas Kroh for his support preparing the manuscript. Herbert.C. Klinger (Capetown) is gratefully acknowledged for carefully reviewing the manuscript.

References

Amédro, F. and Hancock, J.M., 1985. Les Ammonites de l'Autoroute « L'Aquitaine ». France (Turonien et Santonien). Cretaceous Research, 6, 15–32.

Baily, W.H., 1855. Description of some Cretaceous fossils from South Africa. Quarterly Journal of the Geological Society London, 11, 454–465.

Basse, E. 1939. Sur quelques mollusques crétacés des Corbières meridionales. Bulletin de la Societé Géologique de France, 5, 9, 35-38.

Böhm, J., 1915. Vorlage von Inoceramen aus dem subhercynen Emscher und Untersenon. Zeitschrift der Deutschen Geologischen Gesellschaft, 67, 181–183.

Brinkmann, R., 1935. Die Ammoniten der Gosau und des Flysch in den nördlichen Ostalpen. Mitteilungen des Geologischen Staatsinstituts Hamburg, 15, 1–14.

Cobban, W.A., Hook, S.C. and Mc Kinney, K.C., 2008. Upper Cre-

taceous molluscan record along a transect from Virden, New Mexico, to Del Rio, Texas. New Mexico Geology, 30/3, 75–92.

Collignon, M., 1931. Faunes Sénoniennes du Nord et de l'Ouest de Madagascar. Annales géologiques du Service des Mines, Madagascar 1, 7–64.

Collignon, M., 1961. Ammonites néocrétacées du Menabe (Madagascar), VII. Les Desmoceratidae. Annales géologiques du Service des Mines, 31, 1–115.

Collignon, M., 1966. Atlas des fossiles caracteristiques de Madagascar (Ammonites) XIV, Santonien, 88 pp.

Collignon, M., 1969. Atlas des fossiles caracteristiques de Madagascar (Ammonites) XV, Campanien inférieur, 216 pp.

Collignon, M., 1983. Les faunes d'Ammonites du Santonien. In: Bilotte, M. and Collignon, M., 1983. Biostratigraphie et Paléontologie des ammonites du Sénonien inférieur de Rennes-les-Bains – Sougraigne (Aude) [Zone sous-pyrénéenne orientale]. Documents du Laboratoire Géologique, Faculté des Sciences, Université Claude Bernard, Lyon, H.S., 6, 175–223.

Desio, A. 1920. La Creta nel Bacino di Firenze. Paleontographica Italica, 26, 189-243.

Dhondt, A., 1984. Bivalves from the Hochmoos Formation (Gosau-Group), Oberösterreich, Austria. Annalen des Naturhistorischen Museums in Wien, Serie A, 88, 41–102.

Diener, C., 1925. Fossilium Catalogus (1: Animalia). Ammonoidea Neocretacea, 244 pp.

Felix, J., 1908. Studien über die Schichten der oberen Kreideformation in den Alpen und den Mediterrangebieten. Palaeontographica, 54/6, 251–339.

Forbes, E., 1846. Report on the fossil Invertebrata from Southern India, collected by Mr. Kaye and Mr. Cunliffe. Transactions and Proceedings of the Geological Society London, (2), 7, 97–147.

Gale, A.S., Hancock, J.M., Kennedy, W.J., Petrizzo, M.R., Lees, J.A. Walaszczyk, I. and Wray, D.D., 2008. An Integrated study (geochemistry, stable oxygen and carbon isotopes, nannofossils, planktonic foraminifera, inoceramid bivalves, ammonites and crinoids) of the Waxachachie Dam Spillway section, north Texas: a possible boundary stratotype for the base of the Campanian stage. Cretaceous Research, 29/1, 131–167.

Gallemi, J., Lopez, G., Martinez, R. and Pons, J.M., 2007. Macrofauna of the Cantera de Margas section, Olazagutia: Coniacian/Santonian boundary, Navarro-Cantabrian Basin, northern Spain. Cretaceous Research, 28, 5–17.

Gauthier, H. 2006. Révision Critique de la Paléontologie Française d'Alcide d'Orbigny, 6, Céphalopodes Crétacés. Backhuys, Leiden 292 + 662 + 28p.

Gerth, H. 1961. Neue Ammonitenfunde in den Gosauschichten der Gosau und ihre stratigraphische Bedeutung. Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen, 112/2, 119-142.

Gill, T. 1871. Arrangement of the families of mollusks. Smithsonian Miscellaneous Collections, 227, xvi + 49 pp.

Grossouvre, A. de, 1894. Recherches sur la Craie supérieure, 2. Partie, Paléontologie. Les ammonites de la craie supérieure. Mémoires du Service Carte géologique détaillée de La France, 264 pp.

Hampton, M.J., Bailey, H.W., Gallagher, L.T., Mortimore, R.N., and Wood, C.J., 2007. The biostratigraphy of Seaford Head, Sussex, southern England; an international reference section for the basal boundaries for the Santonian and Campanian Stages in chalk facies. Cretaceous Research, 28, 46–60.

Hancock, J.M. and Gale, A.S., 1996. The Campanian Stage. Proceedings 2. International Symposium on Cretaceous Stage Boundaries. Bulletin del'Institut Royal des Sciences Naturales de Belgique, Sciences de la Terre, 66/Supplement, 103–109.

Hauer, F. v. 1858. Über die Cephalopoden der Gosauschichten. Beiträge zur Palaeontographie von Österreich, 1, 7-14.

Henderson, R., 1970. Ammonoidea from the Mata Series (Santonian – Maastrichtian) of New Zealand. Palaeontology, Special Papers, 6, 1–81.

Herm, D., Kaufmann, E.G. and Wiedmann, J., 1979. The age and depositional environment of the "Gosau"-group (Coniacian -Santonian), Brandenberg, Tirol, Austria. Mitteilungen der Bayerischen Staatssammlung für Paläontologie und historische Geologie, 19, 27–92.

Hoepen, E.C.N. van, 1921. Cretaceous Cephalopoda from Pondoland. Annals of the Transvaal Museum, 8/1, 1–48.

Holzapfel, E., 1887–1888. Die Mollusken der Aachener Kreide. Cephalopoda und Glossophora. Palaeontographica, 34/1.

Hourcq, V. 1949. Paléontontologie de Madagascar, XXVIII. Sur quelques ammonites du Sénonien. Annales de Paléontologie 35:10 – 31.

Hyatt, A. 1903. Pseudoceratites of the Cretaceous, U.S. Geological Survey Monographs, 44, 351 pp.

Immel, H., 1987. Die Kreideammoniten der nördlichen Kalkalpen. Zitteliana, 15, 3–163.

Immel, H., Klinger, H.C. and Wiedmann, J., 1982. Die Cephalopoden des Unteren Santon der Gosau von Brandenberg/Tirol, Österreich. Zitteliana, 8, 3–32.

Jagt, J.W.M., 1989. Ammonites from the early Campanian Vaals Formation at the CPL quarry (Haccourt, Liège, Belgium) and their stratigraphic implications. Mededelingen van de Rijks Geologische Dienst, 43, 1–33.

Kannenberg, M. 1985. Stratigraphische Arbeiten in der Kreide der westlichen Barranca in Navarra/Nordspanien und statistische Untersuchungen der Echiniden-Gattung Micraster im Steinbruch Olazagutia (Coniac – Campoan). Unpublished Diplom Thesis. Freie Universität Berlin, 1-100.

Kaplan, U. and Kennedy, W.J., 2000. Santonian ammonite stratigraphy of the Münster basin, NW Germany. Acta Geologica Polonica, 50/1, 99–117.

Kaplan, U., Kennedy, W.J. and Ernst, G., 1996. Stratigraphie und Ammonitenfaunen des Campan im südöstlichen Münsterland. Geologie und Paläontologie in Westfalen, 43, 133 pp.

Kaplan, U., Kennedy, W.J. and Hiss, M., 2005. Stratigraphie und Ammonitenfaunen des Campan im nordwestlichen und zentralen Münsterland. Geologie und Paläontologie in Westfalen, 64, 171 pp.

Kaplan, U., Kennedy, W.J. and Scheer, U., 2006. Ammoniten der Bottrop Formation, Campanium, westliches Münsterland.

Geologie und Paläontologie in Westfalen, 67, 70 pp.

Kennedy, W.J, 1986. Campanian and Maastrichtian Ammonites from northern Aquitaine, France. Special Papers in Palaeontology, 36, 145 pp.

Kennedy, W.J., 1987. Ammonites from the type Santonian and adjacent parts of the northern Aquitaine, western France. Palaeontology, 30/4, 765–782.

Kennedy, W.J., 1995. Systematic Palaeontology. In: Kennedy, W.J., Bilotte, M. and Melchior, P. Ammonite faunas, biostratigraphy and sequence stratigraphy of the Coniacian-Santonian of the Corbières (NE Pyrénées). Bulletin des Centres du Recherche, Exploration –Production. Elf Aquitaine, 19/2, 377–499.

Kennedy, W.J. and Christensen, W.K., 1991. Coniacian and Santonian ammonites from Bornholm, Denmark. Bulletin Geological Society of Denmark, 38, 203–226.

Kennedy, W.J. and Christensen, W.K., 1993. Santonian ammonites from the Köpingsberg 1 borehole, Sweden. Bulletin Geological Society of Denmark, 40/1–2, Tove Birkelund Memorial Vol., 149–156.

Kennedy, W.J. and Christensen, W.K., 1997. Santonian to Maastrichtian ammonites from Scania, southern Sweden. Fossils and Strata, 44, 75–128.

Kennedy, W.J. and Cobban, W.A., 1991. Upper Cretaceous (upper Santonian) *Boehmoceras* fauna from the Gulf Coast region of the United States. Geological Magazine, 128, 167–189.

Kennedy, W.J. and Cobban, W.A, 1993. Lower Campanian (Upper Cretaceous) ammonites from the Merchantville Formation of New Jersey, Maryland and Delaware. Journal of Paleontology, 67/5, 828–849.

Kennedy, W.J., Cobban, W.A, Landman, N.H. and Johnson, O., 1997. New Ammonite Records from the Merchantville Formation (Upper Cretaceous) of Maryland and New Jersey. American Museum Novitates, 3193, 17 pp.

Kennedy, W.J., Hansotte, M., Bilotte, M. and Burnett, J., 1992. Ammonites and Nannofossils from the Campanian of Nalzen (Ariège, France). Geobios, 25/2, 263–278.

Kennedy, W.J. and Henderson, R.A. 1992.Non-heteromorph ammonites from the Upper Maastrichtian of Pondicherry, South India. Palaeontology, 35/2: 381-442.

Kennedy, W.J. and Jagt, J.W.M., 1995. Lower Campanian heteromorph ammonites from the Vaals Formation around Aachen, Germany, and adjacent parts of Belgium and The Netherlands. Neues Jahrbuch, Geologie und Paläontologie, Abhandlungen, 1995/3, 275–294.

Kennedy, W.J. and Kaplan, U., 1995. *Parapuzosia (Parapuzosia) seppenradensis* (Landois) und die Ammonitenfauna der Dülmener Schichten, unteres Unter-Campan, Westfalen. Geologie und Paläontologie in Westfalen, 33, 127 pp.

Kennedy, W.J. and Kaplan, U., 2000. Ammonitenfaunen des hohen Oberconiac und Santon in Westfalen. Geologie und Paläontologie in Westfalen, 57, 131 pp.

Kennedy, W.J. and Klinger, H.C., 2006. Cretaceous Faunas from Zululand and Natal, South Africa. The ammonite family Pachydiscidae Spath, 1922. African Natural History, 2, 17–166.

Kennedy, W.J. and Klinger, H. C., 2012a. Cretaceous Faunas from Zululand and Natal, South Africa. The Santonian-Campanian ammonite genus *Eulophoceras* Hyatt, 1903. African Natural History, 8, 30 – 39.

Kennedy, W.J. and Klinger, H. C., 2012b. The ammonite genus *Diaziceras* Spath, 1921, from the Campanian of KwaZulu-Natal, South Africa, and Madagascar. Palaeontologia Africana, 47, 3-13.

Kennedy, W.J., Klinger, H.C. and Summesberger, H. 1981. Cretaceous Faunas from Zululand and Natal, South Africa. Additional Observations on the Subfamily Texanitinae Collignon, 1948. Annals of the South African Museum, 86, 115-155.

Kennedy, W.J., Landman, N.H, and Cobban, W.A., 2001. Santonian ammonites from the Blossom Sand in northeast Texas. American Museum Novitates, 3332, 1–9.

Kennedy, W.J., Walaszczyk, I. and Klinger, H.C., 2008. *Cladoceramus* (Bivalvia, Inoceramidae) ammonite associations from the Santonian of KwaZulu-Natal, South Africa. Cretaceous Research, 29, 267–293.

Kennedy, W.J. and Wright, C.W., 1983. *Ammonites polyopsis* Dujardin, 1837 and the Cretaceous Ammonite family Placenticeratidae, Hyatt, 1900. Palaeontology, 26/4, 855–873.

Kilian, W. and Reboul, P., 1909. Les céphalopodes néocrétacés des iles Seymour and Snow Hill. Wissenschaftliche Ergebnisse der Schwedischen Südpolar Expedition, 3, 1–75.

Klinger, H.C., 1976. Cretaceous heteromorph ammonites from Zululand. Memoirs of the Geological Survey, Republic South Africa, 69, 1–142.

Klinger, H.C. and Kennedy, W.J., 2003. Cretaceous Faunas from Zululand and Natal, South Africa. The ammonite families Nostoceratidae Hyatt, 1894 and Diplomoceratidae Spath, 1926. Annals South African Museum, 110/6, 219–336.

Klinger, H.C., Kennedy, W.J. and Grulke, W.E., 2007. New and little-known Nostoceratidae and Diplomoceratidae (Cephalopoda: Ammonoidea) from Madagascar. African Natural History, 3, p. 89–115.

Kollmann, H. A., 1980. Gastropoden aus der Sandkalkbank (Hochmoosschichten, Obersanton) des Beckens von Gosau (O.Ö.). Annalen des Naturhistorischen Museums Wien, 83, 187–213.

Kollmann, H. A., in: Plöchinger, B., 1982. Geologische Spezialkarte der Republik Österreich 1:50.000, Blatt 95 (St. Wolfgang), part „Becken von Gosau".

Kollmann, H. A., in: Plöchinger, B., 1982. Erläuterungen zur Geologischen Spezialkarte der Republik Österreich, Blatt 95, Das Becken von Gosau, 30 –34.

Kollmann, H.A. and Summesberger, H., 1982. Excursions to Coniacian - Maastrichtian in the Austrian Alps. Working Group on the Coniacian - Maastrichtian Stages; 105 pp.

Kollmann, H.A., Summesberger, H. and Wagreich, M., 2000. Field trip C, Cretaceous of Eastern Austria; 6th International Cretaceous Symposium, Vienna, Austria. 56 pp.

Küchler, T. 1998.Upper Cretaceous of the Barranca (Navarra, northern Spain); integrated litho-, bio- and event stratigraphy. Part I: Cenomanian through Santonian. Acta Geologica

Polonica, 48/4,157–236.

Landois, H., 1895. Die Riesenammoniten von Seppenrade. Jahresberichte des Westfälischen Provinzvereins für Wissenschaft und Kunst, 23, 1–10.

Lewy, Z., 1983. A well-preserved heteromorph ammonite from Israel. Geological Survey of Israel, Current Research, 1982, 1983, 24–27.

Lommerzheim, A. J., 1995. Stratigraphie und Ammonitenfaunen des Santons und Campans im Münsterländer Becken (NW- Deutschland). Geologie und Paläontologie in Westfalen, 40, 97 pp.

Matura, A. and Summesberger, H., 1980. Geology of the Eastern Alps. Excursion Guide. 26. Congres Geologique Internationale. Abhandlungen der Geologischen Bundesanstalt Wien, 34, 103 – 170.

Meek, F. B. 1876. A report on the invertebvrate Cretaceous and Tertiary fossils of the Upper Missoury country. United States Geological Survey, Territories 9, 629 p.

Moberg, J.C., 1885, Cephalopoderna i Sveriges Kritsystem, II. Artbeskrifning. Sveriges. Geologiska Undersökning, Ser. C, Afhandlingar och uppsatser, 73, 3–64.

Morton, S.G., 1834. Synopsis of the Organic Remains of the Ferrugineous Sand Formation of the United States. Illustrated by nineteen plates, to which is added an appendix containing a tabular view of the Tertiary fossils discovered in America. 88 pp., Philadelphia: Key and Biddle.

Müller, G. and Wollemann, A., 1906. Die Molluskenfauna des Untersenon von Braunschweig und Ilsede. II. Die Cephalopoden. Abhandlungen Königlich Preussischer Geologischer Landesanstalt, 47, 1–30.

Ogg, J.G., and Hinnov, L.A., 2012. Cretaceous. In: Gradstein, F. M., Ogg, J.G., Schmitz, M.D., Ogg, G.M. (eds.). The Geological Time Scale, 2012. Amsterdam, Elsevier, pp. 793-853.

Okamoto, T. and Shibata, M., 1997. A cyclic mode of shell growth and its implications in a Late Cretaceous ammonite *Polyptychoceras pseudogaultinum* (Yokoyama). Palaeontological Research, 1/1, 29–46.

Petrascheck, W., 1906. Über Inoceramen aus der Gosau und dem Flysch der Nordalpen. Jahrbuch der kaiserlich-königlichen Geologischen Reichsanstalt, 56, 155–168.

Redtenbacher, A., 1873. Die Cephalopodenfauna der Gosauschichten in den nordöstlichen Alpen. Abhandlungen der kaiserlich-königlichen Geologischen Reichsanstalt, 5, 91–140.

Remin, Z., 2004. Biostratigraphy of the Santonian in the SW margin of the Holy Cross Mountains near Lipnik, a potential reference section for extra Carpathian Poland. Acta Geologica Polonica, 54/4, 587–596.

Remin, Z., 2010. Upper Coniacian, Santonian, and lowermost Campanian ammonites of the Lipnik-Kije Section, central Poland-taxonomy, stratigraphy, and palaeogeographic significance. Cretaceous Research, 31, 154–180.

Riedel, L., 1931. Zur Stratigraphie und Faciesbildung im Oberemscher und Untersenon am Südrande des Beckens von Münster. Jahrbuch der Preussischen Geologischen Landesanstalt, 51, 605–713.

Riegraf, W. and Scheer, U., 1991. Reproduction of the German edition, 1867–1876 of Cephalopoden der oberen deutschen Kreide by Schlüter, C. A. Goldschneck Verlag, Korb, Germany.

Roemer, F., 1852. Die Kreidebildungen von Texas und ihre organischen Einschlüsse. 100 pp., 11 pls., A. Marcus, Bonn.

Roemer, F.A., 1841. Die Versteinerungen des norddeutschen Kreidegebirgs. – iv + 145 pp., 16 pls., Hahn'sche Hofbuchandlung, Hannnover.

Santamaria, R., 1991. Ammonoideos del Cretacico Superior de la Plataforma Nord-Castellana y Parte de la Cuenca Navarro Cantabra, Paleontologia y Bioestratigrafia, 397 pp., 9 pls., Bellaterra.

Santamaria Zabala , R. 1992. Los Ammonoideos del Cenomaniense superior al Santoniense dela plataforma nord-castellana y la cuenca navarro-cántabra. Parte I: Bioestratigrafía y sistemática: Phylloceratina, Ammonitina (Desmoceratáceae y Hoplitaceae) y Ancyloceratina. Treballs del Museu de Geologia de Barcelona. Bellaterra.

Schlüter, C., 1871–1876. Cephalopoden der oberen deutschen Kreide. Palaeontographica, 21, 1–24, (1871); 21, 25–120 (1872); 24, 1–144 (121–264) + x, (1876).

Schönfeld, H.-J., 1985. Zur Lithologie, Biostratigraphie und Fossilführung des Ober-Santon Mergels von Westerwiehe (Ostwestfalen). Geologie und Paläontologie in Westfalen, 5, 7–50.

Seitz, O., 1961. Die Inoceramen des Santon von Nordwestdeutschland. I.Teil (Die Untergattungen *Platyceramus*, *Cladoceramus* und *Cordiceramus*. Geologisches Jahrbuch, Beihefte, 46, 186 pp.

Seitz, O., 1965. Die Inoceramen des Santon und Unter-Campan von Nordwestdeutschland. II.Teil (Biometrie, Dimorphismus und Stratigraphie der Untergattung *Sphenoceramus* J.Böhm). Geologisches Jahrbuch, Beihefte, 69, 194 pp.

Seitz, O., 1967. Die Inoceramen des Santon und Unter-Campan von Nordwestdeutschland. III Teil. Taxonomie und Stratigraphie der Untergattungen *Endocostea*, *Haenleinia*, *Platyceramus*, *Cladoceramus*, *Selenoceramus* und *Cordiceramus* mit besonderer Berücksichtigung des Parasitismus bei diesen Untergattungen. Geologisches Jahrbuch, Beihefte, 75, 171 pp.

Sornay, J. Kennedy, W. J. and Juignet, P. 2006. *Eubostrychoceras acuticostatum* (d'Orbigny, 1842), p. 174, pl. 64, Fig. 3a,b. In: Fischer , J.-C. 2006. Révision Critique de la Paléontologie Française d'Alcide d'Orbigny, 6: Gauthier, H. Céphalopodes Crétacés. Backhuys, Leiden 292 + 662 + 28p.

Spath, L. F., 1921. Cretaceous Cephalopoda from Zululand. Annals of the South African Museum, 12/7, 217–321.

Spath, L. F., 1953. The Upper Cretaceous cephalopod fauna of Graham Land. Falkland Islands Dependencies Survey, Scientifc Report, 3, 1–60.

Spötl, C., Vennemann, T., 2003. Continuous-flow isotope ratio mass spectrometric analysis of carbonate minerals. Rapid Communications in Mass Spectrometry, 17, 1004–1006.

Summesberger, H., 1979. Eine obersantone Ammonitenfauna aus dem Becken von Gosau (Oberösterreich). Annalen des

Naturhistorischen Museums in Wien, Serie A, 82, 109–176.

Summesberger, H., 1980. Neue Ammoniten aus der Sandkalkbank der Hochmoosschichten (Obersanton; Gosau, Österreich). Annalen des Naturhistorischen Museums Wien, Serie A, 83, 275–283.

Summesberger, H., 1985. Ammonite Zonation of the Gosau Group (Upper Cretaceous, Austria). Annalen des Naturhistorischen Museums in Wien, Serie A, 87, 145–166.

Summesberger, H., 2000. Stop. 2.5. Forest road into the Finstergraben N of the village Gosau. In: Egger, J., Kollmann, H. A., Sanders, D., Summesberger, H. and Wagreich, M., 2000., 6th International Cretaceous Symposium, Vienna, 2000. Field trip C: Cretaceous of Eastern Austria, 26, Vienna.

Summesberger, H., Kennedy, W. J., and Skoumal, P., 2017a. Early and middle Santonian Cephalopods from the Gosau Group (Upper Cretaceous, Austria) 1. Nautiloidea and non-Heteromorph Ammonoidea. Abhandlungen der Geologischen Bundesanstalt, 71, in press.

Summesberger, H., Kennedy, W. J., and Skoumal, p. 2017b. Early and middle Santonian Cephalopods from the Gosau Group (Upper Cretaceous, Austria) 2. Heteromorph Ammonoidea. Abhandlungen der Geologischen Bundesanstalt, 71, in press.

Summesberger, H., Kennedy, W.J., Wolfgring, E., Wagreich, M., Tröger, K.-A. and Skoumal, P., 2017c: Integrated stratigraphy of the Upper Santonian (Upper Cretaceous) Hochmoos and Bibereck Formations of the Schattaugraben section (Gosau Group; Northern Calcareous Alps, Austria). Abhandlungen der Geologischen Bundesanstalt, 71, in press, Wien.

Summesberger, H. and Zorn, I. 2012. A catalogue of the type specimens of Late Cretaceous Cephalopods housed in the Collections of the Geological Survey of Austria in Vienna. Abhandlungen der Geologischen Bundesanstalt, 152/1-4, 101-144.

Trenkwalder, M., 1999. Stratigraphie, Tektonik und Mikrofauna der Oberen Kreide südlich von Gosau. Unpublished Diplomarbeit, University of Innsbruck, 154 pp.

Tröger, K.-A. and Summesberger, H., 1994. Coniacian and Santonian inoceramid bivalves from the Gosau-Group (Cretaceous, Austria) and their biostratigraphic and palaeogeographic significance. Annalen des Naturhistorischen Museums in Wien, Serie A, 96, 161-197.

Wagreich, M., 1992. Correlation of Late Cretaceous calcareous nannofossil zones with ammonite zones and planktonic foraminifera: the Austrian Gosau sections. Cretaceous Research, 13, 505–516.

Wagreich, M., 2003. The Grabenbach Formation (Gosau Group, Santonian – Lower Campanian) in the Lattengebirge (Germany): lithostratigraphy, biostratigraphy and strontium isotope stratigraphy. In: Piller, W. E. (Ed.). Stratigraphia Austriaca. Österreichische Akademie der Wissenschaften, Schriftenreihe der Erdwissenschaftlichen Kommissionen, 16, 141–150.

Wagreich, M. and Decker, K., 2001. Sedimentary tectonics and subsidence modelling of the type Upper Cretaceous Gosau basin (Northern Calcareous Alps, Austria). International Journal of Earth Sciences (Geologische Rundschau), 90, 714–726.

Wagreich, M., Dinarès-Turell, J. and Wolfgring, E., 2015. A reference section for the Santonian-Campanian boundary: The Postalm section, Austria. EGU General Assembly 2015, Geophysical Research Abstracts, 17, EGU2015-8542.

Wagreich, M. and Neuhuber, S., 2005. Stratigraphy and geochemistry of an Early Campanian deepening succession (Bibereck Formation, Gosau Group, Austria). Earth Science Frontiers, 12, 123–131.

Wagreich, M., Summesberger, H. and Kroh. A., 2010. Late Santonian bioevents in the Schattau section, Gosau Group of Austria – implications for the Santonian-Campanian boundary stratigraphy. Cretaceous Research, 31, 181-191.

Walaszczyk, I. and Cobban, W. A., 2006. Inoceramid fauna and biostratigraphy of the middle Upper Coniacian and Santonian of the U.S.Western Interior. Acta Geologica Polonica, 56, 241–348.

Walaszczyk, I. and Cobban, W.A., 2007. Inoceramid fauna and biostratigraphy of the upper Middle Coniacian – lower Middle Santonian of the Pueblo Section (SE Colorado, US Western Interior). Cretaceous Research, 28, 132 – 142.

Walaszczyk, I., Kennedy, W. J., Dembicz, K., Gale, A.S., Praszkier, T., Rasoamiaramanana, A. and Randrianaly, H. 2014. Ammonite and inoceramid biostratigraphy and biogeography of the Cenomanian through basal Middle Campanian (Upper Cretaceous) of the Morondava Basin, western Madagascar. Journal of African Earth Sciences, 89, 79-132.

Wegner, T., 1905. Die Granulatenkreide des westlichen Münsterlandes. Zeitschrift der Deutschen Geologischen Gesellschaft, 57, 112–232.

Weigel, O., 1937. Stratigraphie und Tektonik des Beckens von Gosau. Jahrbuch der Geologischen Bundesanstalt, 87, 11–40.

Weiss, W., 1975. Mikropaläontologische Gliederung der Unteren Gosauschichten im N-Teil des Beckens von Gosau (Oberösterreich). Diplomarbeit Universität München, 73 pp.

Weiss, W., 1977. Korrelation küstennaher und küstenferner Faziesbereiche in den Unteren Gosauschichten (Oberkreide, Österreich). Neues Jahrbuch Geologie und Paläontologie, Monatshefte, 1977, 289–302.

Wiedmann, J., 1960b. Le Crétacé supérieur de l'Espagne et du Portugal et ses Céphalopodes. C.R 84e Congrès des Sociétés savantes (1959), Section scientifique, Colloque sur le Crétacé supérieur français, 709–764. Paris.

Wiedmann, J., 1978. Eine paläogeographisch interessante Ammonitenfaunula aus der alpinen Gosau. (Santon, Becken von Gosau, Oberösterreich). Eclogae geologicae Helvetiae, 71/3: 663 – 675.

Wiedmann, J., 1994. Systematic description of the age-defining ammonites. In: Gischler; E., Graefe, K.-W. and Wiedmann, J. The Upper Cretaceous "Lacazina" limestone in the Basco-Cantabrian and Iberian basins of northern Spain: cold water grain associations in warm water environments. Facies 30: 232-242.

Wiese, F., 2000. Coniacian (Upper Cretaceous) ammonites from the North Cantabrian Basin (Cantabria, northern Spain). Acta

Geologica Polonica, 50/1, 25–142.
Woods, H., 1906. The Cretaceous fauna of Pondoland. Annals of the South African Museum, 4/7, 275–350.
Wright, C.W., 1952. A classification of the Cretaceous ammonites. Journal of Paleontology, 26, 213–226.
Wright, C.W., 1957. Cretaceous Ammonoidea. In: Moore, R.C. (ed.), Treatise on Invertebrate Paleontology. Part L, Mollusca 4. xxii and 490 pp. New York and Lawrence.
Wright, C.W., Callomon, J.H. and Howarth, M.K., 1996. Cretaceous Ammonoidea. In: Kaesler, R.L. (ed.), Treatise on Invertebrate Paleontology. Part L, Mollusca 4, revised, vol. 4, xx and 362 pp. Boulder, Colorado and Lawrence, Kansas.
Wright, C.W. and Matsumoto, T., 1954. Some doubtful Cretaceous ammonite genera from Japan and Saghalin. Memoirs of the Faculty of Science, Kyushu University (ser. D., Geology), 4, 107–134.
Yabe, H., 1904. Cretaceous Cephalopoda from the Hokkaido. Part II. Turrilites, Helicoceras, Heteroceras, Nipponites, Olcostephanus, Desmoceras, Hauericeras, and an undetermined genus. Journal of the College of Science, Imperial University, Tokyo, 20/2, 1–45.
Yokoyama, M., 1890. Versteinerungen aus der japanischen Kreide. Palaeontographica, 36, 159–202.
Young, K., 1963. Upper Cretaceous Ammonites from the Gulf Coast of the United States. The University of Texas Publication Nr. 6304, 373 pp.
Zittel, K.A., 1865–1866. Die Bivalven der Gosaugebilde in den östlichen Alpen. Beitrag zur Charakteristik der Kreideformation in Österreich. Denkschriften der kaiserlichen Akademie der Wissenschaften, mathematisch – naturwissenschaftliche Classe, 24, 1–72; 25, 73–198.

Received: 07 April 2017
Accepted: 10 June 2017

Herbert SUMMESBERGER[1)*)], William J. KENNEDY[2)] & Peter SKOUMAL[3)]

[1)] Museum of Natural History Vienna, Burgring 7, 1010 Vienna, Austria;
[2)] Oxford University, Museum of Natural History, Oxford OX1 3PW, United Kingdom;
[3)] Bastiengasse 56, 1180 Vienna, Austria;
[*)] Corresponding author, herbert.summesberger@nhm-wien.ac.at

Figure 4: *Eulophoceras jacobi* Hourcq, 1949
Fig. 4/1, 4: SK/HO/2004/15
Fig. 4/2: SK/HO/2003/9
Fig. 4/3: SK/HO/2003/10
Fig. 4/5: SK/HO/2004/19
Fig. 4/6: SK/HO/2004/16
Fig. 4/7: SK/HO/2003/12
Fig. 4/8: SK/HO/2004/20
All are late Santonian. All are coated with ammonium chloride. All are from the Hofergraben site. Figs. 1, 4, 6, 7 are x 2, Figs. 2, 3, 54, 8 are x 1.

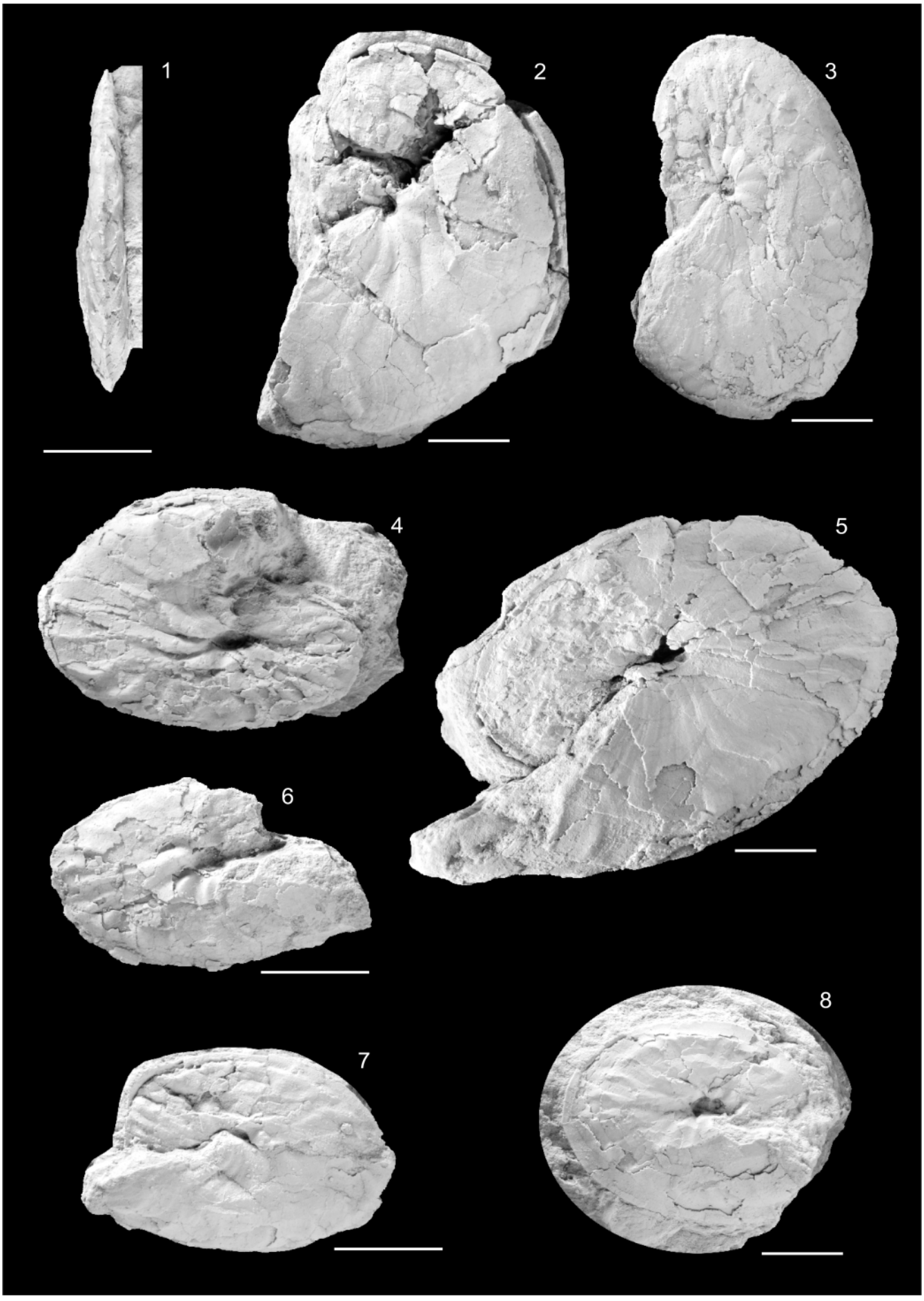

1
2
3
4
5
6
7
8

Figure 5:
Fig. 5/1: SK/HO/1989/2d
Fig. 5/2: SK/HO/1989/2c
Fig. 5/3: NHMW 2017/0050/0002
Fig. 5/4: ; NHMW 2017/0050/0001
Fig. 5/5: SK/HO/1989/2a
Fig. 5/6: SK/HO/1989/2b
Fig. 5/7: SK/HO/1989/1f
Fig. 5/8: SK/HO/1989/1d
Fig. 5/9: SK/HO/1989/1a
Fig. 5/10: SK/HO/1989/1e
Fig. 5/11: SK/HO/1989/1b
Fig. 5/12: SK/HO/1989/1c
All are *Jouaniceras*, 1-6, 8, 9, 11, 12, are *J. hispanicum* Wiedmann, 1994, 7, 10 are *Jouaniceras* sp. All are coated with ammonium chloride. All are from the Hofergraben site.1, 3, 4, 5, 6, 10, 11, 12 are x 1.5; 2, 7, 8, 9 are x 2.

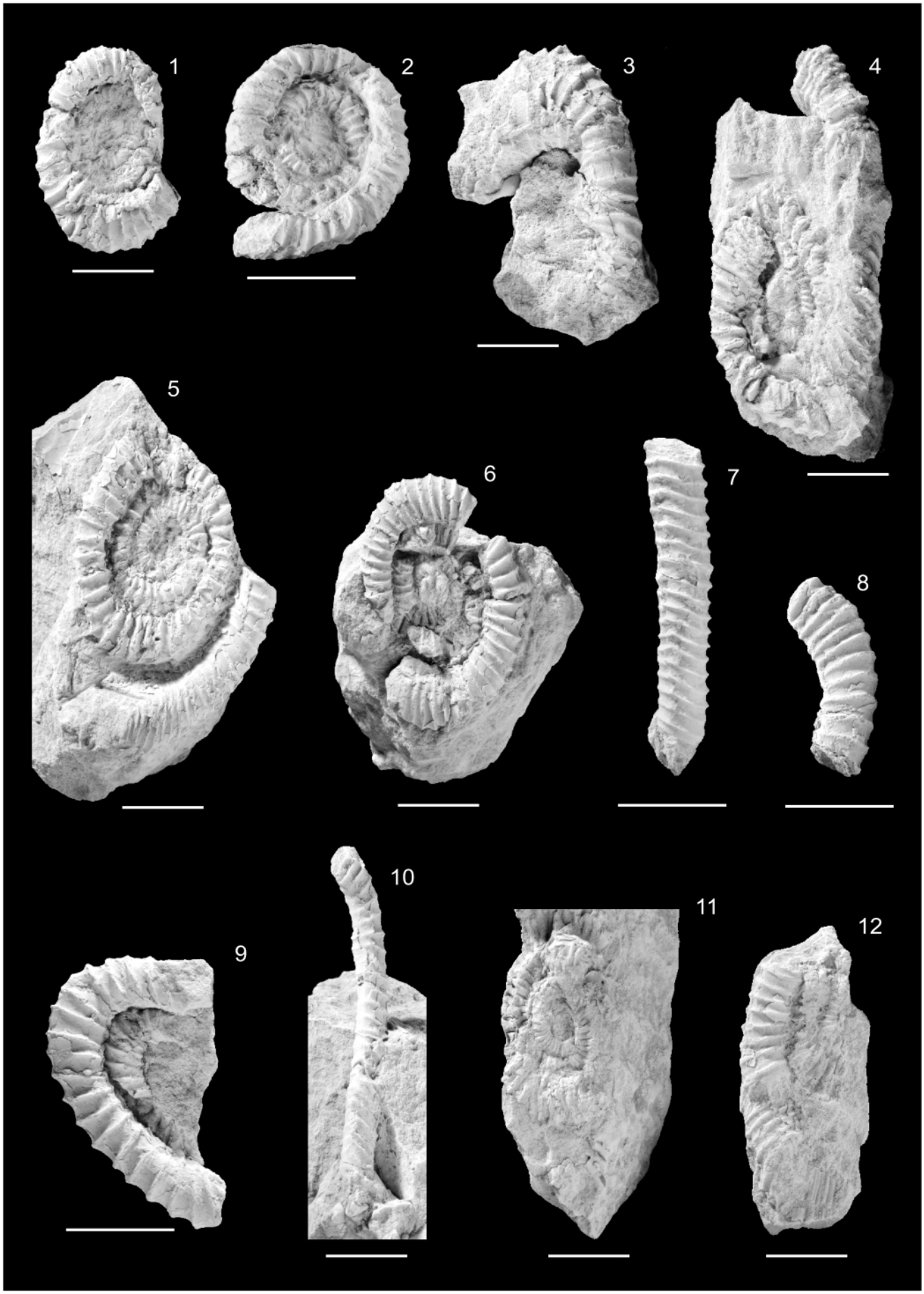

1
2
3
4
5
6
7
8
9
10
11
12

Figure 6:
Fig. 6/ 1, 2, 3, 4: *Glyptoxoceras crispatum* (Moberg, 1885),
Fig. 6/1: SK/HO/1989/3a
Fig. 6/2: SK/HO/1989/3d
Fig. 6/3: SK/HO/2004/17
Fig. 6/4: SK/HO/2004/18
Fig. 6/5: *Pachydiscus* sp., SK/HO/1996/8
Fig. 6/6, 7: *Placenticeras polyopsis* (Dujardin, 1837); SK/HO/1989/4
Fig. 6/8, 9, 10, 11: *Eubostrychoceras acuticostatum* (d'Orbigny)
Fig. 6/8, 9: SK/HO/1989/6a
Fig. 6/10, 11: SK/HO/1989/6b
All are coated with ammonium chloride. All are from the Hofergraben site. 1, 2, 3, 5, 8, 9, 10, 11 are x 2; 4, 6, 7, are x 1,5

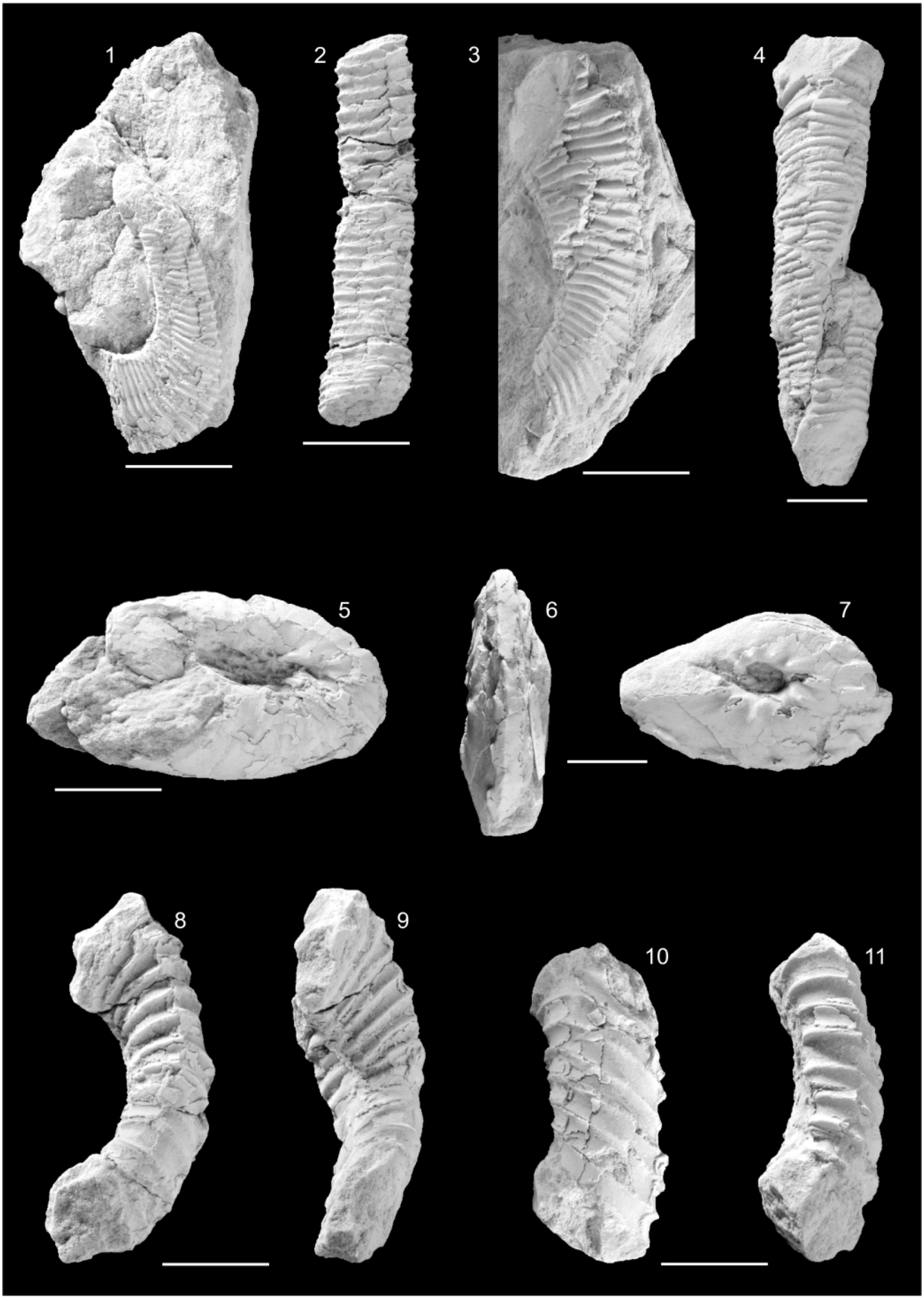
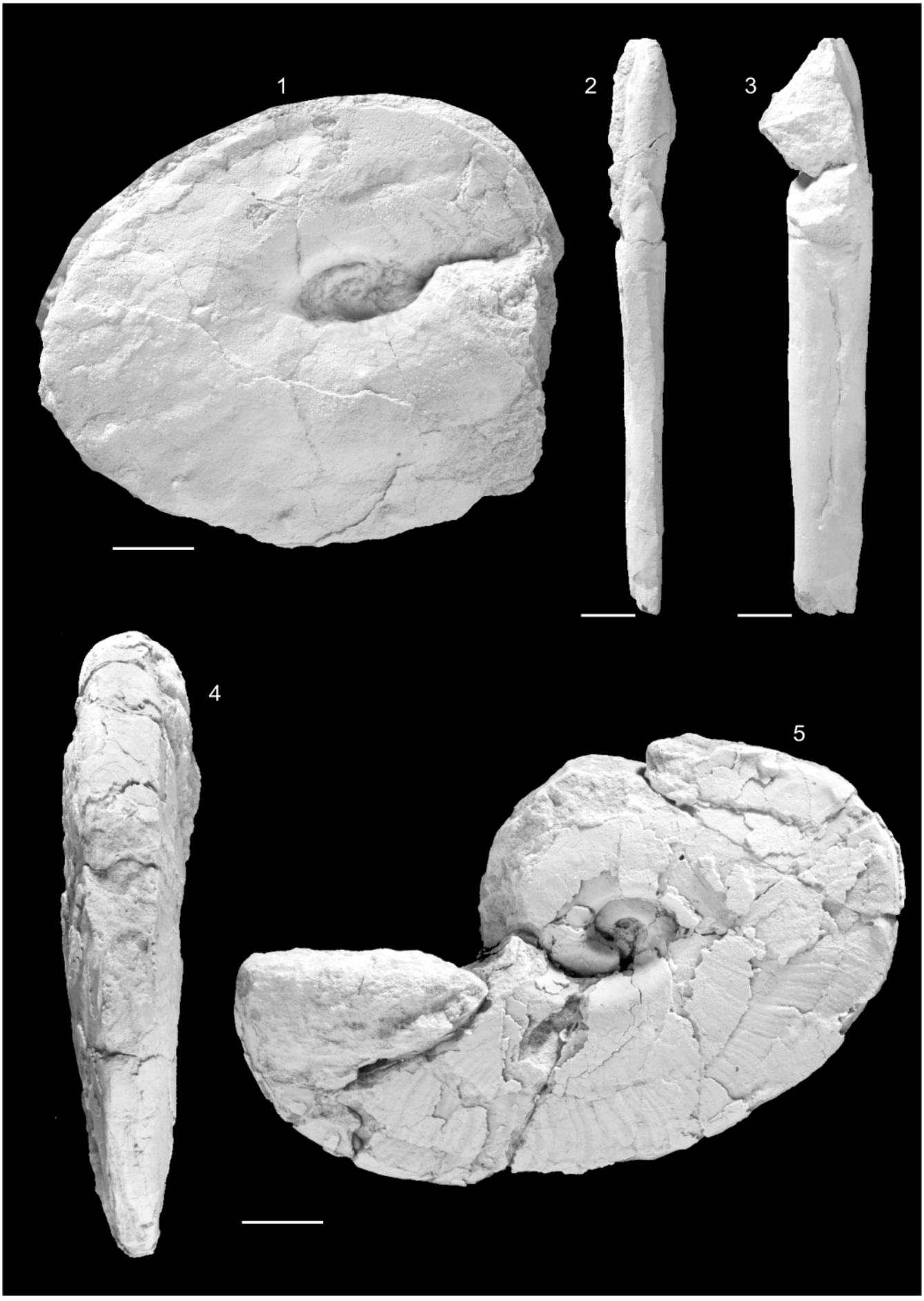

1
2
3
4
5
6
7
8
9
10
11

Figure 7:
Fig. 7/1: *Placenticeras paraplanum* Wiedmann, 1978; NHMW 1884 D 2522
Fig. 7/2, 3: *Baculites fuchsi* Redtenbacher 1873; GBA 1935/001/0026
Fig. 7/4, 5: *Placenticeras* aff. *maherndli* Summesberger, 1979; SK/HO/1995/7
All are coated with ammonium chloride. 1, 2, 3 are from a historic site in the Hofergraben. 4, 5 are from the same site in the Hofergraben as all the others on the preceding figures. 2,3 are x1; 1, 4, 5 are x 1.5.


1
2
3
4
5